JSPM's Bhivarabai Sawant Institute of Technology & Research, Wagholi, Pune (412207)

CRITERION 1 - CURRICULAR ASPECTS

1.3
Curriculum Enrichment

1.3.2

Number of courses that include experiential learning through project work/field work/internship during the year

DEPARTMENT OF COMPUTER ENGINEERING

Tablabs Technologies

Jamgaonkar, Prasad Chembers, Near Premdan Hotel, Savedi, Ahmednagar 414001

Subject: Confirmation of Project Work and Completion of Internship as Software Developer, with Reference to your letter regarding.

Respected Sir/Madam,

It is to bring your kind notice that **Mr. Vishal Balu Gaikwad** Student from **JSPM's Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune** has been completed **Internship** as a **Software Developer** for the period of **15th Dec 2023 to 15th Feb 2024.**

Tablabs Technologies is an **IT Company** has business-oriented company with the focus on emerging segment of technology entirely focus on user demands and compliance driven requirements. As a social responsibility we also provide skill training to pupil to build skillful nation.

During Training Period, we were found, he has successfully completed his live project within deadline in our esteemed organization

We found him hard working and sincere during the period of internship.

We wish all the best for his career.

B.S.Shah

For Tablabs Technologies

Head - IT Development

TABLABS TECHNOLOGIES AHMEDNAGAR

INTERNET OF THINGS
hIOTron

Internship Offer Letter

5 January 2024

Dear Nikhil,

We are pleased to offer you the position of Intern at Hiotron India Pvt. Ltd for the duration of 8 Jan 2024 to 8 Feb 2024. We were highly impressed with your qualifications and your performance during the interview, and we believe that your skills and enthusiasm will be a valuable addition to our team software development. During your temporary employment with Hiotron India Pvt. Ltd, you may have access to trade secrets and confidential or proprietary business information belonging to Hiotron India Pvt. Ltd . By accepting this offer, you acknowledge that this information must remain confidential and agree to refrain from using it for your own purposes or disclosing it to anyone outside Hiotron India Pvt. Ltd.

This position is scheduled for Monday to Saturday from 2:00 PM to 5:00 PM. This is the full and final extent of the internship offer. Any previous discussions about the position are null and void. If you wish to request any changes to this agreement, you may do so in writing for us to consider. Please direct any queries to the recruitment team.

Please report to Yogesh Takwale on your first day, and they will provide you with a detailed orientation about your responsibilities. We look forward to your contribution to and hope this internship will be a valuable experience for your career.

Regards,

HIOTRON INDIA PRIVATE LIMITED

HR Department
Hiotron India Pvt. Ltd.

CERTIFICATE
OF PROJECT COMPLETION

RAISE DIGITAL

THIS CERTIFICATE IS PROUDLY PRESENTED TO

Shreya Charandas Patil

has successfully undergone Industrial Program on Web Development Front-end
from Raise Digital from 01st Feb, 2024 to 31st Mar, 2024 and
successfully completed the projects on

- Creation of Single Page Website
- Bootstrap and HTML Calculator
- HTML To Do List

Under the guidance of the mentor and company representative

1

07-Apr-2024

DATE

1stop
Keep Growing

PROJECT HEAD

AvidLogic

Date: 14th January 2024

SUBJECT: INTERNSHIP COMPLETION LETTER

Our team is pleased to announce that **Diya Gandhi** has successfully completed her internship at **AvidLogic Solutions.**

Duration: 3 months
Dates: 13th October 2023 to 13th January 2024
Role: DevOps Engineer Intern

During her internship, she was exposed to the various activities in **AWS, CI/CD and Azur**

We found her **extremely inquisitive** and **hard working**. She was very much interested to learn the functions of our core division and also willing to put her best efforts and get into the depth of the subject to understand it better.

Her association with us was very fruitful and we wish her all the best in his future endeavors.

CEO
Asit Sonawane
AvidLogic Solutions

C.ID: 1ed3298

CodSoft

CERTIFICATE

OF COMPLETION

PROUDLY PRESENTED TO

Prasad Bhagwanappa Khotkar

has successfully completed 4 weeks of a virtual internship program in

Web Development

with wonderful remarks at **CODSOFT** from 20/12/2023 to 20/01/2024.

We were truly amazed by his/her showcased skills and invaluable contributions to the tasks and projects throughout the internship.

CERTIFIED ISO 9001-2015 COMPANY

MSME MICRO, SMALL & MEDIUM ENTERPRISES

Founder

contact@codsoft.in

www.codsoft.in

Date: 23/01/2024

C.ID: d2b26e3

CodSoft

CERTIFICATE

OF COMPLETION

PROUDLY PRESENTED TO

Anagha Venunath Thorat

has successfully completed 4 weeks of a virtual internship program in

Web Development

with wonderful remarks at **CODSOFT** from 05/01/2024 to 05/02/2024.

We were truly amazed by his/her showcased skills and invaluable contributions to the tasks and projects throughout the internship.

Founder

CERTIFIED ISO 9001-2015 COMPANY

MSME
MICRO, SMALL & MEDIUM ENTERPRISES
सूक्ष्म, लघु एवं मध्यम उद्यम

contact@codsoft.in

www.codsoft.in

Date: 08/02/2024

BHARAT INTERN

Completion Certificate

Proudly Presented to

ROHAN UMESH RANDHAVE

successfully completed the Virtual Internship Program at BHARAT INTERN in Full Stack Web Development as an active participant from January 10, 2024 to February 10, 2024.

MSME
MICRO, SMALL & MEDIUM ENTERPRISES
सूक्ष्म, लघु एवं मध्यम उद्यम

Verified by,
BHARAT INTERN

Internship Offer Letter

21st Jan 2024

Hodade Pratiksha Satish,
Wagholi, Pune

Dear Pratiksha,

We are pleased to offer you an internship opportunity in collaboration with our training partner, Dnyanyog Education Wagholi, at SGTEK SYSTEMS PRIVATE LIMITED as a "Java Development" Intern. Your exceptional academic background and enthusiasm for software development have caught our attention, and we are excited to have you join our team.

Internship Details:

Position: Java Development Intern
Duration: 25th Jan 2024 to 23rd Apr 2024, 10 AM to 5 PM (Weekdays)
Mode: Hybrid (Online + Co-located Workspace in Pune/Wagholi)

This internship aims to provide you with hands-on experience and expose you to real-world software development practices. You will have the opportunity to learn how our experienced teams work, contribute to ongoing projects from a learning point of view, and gain insights from seasoned professionals in the field.

At the end of your internship, you will receive a certificate of completion and a detailed assessment of your performance during the internship period.

Internships may get terminated at any given point of time if interns failed to follow the rules/agreements.

Internship Requirements:

Strong interest in Java development and software engineering.
Proficiency in Java programming language & frameworks such as Spring, Spring Boot, Hibernate
Willingness to learn Angular/ReactJS by own and complete the assignments

Should you have any questions or require further clarification, please feel free to reach out to our HR at hr@sgteksystems.com.

We are excited to welcome you to SGTEK SYSTEMS PRIVATE LIMITED and look forward to working with you to make the most of this internship opportunity.

Sincerely,

Sawan Zanwar
Recruitment Operations Manager
SGTEK SYSTEMS PRIVATE LIMITED
sawan@sgteksystems.com
+918275852885

SGTEK SYSTEMS PVT. LTD. BEED

CERTIFICATE

ISO 9001 2015 CERTIFIED

Corporate Identity Number :
U62013OD2023PTC044081

OCTANET SERVICES PVT LTD

TECH

OCTANET SERVICES PVT LTD.

This is certify that

Koli Mohanlal Govinda

Web Development Internship

Duration: 1 Month (1st January 2024 to 1st February 2024)

During the internship period, He/She has demonstrated exceptional dedication, enthusiasm and a strong willingness to learn. They actively engaged in various projects and tasks assigned to them, exhibiting remarkable skills and a high level of professionalism.

Verified By :

Chief Technology Officer
TECHOCTANET SERVICES PVT LTD

TECHOCTANET SERVICES PVT. LTD.

MINISTRY OF CORPORATE AFFAIRS
GOVERNMENT OF INDIA

IAF

AICTE

ISO 9001Certified

MSME

Verify at https://verification.givemycertificate.com/v/eedeb9b1-4b11-462c-8fa6-0522bf5a2e88

★★★

CERTIFICATE OF COMPLETION

Cognizee INFOBYTE

THIS CERTIFICATE IS PROUDLY PRESENTED TO

POORVA GUJARATHI

HAS SUCCESSFULLY COMPLETED ONE MONTH INTERNSHIP IN **DATA ANALYTICS**

ON APRIL 04,2024

TEAM COGNIZEE INFOBYTE

COGNIZEE INFOBYTE IT SEVICES

MSME

JSPM’s Bhivarabai Sawant Institute of Technology & Research, Wagholi, Pune (412207)

CRITERION 1 - CURRICULAR ASPECTS

1.3

Curriculum Enrichment

1.3.2

Number of courses that include experiential learning through project work/field work/internship during the year

DEPARTMENT OF INFORMATION TECHNOLOGY

Savitribai Phule Pune University, Pune Second Year Information Technology (2019 Course) **214458: Project Based Learning**		
Teaching Scheme:	**Credit Scheme:**	**Examination Scheme:**
Practical (PR): 04hrs/week	**02**	**TW : 50 Marks**

Home

Prerequisite Courses, if any:

Preamble:

Project Based Learning (PBL) is an instructional approach that emphasizes critical-thinking, collaboration and personalized learning. In PBL, student groups engage in meaningful inquiry that is of personal interest to them. These projects are based on problems, which are real-life oriented, curriculum-based and often interdisciplinary. Students decide how to approach a problem and what activities or processes they will perform. They collect information from a variety of sources, analyze, synthesize and derive understanding from it. The real-world focus of PBL activities is central to the process because it motivates students and adds value to their work. Their learning is connected to something real and involves life skills such as collaboration and reflection. The faculty assigned to the group is referred as mentor. Technology enables students and Mentor in various phases of the PBL process. At the end of the PBL, students demonstrate their newly acquired knowledge and are evaluated by how much they have learned and how well they communicate it. Students also conduct self-evaluation to assess their own growth and learning. Throughout this process, the mentor's role is to guide and advise students, rather than to direct and manage student work.

Companion Course: Online courses relevant to the project, along with expert lecture on Intellectual property rights, patents and software engineering.

Course Objectives :

1. To learn the various processes involved in project based learning.
2. To develop critical thinking and engineering problem solving skills amongst the students.
3. To explain the roles and responsibilities of IT engineers to the solution of engineering problems within the social, environmental and economic context.
4. To equip the students with knowledge and skills require to develop solutions for the problems coming from various Hackathon.

Course Outcomes

On completion of the course, student will be able to --

CO1: Design solution to real life problems and analyze its concerns through shared cognition.

CO2: Apply learning by doing approach in PBL to promote lifelong learning.

CO3: Tackle technical challenges for solving real world problems with team efforts.

CO4: Collaborate and engage in multi-disciplinary learning environments.

COURSE CONTENTS

Group Structure

Group structure should enable students to work in mentor–monitored groups. The students plan, manage and complete a task/project / activity which addresses the stated problem.

1. There should be a team of 3 to 6 students who will work cohesively.
2. A Mentor should be assigned to individual groups who will help them with learning and development process.

Selection of Project/Problem

1. The project scope/topic can be from any field/area, but selection related to IT technical aspect is desirous.
2. The project/problem done in first year engineering could be extended further, based on its potential and significance analysis.
3. Project/problem requiring solutions through conceptual model development and use of software tools should be preferred.
4. Different alternate approaches such as theoretical, practical, working model, demonstration or software analysis should be used in solving/implementing of project/problem.
5. The project/problem requiring multi-disciplinary approach to solve it, should be preferred.
6. Problem may require in depth study of specific practical, scientific or technical domain.
7. Hands-on activities, organizational and field visits, interacting with research institutes and expert consultation should be included in the approach to make students aware of latest technologies.

Assessment

The department should be committed to assess and evaluate both student performance and solution impact.

Progress of PBL will be monitored regularly on weekly basis. Weekly review of the work is necessary. During process of monitoring and continuous assessment and evaluation the individual and team performance is to be measured by mentor.

Students must maintain an institutional culture of authentic collaboration, self- motivation, peer-learning and personal responsiveness. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and students must actively participate in assessment and evaluation processes. Group may demonstrate their knowledge and skills by developing a public product and/or report and/or presentation.

1. Individual assessment for each student (Understanding individual capacity, role and involvement in the project).
2. Group assessment (roles defined, distribution of work, intra-team communication and togetherness.
3. Documentation and presentation.

Evaluation and Continuous Assessment

It is recommended that the all activities are to be recorded in PBL workbook, regular assessment of work to be done and proper documents are to be maintained at college end by both students as well as mentor.

The PBL workbook will reflect accountability, punctuality, technical writing ability and work flow of the task undertaken. Continuous Assessment Sheet (CAS) is to be maintained by all mentors/department.

Recommended parameters for assessment, evaluation and weightage:

1. Idea Inception (5%)
2. Outcomes of PBL/Problem Solving Skills/Solution provided/Final product**(40%)** (Individual assessment and team assessment)
3. Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents **(25 %)**
4. Potential for the patent**(10%)**
5. Demonstration (Presentation, User Interface, Usability etc.) **(10%)**
6. Contest Participation/ publication **(5%)**
7. Awareness /Consideration of Environment/ Social /Ethics/ Safety measures/Legal aspects **(5%).**

Design the rubrics based on the above parameters for evaluation of student performance

Faculty / Mentor is expected to perform following activities

Faculty/ Mentor is expected to perform following activities:

Revision of PBL concepts
Skill assessment of students
Formation of diversified and balanced groups
Share information about patent, copyright and publications to make students aware about it
Discussion of sample case studies
Design of the rubrics for evaluation of student performance
Discussion of the rubrics with students
Weekly Assessment of the deliverables such as Presentation, Report, Concept map, logbook
Scaffolding of the students
Summative and Formative assessment

Reference Books:

1. Project-Based Learning, Edutopia, March 14,2016.
2. What is PBL? Buck Institute forEducation.
3. www.schoology.com
4. www.wikipedia.org
5. www.howstuffworks.com

HOME

Savitribai Phule Pune University, Pune
Third Year Information Technology (2019 Course)
314455: Internship

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Theory (TH) : 4 hrs/week	04 Credit	Team work: 100 Marks

Prerequisite Courses: if Any

Course Objectives:

- To encourage and provide opportunities for students to get professional/personal experience through internships.
- To learn and apply the technical knowledge gained from academics /classroom learning in real life/industrial situations.
- To get familiar with various tools and technologies used in industries and their applications.
- To enable students to develop professional skills and expand their professional network with thedevelopment of employer-valued skills like teamwork, communication.
- To apply the experience gained from industrial internship to the academic course completion project.
- To nurture professional and societal ethics in students
- Understand the social, economic and administrative considerations that influence the working environment of industrial organizations

Course Outcomes:

On completion of the internship, learner will be able to –

CO1: To develop professional competence through industry internship.
CO2: To apply academic knowledge in a personal and professional environment
CO3: To build the professional network and expose students to future employees.
CO4: To Apply professional and societal ethics in their day to day life.
CO5: To become a responsible professional having social, economic and administrative considerations.
CO6: To make own career goals and personal aspirations.

Guidelines:

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices and culture. Internship is structured, short- term, supervised training often focused around particular tasks or projects with defined time scales.

Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

Engineering internships are intended to provide students with an opportunity to apply theoretical knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum.

Duration:

Internship to be completed after semester 5 and before commencement of semester 6 of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester 6.

Internship work Identification:

Student may choose to undergo Internship at Industry/Govt./NGO/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship. Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO's/Government organizations/Micro/Small/ Medium enterprises to makethemselves ready for the industry.

Contacting various companies for Internship and Internship work identification process should be initiated in the Vth semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their Vth semester examination.

Student can take internship work in the form of Online/onsite work from any of the following but not limited to:

- Working for consultancy/ research project,
- Participation at Events (Technical / Business)/in innovation related completions like Hackathon,
- Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute /
- Learning at Departmental Lab/Tinkering Lab/ Institutional workshop,
- Development of new product/ Business Plan/ registration of start-up,
- Participation in IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos,
- Industry / Government Organization Internship,
- Internship through Internshala,
- In-house product development, intercollegiate, inter department research internship under research lab/group, micro/small/medium enterprise/onle ineinternship,
- Research internship under professors, IISC, IIT's, Research organizations,
- NGOs or Social Internships, rural internship,
- Participate in open source development.

Internship Diary/ Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. The training diary/workbook should be signed after every day by the supervisor/ in charge of the section where the student has been working.

Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. Internship Diary/workbook may be evaluated on the basis of the following criteria:

- Proper and timely documented entries
- Adequacy & quality of information recorded
- Data recorded
- Thought process and recording techniques used
- Organization of the information

Internship Work Evaluation:

Every student is required to prepare a maintain documentary proofs of the activities done by him as internship diary or as workbook. The evaluation of these activities will be done by Programme Head/Cell In-charge/ Project Head/ faculty mentor /faculty or Industry Supervisor based on- Overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External – a supervisor from place of internship.

Recommended evaluation parameters-Post Internship Internal Evaluation -50 Marks +Internship Diary/Workbook and Internship Report - 50 Marks

Evaluation through Seminar Presentation/Viva-Voce at the Institute-

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

- Depth of knowledge and skills Communication & Presentation Skills
- Team Work
- Creativity
- Planning & Organizational skills
- Adaptability
- Analytical Skills
- Attitude & Behavior at work

- Societal Understanding
- Ethics
- Regularity and punctuality
- Attendance record
- Log book
- Student's Feedback from External Internship Supervisor

After completion of Internship, the student should prepare a comprehensive report to indicate what he/she has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/Faculty/TPO for assigning special topics and problems and should prepare the final report on the student's presence physically, if the student is found absent without prior intimation to the department/institute/concern authority/T & P Cell, entire training can be cancelled.

The report shall be presented covering following recommended fields but limited to,

- Title/Cover Page
- Internship completion certificate
- Internship Place Details- Company background-organization and activities/Scope and object of the study / personal observations
- Index/Table of Contents
- Introduction

  Title/Problem statement/objectives Motivation/Scope and rationale of the study Methodological details

  Results / Analysis /inferences and conclusion

  Suggestions / Recommendations for improvement to industry, if any Attendance Record

  Acknowledgement

  List of reference (Library books, magazines and other sources)

Feedback from internship supervisor(External and Internal)

Post internship, faculty/faculty coordinator should collect feedback about student with following recommended parameters-

Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Team work, Leadership.

Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414448: Project Stage I

Teaching Scheme:	Credit Scheme:	Examination Scheme:
Tutorial (TUT): 02 hrs/week	02 Credits	Term Work: 50 Marks

Prerequisite Courses, if any: PBL, Seminar, Basic Knowledge of Latest Technologies in IT.

Companion Course, if any: NOT APPLICABLE

Course Objectives:

1. To build up their practical experience with implementation and hence develops self-confidence.
2. To generate the opportunities to experience practically the facts learned in various fields together.
3. To improve overall communication skill, Teamwork and Leadership Qualities, professionalism.
4. To apply the knowledge for solving realistic problems.
5. To evaluate alternative approaches and justify the use of selected tools and methods.

Course Outcomes:

On completion of the course, students will be able to–

CO1. To apply knowledge of mathematics, science, and engineering to formulate the Problem statement.
CO2. To design and conduct experiments, as well as to analyze and interpret data.
CO3. Understand the professional and ethical responsibility.
CO4. To communicate effectively.
CO5. Get broad education which is necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
CO6. Recognition of the need for, and an ability to engage in life-long learning.
CO7. To use the techniques, skills, and modern engineering tools necessary for engineering practices.
CO8. To design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Introductory Information:

BE Project can be application oriented and/or will be based on some innovative work in recent technologies like IoT, Cloud Computing, Web Technologies, Bio-inspired Algorithms, Artificial Intelligence, Machine Learning, Natural Language Processing, Theoretical Computer Science fundamentals. In Project Phase-I the student will undertake project over the academic year, which will involve the analysis, design of a system or sub system in the area identified earlier in the field of Information Technology and Computer Science and Engineering. The project will be undertaken preferably by a group of 3-4 students who will jointly work and implement the project. The group will select a project based on their internship or Guide can suggest based on recent technologies / Industrial Applications.

Guidelines to Faculty and Students:

1) The Head of the department / Project coordinator shall constitute a review committee (preferably same committee needs to carry throughout the year) for project group; project guide would be one member of that committee by default.
2) For sponsored projects, an employee of the sponsoring organization may be one of the member of review committee.
3) There shall be **TWO** reviews in Project phase –I (in semester-I) by the review committee.
4) The Project Review committee will be responsible for evaluating the timely progress of the projects. It is suggested to evaluate the skills learned by the students in their PBL (in their previous years).
5) Student should identify project of enough complexity, which has at least 4-5 major functionalities.
6) Student should adopt skills learned in Software Engineering / Software Architecture to identify stakeholders, actors, Architectural Styles etc... and write detail problem statement for the system.
7) Review committee should finalize the scope of the project.
8) If change in project topic is unavoidable then the students should complete the process of Project approval by submitting synopsis along with the review of important papers which should be approved by review committee.
9) Every student of the project group shall make presentation on the progress made by them before the committee during each review. Each student/group is required to give presentation as part of review for 10 to 15 minutes followed by a detailed discussion and query session.
10) Students need to note down the queries raised during review(s) and comply the same in the next review session.
11) The record of the remarks/suggestions of the review committee (project dairy) should be properly maintained and should be made available at the time of university examination.
12) Project group needs to present / publish TWO papers (One in each semester, at least one paper should be in **UGC – Care journal**).
    a) Paper must be checked for Plagiarism by any open software.
    b) One paper during first semester which includes Literature Survey and Detailed design components of the Project Statement.
    c) One paper during second semester which includes Methodologies / Algorithms implemented, Results obtained, Analysis of results and conclusion.
13) Project report must also be checked for Plagiarism.
14) The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers, and report.

Review 1: Synopsis –

Points to be covered:

1) The precise problem statement/title based on literature survey and feasibility study.
2) Motivation, objectives, and scope of the project.
3) List of required hardware, software, or other equipment for executing the project, test Environment/tools, cost and software measurement/human efforts in hours.
4) System overview- proposed system and expected outcomes.
5) Architecture and initial phase of design (DFD).

Review 2: Requirement and Design Specification

Points to be covered:

1) User and System Requirements.
2) Functional and Non-functional Requirements.
3) SRS Document, Writing structures SRS as per Problem Statement.
4) Requirement Analysis / Models.
5) UML/ER Diagrams.
6) Detail architecture / System design/ Algorithms with analysis / Methods / Techniques.
7) Need to discuss Design models and Component level designs.
8) Detailed Design (DFD levels as per the problem statement).
9) At least 30-40% coding documentation with at least 3 to 4 working modules.
10) Identification of test to be essential and appropriate (to be implement later).
11) Project plan.

Evaluation Criteria:

Following criteria and weightage is suggested for evaluation of Project-Phase I Term Work.

1) Originality of Problem Statement: 10% (05 Marks)
2) Depth of Understanding the Problem Statement: 10% (05 Marks)
3) Concreate Literature Survey with identified gaps in all referred papers: 10% (05 Marks)
4) Design and Analysis of Algorithm / Model / Architecture / System: 40% (20 Marks)
5) Representation of results using suitable tools like tabulation, graph etc: 10% (05 Marks)
6) Presentation Skill: 10% (05 Marks)
7) Report preparation and Paper publication: 10% (05 Marks)

Project report contains the details as Follows:

Project report must have:

- **i.** Certificate from the institute
- **ii.** Certificate sponsoring organization (If any)
- **iii.** Acknowledgement
- **iv.** Abstract
- **v.** Contents
- **vi.** List of Abbreviations (As applicable)
- **vii.** List of Figures (As applicable)
- **viii.** List of Graphs (As applicable)
- **ix.** List of Tables (As applicable)

1. Introduction and aims/motivation and objectives.
2. Literature Survey (with proper citation).
3. Problem Statement/definition.
4. Software Requirement Specification (In SRS Documentation only).
5. Flowchart
6. Project Requirement specification.
7. Proposed system Architecture.
8. High level design of the project (DFD,UML, ER Diagrams).
9. System implementation-code documentation: Algorithm style, Description of detailed methodologies, protocols used etc..as applicable.
10. Test cases.
11. Proposed GUI/Working modules/Experimental Results (Module wise if available) in suitable format.
12. Project Plan.
13. Conclusions.
14. Bibliography in IEEE format.

Appendices:

- **A.** Plagiarism Report of Paper and Project report from any open-source tool.
- **B.** Base Paper(s) [If any].
- **C.** Tools used / Hardware Components specifications [If any].
- **D.** Published Papers and Certificates.

Use appropriate plagiarism tools, reference managers, Latex for efficient and effective project writing.

Reference Books:

1. UML2 Bible by Tom Pender, Wiley India Pvt. Limited 2011
2. Applying UML and Patterns Second Edition by Craig Larman, Pearson Education
3. UML 2 and the Unified Process, Second Edition, JIM Arlow, Ila Neustadt, Pearson
4. Design Patterns: Elements of Reusable Object-Oriented Software, Erich Gamma, Pearson
5. Design Patterns in Java Second Edition by Steven John Metsker, Pearson

All the assignments should be conducted on Latest version of Open-Source Operating Systems, tools and Multi-core CPU supporting Virtualization and Multi-Threading

<table>
<tr><td colspan="3" align="center">Savitribai Phule Pune University, Pune
Final Year Information Technology (2019 Course)
414456 : Project-II</td></tr>
<tr><td>Teaching Scheme:</td><td>Credit Scheme:</td><td>Examination Scheme:</td></tr>
<tr><td>Practical: 10 hrs/week</td><td>05 Credits</td><td>Term Work : 100 Marks
Oral : 50 Marks</td></tr>
<tr><td colspan="3">Prerequisite Courses, if any: Project Phase-I (B.E. (IT) Final Year Semester-I)</td></tr>
<tr><td colspan="3">Companion Course, if any: NA</td></tr>
</table>

Course Objectives:

1. To enable the student to extend further the investigative study taken up under Project stage-I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory / Industry.
2. To build up exposure of implementation and hence develops analysis of results by considering performance measures.
3. To expose students to product development environment using industrial experience, use of state of art technologies.
4. To encourage and expose students with funding agency for sponsored projects.
5. To generate the opportunities to experience practically the facts learned in various fields together.
6. To improve overall communication skill, Teamwork and Leadership Qualities, professionalism.
7. Evaluate the various validation and verification methods.
8. Analyzing professional issues, including ethical, legal and security issues, related to computing projects.
9. To evaluate alternative approaches, and justify the results obtained.

Course Outcomes:

On completion of the course, students will be able to–

1. To apply engineering and mathematical knowledge to investigate / select proper technology / Algorithm suitable to solve the problem in hand.
2. To apply knowledge of statistics for analysis of results and express conclusion and justification for the same.
3. To design and conduct experiments, as well as to analyze and interpret data or develop prototype model of the application.
4. To communicate effectively.
5. Get broad education which is necessary to understand the impact of engineering solutions in a global, economic, environmental, ethically and societal context.
6. Recognition of the need for, and an ability to engage in life-long learning.

Introductory Information:

BE Project Phase-II is the continuation of Project Phase-I for implementation, and analysis of results to arrive a valid conclusion with justification.

Guidelines to Faculty and Students:

1. Preferably same review committee needs to continue for Project Phase-II.
2. There shall be **TWO** reviews in Project phase –II (in semester-II) by the review committee.
3. The Project Review committee will be responsible for evaluating the timely progress of the projects. It is suggested to evaluate the skills learned by the students in their PBL (in their previous years).
4. Student needs to justify the Algorithm / Model used for implementation.
5. Every student of the project group shall make presentation on the progress made by them before the committee during each reviews. Each student/group is required to give presentation as part of review for 10 to 15 minutes followed by a detailed discussion and query session.
6. Students need to note down the queries raised during review(s) and comply the same in the next review session.
7. The record of the remarks/suggestions of the review committee (project dairy) should be properly maintained in continuation of Project Phase-II and should be made available at the time of university examination.
8. Project group needs to present / publish **TWO** papers (One in each semester, at least one paper should be in **UGC – Care journal**).
    a. Paper must be checked for Plagiarism by any open software.
    b. One paper during second semester which includes Methodologies / Algorithms implemented, Results obtained, Analysis of results and conclusion.
9. Project report must also be checked for Plagiarism.
10. The examinee will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on work undergone, content delivery, presentation skills, documentation, question-answers and report.

Review 3: Implementation –

Points to be covered:

1. Detailed study of Algorithm(s) / Model / Hardware specification (As applicable).
2. Confirmation of Data set used (As applicable)
3. Detailed ER Diagram / DFD diagrams.
4. Detailed UML Diagrams.
5. Sample results (module based).

Review 4: Testing and Result Analysis.

Points to be covered:

1. Appropriate test cases and results of test cases.
2. Representation of results with analysis.
3. Conclusion over performance parameters (as applicable)
4. Conclusion and future work suggested.
5. Knowledge of references utilized.

Evaluation Criteria:

Following criteria and weightage is suggested for evaluation of Project-Phase II Term Work.

1. Availability of standard Data set / Input parameters: 10%
2. Depth of Understanding of implemented Technology / Algorithm / Domain / Model: 40%
3. Test cases / Validation and Verification process: 10%
4. Justification of Algorithm / Model / Architecture / System: 10%
5. Analysis of results and conclusion: 10%
6. Presentation Skill: 10%
7. Report preparation and Paper publication: 10%

Project report contains the details as Follows:

It is suggested to have only one Project report which includes work carried at Project Phase-I as well. Project report must have:

i. Certificate from the institute.
ii. Certificate sponsoring organization (If any).
iii. Acknowledgement.
iv. Abstract.
v. Contents.
vi. List of Abbreviations (As applicable).
vii. List of Figures (As applicable).
viii. List of Graphs (As applicable).
ix. List of Tables (As applicable).

1) Introduction and aims/motivation and objectives.
2) Literature Survey (with proper citation).
3) Problem Statement/definition.
4) Software Requirement Specification (In SRS Documentation only).
5) Flowchart
6) Project Requirement specification.
7) Proposed system Architecture.
8) High level design of the project (DFD , UML , ER Diagrams).
9) System implementation-code documentation: Algorithm style, Description of detailed methodologies, protocols used etc..as applicable.
10) Test cases.
11) GUI/Working modules and Experimental Results in suitable format.
12) Project Plan.
13) Analysis and Conclusions with future work.
14) Bibliography in IEEE format.

Appendices

a) Plagiarism Report of Paper and Project report from any open source tool.
b) Base Paper(s) [If any].
c) Tools used / Hardware Components specifications [If any].
d) Published Papers and Certificates (Both Papers).

Use appropriate plagiarism tools, reference managers, Latex for efficient and effective project writing.

JAYAWANT SHIKSHAN PRASARAK MANDAL's

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Principal

Institute Accredited by National Assessment and Accreditation Council (NAAC), Bengaluru
National Board of Accreditation (NBA), New Delhi. Accredited Programs:
Information Technology, Electronics and Telecommunication Engineering, Electrical Engineering

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Academic Year – 2023-24

CRITERION 1 - CURRICULAR ASPECTS

1.3

Curriculum Enrichment

1.3.2

Number of courses that include experiential learning through project work/field work/internship during the year

Savitribai Phule Pune University, Pune
S.E. (Electronics / E&TC Engineering) 2019 Course
(With effect from Academic Year 2020-21)

Semester-III

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
207005	Engineering Mathematics III	04	-	01	30	70	25	-	-	125	04	-	01	05
204181	Electronic Circuits	03	-	-	30	70	-	-	-	100	03	-	-	03
204182	Digital Circuits	03	-	-	30	70	-	-	-	100	03	-	-	03
204183	Electrical Circuits	03	-	-	30	70	-	-	-	100	03	-	-	03
204184	Data structures	03	-	-	30	70	-	-	-	100	03	-	-	03
204185	Electronic Circuit Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
204186	Digital circuits Lab		02					50		50		01		01
204187	Electrical Circuit Lab	-	02	-	-	-	25	-	-	25	-	01	-	01
204188	Data Structures Lab	-	02	-	-	-	-	-	25	25	-	01	-	01
204189	Electronic Skill Development	-	02	-	-	-	25	-	-	25	-	01	-	01
204190	Mandatory Audit Course 3 [&]	-	-	-					-	-	-	-	-	-
Total		**16**	**10**	**01**	**150**	**350**	**75**	**100**	**25**	**700**	**16**	**05**	**01**	**22**

Savitribai Phule Pune University, Pune
S.E. (Electronics / E&TC Engineering) 2019 Course
(With effect from Academic Year 2020-21)

Semester-IV

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
204191	Signals & Systems	03	-	01	30	70	25	-	-	125	03	-	01	04
204192	Control Systems	03	-		30	70		-	-	100	03	-	-	03
204193	Principles of Communication Systems	03	-	-	30	70	-	-	-	100	03	-	-	03
204194	Object Oriented Programming	03	-	-	30	70	-	-	-	100	03	-	-	03
204195	Signals & Control System Lab		02				50			50		01		01
204196	Principle of Communication Systems Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
204197	Object Oriented Programming Lab	-	02	-	-	-	-	-	50	50	-	01	-	01
204198	Data Analytics Lab		02				-		25	25		01		01
204199	Employability Skill Development	02	02	-	-	-	50	-	-	50	02	01	-	03
204200	Project Based Learning $^{\eta}$	-	04				50		-	50		02		02
204201	Mandatory Audit Course 4$^{\&}$	-	-	-	-	-	-	-	-	-	-	-	-	-
Total		**14**	**14**	**01**	**120**	**280**	**175**	**50**	**75**	**700**	**14**	**07**	**01**	**22**

Abbreviations:

In-Sem: In semester | End-sem: End semester | TH : Theory | TW : Term Work
PR : Practical | OR : Oral | TUT : Tutorial

Note: Interested students of S.E. (Electronics/E&TC) can opt any one of the audit course from the list of audit courses prescribed by BoS (Electronics & Telecommunications Engineering)

Savitribai Phule Pune University Second Year of Electronics / E & Tc Engineering (2019 Course) 204200: Project Based Learning		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 04 hrs. / week	**02**	**Term Work: 50 Marks**

Preamble:

The main stream engineering education follows traditional classroom teaching, in which the major focus is mainly on the lecturer and the student has very little (if any) choice on the learning process. However rapid development in engineering and technology requires adopting a teaching approach that would assist students not only in developing a core set of industry relevant skills, but also enable them to adapt to changes in their professional career.

PBL is an approach to design Electronic Systems Curricula for making electronics more appealing to students. Since electronics is an important grounding for other disciplines (computer science, signal processing, and communications), this approach proposes the development of multidisciplinary projects using the PBL strategy for increasing the attractiveness of the curriculum. Promoting electronics as grounding for other disciplines can be done by defining a new curriculum that includes practical courses (laboratories) in which the students develop whole systems involving multidisciplinary knowledge.

Course Objectives: On completion of the course, learner will be able to -

- To emphasize project based learning activities that are long-term, interdisciplinary and student-centric.
- To inculcate independent and group learning by solving real world problem with the help of available resources.
- To be able to develop application based on the fundamentals of electronics and communication engineering by possibly the integration of previously acquired knowledge.
- To get practical experience in all steps in the life cycle of the development of electronic systems: specification, design, implementation, and testing.
- To be able to select and utilize appropriate hardware and software tools to design and analyze the proposed system.
- To provide every student the opportunity to get involved either individually or as a group so as to develop team skills and learn professionalism.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Identify the real-world problem (possibly of interdisciplinary nature) through a rigorous literature survey and formulate / set relevant aim and objectives.

CO2: Contribute to society through proposed solution by strictly following professional ethics and safety measures.

CO3: Propose a suitable solution based on the fundamentals of electronics and communication engineering by possibly the integration of previously acquired knowledge.

CO4: Analyze the results and arrive at valid conclusion.

CO5: Use of technology in proposed work and demonstrate learning in oral and written form.

CO6: Develop ability to work as an individual and as a team member.

Group Structure:

Working in supervisor/mentor –monitored groups. The students plan, manage and complete a task/project/activity which addresses the stated problem.

1. Create groups of 5 (five) to 6 (six) students in each class

Project Selection:

Survey through journals, patents or field visit (A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific), check the physibility of solution, analyze the problem, design and find the values of components.

There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content and structure of the activity.

The problem-based project oriented model for learning is recommended. The model begins with the identifying of a problem, often growing out of a question or “wondering”. This formulated problem then stands as the starting point for learning. A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students’ wondering within different disciplines and professional environments. As stated in the preamble as electronics is an important grounding for other disciplines (computer science, signal processing, and communications), the project topic can be Interdisciplinary in nature. However the chosen problem must involve the application of electronics and communication engineering fundamentals. Out of the total developed system setup, the project must involve minimum 40% electronic components. Although in a genuine case 100% software based project topic may be allowed.

Ethical Practices, team work and project management:

Use IEEE standards for project manufacturing, respect the time of others, attend the reviews, poster presentation and model exhibitions, strictly follow the deadline of project completion, comply with all legislation requirements that govern workplace health and safety practices.

Effective Documentation:

In order to make our engineering graduates capable to prepare effective documentation, it is required for the students to learn the effective writing skills. The PBL final report is expected to consist of the Literature Survey, Problem Statement, Aim and Objectives, System Block Diagram, System Implementation Details, Discussion and Analysis of Results, Conclusion, System Limitations and Future Scope. Many freely available software tools (for instance Medley (Elsevier), Grammerly) are expected to be used during the preparation of PBL synopsis and final report. It is expected that the PBL guides/mentors shall teach students about utilizing valid sources of information (such as reference papers, books, magazines, etc) related to their PBL topic.

Evaluation & Continuous Assessment:

The institution/head/mentor is committed to assessing and evaluating both student performance and program effectiveness. Progress of PBL is monitored regularly on weekly basis. Weekly review of the work is necessary. During process of monitoring and continuous assessment and evaluation the individual and team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor /mentor and authorities. Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and Students must actively participate in assessment and evaluation processes.

It is recommended that the all activities are required to be recorded and regularly. A regular assessment of PBL work is required to be maintained at the department in PBL log book by students. It is expected that the PBL log book must include following:

1. Weekly monitoring by the PBL guide,
2. Assessment sheet for PBL work review by PBL guide and PBL Evaluation Committee (PEC).

The PEC structure shall consist of Head of the department, 1/2 senior faculties of the department and one industry expert (optional). Continuous Assessment Sheet (CAS) is to be maintained by the department.

Recommended parameters for assessment, evaluation and weightage:

1. Idea Inception (kind of survey). (10%)
2. Outcome (Participation/ publication, copyright, patent, product in market). (50%)
3. Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents). (15%)
4. Attended reviews, poster presentation and model exhibition. (10%)
5. Demonstration (Poster Presentation, Model Exhibition etc). (10%).
6. Awareness /Consideration of - Environment/ Social /Ethics/ Safety measures/Legal aspects. (5%)

Learning Resources

Reference Books / Research Articles:

1. John Larmer, John R. Mergendoller, and Suzie Boss, "Setting the Standard for Project Based Learning".

2. John Larmer and Suzie Boss, "Project Based Teaching: How to Create Rigorous and Engaging Learning Experiences".

3. Erin M. Murphy and Ross Cooper, "Hacking Project Based Learning: 10 Easy Steps to PBL and Inquiry". M. Krašna, "Project based learning (PBL) in the teachers' education,"39th International Convention on Information and Communication Technology, Electronics and Microelectronics (MIPRO), Opatija, 2016, pp. 852-856, doi: 10.1109/MIPRO.2016.7522258.

4. J. Macias- Guarasa, J.M. Montero, R. San-Segundo, A. Araujo and O. Nieto-Taladriz, "A project based learning approach to design electronic systems curricula", IEEE transactions on Education, vol.49, no. 3, pp. 389-397, Aug. 2006, doi: 10.1109/TE.2006.879784

Web resources:

- Project-Based Learning, Edutopia, March 14, 2016.
- What is PBL? Buck Institute for Education.
- www.howstuffworks.com
- www.wikipedia.org

Savitribai Phule Pune University, Pune
T.E. (Electronics& Telecommunication Engineering) 2019 Course
(With effect from Academic Year 2021-22)

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Semester-V												
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
304181	Digital Communication	03	-	-	30	70	-	-	-	100	03	-	-	03
304182	Electromagnetic Field Theory	03	-	01	30	70	25	-	-	125	03	-	01	04
304183	Database Management	03	-	-	30	70	-	-	-	100	03	-	-	03
304184	Microcontrollers	03	-	-	30	70	-	-	-	100	03	-	-	03
304185	Elective - I	03	-	-	30	70	-	-	-	100	03	-	-	03
304186	Digital Communication Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
304187	Database Management Lab	-	02	-	-	-	-	-	25	25	-	01	-	01
304188	Microcontroller Lab	-	02	-	-	-	-	50	-	50	-	01	-	01
304189	Elective I Lab	-	02	-	-	-	-	25	-	25	-	01	-	01
304190	Skill Development	-	02	-	-	-	25	-	-	25	-	01	-	01
304191A	Mandatory Audit Course 5 &	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**10**	**01**	**150**	**350**	**50**	**125**	**25**	**700**	**-**		**-**	**-**
								Total Credit			**15**	**05**	**01**	**21**

Elective -I

1) Digital Signal Processing
2) Electronic Measurements
3) Fundamentals of JAVA Programming
4) Computer Networks

Savitribai Phule Pune University, Pune
T.E. (Electronics& Telecommunication Engineering) 2019 Course
(With effect from Academic Year 2021-22)

Semester-VI

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
304192	Cellular Networks	03	-	-	30	70	-	-	-	100	03	-	-	03
304193	Project Management	03	-	-	30	70	-	-	-	100	03	-	-	03
304194	Power Devices & Circuits	03	-	-	30	70	-	-	-	100	03	-	-	03
304195	Elective-II	03	-	-	30	70	-	-	-	100	03	-	-	03
304196	Cellular Networks Lab	-	02	-	-	-	-	-	50	50	-	01	-	01
304197	Power Devices & Circuits Lab	-	02	-	-	-	-	50	-	50		01		01
304198	Elective-II Lab	-	02	-	-	-	-	25	-	25	-	01	-	01
304199	Internship**	-	-	-	-	-	100	-	-	100	-	-	04	04
304200	Mini Project	-	04	-	-	-	25	-	50	75	-	02	-	02
304191 B	Mandatory Audit Course 6 [&]	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**12**	**10**	**00**	**120**	**280**	**125**	**75**	**100**	**700**				
							Total Credit				**12**	**05**	**04**	**21**

Abbreviations:

In-Sem: In semester End-Sem: End semester TH: Theory TW : Term Work

PR: Practical OR: Oral TUT: Tutorial

Note: Students of T.E. (Electronics & Telecommunications) have to opt any one of the audit course from the list of audit courses prescribed by BoS (Electronics & Telecommunications Engineering)

Elective -II

1) Digital Image Processing
2) Sensors in Automation
3) Advanced JAVA Programming
4) Embedded Processors
5) Network Security

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304199: Internship		
Teaching Scheme:	**Credit**	**Examination Scheme:**
**	04	**Term Work: 100 Marks**

Course Objective:

- Will expose technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
- Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
- Exposure to the current technological developments relevant to the subject area of training.
- Experience gained from the **'Internship'** will be used in classroom discussions.
- Create conditions conducive to quest for knowledge and its applicability on the job.
- Learn to apply the Technical knowledge in real industrial situations.
- Gain experience in writing Technical reports/projects.
- Expose students to the engineer's responsibilities and ethics.
- Familiarize with various materials, processes, products and their applications along with relevant aspects of quality control.
- Promote academic, professional and/or personal development.
- Expose the students to future employers.
- Understand the social, economic and administrative considerations that influence the working environment of industrial organizations.
- Understand the psychology of the workers and their habits, attitudes and approach to problem solving.

Course Outcomes: On completion of the internship, learner will be able to –

CO1: To develop professional competence through internship.

CO2: To apply academic knowledge in a personal and professional environment.

CO3: To build the professional network and expose students to future employees.

CO4: Apply professional and societal ethics in their day to day life.

CO5: To become a responsible professional having social, economic and administrative considerations.

CO6: To make own career goals and personal aspirations.

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices and culture. Internship is structured, short-term, supervised training often focused around particular tasks or projects with defined time scales.

Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

Engineering internships are intended to provide students with an opportunity to apply theoretical knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum.

A. Duration:

Internship to be completed after semester 5 and before commencement of semester 6 of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester 6.

B. Framework of Internship:

- ✓ Students are required to be involved in Inter/ Intra Institutional Activities viz; Training with higher Institutions.
- ✓ Soft skill training organized by Training and Placement Cell of the respective institutions; contribution at incubation/ innovation /entrepreneurship cell of the institute; participation in conferences/ workshops/ competitions etc.
- ✓ Learning at Departmental Lab/ Tinkering Lab/ Institutional workshop.
- ✓ During the vacation after 5^{th} semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship / Innovation / Entrepreneurship related activities.
- ✓ Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry.
- ✓ Every student is required to prepare a file containing documentary proofs of the activities done by him. The evaluation of these activities will be done by Programmed Head / Cell In-charge / Project Head / TPO / faculty mentor or Industry Supervisor.

C. Internship Guidelines:

a) Guidelines to the Institute:

Department will arrange internship for students in industries / organization after fifth semester or as per AICTE/ affiliating University guidelines & managing internships. The general procedure for arranging internship is given below:

Step 1: Request Letter/ Email should go to industry to allot various slots of 4-6 weeks as internship periods for the students. Students request letter /profile / interest areas may be submitted to industries for their willingness for providing the training.

Step 2: Industry will confirm the training slots and the number of seats allocated for internships via Confirmation Letter/ Email. In case the students arrange the training themselves the confirmation letter will be submitted by the students.

Step 3: Students on joining Training at the concerned Industry / Organization, submit the Joining Report/ Letters / Email.

Step 4: Students undergo industrial training at the concerned Industry / Organization. In-between Faculty Member(s) evaluate(s) the performance of students once/twice by visiting the Industry/Organization and Evaluation Report of the students is submitted in department.

Step 5: Students will submit training report after completion of internship.

Step 6: Training Certificate to be obtained from industry.

Step 7: List of students who have completed their internship successfully will be issued by Training and Placement Cell.

b) Guidelines to the students:

Any absenteeism by students during their internship should be informed immediately to the mentor/reporting manager and the internal guide. No special considerations will be accepted. Students cannot take leave for college work or fest activities. The leave permission for any college related activities will be solely approved by the HOD. The monthly attendance format should be duly submitted to the internal guide by the intern.

c) Internal reporting Guidelines:

Every intern should send weekly report to their internal guide without fail. It is mandatory for the intern to send weekly reports to their respective guide on regular basis. Interns should have at least fortnightly verbal communication with the internal guide without fail. In cases where in the company wants to secure their confidential information in the project / internship report, the internal guide should duly co-ordinate with the respective mentor/reporting manager on the method of reporting to assure that no information will be leaked outside and is purely for academic purposes.

d) Internship Diary / Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary account of the observations, impressions, information gathered and suggestions given, if any. The training diary/workbook should be signed after every day by the supervisor/ in charge of the section where the student has been working.

Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. Internship Diary / workbook may be evaluated on the basis of the following criteria:

- Proper and timely documented entries.
- Adequacy & quality of information recorded
- Data recorded.
- Thought process and recording techniques used.
- Organization of the information.

e) Internship Work Evaluation:

Every student is required to prepare a maintain documentary proofs of the activities done by him / her as internship diary or as workbook. The evaluation of these activities will be done by Programme Head/ Cell In-charge / Project Head / faculty mentor or Industry Supervisor based on-overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities.

Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External - a supervisor from place of internship).

f) Evaluation through Seminar presentation / Viva-voce at the institute:

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

- ✓ Depth of knowledge and skills Communication & Presentation Skills.
- ✓ Team Work
- ✓ Creativity
- ✓ Planning & Organizational skills
- ✓ Adaptability and Analytical Skills
- ✓ Attitude & behavior at work.
- ✓ Societal Understanding
- ✓ Ethics
- ✓ Regularity and punctuality
- ✓ Attendance record
- ✓ Log book
- ✓ Student's Feedback from External Internship Supervisor

g) Internship Report:

The report shall be presented covering following recommended fields but limited to:

- Title/Cover Page
- Internship completion certificate.
- Internship Place Details- Company background-organization and activities/Scope and object of the study / personal observation.
- Index/Table of Contents
- Introduction
- Title/Problem statement/objectives
- Motivation/Scope and rationale of the study
- Methodological details
- Results / Analysis /inferences and conclusion
- Suggestions / Recommendations for improvement to industry, if any
- Attendance Record
- List of reference (Library books, magazines and other sources)

h) Feedback from internship supervisor (External and Internal):

Post internship, faculty coordinator should collect feedback about student with following recommended parameters:

- ✓ Technical knowledge
- ✓ Discipline
- ✓ Punctuality
- ✓ Commitment
- ✓ Willingness to do the work
- ✓ Communication skill
- ✓ Individual work
- ✓ Team work
- ✓ Leadership

Savitribai Phule Pune University Third Year of E & Tc Engineering (2019 Course) 304200: Mini Project		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 04 hrs. / week	**02**	**Term Work: 25 Marks** **Oral: 50 Marks**

Course Objectives:

- To understand the ―Product Development Process" including budgeting through Mini Project.
- To plan for various activities of the project and distribute the work amongst team members.
- To inculcate electronic hardware implementation skills by -
- Learning PCB artwork design using an appropriate EDA tool.
- Imbibing good soldering and effective trouble-shooting practices.
- Following correct grounding and shielding practices.
- To develop student's abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project.
- To understand the importance of document design by compiling Technical Report on the Mini Project work carried out.

Course Outcome:

On completion of the course, student will be able to

CO1: Understand, plan and execute a Mini Project with team.

CO2: Implement electronic hardware by learning PCB artwork design, soldering techniques, testing and troubleshooting etc.

CO3: Prepare a technical report based on the Mini project.

CO 4: Deliver technical seminar based on the Mini Project work carried out.

A) Execution of Mini Project

- Project group shall consist of **not more than 3** students per group.
- Mini Project Work should be carried out in the Design / Projects Laboratory.

- Project designs ideas can be necessarily adapted from recent issues of electronic design magazines Application notes from well known device manufacturers may also be referred.
- Use of Hardware devices/components is mandatory.
- Layout versus schematic verification is mandatory.
- Bare board test report shall be generated.
- Assembly of components and enclosure design is mandatory.

B: Selection: Domains for projects may be from the following, but not limited to:

- Instrumentation and Control Systems
- Electronic Communication Systems
- Biomedical Electronics
- Power Electronics
- Audio , Video Systems
- Embedded Systems
- Mechatronic Systems
- Microcontroller based projects should preferably use Microchip PIC controllers / ATmega controller / AVR microcontrollers / Ardino / Rasberry Pi.

C. Monitoring: (for students and teachers both): Suggested Plan for various activities to be monitored by the teacher.

Week 1 & 2: Formation of groups, Finalization of Mini project & Distribution of work.

Week 3 & 4: PCB artwork design using an appropriate EDA tool, Simulation.

Week 5 to 8: PCB manufacturing through vendor/at lab, Hardware assembly, programming (if required) Testing, Enclosure Design, Fabrication etc

Week 9 & 10: Testing of final product, Preparation, Checking & Correcting of the Draft Copy of Report

Week 11 & 12: Demonstration and Group presentations.

Log book for all these activities shall be maintained and shall be produced at the time of examination.

D. Report writing: A project report with following contents shall be prepared:

- Title
- Specifications
- Block Diagram
- Circuit Diagram
- Selection of components, calculations
- Simulation Results
- PCB Art work
- Testing Procedures
- Enclosure Design
- Test Results & Conclusion
- References

Savitribai Phule Pune University, Pune
B.E. (Electronics & Telecommunication) 2019 Course
(With effect from Academic Year 2022-23)

Semester-VII

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
404181	Radiation & Microwave Theory	03	-	-	30	70	-	-	-	100	03	-	-	03
404182	VLSI Design and Technology	03	-	-	30	70	-	-	-	100	03	-	-	03
404183	Cloud Computing	03	-	-	30	70	-	-	-	100	03	-	-	03
404184	Elective - 3	03	-	-	30	70	-	-	-	100	03	-	-	03
404185	Elective - 4	03	-	-	30	70	-	-	-	100	03	-	-	03
404186	Lab Practice - 1 (RMT & Cloud Computing)	-	04	-	-	-	25	-	50	75	-	02	-	02
404187	Lab Practice - 2 (VLSI Design & Elective -3)	-	04	-	-	-	25	50	-	75	-	02	-	02
404188	Project Stage - I	-	02	-	-	-	50	-	-	50	-	01	-	01
404189	Mandatory Audit Course 7	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**10**	**-**	**150**	**350**	**100**	**50**	**50**	**700**	**-**	**-**	**-**	**-**
					Total Credits						**15**	**05**	**-**	**20**

Elective - 3	**Elective - 4**
1. Speech Processing	1. Data Mining
2. PLC SCADA & Automation	2. Electronic Product Development
3. JAVA Script	3. Deep Learning
4. Embedded & RTOS	4. Low Power CMOS
5. Modernized IoT	5. Smart Antennas

Mandatory Audit Course - 7
1. Management Information System
2. Patent Search & Analysis
3. Knowledge Management
4. Energy Economics & Policy
5. Educational Leadership
6. Human Resource Development

Savitribai Phule Pune University, Pune
B.E. (Electronics & Telecommunication) 2019 Course
(With effect from Academic Year 2022-23)

Semester-VIII

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit			
		Theory	Practical	Tutorial	In-Sem	End-Sem	TW	PR	OR	Total	TH	PR	TUT	Total
404190	Fiber Optic Communication	03	-	-	30	70	-	-	-	100	03	-	-	03
404191	Elective - 5	03	-	-	30	70	-	-	-	100	03	-	-	03
404192	Elective - 6	03	-	-	30	70	-	-	-	100	03	-	-	03
404193	Innovation & Entrepreneurship	-	-	02	-	-	50	-	-	50	-	-	02	02
404194	Digital Business Management	-	-	02	-	-	50	-	-	50	-	-	02	02
404195	Fiber Optic Lab	-	02	-	-	-	25	-	50	75	-	01	-	01
404196	Lab Practice - 3 (Elective - 5)	-	02	-	-	-	25	50	-	75	-	01	-	01
404197	Project Stage - II	-	10	-	-	-	100	-	50	150	-	05	-	05
	Total	**09**	**14**	**04**	**90**	**210**	**250**	**50**	**100**	**700**	**-**	**-**	**-**	**-**
	Total Credits										**09**	**07**	**04**	**20**

Elective - 5	**Elective - 6**
1. Biomedical Signal Processing	1. System on Chip
2. Industrial Drives & Automation	2. Nano Electronics
3. Android Development	3. Remote Sensing
4. Embedded System Design	4. Digital Marketing
5. Mobile Computing	5. Open Elective

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404188: Project Phase – I		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 02 Hrs. / Week	**01**	**Term Work: 50 Marks**

Course Objectives:

- To understand the basic concepts & broad principles of projects.
- To understand the value of achieving perfection in project implementation & completion.
- To apply the theoretical concepts to solve real life problems with teamwork and Multidisciplinary approach.
- To demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.

Course Outcomes:

CO1: Demonstrate a sound technical knowledge in field of E&TC in the form of project.
CO2: Undertake real life problem identification, formulation and solution.
CO3: Design engineering solutions to complex problems utilizing a systematic approach.
CO4: Demonstrate the knowledge, effective communication skills and attitudes as professional engineer.

Project phase 1 is an integral part of the project work. The project work shall be based on the knowledge acquired by the student during the graduation and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems in the field of Electronics and communication where the student likes to acquire specialized skills. The student shall prepare the duly certified Fourth report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

Guidelines:

1. Group Size: The student shall carry the project work individually or by a group of students. Optimum group size shall be 3 students. However, if project complexity demands a maximum group size of 4 students, the project committee should be convinced about such complexity and scope of the work. Projects selected should meet and contribute towards the needs of the society.
2. Selection and approval of topic: Topic should be related to real life application in the field of Electronics and Telecommunication engineering.
3. The topic may be based on : Investigation of the latest development in a specific field of Electronics or Communication / The investigation of practical problem in manufacture and / or testing of electronics or communication equipment/ Software based projects related to VHDL, Communication, Instrumentation, Signal Processing agriculture Engineering etc. with the justification for techniques used / any topic in the field of E&TC may be allowed.
4. Interdisciplinary projects should be encouraged. The examination of Interdisciplinary projects shall be conducted independently in respective departments.
5. The term work assessment of project phase 1 shall be based on Innovative Idea of selected project, literature survey, Depth of understanding, Applications, Individual contributions, presentation, project report, timely completion of work.
6. The department should prepare project planner and should follow accordingly
7. A log book of work carried out during the semester should be maintained with weekly review remarks by the guide and committee.
8. A certified copy of report preferably using LATEX is required to be presented to external examiner at the time of Fourth examination.
9. The project report must undergo by plagiarism check and the similarity index must be less than 15%. The plagiarism report should be included in the project report.

Savitribai Phule Pune University Fourth Year of E & Tc Engineering (2019 Course) 404197: Project Phase – II		
Teaching Scheme:	**Credit**	**Examination Scheme:**
Practical: 10 Hrs. / Week	**05**	**Term Work: 100 Marks** **Oral: 50 Marks**

Project phase 2 is extension of Project phase 1 carried out in seventh semester. The student shall prepare the duly certified Fourth report of project work in standard format preferably in LATEX for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

GUIDELINES

1.	The project TW/OR assessment shall be based on Live Project Demonstration and presentation by the students. The assessment parameters shall be Innovative Idea of selected project, literature survey, Depth of understanding, Applications, Individual contributions, presentations, project report, timely completion of work (Project review presentations), participation in project competition, publication of research work in journal/conference, publication in the form of patent and copyright etc. The college can prepare the rubrics based on these parameters
2.	Certified hard bound project report to be submitted by the students in prescribed format.
3.	Students must preferably publish at least one technical paper on project work in the conference or peer reviewed Journals or publish patent or copyright or should participate into one of the project competition at university/State/National/International level.
4.	A log book of work carried out during the semester should be maintained with weekly review remarks by the guide and committee.
5.	A certified copy of report preferably using LATEX is required to be presented to external examiner at the time of Fourth examination.
6.	The project report must undergo by plagiarism check and the similarity index must be less than 10%. The plagiarism report should be included in the project report.

Department of Electronics and Telecommunication Engineering
List of PBL
A.Y. 2023-24

Sr.no.	Group No.	Roll No.	Name of the Student	Project Topic	Domain
1	G1	2208	Biradar Shriram	Temperature Based fan speed controller using ARDUINO	Power Electronics
2		2207	Bhole Krushna		
3		2214	Dhonde Sagar		
4		2205	Bhamare Ajinkya		
5		2211	Chole Ramkishan		
6	G2	2219	Ishita Ganvir	Smart GPS Tracker using ARDUINO	Microcontroller
7		2213	Rutuja Dhawale		
8		2216	Pratiksha Dighe		
9		2203	Sejal Awhale		
10	G3	2204	Asmita Bende	Smart Irrigation System using ARDUINO	Microcontroller
11		2210	Sakshi Chendkapure		
12		2218	Gauri Gadevar		
13	G4	2201	Parth Amande	Automatic Hand Sanitizer using ARDUINO	Microcontroller
14		2220	Prasad Gawade		
15		2215	Ganesh Dhorajkar		
16		2209	Yash Chakar		
17		2212	Vedant Dhake		
18	G5	2233	Kene Ayush Suresh	Motion sensing light	Power Electronics
19		2226	Jadhav Tushar Bhimrao		
20		2228	Joshi Atharv Arvind		
21		2221	Ghodake Shravani Mangesh		
22		2222	Humbe Manasi Ramchandra		
23	G6	2229	Kakde Ashish Rajendra	Third eye ultrasonic vibrating glove	Microcontroller
24		2238	Kulkarni Yash Nagorao		
25		2231	Kaldhone Chaitanya Sanjay		
26		2224	Jadhav Adhiraj Umesh		
27	G7	2239	Mahale Rahul Rajesh	Vehicle Accident Alert System	Microcontroller
28		2225	Jadhav Samarth Anand		
29		2232	Kale Premkumar Anand		
30		2227	Jagdale Tanmay Maruti		

Sr.no.	Group No.	Roll No.	Name of the Student	Project Topic	Domain
31	G8	2230	Kalbhor Siddhi Babasaheb	Fire Fighting robot using arduino	Microcontroller
32		2237	Kulkarni Shivranjani Dhananjay		
33		2234	Khedkar Samruddhi Sanjaykumar		
34	G9	2236	Kolhe Sanika Satish	Earthquake detector	Power Electronics
35		2235	Koditkar Saloni Sunil		
36		2240	Mashere Mohini Gotiram		
37	G10	2241	Mohite Siddhi Pramod	Measure voltage and amp using Arduino	Microcontroller
38		2246	Pandit Gauri Kishor		
39		2257	Sankpal Asmita Navnath		
40		2245	Pakhale Ketaki Devidas		
41		2258	Sharma Lakshya Deepak		
42	G11	2260	Shinde Pranjal Pralhad	Auto campus light control	Power Electronics
43		2242	Nale Sejal Sanjay		
44		2249	Pawar Sakshi Baban		
45		2251	Phanse Purva Shrikant		
46	G12	2243	Narale Ajay Tanaji	Smart blind stick	Microcontroller
47		2252	Pokharkar Ashish Janardan		
48		2247	Pawar Ashutosh Santosh		
49		2259	Shete Piyush Dhananjay		
50		2250	Phand Abhishek Bapu		
51	G13	2253	Rathod Rohit Rajesh	Password door lock security system	Microcontroller
52		2254	Raut Aarti Ganesh		
53		2256	Said Sapana Dattatray		
54		2244	Paikine Aniket Kishanrao		
55	G14	2264	Vaishnavi Talekar	Automated washroom Light controller using ARDUINO	Microcontroller
56		2275	Simran Shaikh		
57		2272	Snehal Katore		
58		2266	Tanpure Divyani		
59		2271	Shanti Vanekari		

Sr.no.	Group No.	Roll No.	Name of the Student	Project Topic	Domain
60	G15	2262	Shreya Mogale	Digital Clock using ARDUINO	Embedded Systems
61		2263	Sawli Surve		
62		2268	Mayuri Walke		
63	G16	2270	Vinayak Sonwane	Intelligent Shoes for blind people using ARDUINO	Microcontroller
64		2274	Shreya Jogdand		
65		2280	Sakshi Patil		
66		2265	Rushabh Tandale		
67		2273	Darshan Thanambir		
68	G17	2278	Kakade Aniket	ARDUINO Based wet and dry separation	Embedded Systems
69		2279	Jagtap Vedant		
70		2277	Ghoplap Pravin		
71		2267	Manas Vyas		
72		2276	Hase Sakshi		

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Department of Electronics and Telecommunication Engineering
List of Mini Project
A.Y. 2023-24

Sr.no	Grp. No.	Group Members: Name	Group Members: Roll No.	Topic Finalised	Domain
1	**1**	Adhav Arya Shivaji	3204	RFID tag attendance system	Embedded System
2		Nair Anjali Rajan	3232		
3		Walkikar Saniya Dinesh	3261		
4	**2**	Cirvi Umesh Mohanlal	3215	Automatic Engine locking using alcohol detection	Instrumentation System
5		Patil Rushikesh Vishnu	3236		
6		Singh Sundaram Brajesh	3266		
7	**3**	Prateek Gajendra Hajare	3272	Object detection using tensor flow and external camera	Instrumentation System
8		Adhau Abhishek Vinod	3265		
9		Kulkarni Parjanya Pravin	3263		
10	**4**	Rode Ashwini Tanaji	3245	Automatic door bell sensor	Embedded System
11		Parigha Sanjay Patil	3276		
12		Archana Shivaji Sonawane	3275		
13	**5**	Andhare Priya Vinayak	3206	Over and under voltage protection	Power Electronics
14		Pawar Samruddhi Prakash	3264		
15	**6**	Pranita Jalindar Gadhave	3241	Fire security system using GSM module	Electronic Communication Systems
16		Nikam Vishakha Sudhakar	3234		
17		Shardul Nikita Nitin	3252		
18	**7**	Shitole Shivani Minanath	3255	Car speed detector using arduino	Embedded System
19		Sonawane Shalaka Sunil	3256		
20		Shraddha Bhaskar Dighe	3273		
21	**8**	Mourya Tushar Anil	3231	Automatic waste	

22		Rode Abhiraj Pravin	3203	segeregation system	Instrumentation System
23		Auti Soham Ramdas	3208		
24	9	Rambhad Rushita Yogesh	3242	Temperature monitoring system	Embedded Systems
25		Shete Rutuja Ratan	3253		
26	10	Phad Gaytri Haribhau	3240	Sensor based accident prevention system in curving	Instrumentation System
27		Rokade Sakshi Anil	3246		
28		Divya Zumbar Kawale	3274		
29	11	Bhosale Shambhuranje Santosh	3210	Powerfull vaccum cleaner	Embedded Systems
30		Holkar Mansi Mukund	3221		
31		Choure Pranita Bhausaheb	3214		
32	12	Sayyed Muskan Rasulsab	3251	Automatic agricultural system	Embedded Systems
33		Kakade Pranitee Arjun	3226		
34	13	Avinash Bharat Ghalme	3271	Three phase motor control using NRF 24L01	Mechatronic Systems
35	14	Salegaonkar Anand Gopalrao	3248	Obstacle avoiding robot	Embedded Systems
36		Role Rohit Bhimrao	3247		
37	15	Karle Kamlesh Rajendra	3227	Rain sensing automatic car wipers	Embedded Systems
38		Kumbhar Akshay Vijay	3229		
39		Thakare Sandesh Shankar	3259		
40	16	Ghule Sanket Arun	3219	Pulse rate oximeter using Arduino UNO	Biomedical Electronics
41		Kate Chandrashekhar Bhausaheb	3228		
42		Ubale Kuber Anil	3260		
43	17	Chavare Atharv Umesh	3213	Automatic TOLL gate	Embedded Systems
44		Ajay Sunil Kasabe	3205		
45		Jadhav Sitaram Subhash	3222		

46	**18**	Yenge Anteshwar Namdev	3262	Liquid despenser using Arduino	Embedded Systems
47		Rasal Uday Sharad	3244		
48		Chavan Piyush Kautik	3211		
49	**19**	Tale Pratik Subhashrao	3258	Automatic Solar tracker using Arduino	Embedded Systems
50		Thakur Ashutosh Ram	3267		
51		Nishant S Pawar	3235		
52	**20**	Rasal Kartiki Sachin	3258	Sentry Turret using Arduino	Embedded Systems
53		Peshave Madhura Sanjay	3239		
54		Sarule Ashish Devichand	3250		
55	**21**	Kadam Aditya Manohar	3224	Smart blind glasses	Embedded Systems
56		Dhalpe Atharv Vijaykumar	3216		
57		Ankushe Mahesh Rajendra	3207		
58	**22**	Bande Rushikesh Laxman	3209	Automatic contactless switch for smart home	Embedded Systems
59		Narwade Ritesh Santosh	3233		
60		Shinde Sushant Rajendra	3254		
61	**23**	Abhijeet Tatyasaheb Chaudhari	3270	Oscilloscope using Arduino	Embedded Systems
62		Gund Sandesh Santosh	3220		
63		Salunke Ganesh Shivaji	3249		
64	**24**	Wahul Deepak Ganesh	3268	Automatic Street light system	Embedded Systems
65	**25**	Gaikwad Prasad Santosh	3202	Third eye for blind	Embedded Systems

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Department of Electronics & Telecommunication Engineering

Internship List
Academic Year 2023-24

Sr. No.	Candidate Name	Name of the Company	Area /Domain	Duration (From)	Duration (To)
1	Gaikwad Prasad Santosh	Proazure Software Solutions Pvt.Ltd	Web Development	11-12-2023	11-01-2024
2	Rode Abhiraj Pravin	Codsoft	UI/UX Design	01-01-2024	31-01-2024
3	Adhav Arya Shivaji	Codsoft	UI/UX Design	30-12-2023	31-01-2024
4	Ajay Sunil Kasabe	Codsoft	Web Development	01-01-2024	01-02-2024
5	Andhare Priya Vinayak	Oasis Infobyte	Web Development	01-01-2024	05-02-2024
6	Ankushe Mahesh Rajendra	Codsoft	Web Development	01-01-2024	01-02-2024
7	Auti Soham Ramdas	Codsoft	Web Development	15-12-2023	15-01-2024
8	Bande Rushikesh Laxman	Proazure Software Solutions Pvt.Ltd	Web Development	11-12-2023	11-01-2024
9	Bhosale Shambhuranje Santosh	Codsoft Info Tech	Web Development	01-01-2024	30-01-2024
10	Chavan Piyush Kautik	Subhansh Sewa Trust	Human Resource Intern	16-01-2024	29-02-2024
11	Chavan Raviraj Anandrao	Oasis Infobyte	Web Development	15-01-2024	15-02-2024
12	Chavare Atharv Umesh	Shrinath Mahskoba Sugar Factory	Instumentation Division	12-28-2023	01-31-2024
13	Choure Pranita Bhausaheb	Digitalizeme	UI/UX Design	07-08-2023	08-12-2023
14	Cirvi Umesh Mohanlal	Octanet Services Private Limited	Web Development	01-01-2024	31-01-2024
15	Dhalpe Atharv Vijaykumar	Proazure Software Solutions Pvt. Ltd. Pune	Web Development	12-12-2023	12-01-2024
16	Ghule Sanket Arun	Oasis Infobyte	Python Programming	15-01-2024	15-02-2024
17	Holkar Mansi Mukund	Codsoft	Web Development	31-12-2023	31-01-2024

Sr. No.	Candidate Name	Name of the Company	Area /Domain	Duration (From)	Duration (To)
18	Jadhav Sitaram Subhash	Octanet	Web Development	29-12-2023	01-01-2024
19	Jadhawar Ashutosh Ramesh	Codsoft	Web Development	05-01-2024	05-02-2024
20	Kadam Aditya Manohar	Sppu,Pune	Electronic	01-01-2024	15-02-2024
21	Kakade Pranitee Arjun	Oasis Infobyte	Web Development	01-01-2024	31-01-2024
22	Karle Kamlesh Rajendra	Codsoft	Web Development	01-01-2024	31-01-2024
23	Kate Chandrashekhar Bhausaheb	Octanet Services Pvt.Ltd	C++ Programing	01-01-2024	01-30-2024
24	Kumbhar Akshay Vijay	Technohacks	Web Development	01-01-2024	01-02-2024
25	More Anurag Chaurang	Technohacks	Web Development	01-01-2024	01-02-2024
26	Mourya Tushar Anil	Internpe	Web Development	01-01-2024	28/1/2024
27	Nair Anjali Rajan	Codsoft	UI/UX Design	01-01-2024	31-01-2024
28	Narwade Ritesh Santosh	Proazure Software Solution	Web Development	15-12-2023	15-12-2023
29	Nikam Vishakha Sudhakar	Codsoft	UI/UX Design	01-01-2024	31-01-2024
30	Nishant S Pawar	Octane Services Pvt Ltd.	Web Development	01-02-2024	01-03-2024
31	Patil Rushikesh Vishnu	Codsoft	Data Science Intern	15-12-2023	15-01-2024
32	Peshave Madhura Sanjay	Codsoft	Data Science Intern	20-12-2023	20-01-2024
33	Phad Gaytri Haribhau	Acmegrade	Internet of Things	15-01-2024	15-04-2024
34	Pranita Jalindar Gadhave	Codsoft	UI/UX Design	01-01-2024	31-01-2024
35	Rambhad Rushita Yogesh	Codesoft	UI/UX Design	15-12-2023	15-01-2024
36	Rasal Kartiki Sachin	Oasisinfobyte	Java Programming	04-01-2024	05-02-2024
37	Rasal Uday Sharad	Codesoft	Web Development	15-12-2023	15-01-2024
38	Rode Ashwini Tanaji	Codsoft	Web Development	25-12-2023	25-01-2024

Sr. No.	Candidate Name	Name of the Company	Area /Domain	Duration (From)	Duration (To)
39	Rokade Sakshi Anil	Proazure	Web Development	15-12-2023	15-01-2024
40	Role Rohit Bhimrao	Oasisinfobyte	Web Development	04-01-2024	05-02-2024
41	Salegaonkar Anand Gopalrao	Codsoft	Web Development	10-01-2024	10-02-2024
42	Sarule Ashish Devichand	Oasisinfobyte	Web Development	04-01-2024	05-02-2024
43	Sayyed Muskan Rasulsab	Codsoft	Web Development	01-01-2024	31-01-2024
44	Shardul Nikita Nitin	Codsoft	UI/UX Design	01-01-2024	31-01-2024
45	Shete Rutuja Ratan	Proazure Software Solutions Pvt.Lmt	UI/UX Design	12-12-2023	12-01-2024
46	Shinde Sushant Rajendra	Codsoft	Web Development	01-01-2024	31-01-2024
47	Shitole Shivani Minanath	Codeclause	Web Development	01-01-2024	01-02-2024
48	Sonawane Shalaka Sunil	Badve Autocomp Pvt Ltd.	Materials Department	01-03-2024	02-03-2024
49	Tale Pratik Subhashrao	Codsoft	UI/UX Design	20-12-2023	20-01-2024
50	Thakare Sandesh Shankar	Codeclause	Web Development	01-01-2024	01-02-2024
51	Ubale Kuber Anil	Iosis Infobyte	Control Communicatio n	15-11-2023	15-12-2023
52	Walkikar Saniya Dinesh	Codsoft	UI/UX Design	01-01-2024	31-01-2024
53	Yenge Anteshwar Namdev	Codsoft	Web Development	10-01-2024	10-02-2024
54	Kulkarni Parjanya Pravin	Sppu,Pune	Electronic	01-01-2024	15-02-2024
55	Pawar Samruddhi Prakash	Codeclause	Artificial Intelligence	01-01-2024	01-02-2024
56	Adhau Abhishek Vinod	Codsoft	Python Programming	01-10-2024	02-10-2024
57	Singh Sundaram Brajesh	Octanet Pvt Ltd.	Web Development	01-01-2024	01-02-2024
58	Thakur Ashutosh Ram	Codsoft	UI/UX Design	25-01-2024	25-02-2024
59	Wahul Dipak Ganesh	Codsoft	UI/UX Design	08-01-2024	27-01-2024

Sr. No.	Candidate Name	Name of the Company	Area /Domain	Duration (From)	Duration (To)
60	Patharkar Yogesh Prakash	Codsoft	Web Development	25-01-2024	25-02-2024
61	Abhijeet Tatyasaheb Chaudhari	Codsoft	Web Development	25-01-2024	25-02-2024
62	Avinash Bharat Ghalme	Pantech Solution Pvt.Ltd	Embeddd Systems	01-12-2023	02-01-2024
63	Prateek Gajendra Hajare	Proazure Software Solutions Pvt.Lmt	Web Development	12-12-2023	12-01-2024
64	Shraddha Bhaskar Dighe	Codsoft	Web Development	10-01-2024	10-02-2024
65	Divya Zumbar Kawale	Codeclause	Artificial Intelligence	01-01-2024	01-02-2024
66	Archana Shivaji Sonawane	Codsoft	Java Programming	10-01-2024	10-02-2024
67	Parigha Sanjay Patil	Acmegrade	Java Programming	15-01-2024	15-04-2024

Dr. Y. S. Angal
HOD(E&TC), BSIOTR

H.O.D.
Electronics & Telecommunication Dep
Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune- 412 207

Department of Electronics and Telecommunication Engineering
List of BE Project
A.Y. 2023-24

Sr. No.	Group No.	Roll No.	Name of Students	Title of projects
1	1	4230	Narwade Kunal Dilip	Pollution detection & monitoring system
2		4241	Shaikh Ujef Samad	
3	2	4202	Aekagra Dhamani	Smart Irrigation System Using IOT
4		4244	Shubham Ashok Pawar	
5		4266	Shaikh Arman Sameer	
6	3	4235	Randive Kishori Ramdas	Head operated Wheelchair for Physically challeged person
7		4226	Mane Rutuja Kailas	
8		4212	Gat Sheetal Babaji	
9	4	4209	Deshpande Chaitra	Safty device for women and children
10		4213	Gole Aishwarya Suhas	
11		4224	Mane Abhay Sudhakar	
12	5	4257	Sharadhha Bade	Automatic room light controller and
13		4211	Gardare Kiran	
14		4220	Koli Pradeep Deepak	
15	6	4231	Patil Priyanka Bapurao	Rasberry Pi Based Reader for Blind Person
16		4254	Tupsoundare Rajnandini Rajkumar	
17		4239	Sawargave Rajnandini Dipak	
18	7	4275	Gawali Shubham Sunil	Automatic solar panel cleaning robot
19		4246	Sonawane Kalpesh Yuvraj	
20		4242	Vaibhav shelke	
21	8	4206	Borse Anshulika Yuvraj	Hospital sanitising Robot
22		4240	Parvej Shaikh	
23		4218	Kekan Prajakta Pandurang	

Sr. No.	Group No.	Roll No.	Name of Students	Title of projects
24	9	4228	Mustkin Mulani	PLC based railway accident avaidance system
25		4273	Londhe Pruthviraj Suresh	
26		4260	Patil Yuvraj Rajaram	
27	10	4256	Waghmode Mahesh Namdev	Student attendance using biometrics
28		4208	Daphal Chetan Shahaji	
29		4204	Bhoite Abhijit Shahaji	
30	11	4251	Tengale Adesh Laxman	Automatic bottle filling system using PLC
31		4243	Shinde Abhay Pramod	
32		4248	Tamhane Vaishnavi Vinod	
33	12	4210	Dhake Tilakchand Umakant	Solar based wireless electric vehical charging
34		4237	Sakhare Swapnil Tanaji	
35		4229	Narute Harshad Dhanaji	
36	13	4214	Hargude Aishwarya Anil	Development of regenerating power system in EV through solar system
37		4252	Thakare Vaishnavi Jagadeo	
38		4255	Vadak Komal Vijendra	
39	14	4225	Mane Nikita Nilesh	Hand gesture regnition system
40		4253	Thakur Gaurav Ram	
41		4215	Jade Meghsham Sanjay	
42	15	4221	Kuwar Sakshi Jayesh	E&TC department light control based on IOT
43		4234	Petkar Sayali Dhanraj	
44		4236	Raut Dnyaneshwari Shivshankar	
45	16	4233	Patil Vyankatesh Kamlesh	Automated platform Bridge in Railway station
46		4222	Lagad Pratik Dhondiba	
47		4205	Borhade Shivam Pandurang	
48	17	4258	Figredo Ispurleen Peter	Emergency alarm system for patient in hospital
49		4217	Joshi Bhargavi Dinesh	
50		4247	Tambe Ekta Dinesh	

Sr. No.	Group No.	Roll No.	Name of Students	Title of projects
51	**18**	4267	Supriya Sunil Mohite	Tunnel Safty Using Wind Energy
52		4232	Patil Vishwatej Dattatraya	
53	**19**	4259	Atharva Jairaj Kadam	Electric motor fault detection using IOT
54		4268	Chavan Dnyaneshwar	
56		4270	Khatavakar Priyanka Nagnath	
57	**20**	4261	Sontakke Divya Dnyaneshwar	Automatic smart babycare system
58		4272	Sawant Sneha Balaso	
59		4264	Kand Akaksha Ramdas	
60	**21**	4207	Ajinkya Sunil Dahiwal	Vegetable Dryer
61		4216	Ajay Shesgarao Jagtap	
62		4227	Amar Chhatrabhuj Matkar	
63	**22**	4262	Takle Ashlesha	Advance fire fighting
64		4265	Takle Anjali	
65		4271	Londhe Ankita	
66	**23**	4203	Nameera Attar	Automatic Solar Grass Cutter
67		4249	Devendra Tayade	
68		4245	Amruta Sonawane	
69		4269	Gadekar Jayawant Bhimrao	

Dr. Y. S. Angal
HOD(E&TC), BSIOTR
H.O.D.
Electronics & Telecommunication Dep
Bhivarabai Sawant Institute of
Technology & Research
Wagholi, Pune- 412 207

JAYAWANT SHIKSHAN PRASARAK MANDAL's
Bhivarabai Sawant Institute of Technology & Research
(Approved by AICTE New Delhi, DTE Mumbai & Affiliated to Savitribai Phule Pune University)
Accredited with B++ Grade by NAAC
Gat No. 719/1 & 2, Wagholi, Pune-Nagar Road, Pune-412207
Ph : 020-067335108, 65217050, 67335100
Telefax : 020-67335100
Website : www.jspm.edu.in / www.bsiotr.org
EN 6311 / CEGP-013100

Prof. Dr. T. J. Sawant
B.E. (Elec.) PGDM, Ph.D
Founder Secretary

Dr. T.K. Nagaraj
ME. (Civil Engg), Ph.D (Civil Engg)
LMISTE, LMIGS, LMIRC
LMISRMTT, LMIE
Principal

DEPARTMENT OF ELECTRONICS & TELECOMMUNICATION ENGINEERING

MEMORANDUM OF UNDERSTANDING (MOU)

Sr. No.	Name of the Company	Duration	Valid upto
1.	Scientech Technologies Pvt. Ltd.	3 Years	Dec. 28th, 2025
2.	Electronic Study Center	5 Years	June 24th, 2027
3.	Smartlogic Technologies	5 Years	June 2nd, 2027
4.	Dolphin Labs Embeded Systems (OPC) Pvt. Ltd.	5 Years	April 18th, 2027
5.	Neeshionics	Until terminated by either of the Parties	

Prof. N. A. Mohota
Incharge

Dr. Y. S. Angal
HOD

H. O. D.
Electronics & Telecommunication Dep
Bhivarabai Sawant Institute of
Technology & Research
Wagholi, Pune- 412 207

MEMORANDUM OF UNDERSTANDING (MOU)

BETWEEN

JSPM's Bhivarabai Sawant Institute of Technology, Wagholi, Pune-412207

and

Scientech Technologies Private Limited

This Memorandum of Understanding is executed in Bhivarabai Sawant Institute of Technology, Wagholi, Pune on the 29th day of December 2022 between:

Bhivarabai Sawant Institute of Technology, Wagholi, Pune, having its principal address at Gate No. 719/1 & 2, Wagholi, Pune Nagar Road, Pune, Maharashtra 412207, herein after referred to as BSIOTR, Wagholi, Pune.

AND

Scientech Technologies Private Limited, having its principal address at 94, Electronic Complex, Pardesipura, Indore, herein after referred to as Scientech, a company providing practical engineering solutions to the budding engineers.

WHEREAS:

(i) **BSIOTR, Wagholi,** Pune, nurtures scientific manpower in theniche areas of Engineering and Technology and takes up industrial challenges and consultancy with pro founding research architects thereby contributing to our futuristic Nation.

(ii) **Scientech Technologies** Private Limited is affianced in exploring different avenues of analog and Digital Communication through IoT for building innovative solutions.

BSIOTR, Wagholi, Pune and Scientech are hereinafter individually referred to as 'Party' and jointly referred to as 'Parties'.

In pursuance of the aforesaid, both, **BSIOTR, Wagholi**, Pune and Scientech Technologies, hereto wish to record under this MoU, the terms of their mutual understanding in order to establish a framework for initiating innovative solutions and research in the areas of Communication Engineering and IoT focusing towards:

- Research and Development in the areas of Communication Engineering and IoT.
- Exposing the students to the emerging technologies by imparting industrial training to the budding engineers.
- Appreciating and creating a large reservoir of highly qualified manpower in the functional areas of Communication Engineering, IoT, and AI
- Clubbing their efforts by pooling their expertise and resources.

INTEND to form a nucleus for promoting excellent quality manpower in the fields of Engineering and Technology with special emphasis on Communication Engineering and IoT.

This MoU sets out the framework within which both BSIOTR, Wagholi, Pune and Scientech will jointly consent and work together to explore on the scope of potential activities for mutual benefit. This MoU is for discussion purposes only and does not constitute an offer worthy of acceptance. The proposed transactions contemplated hereunder in this MoU will be incorporated based on the mutually agreeable terms and conditions cited.

ARTICLE-III: SHARING OF FACILITIES:

a) BSIOTR, Wagholi, Pune and Scientech will make magnanimous and reasonable provisions in an Endeavour to share their respective R&D facilities in order to promote academic and research interaction in the areas of co-operation.

b) BSIOTR, Wagholi, Pune and Scientech may permit the sharing of software and other materials and components developed in-house in the areas of cooperation, if permissible within the rules and policies governing the two institutes and organization. However, responsibility for safety of software and other materials during the exchange will be implemented based on the consent from the respective Head of the academic department / Section and Organization heads.

ARTICLE-IV:CO-ORDINATION OF THE PROGRAMME INCLUDING FINANACIAL ARRANGEMENTS:

a) The collaborative programme between BSIOTR, Wagholi, Pune and Scientech shall be co-ordinated by a co-ordination committee appointed by Dean/Director of both the Institute and organization.

b) BSIOTR, Wagholi, Pune and Scientech are independent contractors and this MoU will not establish any relationship of partnership, joint venture, employment, franchise or agency between BSIOTR, Wagholi, Pune and Scientech.

ARTICLE-V: EFFECTIVE DATE AND DURATION OF MoU:

a) This MoU shall be effective from the last date of execution by competent authorities at both ends as specified in signature block below.

b) The duration of the MoU shall be for a period of 3 years from the effective date.

c) During its tenancy, the MoU may be extended or terminated by a prior notice of not less than six months by either party.

d) Any clause or article of the MoU may be modified or amended by mutual agreement of BSIOTR, Wagholi, Pune and Scientech.

ARTICLE-VI:CONFIDENTIALITY:

During the tenure of the MoU both BSIOTR, Wagholi, Pune and Scientech will maintain strict confidentiality and prevent disclosure of any or all of the information and data exchanged under the scope of the MoU for any purpose other than in accordance with this MoU.

Both BSIOTR, Wagholi, Pune and Scientech shall bind their respective personnel who come into possession or knowledge of any confidential information not to disclose the same to third parties without written approval of the disclosing party or use such confidential information for any use other than intended under this agreement of agreed PROJECTS.

ARTICLE VII: AMENDMENTS:

Any amendment and / or addenda to the MoU shall be in writing and signed by the PARTIES hereto an shall only after such execution be deemed to form part of the MoU and have the effect of modifying the MoU to the extent required by such amendment or addenda.

ARTICLE VIII: RESOLUTION OF DISPUTES:

a) This agreement shall take effect and be construed in accordance with the Laws of India and be subject to the jurisdiction of the courts at Pune.

b) The dispute or difference whatsoever arises between PARTIES in relation to or in connection with this MoU both the parties shall first try to resolve the dispute / difference amicably between the Dean , BSIOTR, Wagholi, Pune and the Managing Director ,Scientech themselves, failing which the matter shall be referred to and settled through arbitration in the court under Pune jurisdiction. Each party shall nominate arbitration which would be final and binding.The arbitration proceedings shall be held in accordance with the provision of Indian Arbitration and Reconciliation ACT, 1996. The venue of arbitration shall be Pune and Language of arbitration shall be English. The Court of Pune shall have the exclusive jurisdiction in all the matters.

The Period of Agreement is for three years and could be extended with mutual agreement.

From (Date) 29th December 2022 To(Date) 28th December 2025

In WITNESS WHEREOF, the parties hereto have executed this agreement (MoU) by their duly authorized Executives/Representatives.

Mr. Satish Thakare

Chief Technology Officer (CTO)

For and On-behalf of
Scientech Technologies Pvt. Ltd.,

Scientech Technologies Pvt. Ltd. INDORE

29/12/2022

Dr. T. K. Nagaraj
Principal
BSIOTR, Wagholi, Pune.

PRINCIPAL
JSPM's Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune-412 207

Witnesses:

(Signature) Anand Pawar

Name in Block Letters:

Designation: Application

Address: Support Engineer

Pune.

Bhivarabai Sawant Institute of Technology & Research Wagholi Pune - 412 207

Name in Block Letters: 29|12|2022

Designation: Prof. HOD (E&TC)

Address: BSIOTR

H. O. D.
Electronics & Telecommunication
Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune-412 207

ELECTRONICS STUDY CENTRE

An ISO 9001:2008 Certified

402, 'Olive Arcade', besides Metro Mall, Tapowan Link Road, Station Road
Nasik. Dist. Nasik (Maharashtra) 422011
9370940465 73040 40465, 98909 40465,
website- www.escworkshop.in
email- esc.electronics@gmail.com

2022-23

Date- 25/06/2022

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU) is made between the

ELECTRONICS STUDY CENTRE,
402, 'Olive Arcade', besides Metro Mall,
Tapowan Road, Station Road,
NASHIK, Dist. Nasik, Maharashtra, INDIA. 422011

--------- Here-in after referred as **ESC.**

AND

JSPM's Bhivarabai Sawant Institute of Technology & Research,
Department of Electronics & Telecommunication Engineering,
Wagholi- Pune
Dist: Pune
Maharashtra, INDIA

--------- Here-in after referred as **BSIOTR.**

Introductory:

About Electronics Study Centre, Nasik

Established in 2012, Electronics Study centre is an ISO 9001:2008 Certified Study Centre. It works on the core branches like Electrical/ Electronics/ Mechanical with the sole objective of professional skill development of the students from Electrical/ Electronics engineering. Our motto is to minimize the gap between education and Industry. We had taken a copyright on 'Three phase induction motor panel assembly and its maintenance' by the name "Me and My Pump." Also we have published a book on core Electrical/ Electronics entitled, 'A Manual of Electronic Components.' We organizes the Seminars, Workshops, Internship, Industrial trainings, Interview sessions, Technical debates/ competition/ quiz etc.

Vision- Empowering Engineering Professionals as Electrical/ Electronics Entrepreneurs.

Mission- To Develop Electrical/ Electronics Engineering Students' Skill by practice.

Aim- To increase students' interest in Electrical/ Electronics and boost their confidence.

...ut JSPM's Bhivarabai Sawant Institute of Technology & Research, Wagholi- Pune

JSPM's Bhivarabai Sawant Institute of Technology & Research, Wagholi- Pune (BSIOTR), was established in year 2009, approved by AICTE, New Delhi & Affiliated to Savitribai Phule Pune University, Maharashtra. We offer a world of opportunities to students with modern educational philosophy and experienced faculty members. Our institution includes strong engineering foundation design to prepare engineers with a broad base of technical knowledge and personality. Presently offers undergraduate programs in four disciplines like Computer Engineering, Electronics & Telecommunication, Electrical Engineering, Information Technology and Mechanical Engineering.

1. Benefits to the Institute:

1. Academic ☐	2. Projects ☐	3. Internship ☐
4. Workshop ☐	5. Research ☐	6. Entrepreneurship Development ☐

It is mutually agreed by **ESC, Nasik** and **BSIOTR Wagholi** that this MOU is to bridge the gap between the industry and the academia, empowering professionals as Entrepreneurs and enrich young talent pool from **BSIOTR,** by enhancing their technical competencies to match the industry requirements.

BSIOTR, and ESC Academy of skill development Technology have identified certain forefront areas to carry out joint work as follow:

1. Conduction of Expert lecture/ Seminar to the students on the core area.
2. Conduction of Hands-on practice workshop for students to develop their skills in the core area.
3. Organizing Industrial Visit to the core Industry.
4. Internship for students in winter/ summer vacation.
5. Conduction of Entrepreneurship Development Camps for **BSIOTR** Students.
6. Developing Entrepreneurship Centre to develop students as a Entrepreneur.
7. Developing a Centre of Maintenance and Repairs of Electric domestic/ industrial appliances to provide service to the college and society.
8. Developing a domestic/ commercial/ industrial product, its manufacturing and marketing in entrepreneurship development of **BSIOTR** students.
9. Guidance and help for Mini Projects.
10. Allotment of industry need based project work and its guidance to **BSIOTR** final year students.
11. Providing necessary platform to carry out the projects at industry.
12. Developing and contributing in the curriculum development at **BSIOTR**, Pune.
13. Developing laboratory by Technical flex chart, banners, display board, components showcase board etc.
14. Sponsoring the technical events and symposiums conducted at **BSIOTR**.
15. Conduction of virtual campus interview for students.

TERMS AND CONDITIONS

1. This MOU shall be effective from the date it is executed by or on behalf of both the parties.
   In witness whereof, both the parties hereto have executed this MOU in duplicate on the day and the year herein under indicated.
2. All the activities shall be planned and arranged at the discretion and with the prior consent of both the parties.
3. Both the parties reserve the discretion of deciding their area of interest. This understanding between the two parties is non-exclusive.
4. Either party may terminate this agreement with a notice of 60 days to other party.
5. The MOU would be revised at the end of 60 months from the date of signing.
6. The infrastructural arrangement for conducting training program, workshop and guest lectures will be made by the host organization at the time of event.
7. **BSIOTR** will not charge any amount against infrastructure used during Workshop and Training.
8. Placement of the students will be as per the requirement, terms and condition of the companies.

For and on behalf of

ELECTRONICS STUDY CENTRE,
402, 'Olive Arcade', besides Metro Mall,
Tapowan Road, Station Road,
Nasik, Maharashtra (India)

(Mr. Sanjay Chaudhari)
Director
Electronics Study Centre
Nasik Dist. Nasik HO - Jalgaon
Place- Shirpur Dist.- Dhule
Date- 25/06/2022

JSPM's Bhivarabai Sawant Institute of , Technology & Research, Wagholi Pune
Dist.-Pune
Maharashtra (India)

(Dr. T. K. Nagraj)
Principal
JSPM's B.S. I.O.T.R, Wagholi- Pune
Wagholi Dist.- Pune
Place- Wagholi Dist.- Pune
Date- 25/06/2022

PRINCIPAL
JSPM'S Bhivarabai Sawant Institute of
Technology & Research

In presence of

23/6/2022

Prof. Dr. Yogesh Angal
HoD E&TC Department
BSIOTR Wagholi- Pune
Date- 25/06/2022

H. O. D.
Electronics & Telecommunication De.
Bhivarabai Sawant Institute of
Technology & Research
Wagholi, Pune- 412 207

25/06/22

Prof. Nilesh. A. Mohota
T & P Co-ordinator
BSIOTR Wagholi- Pune
Date- 25/06/2022

JSPM's BHIVRABAI SAWANT INSTITUTE OF TECHNOLOGY AND RESEARCH
Wagholi, Pune.

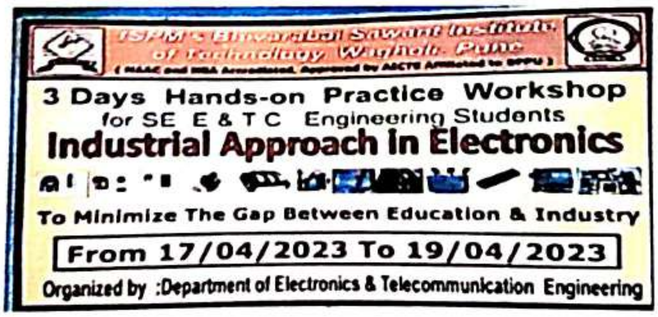
REPORT ON

Three Days Hands on workshop on "Industrial Approach in Electronics"

Name of The Programme	Three Days Hands on workshop on "Industrial Approach in Electronics" under ETSA(Electronics and Telecommunication Students Association)
Date	17/04/2023 to 19/04/2023
Mode	Offline
Organizer	Department of Electronics and Telecommunication Engineering of Bhivarabai Sawant Institute of Technology & Research Wagholi, Pune
Programme Convener	Dr. Y. S. Angal, HOD (E&TC)
Resource Person	Mr. Sanjay Chaudhary
Faculty Coordinator	Assit Prof. J.Y.Suryawanshi, Assit. Prof. P.V.Gawade
Participants	61 students SE E&TC (36-Male, 25-Female)

Introduction

Three days workshop was organized on 17th April, 2023 to 19th April, 2023 in Electronics and telecommunication department in offline mode. Resource Person Mr. Sanjay Chaudhay, CEO of Electronics study Centre, Nashik conducted the workshop. The function was started with inauguration by hands of Principal Dr. T. K. Nagaraj. HOD Dr. Y.S. Angal was given motivational speech for students. 61 SE (E&TC) students were participated in hands-on workshop.



Program Objective:

Sr. No.	Programme Objective
1	To enhancing knowledge of testing basic Electronic components.
2	To improving soldering and disordering skills.
3	To building team handling skills.

- **Workshop Agenda-**

Day	Time	Program	Topic
1	9.30am To 10 am	Registration	Latest Color PP size photo required
	10 am To 1 pm	Morning session	Component Identification & Testing Practice
	1 pm To 2 pm	Lunch Break	-----------------------------
	2 pm To 5 pm	Evening Session	Component Identification & Testing Practice
2	9 am To 1pm	Morning session	Component Identification & Testing Practice
	1 pm To 2 pm	Lunch Break	-----------------------------------
	2pm To 5 pm	Evening Session	PCB study types - Designing Art work etching Assembling, Soldering, desoldering Tips, Technique, Practice
3	9 am To 1pm	Morning session	Project Construction & Testing
	1 pm To 2 pm	Lunch Break	-----------------------------------
	2pm To 5 pm	Evening Session	Discussion, Feedback

Day 1:

On first day, Discussion on basic electronic components i.e. resister, capacitor, inductors and its colour coding. In morning session, components introduction and its colour coding covered. In afternoon session, Components identification and testing of components were performed by students individually.

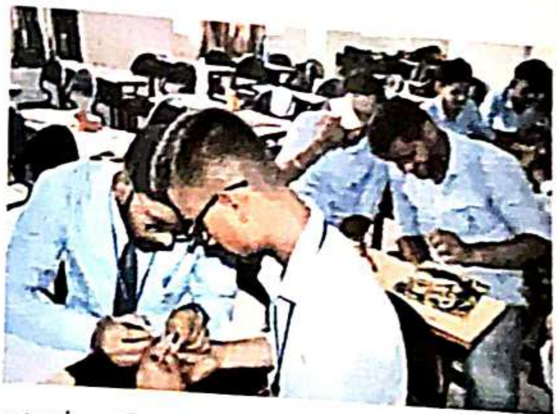
Dr.Y.S.Angal (HOD E&TC) motivating students

Students performing testing of components

Performing LED testing

Day 2:

On second day, Identification and testing of components like diodes, relay, FET, IGBT etc. performed by students individually using testing devices (multimeter). In that measure value of forward and reveres resistance of components.



Students performing testing of components

Day 3:

On third day, mini project task was given to students in group of 3 students. Mini project like water level detector, fire alarm system etc. Introduction of PCB, assembling of components on PCB, soldering of components and testing were performed by groups of students.

Soldering the components

Performing project with Dr. Sanjay Chaudhary

Ms.Rajnandini Tupsundare (TE E&TC) worked as volunteer falicitated by Mr. Sanjay Chaudhary

A valedictory function was carried out at last with presence of HOD Dr. Y.S.Angal and other faculty co-ordinators. Certificate distribution event was held.

AN ISO 9001 : 2008 CERTIFIED

Electronics Study Centre

JSPM's Bhivarabai Sawant Institute of Technology & Research Wagholi- Pune.

(NAAC and NBA Accredited, Approved by AICTE Affiliated to SPPU)

website : www.escworkshop.in

email : escelectronics@gmail.com

Certificate

This is to Certify that,

Dept. of Electronics & Telecommunication Engineering JSPM's Bhivarabai Sawant Institute of Technology & Research, Wagholi- Pune.

has organized a Workshop on

" Industrial Approach in Electronics"

(Study of Components - Identification, Testing, PCB Designing and Assembling of Innovative Projects)

held during 17 - 04 - 2023 To 19 - 04 - 2023 for students at Electronics & Telecommunication Engineering Department JSPM's Bhivarabai Sawant Institute of Technology & Research, Wagholi- Pune.

Dr T K Nagaraj
Principal
JSPM's BSIOTR

Sanjay Chaudhari
Director
Electronics Study Centre

Sample certificate of Workshop

Sr. No.	Outcome	PO	PSO
1	Understand all types of components and testing	PO1,PO2,PO5,PO6, PO7,PO12	PSO1, PSO3
2	Identify team handling skill	PO1,PO2, PO5,PO8,PO9, PO10, PO12	PSO1,PSO3

Assit.Prof. J.Y.Suryawanshi & Assit.Prof. P.V.Gawade
Workshop Coordinator

Prof. Meenakshi A.
ETSA Co-ordinator

Dr. Y. S. Angal
HOD E&TC

Dr. T. K. Nagaraj
Principal
PRINCIPAL
Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune-412207

JSPM's Bhivarabai Sawant Institute of Technology & Research Wagholi
Organized by Electronics & Telecommunication Department
3 Days Workshop "Industrial Approach in Electronics"

Class: SE E & TC   Attendance: 17/04/2021 to 19/04/2021

Sr. No.	Name of the student	Participants signature		
		17/04/2021	18/04/2021	19/04/2021
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

JSPM's Bhivarabai Sawant Institute of Technology & Research Wagholi
Organized by Electronics & Telecommunication Department
3 Days Workshop "Industrial Approach in Electronics"

Class: SE E & TC   Attendance: 17/04/2021 to 19/04/2021

Sr. No.	Name of the student	Participants signature		
		17/04/2021	18/04/2021	19/04/2021
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

JSPM's Bhivarabai Sawant Institute of Technology & Research Wagholi
Organized by Electronics & Telecommunication Department
3 Days Workshop "Industrial Approach in Electronics"

Class: SE E & TC   Attendance: 17/04/2021 to 19/04/2021

Sr. No.	Name of the student	Participants signature		
		17/04/2021	18/04/2021	19/04/2021
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Jayawant Shikshan Prasarak Mandal's (JSPM's)

BHIVARABAI SAWANT INSTITUTE OF TECHNOLOGY & RESEARCH, Wagholi, Pune-412207 (BSIOTR)

(Approved by AICTE New Delhi, DTE Mumbai, Govt. of Maharashtra & Affiliated to Savitribai Phule Pune University)

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

(Accredited by NBA & NAAC)

REPORT ON

"Two Days workshop on PCB Design"

(Under the Electronics & Telecommunication Students Association)

at

Department of Electronics and Telecommunication Engineering

Bhivarabai Sawant Institute of Technology & Research Wagholi, Pune

Name of The Programme	**"Two Day workshop on PCB Design" (Under the Electronics & Telecommunication Students Association)**
Date	13th March 2023 to 14th March 2023
Mode	Offline
Organizer	Department of Electronics and Telecommunication Engineering of Bhivarabai Sawant Institute of Technology & Research Wagholi, Pune
Programme Convenor	Dr. Y. S. Angal, HOD (E&TC)
Programme Co-Ordinator	Asst. Prof. S. V. Malge (E&TC)
Participants	76 Participants (SE E&TC)

Introduction:

In today's engineering world, it is very important to develop practical skills along with theoretical knowledge. The workshop was aimed to provide knowledge about Complete PCB Designing using simulation tool to test circuit and also its Fabrication design software named as Proteus & to make physical PCB so that any student can make project on his own. The Workshop provide opportunities to students should be equipped with additional knowledge to face the competitive world, instead of always restricted to curricular knowledge. The workshop was attended by 76 participants from Second Year Electronics & Telecommunication Engineering Students.

The objective of this workshop was to give hands on training to the Second year Engineering students on designing and fabricating the printed circuit boards. The workshop was free and compulsory to all students.

Workshop Objective:

Sr. No.	Workshop Objective
1	Understand the need for PCB Design and steps involved in PCB Design and Fabrication process.
2	Familiarize Schematic and layout design flow using Open-source Tools.

The workshop was conducted for two days. On first day, In the introduction explained the basic knowledge of Printed circuit boards and how they differ from general circuit boards and breadboards. All the students were explained about the significance of PCB design and the steps in the design process. Students learned Proteus Open-Source software for schematic and layout design of circuit with an example. Simultaneously students also handled the software. also demonstrated some examples by simulating different circuits. Students were instructed to simulate some other logical circuits along with hands on session on the same projects.

On second day, all the students grouped in batch of four students have exposed to hands on practice on various steps in the circuit preparation and learned Copper clad cutting, clean copper clad, apply photo resist, expose to Ultraviolet light through Negative Image, Post Baking of copper clad, Etching Process, Drilling Process, PCB Soldering procedure & dos and don'ts of making PCB & Test PCB Board & mount components and soldering process. all the students were taken to project laboratory for simulating the PCB design process. An interactive session was also organized to bridge the gap of knowledge between students and faculties. Different queries of students regarding printed circuit boards were solved and briefly explained.

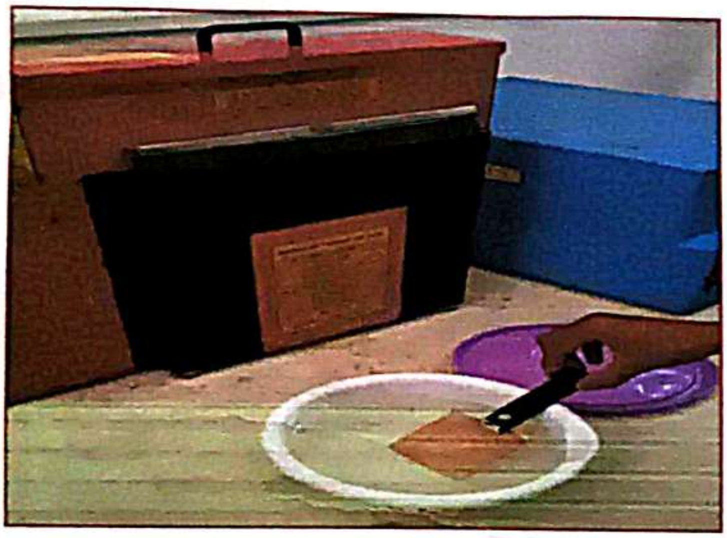
Tools Used for PCB workshop:

Sr. No.	Tools	Description
1	Software	Proteus (Open-Source)
2	Hardware	PCB Cutter
3		PCB Coater Cum Dryer
4		UV Exposer
5		PCB Etcher
6		PCB Driller

GLIMPSES OF THE WORKSHOP:

Copper clad cutting

Cleaning copper clad



Applying photo resist

Drying Copper Clad

Exposing to UV light through Negative Image

Post Baking of copper clad

Etching Process

Drilling Process

Mounting components and soldering process

Final Printed Circuit Board

Bhivarabai Sawant Institute of Technology & Research

Department of Electronics and Telecommunication Engineering

"Printed Circuit Board Workshop"

Under Electronics and Telecommunication Students Association

Class:SE

Date: 15 & 16 March 2025

Roll No	Student Name	Sign
2201	BAGWAN MUBEEN SAMEER	
2202	GAIKWAD PRASAD SANTOSH	
2203	BODE ABHIRAJ PRAVIN	
2204	ADHAV ARYA SHIVAJI	
2205	AJAY SUNIL KASABE	
2206	ANDHARE PRIYA VINAYAK	
2207	ANKUSHE MANESH RAJENDRA	
2208	AUTI SONAM RAMDAS	
2209	BANDE RUSHIKESH LAXMAN	
2210	BHOSALE SHAMBHURAJE SANTOSH	
2211	CHAVAN PIYUSH KAUTIK	
2212	CHAVAN RAVIRAJ ANANDRAO	
2213	CHAVARE ATHARV UMESH	
2214	CHOURE PRANITA BHAUSAHEB	
2215	CIRVI UMESH MOHANLAL	
2216	DHALPE ATHARV VIJAYKUMAR	
2217	DHULGANDE KIRAN SURYAKANT	
2218	GAVANDI UDDHAV SANJAY	

2219	GHULE SANKET ARUN	
2220	GUND SANDESH SANTOSH	
2221	HUKKAR MANSI MUKUND	
2222	JADHAV SITARAM SUBHASH	
2223	JADHAWAR ASHUTOSH RAMESH	
2224	KADAM ADITYA MANOHAR	
2225	KADAM KUNAL ASHISH	
2226	KAKADE PRANITEE ARJUN	
227	KARLE KAMLESH RAJENDRA	
2228	KATE CHANDRASHEKHAR BHAUSAHEB	
2229	KUMBHAR AKSHAY VIJAY	
2230	MORE ANURAG CHAURANG	
2231	MOURYA TUSHAR ANIL	
2232	NAIR ANJALI RAJAN	
2233	NARWADE RITESH SANTOSH	
2234	NIKAM VISHAKHA SUDHAKAR	
2235	NISHANT S PAWAR	
2236	PATIL RUSHIKESH VISHNU	
2237	PATIL SIDDHANT SOMNATH	
2238	PATIL VAIBHAV RAJENDRA	
2239	PESHAVE MADHURA SANJAY	
2240	PHAD GAYTRI HARIBHAU	
2241	PRANITA JALINDAR GADHAVE	
2242	RAMBHAD RUSHITA YOGESH	
2243	RASAL KARTIKI SACHIN	
2244	RASAL UDAY SHARAD	

2245	RODE ASHWINI TANAJI	
2246	ROKADE SAKSHI ANIL	
2247	ROLE ROHIT BHIMRAO	
2248	SALEGAONKAR ANAND GOPALRAO	
2249	SALUNKE GANESH SHIVAJI	
2250	SARULE ASHISH DEVICHAND	
2251	SAYYED MUSKAN RASULSAB	
2252	SHARDUL NIKITA NITIN	
2253	SHETE RUTUJA RATAN	
2254	SHINDE SUSHANT RAJENDRA	
2255	SHITOLE SHIVANI MINANATH	
2256	SONAWANE SHALAKA SUNIL	
2257	SOPANE DNYANESHWARI SAHEBRAO	
2258	TALE PRATIK SUBHASHRAO	
2259	THAKARE SANDESH SHANKAR	
2260	UBALE KUBER ANIL	
2261	WALKIKAR SANIYA DINESH	
2262	YENGE ANTESHWAR NAMDEV	
2263	KULKARNI PARJANYA PRAVIN	
2264	PAWAR SAMRUDDHI PRAKASH	
2265	ADHAU ABHISHEK VINOD	
2266	SINGH SUNDARAM BRAJESH	
2267	THAKUR ASHUTOSH RAM	
2268	WAHUL DIPAK GANESH	
2269	PATHARKAR YOGESH PRAKASH	
2270	ABHIJEET TATYASAHEB CHAUDHARI	

2271	AVINASH BHARAT GHALME	
2272	PRATEEK GAJENDRA HAJARE	
2273	SHRADHA BHASKAR DIGHE	
2274	DIVYA ZUMBER KAWALE	
2275	ARCHANA SHIVAJI SONAWANE	
2276	PARIGHA SANJAY PATIL	
2277	RUDRESH RODE	

Program co-ordinator

A. Meenakshi

H.O.D.

Electronics & Telecommunication Dept.
Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune-412 207

Workshop Outcome:

By attending the workshop, the students can be able to perform different projects under "Project based Learning", Mini as well as Major projects, as part of the curriculum. Further, the students will gain knowledge on hardware design related issues.

Sr. No.	Workshop Outcome	PO	PSO
1	Understand the steps involved in schematic, layout, fabrication and assembly process of PCB design	PO1, PO2, PO3, PO4, PO10	PSO1, PSO2
2	Design (schematic and layout) and fabricate PCB for simple circuits.	PO1, PO2, PO3, PO4, PO5, PO10	PSO3

Programme Co-Ordinator	Asst. Prof. S. V. Malge (E&TC) BSIOTR	
ETSA Co-Ordinator	Asst. Prof. Meenakshi Annamalai (E&TC) BSIOTR	A. Meenakshi
Programme Convenor	Dr. Y. S. Angal, HOD (E&TC), BSIOTR	H. O. D. Electronics & Telecommunication Dep Bhivarabai Sawant Institute of Technology & Research Wagholi, Pune- 412 207
Principal	Dr. T. K. Nagaraj, Principal, BSIOTR	

PRINCIPAL
J.S.P.M 'S Bhivarabai Sawant Institute of Technology & Research Wagholi, Pune-

Date: 03/06/2022

MEMORANDUM OF UNDERSTANDING

Smart Logic Technologies,
A3/402, Shriyash Garden
Survey No. 35/5, Mohannagar,
Dhankawadi, Pune - 411043

--------- Here-in after referred as **SLT.**

AND

JSPM's Bhivarabai Sawant Institute of Technology & Research,
Wagholi- Pune,
Dist: Pune
Maharashtra, INDIA

--------- Here-in after referred as **BSIOTR.**

Introductory:

About Smart Logic Technologies, Pune

Smart Logic Technologies, established in 2012, is engaged in Business, Manufacturing, Skill Development, Education and R&D Services in the fields of – ***Embedded Systems, Internet of Things and VLSI Technology.***

Smart Logic Technologies have outsized range of microcontroller development boards, VLSI Development Boards, IoT Development Boards, Electronic trainer kits which can be utilized by engineering colleges so that the students learn emerging technologies. Smart Logic Technologies provides their expertise to various electronics companies for their product development. Smart Logic Technologies also work in an area of corporate training dealing various hot trends in technologies. Smart Logic Technologies have an expertise in System Design, Firmware Development, and Hardware debugging and Technical Documentation. We at Smart Logic Technologies, Pune trained the students by providing live internship to the students and by providing them an opportunity to work on the problems of the industries.

About JSPM's Bhivarabai Sawant Institute of Technology & Research, Wagholi- Pune

The College was established in year 2009, approved by AICTE, New Delhi & Affiliated to Savitribai Phule Pune University, Maharashtra, an institution with a vigorous past, a dynamic present and brilliant future.

We offer a world of opportunities to students with modern educational philosophy and experienced faculty members. Our institution includes strong engineering foundation design to prepare engineers with a broad base of technical knowledge and personality. Presently offers undergraduate programs in four disciplines like Computer Engineering, Electronics & Telecommunication, Electrical Engineering, Information Technology and Mechanical Engineering.

- ***Benefits to the Institute:***

1. Academic ☐ 2. Projects ☐ 3. Internship ☐
4. Workshop ☐ 5. Research ☐ 6. Entrepreneurship Development ☐

It is mutually agreed by Smart Logic Technologies, Pune and BSIOTR Wagholi that this MOU is to bridge the gap between the industry and the academia, empowering professionals as Entrepreneurs and enrich young talent pool from BSIOTR, by enhancing their technical competencies to match the industry requirements.

BSIOTR, and Smart Logic Technologies have identified certain forefront areas to carry out joint work as follow:

ARTICLE-I: SCOPE AND TERMS OF INTERACTIONS

Both BSIOTR and SMART LOGIC TECHNOLOGIES shall encourage interactions between the Engineers, Scientists, Research fellows, faculty members and students of both the organizations through the following arrangements:

a) Exchange of personnel through deputation as per the rules of the respective institute, for limited periods as mutually agreed upon;
b) Organization of joint conferences and seminars;
c) Practical training of BSIOTR students at SMART LOGIC TECHNOLOGIES;
d) Joint guidance of student projects/thesis and other areas of national interest at BSIOTR by SMART LOGIC TECHNOLOGIES on mutually agreeable terms.
e) SMART LOGIC TECHNOLOGIES would accommodate students who have completed the 6th semester of their program in such a number that SMART LOGIC TECHNOLOGIES deems convenient to it for the purpose of imparting industrial training.
f) SMART LOGIC TECHNOLOGIES may depute its personnel as visiting faculty at BSIOTR to teach any of the regular Course or specialized topics.

g) SMART LOGIC TECHNOLOGIES personnel, as well as research scholars, may also be allowed to enroll for their Ph.D./M.Tech. (Research) at BSIOTR, subject to availability of seats, research facilities and subject to their fulfilling eligibility criteria and all other academic regulations of BSIOTR. Further, SMART LOGIC TECHNOLOGIES may request to design and teach a Course or Courses which it deems fit to enhance quality and performance of its employees. Such Courses maybe run at any mutually convenient premises.

h) SMART LOGIC TECHNOLOGIES may seek assistance/guidance of BSIOTR faculty member/s in product/process modification, modernization, trouble shooting, etc.

i) Would allow the industrial visits of students for half/full day to provide them with an exposure to various equipment, instrument, etc.

j) SMART LOGIC TECHNOLOGIES may showcase its business activities at the seminar/workshop/conference, etc. at BSIOTR.

k) SMART LOGIC TECHNOLOGIES may avail library, Internet, computational facilities at BSIOTR.

l) Post-graduate student will be allotted a Research supervisor from BSIOTR faculty members. A Research Scientist/Engineer at SMART LOGIC TECHNOLOGIES may be appointed a Co-research guide as per the rules of the respective institute for a student Registered for Ph.D/ M.Tech (Regular or Research) degree at BSIOTR. The student maybe encouraged to take up the project such that SMART LOGIC TECHNOLOGIES desirably benefits from its outcomes.

m) The students will carry out part of their Ph.D. research work or M.Tech./B.Tech. project at BSIOTR and SMART LOGIC TECHNOLOGIES depending on the nature of the work as per rules of the respective institute depending on facilities and requirements.

n) Research supervisors from both the Institutes will be the corresponding authors in any publication resulting from the collaborative work. All the efforts put by the student/s as a part of this MoU will be accounted for by way of reporting the work in thesis and/or paper publication except the part for which IPR needs be claimed.

o) Neither of the supervisors will publish the work carried out under this MoU without knowledge of the other.

p) In any of the activities mentioned above, wherever financial aspects are involved, amount, payment conditions, etc. would be spelt out clearly before starting the activity.

q) There will be no restriction on the contents of the thesis and on publication of results of the thesis, subject to the condition that no Intellectual Property Rights can be secured for any part of the work which will be decided with mutual consent. Both BSIOTR and SMART LOGIC TECHNOLOGIES will be free to independently carry out follow-up research on the thesis work conducted under this scheme.

ARTICLE-II: CO-ORDINATION OF THE PROGRAMME INCLUDING FINANCIAL ARRANGEMENTS

a) The collaborative program between BSIOTR and SMART LOGIC TECHNOLOGIES shall be coordinated by a coordination committee appointed by Directors of both the Institutes.

b) Financial arrangements for each specific collaboration will be decided on a case-to-case basis and brought on record in each case after due approval from heads of both the Institutions.

ARTICLE-III: EFFECTIVE DATE AND DURATION OF MOU

a) This MOU shall be effective from the date of its approval by competent authorities at both ends.

b) The duration of the MOU shall be for a period of 5 years from the effective date.

c) During its tenancy, the MOU may be extended or terminated by a prior notice of not less than six months. However termination of the MOU will not in any manner affect the interests of the students/faculty/scientists who have been admitted to pursue a program under the MOU.

d) Any clause or article of the MOU may be modified or amended by mutual agreement of SMART LOGIC TECHNOLOGIES and BSIOTR.

ARTICLE-IV: CONFIDENTIALITY

During the tenure of the MOU both BSIOTR and SMART LOGIC TECHNOLOGIES will maintain strict confidentiality and prevent disclosure of all the information and data exchanged under the scope of this MOU for any purpose other than in accordance with this MOU.

Both BSIOTR and SMART LOGIC TECHNOLOGIES shall bind their respective personnel who come into possession or knowledge of any confidential information not to disclose the same to third parties without written approval of the disclosing party or use such confidential information for any use other than intended under this agreement or PROJECTS.

Further both BSIOTR and SMART LOGIC TECHNOLOGIES shall put in place adequate and reasonable measures to keep and store confidential information secure so as to prevent any unauthorized use.

ARTICLE-V: AMENDMENTS

Any amendment and/or addenda to the AGREEMENT shall be in writing and signed by the PARTIES hereto and shall only after such execution be deemed to form part of the AGREEMENT and have the effect of modifying the AGREEMENT to the extent required by such amendment or addenda.

ARTICLE-VI: RESOLUTION OF DISPUTES

a) This agreement shall take effect and be construed in accordance with the Laws of India and be subject to the jurisdiction of the courts at PUNE.

ARTICLE-VII: MISCELLANEOUS

a) The headings and sub-headings are inserted for convenience only and shall not affect the construction of this Agreement.
b) Both BSIOTR and SMART LOGIC TECHNOLOGIES shall not, during the term of this Agreement directly or indirectly, solicit or offer employment or engagement to any of the personnel of other party.
c) No failure to exercise and no delay in exercising, on the part
d) After this Agreement has been signed, all preceding understandings / negotiations and correspondence pertaining to it shall become null and void.

IN WITNESS WHEREOF PARTIES HERE TO HAVE ENTERED INTO THIS AGREEMENT EFFECTIVE AS ON THE DATE AND YEAR FIRST WRITTEN ABOVE.

Smartlogic Technologies Pune-43

Shridhar

Mr. Shridhar Sudarshan Dudam
Chief Technology Officer,
Smart Logic Technologies, Pune

PRINCIPAL
Shri. Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune-412 207

Sawant Institute of Technology & Research Wagholi, Pune - 412 207

Dr. T. K. Nagaraj
Principal
JSPM'S BSIOTR, Wagholi, Pune

Witness:

1. Mr. Prashant Suter 03/06/2022
(Engineer, Smart Logic Technologies)

Patil

2. Mr. Nitesh Patil
(Engineer, Smart Logic Technlogies)

Witness:

1. Dr. Y. S. Angal 03/06/2022
(HOD Department of E&TC)

H.O.D. Electronics & Telecommunication Dept.
Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune- 412 207

2. Dr. A. L. Wannare
Professor

Wannare 03/06/22

Date: 03/06/2022

Report on
One Day Workshop on "Modernized IoT"

at

Department of Electronics and Telecommunication Engineering
Bhivarabai Sawant Institute of Technology & Research Wagholi, Pune

Name of The Programme	**One Day Workshop On "Modernized IoT"**
Date	4-10-2023
Mode	Offline
Organizer	Electronics and Telecommunication Student's Association (ETSA). Department of Electronics and Telecommunication Engineering of Bhivarabai Sawant Institute of Technology & Research Wagholi, Pune
Association with	IETE Students Forum (ISF) BSIOTR
Programme Convenor	Dr. Y. S. Angal, HOD (E&TC)
Programme Co-Ordinator	Asst. Prof. S. V. Malge (E&TC)
Resource Person	Mr. D. Shridhar, Smart Logic Technologies, Pune
Participants	24 Participants

The "Exploring the Modernized IoT" workshop is a comprehensive and interactive learning experience designed to introduce participants to the exciting world of IoT and empower them to leverage its potential in various domains. In this workshop, attendees will dive into the fundamental concepts, applications, and challenges of IoT, gaining valuable insights into the interconnected devices that shape our modern world.

Workshop Objective:

Sr. No.	Workshop Objective
1	To introduce the fundamentals of sensors and actuators along with the basic concepts of an IoT
2	To Exposing students to the usage of Protocol Standardization for IoT with IoT Edge and Gateway Network with Communication protocols.
3	Hand-on session of various IoT boards, interfacing, and programming for IoT.

In this workshop IoT concepts is introduced to the participants and then the majority of the workshop will include hands-on exercises covering different types of sensors, Wi-Fi modules, Zigbee, Arduino kits, raspberry pi, beagle bone board, different types of actuators and cloud. The workshop is a laboratory-based course, where the trainer is personally involved with the participants to deliver value for the time spent. Additionally, the trainer is working as IoT experts and consultants in the industry. The key facilitator for this course is Mr. D. Shridhar.

JSPM's

BHIVARABAI SAWANT INSTITUTE OF TECHNOLOGY AND RESEARCH,

WAGHOLI, PUNE, MAHARASHTRA 412207 (BSIOTR)

NBA & NAAC Accredited

Department of Electronics & Telecommunication Engineering

Organized By

Electronics & Telecommunication Students' Association (ETSA)

In Association with

IETE Students' Forum (ISF) BSIOTR

TOPIC :-

One day workshop on "Modernized IoT"

By D. Shridhar, Smart Logic Technologies, Pune

Date :- 04/10/2023

Day :- Wednesday

Timings:- 11.45 AM

Venue :- Class room no.203, E&TC Department, D2 Building

Workshop Outcome:
This Workshop aims at providing an opportunity for participants to enrich their knowledge and skill in developing various solutions for solving engineering problems in the society. This workshop serves as a platform for students to interact on cutting-edge technologies in IoT.

Sr. No.	Workshop Outcome	PO	PSO
1	Comprehend and analyze concepts of sensors, actuators, IoT and IoE.	PO1, PO2, PO3, PO4, PO5, PO6, PO7	PSO1, PSO2, PSO3
2	Comprehend the operation of IoT protocols	PO1, PO2, PO3, PO4, PO5, PO6, PO7	PSO1, PSO2, PSO3
3	Describe various IoT boards, interfacing, and programming for IoT.	PO1, PO2, PO3, PO4, PO5, PO6, PO7	PSO1, PSO2, PSO3

Programme Co-Ordinator	Asst. Prof. S. V. Malge (E&TC) BSIOTR	
Programme Convenor	Dr. Y. S. Angal, HOD (E&TC), BSIOTR	
Principal	Dr. T. K. Nagaraj, Principal, BSIOTR	

DOLPHIN LABS EMBEDDED SYSEMS (OPC) PVT. LTD.
REGD OFFICE: Sn 12/2 Fl 301, Himanshu Cons Tulja Bhavaninagar, Narhe Pune 411041
Work Address: Third Floor, Malvika Arcade, Vetalbuva Chauk, Narhe, Pune- 411041
CIN: U72900PN2023OPC217773 GST: 27AAJCD8072F1ZG
E-mail: dolphinlabs17@gmail.com Mobile: 7276028051

Date- 19/04/2022

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU) is made between the

DOLPHIN LABS,

Dolphin Labs Embedded Systems (opc) Pvt. Ltd.
Third Floor, Malvika Arcade, Vetalbuva Chauk, Narhe , Pune – 411041.
Maharashtra, INDIA. 422011

AND

JSPM's Bhivarabai Sawant Institute of Technology & Research,
Wagholi- Pune
Dist: Pune
Maharashtra, INDIA

--------- **Here-in after referred as BSIOTR.**

Introductory:

About Dolphin Labs, Pune

Dolphin Labs is an Technical educational institution that offers various hands on workshops and programs for students to help them explore and learn about state of art fields of science and technology.

This programs and hands on workshops are specifically designed for students who are interested in hi tech projects, allowing them to gain hands-on experience in this field. Dolphin Labs's programs and workshops are a great opportunities for students to learn and explore the exciting world of Technology and Science.

"TechnoSkillVarsity" is the leading brand launched by "Dolphin Labs" Pune to provide Embedded system related state of art training programs. Our expert faculties and specially designed curriculum ensure that students receive the best hand on and practical oriented training. We offer a range of courses designed to meet the needs of industries at all levels of expertise. At TechnoSkillVarsity, we are committed to providing our students with the skills and knowledge they need to succeed in the industry.

About JSPM's Bhivarabai Sawant Institute of Technology & Research, Wagholi- Pune

The College was established in year 2009, approved by AICTE, New Delhi & Affiliated to Savitribai Phule Pune University, Maharashtra, an institution with a vigorous past, a dynamic present, and brilliant future. We offer a world of opportunities to students with modern educational philosophy and experienced faculty members. Our institution includes strong engineering foundation design to prepare engineers with a broad base of technical knowledge and personality. Presently offers undergraduate programs in four disciplines like Computer Engineering, Electronics & Telecommunication, Electrical Engineering, Information Technology and Mechanical Engineering.

1. Benefits to the Institute:

1. Academic ☐	2. Projects ☐	3. Internship ☐
4. Workshop ☐	5. Research ☐	6. Entrepreneurship Development ☐

It is mutually agreed by **Dolphin Labs, Pune** and **BSIOTR Wagholi** that this MOU is to bridge the gap between the industry and the academia, empowering professionals as Entrepreneurs and enrich young talent pool from **BSIOTR,** by enhancing their technical competencies to match the industry requirements.

BSIOTR, and Dolphin Labs Academy of skill development Technology have identified certain forefront areas to carry out joint work as follow:

1. Conduction of Expert lecture/ Seminar to the students on the core area.
2. Conduction of Hands-on practice workshop for students to develop their skills in the core area.
3. Organizing Industrial Visit to the core Industry.
4. Internship for students in winter/ summer vacation.
5. Conduction of Entrepreneurship Development Camps for **BSIOTR** Students.
6. Developing Entrepreneurship Centre to develop students as a Entrepreneur.
7. Developing a Centre of Maintenance and Repairs of Electric domestic/ industrial appliances to provide service to the college and society.
8. Developing a domestic/ commercial/ industrial product, its manufacturing and marketing in entrepreneurship development of **BSIOTR** students.
9. Guidance and help for Mini Projects.
10. Allotment of industry need based project work and its guidance to **BSIOTR** final year students.
11. Providing necessary platform to carry out the projects at industry.
12. Sponsoring the technical events and symposiums conducted at **BSIOTR.**
13. Conduction of virtual campus interview for students.

TERMS AND CONDITIONS

1. This MOU shall be effective from the date it is executed by or on behalf of both the parties. In witness whereof, both the parties hereto have executed this MOU in duplicate on the day and the year herein under indicated.
2. All the activities shall be planned and arranged at the discretion and with the prior consent of both the parties.
3. Both the parties reserve the discretion of deciding their area of interest. This understanding between the two parties is non-exclusive.
4. Either party may terminate this agreement with a notice of 60 days to other party.
5. The MOU would be revised at the end of 5 Years from the date of signing.
6. The infrastructural arrangement for conducting training program, workshop and guest lectures will be made by the host organization at the time of event.
7. BSIOTR will not charge any amount against infrastructure used during Workshop and Training.
8. Placement of the students will be as per the requirement, terms and condition of the companies.

For and on behalf of

Dolphin Labs,
Dolphin Labs Embedded Systems (opc) Pvt. Ltd.

(Mr. Chittaranjan Mahajan)
Director
Dolphin Labs Embedded Systems (opc) Pvt. Ltd
Third Floor, Malvika Arcade,
Vetalbuva Chauk, Narhe , Pune – 411041.
Maharashtra, INDIA. 422011

Place- Wagholi Dist.- Pune
Date- 19/04/2022

DOLPHIN LABS EMBEDDED SYSTEMS (OPC) PVT. LTD ★ PUNE

JSPM's Bhivarabai Sawant Institute of , Technology & Research, Wagholi, Pune

(Dr. T. K. Nagraj)
Principal
JSPM's B.S. I.O.T.R, Wagholi- Pune
Wagholi Dist.- Pune

PRINCIPAL
Bhivarabai Sawant Institute Of Technology & Research
Wagholi, Pune- 412207.

Bhivarabai Sawant Institute Of Technology & Research ★ Wagholi, Pune- 412207. ★
BSIOTR
EN: 6311
Wagholi

Date- 19/04/2022

In presence of

Prof. Dr. Yogesh Angal
HoD E&TC Department
BSIOTR Wagholi- Pune
Date- 19/04/2022

H. O. D.
Electronics & Telecommunication Dep.
Bhivarabai Sawant Institute of
Technology & Research
Wagholi, Pune 412 207

Prof. Yogesh Bahendwar
T & P Co-ordinator
BSIOTR Wagholi- Pune
Date- 19/04/2022

JSPM's BHIVRABAI SAWANT INSTITUTE OF TECHNOLOGY AND RESEARCH
Wagholi,Pune.

Department of Electronics & Telecommunication Engineering
(NAAC and NBA Accredited)
A report on
Industrial Visit to Dolphin Labs R & D Center, Narhe. Pune.

Date of Conduction	10/07/2023
ETSA Coordinator	Prof. Meenakshi A
Faculty Coordinators	Prof. Sneha D.Dhere, Prof. Poonam V. Gawade, Prof. M.S.Sonune and Prof. A.V.Gunjale
ETSA Student Presidents	Gole Aishwarya (BE) & Aekagra Dhamani (BE)
Students Participated	45 (E&TC Dept.)

Objectives of this event:

S.No.	Objectives	Alligned PO's
1.	To know theories, they learn in the classroom being applied in real-life settings.	PO-1, PO-2, PO-3
2.	To acquire and apply fundamental principles of science and engineering.	PO-5, PO-6,PO-8, PO-12
3.	To enhance their skills-set in the area of their expertise	PO-8, PO-9, PO-10, PO-12

JSPM's Bhivarabai Sawant Institute of Technology and Research, Wagholi (E&TC Dept) had organized an Industrial Visit on 10th July, 2023.

The Industrial visit was carried out at Dolphin Labs, Pune on 10th July, 2023 for Semester V and VII Electronics and Telecommunication Engineering Students. Prof. Sneha Dhere, Prof. Poonam Gawde, Prof. Manoj Sonawane and Prof. Aniket Gunjal along with 42 students visited Dolphin Lab Pune.

Students observed various Electronic components like ARDUINO, Raspberry Pie, Microcontroller, various sensors, motors, PCB and types, various input output components like Fan, LEDS, Buzzers, project models, IOT devices etc
The company has been started by the joint collaboration of industrial professionals and consultants. Incepted in the year 2013, They provide manufacturer, trader, service provider

...uation
...nkawadi, Pune-41...
e-mail: jadhav...

and supplier of Microcontroller Board, Arduino and Shields, Raspberry Pi, Quadcopter Parts, Remote and Control Boards, R and D Service for VLSI and Embedded System, Training Services of VLSI and Embedded System etc. Bridging the gap between academic methodologies and industrial needs is high. Along with the manufacturing of training and development products, they are also pioneers in the publication of lucid technical literature. As a training center at Dolphin Labs are focusing on building workforce skill and offer various products and solutions in embedded technology.

We started travelling from the college campus at 9:00 am by our college bus on 10th July 2023 along with our staff coordinators. We reached to the Dolphin Labs at 11:00 am .

Photo: Begin journey from campus to Dolphin Labs

Photo : Electronics components explanation by Prof. Mahajan and Dolphin Lab

Photo: Prof. Mahajan, Prof. M. S. Sonawane, Prof. S. D. Dhere, Prof. P. V. Gawade, Prof. A.V. Gunjal at Dolphin Labs with students of TE and BE E&TC

A. Meenakshi
ETSA Coordinator

Department Of Electronics And Telecommunication Engineering
ETSA
BSIOTR
631/472/0

Dr. Y.S.Angal
H.O.D. E&TC
Electronics & Telecommunication Dept
Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune-412207

Dr. T.K.Nagaraj
Principal
PRINCIPAL
Bhivarabai Sawant Institute Of Technology & Research
Wagholi, Pune- 412207.

NEESHIONICS

• Educational Trainers • Process Automation • Custom Design & Consultation

"NEELAM", 26, Swati Society Dhankawadi, Pune-411 043
M: 9422029292 e-mail: jadhavssj@gmail.com

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MOU) is made between

JSPM's

Bhivarabai Sawant Institute Of Technology & Research
Wagholi- Pune

And

M/S Neeshionics
Dhanakwadi, Pune

PREAMBLE:

Whereas, JSPM'S Bhivarabai Sawant Institute of Technology And Research (BSIOTR) Wagholi, Pune at its various engineering and sciences departments is charged with responsibility of training technical and scientific manpower in various front-line areas of importance for the Nation and is also contributing to the rapidly growing scientific and technological knowledge and professional excellence in Science & Technology by undertaking industrial & applied research and consultancy.

Whereas, M/S NEESHIONICS, Dhankawadi, Pune is engaged in manufacturing/developing of High Tech and Value Added Educational Training Equipment's, Research, Design and Development and Consultancy in the field of Instrumentation and Automation of Industrial Process and customer required test setups in the related fields.

WHEREAS, both BSIOTR and NEESHIONICS, now Recognizing the importance of research and development in the areas of Industrial Automation, as well as imparting industrial training to the engineering/technology/sciences students, etc.

- Appreciating the need for creation of large reservoir of highly qualified manpower in all fields related to Industrial Automation,

-Desiring to club their efforts by pooling their expertise and resources,

INTEND to form a nucleus for promoting excellent quality manpower in the fields of engineering, technology and sciences with special emphasis on Technical Training in industrial Automation and related fields etc.

NOW, THEREFORE, in consideration of the mutual promises made herein and of good and valuable consideration, the receipt and sufficiency of which both BSIOTR and NEESHIONICS hereby acknowledge and agree to sign a memorandum of understanding (MOU).

ARTICLE-I: SCOPE OF THE MOU

This MOU details the modalities and general conditions regarding collaboration between BSIOTR and NEESHIONICS for enhancing, within the country, the availability of highly qualified manpower in the areas of Industrial Automation without any prejudice to prevailing rules and regulations in BSIOTR and NEESHIONICS without any disregard to any mechanism evolved and approved by the competent authorities under Govt. of India in so far as such mechanism applies to BSIOTR and NEESHIONICS. The areas of cooperation can be extended through mutual consent.

ARTICLE-II: SCOPE AND TERMS OF INTERACTIONS

Both BSIOTR and NEESHIONICS shall encourage interactions between the Engineers, Scientists, Research fellows, faculty members and students of both the organizations through the following arrangements:

a) Exchange of personnel through deputation as per the rules of the respective institute, for limited periods as mutually agreed upon;

b) Organization of joint conferences and seminars;

c) Practical training of BSIOTR students at NEESHIONICS;

d) Joint guidance of student projects/thesis and other areas of national interest at BSIOTR by NEESHIONICS on

g) NEESHIONICS personnel, as well as research scholars, may also be allowed to enrol for their Ph.D./M.Tech. (Research) at BSIOTR, subject to availability of seats, research facilities and subject to their fulfilling eligibility criteria and all other academic regulations of BSIOTR. Further, NEESHIONICS may request to design and teach a Course or Courses which it deems fit to enhance quality and performance of its employees. Such Courses maybe run at any mutually convenient premises.

h) NEESHIONICS may seek assistance/guidance of BSIOTR faculty member/s in product/process modification, modernization, trouble shooting, etc.

i) Would allow the industrial visits of students for half/full day to provide them with an exposure to various equipment, instrument, etc.

j) NEESHIONICS may showcase its business activities at the seminar/workshop/conference, etc. at BSIOTR.

k) NEESHIONICS may avail library, Internet, computational facilities at BSIOTR.

l) Post-graduate student will be allotted a Research supervisor from BSIOTR faculty members. A Research Scientist/Engineer at NEESHIONICS may be appointed a Co-research guide as per the rules of the respective institute for a student Registered for Ph.D/ M.Tech (Regular or Research) degree at BSIOTR. The student maybe encouraged to take up the project such that NEESHIONICS desirably benefits from its outcomes.

m) The students will carry out part of their Ph.D. research work or M.Tech./B.Tech. project at BSIOTR and NEESHIONICS depending on the nature of the work as per rules of the respective institute depending on facilities and requirements.

q) Research supervisors from both the Institutes will be the corresponding authors in any publication resulting from the collaborative work. All the efforts put by the student/s as a part of this MoU will be accounted for by way of reporting the work in thesis and/or paper publication except the part for which IPR needs be claimed.

r) Neither of the supervisors will publish the work carried out under this MoU without knowledge of the other.

s) In any of the activities mentioned above, wherever financial aspects are involved, amount, payment conditions, etc. would be spelt out clearly before starting the activity.

n) There will be no restriction on the contents of the thesis and on publication of results of the thesis, subject to the condition that no Intellectual Property Rights can be secured for any part of the work which will be decided with mutual consent.

0) Both BSIOTR and NEESHIONICS will be free to independently carry out follow-up research on the thesis work conducted under this scheme.

ARTICLE-III: CO-ORDINATION OF THE PROGRAMME INCLUDING FINANCIAL ARRANGEMENTS

a) The collaborative program between BSIOTR and NEESHIONICS shall be coordinated by a coordination committee appointed by Directors of both the Institutes.

b) Financial arrangements for each specific collaboration will be decided on a case-to-case basis and brought on record in each case after due approval from heads of both the Institutions.

c) During its tenancy, the MOU may be extended or terminated by a prior notice of not less than six months. However termination of the MOU will not in any manner affect the interests of the students/faculty/scientists who have been admitted to pursue a program under the MOU.

d) Any clause or article of the MOU may be modified or amended by mutual agreement of NEESHIONICS and BSIOTR.

ARTICLE-V: CONFIDENTIALITY

During the tenure of the MOU both BSIOTR and NEESHIONICS will maintain strict confidentiality and prevent disclosure of all the information and data exchanged under the scope of this MOU for any purpose other than in accordance with this MOU.

Both BSIOTR and NEESHIONICS shall bind their respective personnel who come into possession or knowledge of any confidential information not to disclose the same to third parties without written approval of the disclosing party or use such confidential information for any use other than intended under this agreement or PROJECTS. Further both BSIOTR and NEESHIONICS shall put in place adequate and reasonable measures to keep and store confidential information secure so as to prevent any unauthorized use.

ARTICLE-VI: AMENDMENTS

Any amendment and/or addenda to the AGREEMENT shall be in writing and signed by the PARTIES hereto and shall only after such execution be deemed to form part of the AGREEMENT and have the effect of modifying the AGREEMENT to the extent required by such amendment or addenda.

ARTICLE-VII: RESOLUTION OF DISPUTES

a) This agreement shall take effect and be construed in accordance with the Laws of India and be subject to the jurisdiction of the courts at PUNE.

ARTICLE-VIII: MISCELLANEOUS

a) The headings and sub-headings are inserted for convenience only and shall not affect the construction of this Agreement.

b) Both BSIOTR and NEESHIONICS shall not, during the term of this Agreement directly or indirectly, solicit or offer employment or engagement to any of the personnel of other party .

c) No failure to exercise and no delay in exercising, on the part

i) Barty, and right, remedy,power or privilege hereunder shall operate as a waiver thereof, nor shall any single or partial exercise of any right, remedy, power or privilege hereunder preclude any other or further exercise thereof or the exercise of any other right, remedy, power or privilege. The rights, remedies, power and privileges herein provided are cumulative and not exclusive of any right, remedies, powers and privileges provided by law.

d) After this Agreement has been signed, all preceding understandings / negotiations and correspondence

IN WITNESS WHEREOF PARTIES HERE TO HAVE ENTERED INTO THIS AGREEMENT EFFECTIVE AS ON THE DATE AND YEAR FIRST WRITTEN ABOVE.

NEESHIONICS * DHANKAWADI, PUNE

SHIVAJI JADHAV

Proprietor

NEESHIONICS

Bhivarabai Sawant Institute of Technology & Research, Wagholi, Pune - 412 207

Dr. T. K. Nagaraj

Principal

PRINCIPAL

JSPM'S BSIOTR, Wagholi, Pune

JSPM'S Bhivarabai Sawant Institute of Technology & Research, Wagholi, Pune- 412207

Witness:

Dilip

1. **Dilip Gadekar**

Date: 05/01/2022

Witness:

05/01/2022

1. **Dr. Y. S. Angal**

(HOD Department of E&TC)

H.O.D. Electronics & Telecommunication Dep, Bhivarabai Sawant Institute of Technology & Research, Wagholi, Pune- 412 207

2. **Dr. A. L. Wannare**

Professor

05/01/2022

Date: 05/01/2022

JAYAWANT SHIKSHAN PRASARAK MANDAL's
Bhivarabai Sawant Institute of Technology & Research
(Approved by AICTE, NEW Delhi, Govt. of Maha & Affiliated to Pune university)
GAT.NO.720 (1), WAGHOLI, PUNE-NAGAR ROAD, PUNE-412207.
TEL.NO.(020)27051170 FAX.NO.(020)27052990

Date: 28/09/2022

Department of Electronics & Telecommunication

Objective	Faculty and Student guidance for Allan Bradly PLC MICROLIGIX 1500
Date of Conduction	28 / 09/ 2022
Resource Person	Shri. Shrivaji rao Jadhav, Director Neeshionins, Pune.
Coordinator	Dr. Y. S. Angal / Prof. N. A. Mohota
Venue	E&TC Dept. (203)
Outcome	Students were able to understand that: 1) Automation is the use of Machines, Control Systems and Information Technology to optimize productivity in the production of goods and delivery services.[PO5,PO6] 2) The correct incentive for applying automation is to increase productivity with quality.[PO6,PO7] 3) Each and every process requires the need of certain specific instruments for their control.[PO4,PO5] 4) Without knowledge of instrumentation automation cannot be applied.[PO12]

A one day workshp was organized by the department of Electronics & Telecommunication under the Memorendum of Understanding by Neeshionics Industry, for Allan Bradly PLC MICROLIGIX 1500 for which the expert was Mr. Shrivaji rao Jadhav, Director Neeshionins, Pune, who has accepted our invitation for the same. Dr. Y. S. Angal in his speech welcomed the guest and briefed about the importance of automation.

The following things were covered in the workshop

1) PLC Lab Set Up and Maintenance
2) Faculty and Student guidance for Allan Bradly PLC MICROLIGIX 1500
3) Training to Students for PLC Programming
4) Guidance to the faculty members for PLC Installation and Commissioning.

Mr. Shrivaji rao Jadhav has explained the concept through real life examples like Home Automation and Industrial Automation, to name a few. He had also given the knowledge of

SCADA and Programmable Logic Controller (PLC) to the students in his interaction with them. At last he explained the students about the growing demand of automation engineers in industry.

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PLC Lab Training and Guidance

Participated Students got benefit due to real time implementation, installation and Commissioning of PLC. Use of Micrologix 1500 and its programming Concept part,
The event was concluded with vote of thanks.

Prof. N. A. Mohota
TPC

Dr. Y. S. Angal
HoD

PRINCIPAL
JSPM's Bhivarabai Sawant Institute of Technology and Research
Wagholi, Pune- 412 207

JSPM's Bhivarabai Sawant Institute of Technology & Research, Wagholi, Pune (412207)

CRITERION 1 - CURRICULAR ASPECTS

1.3
Curriculum Enrichment

1.3.2

Number of courses that include experiential learning through project work/field work/internship during the year

DEPARTMENT OF ELECTRICAL ENGINEERING

Savitribai Phule Pune University, Pune

Faculty of Science and Technology

Board of Studies

Electrical Engineering

Syllabus

Second Year Electrical Engineering

(2019 Course)

(w.e.f. AY: 2020-21)

Savitribai Phule Pune University

Syllabus: Second Year (SE) Electrical Engineering (2019 Course) w.e.f. AY:2020-2021

SEMESTER-I

Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks						Credits			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
207006	Engineering Mathematics-III	03	--	--	30	70	--	--	--	**100**	03	--	--	**03**
203141	Power Generation Technologies	03	--	--	30	70	--	--	--	**100**	03	--	--	**03**
203142	Material Science	03	04#	--	30	70	25	--	25	**150**	03	02	--	**05**
203143	Analog and Digital Electronics	03	02	--	30	70	--	50	--	**150**	03	01	--	**04**
203144	Electrical Measurement & Instrumentation	03	04#	--	30	70	25	25	--	**150**	03	02	--	**05**
203150	Applications of Mathematics in Electrical Engineering	--	02*	--	--	--	25	--	--	**25**	--	01	--	**01**
203151	Soft Skill	--	02	--	--	--	25	--	--	**25**	--	01	--	**01**
203152	Audit Course-III	--	--	--	--	--	--	--	--	**--**	**Grade: PP/NP**			
Total		**15**	**14**	**--**	**150**	**350**	**100**	**75**	**25**	**700**	**15**	**07**	**--**	**22**

SEMESTER-II

Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks						Credits			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
203145	Power System-I	03	--	--	30	70	--	--	--	**100**	03	--	--	**03**
203146	Electrical Machines-I	03	02	--	30	70	--	50	--	**150**	03	01	--	**04**
203147	Network Analysis	03	02	--	30	70	25	--	--	**125**	03	01	--	**04**
203148	Numerical Methods & Computer Programming	03	02	--	30	70	--	25	--	**125**	03	01	--	**04**
203149	Fundamental of Microcontroller and Applications	03	04$	--	30	70	25	--	25	**150**	03	02	--	**05**
203152	Project Based Learning	--	04	--	--	--	50	--	--	**--**	--	02	--	**--**
203153	Audit Course-IV	--	--	--	--	--	--	--	--	**--**	**Grade: PP/NP**			
Total		**15**	**14**	**--**	**150**	**350**	**100**	**75**	**25**	**700**	**15**	**07**	**--**	**22**

* - Lab sessions on application of Mathematics in Electrical Engineering using professional software.

\# - Practical section will comprises of two Part : a) PART A : 2 hours per week : Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory b) PART B : 2 Hours a week :Practical/case studies/assignments to enable active learning based on advances related to subject to bridge gap between curriculum and enhance practical knowledge required in field .

$ - Practical section will comprises of two Part : a) PART A : 2 hours per week : Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory b) PART B : 2 Hours a week : IOT application in Electrical Engineering using microcontroller and GSM module to bridge gap between curriculum and enhance application knowledge.

Abbreviation: TH: Theory, PR: Practical, TUT:Tutorial, ISE: Insem Exam, ESE: End Sem Exam, TW: Term Work, OR: Oral

207006: Engineering Mathematics-III

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week	**Th**: 03	**In Sem** : 30 Marks **End Sem** : 70 Marks

Prerequisites: - Differential & Integral calculus, Taylor series, Differential equations of first order and first degree, Fourier series, Collection, classification & representation of data, Vector algebra and Algebra of complex numbers.

Course Objectives:

To make the students familiarize with concepts and techniques in Ordinary differential equations, Laplace transform, Fourier transform & Z-transform, Statistics & Probability, Vector Calculus and functions of a Complex Variable. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

Course Outcomes: At the end of this course, students will be able to:

CO1:Solve higher order linear differential equation using appropriate techniques to model and analyze electrical circuits.

CO2: Apply Integral transforms such as Laplace transform, Fourier transform and Z-Transform to solve problems related to signal processing and control systems.

CO3: Apply Statistical methods like correlation, regression and Probability theory as applicable to analyze and interpret experimental data related to energy management, power systems, testing and quality control.

CO4: Perform Vector differentiation and integration, analyze the vector fields and apply to wave theory and electro-magnetic fields.

CO5: Analyze Complex functions, conformal mappings, and perform contour integration in the study of electrostatics, signal and image processing.

Unit I: Linear Differential Equations (**LDE**) and Applications (08Hours)

LDE of n^{th} order with constant coefficients, Complementary Function, Particular Integral,General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE. Modeling of Electrical circuits.

Unit II: Laplace Transform (**LT**) (07Hours)

Definition of LT, Inverse LT, Properties & theorems, LT of standard functions, LT of some special functions viz. Periodic, Unit Step, Unit Impulse. Applications of LT for solving Linear differential equations.

Unit III: Fourier and Z - transforms (08 Hours)

Fourier Transform (**FT**): Complex exponential form of Fourier series, Fourier integral theorem, Fourier Sine & Cosine integrals, Fourier transform, Fourier Sine & Cosine transforms and their inverses.

Z - Transform **(ZT):** Introduction, Definition, Standard properties, ZT of standard sequences and their inverses. Solution of difference equations.

Unit IV: Statistics and Probability (07 Hours)

Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Reliability of Regression estimates.

Probability, Probability density function, Probability distributions: Binomial, Poisson, Normal, Test of hypothesis: Chi-square test.

Unit V: Vector Calculus (08 Hours)

Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal and Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

Unit VI: Complex Variables (08 Hours)

Functions of a Complex variable, Analytic functions, Cauchy-Riemann equations, Conformal mapping, Bilinear transformation, Cauchy's integral theorem, Cauchy's integral formula and Residue theorem.

Text Books:

1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).

Reference Books:

1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).
2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
3. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).
4. Differential Equations, 3e by S. L. Ross (Wiley India).
5. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press).
6. Complex Variables and Applications, 8e, by J. W. Brown and R. V. Churchill (McGraw-Hill Inc.).

203141: Power Generation Technologies

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week	**Th**: 03	**In Sem** : 30 Marks **End Sem** : 70 Marks

Prerequisite:

- Fuel calorific value.
- Semiconductor materials for PV cells.
- Work, power and energy calculation.

Course Objective:

- To introduce conventional energy conversion system with steam, hydro based and nuclear based power plant.
- To initiate non-conventional energy conversion system with solar, wind, fuel cell, tidal ocean, geothermal, biomass etc.
- To commence interconnection of energy source to gird, stand alone and hybrid system.

Course Outcome: Upon successful completion of this course, the students will be able to:

CO1: Identify components and elaborate working principle of conventional power plants.
CO2: Recognize the importance and opportunities of renewable energies.
CO3: Calculate and control power output of wind solar, and hydro power plant.
CO4: Describe process of grid interconnection of distributed generation and requirements.
CO5: Interpret the environmental and social impact of various generation technologies.

Unit 01: Thermal Power Plant **(06 hrs)**

Basic thermodynamic cycles: Carnot cycle, Rankine cycle; Actual Rankine cycle; Reheat cycle (theoretical only); heat rate (Numerical on Heat rate).

Thermal Power Plants: Site selection, Main parts and its working. Types of boilers (FBC, Fire tube, and Water tube). Assessment of heat recovery systems Steam turbines Fuel Handling, Ash disposal and dust collection, Draught systems, electrostatic precipitator.

Unit 02: Nuclear, Diesel, Gas Power Plant **(6 Hrs)**

A. Nuclear Power Plant: Introduction, atomic physics, nuclear reaction, materials, site selection, nuclear reactors and working of each part, classification of nuclear reactor, nuclear waste disposal.

B. Diesel Power Plants: Main components and its working, Diesel plant efficiency and heat balance (Numerical), Site selection of diesel power plant.

C. Gas Power Plant: Introduction to gas cycles. Simple gas turbine power plant, methods to improve thermal efficiency, open loop and closed loop cycle power plants, gas fuels, gas turbine materials, plant layout. Combined cycle power plants, concept of heat to power ratio.

Unit 03: Hydro Power Plant **(6 Hrs)**

Site selection, Hydrology, storage and pondage, general arrangements and operation of hydro power plant, Hydraulic turbines, turbine size, pelton wheel turbine, Francis and Kaplan turbines, selection of turbines, Dams, Spillways, gates, intake and out take works, canals and layout of penstocks, water hammer and surge tank, simple numerical on hydro graphs and number of turbine required. Small, mini and micro hydro power plant (Introduction only).

Unit 04: Wind Energy Systems **(6 Hrs)**

Historical Development of Wind Power, Types of wind turbine, Impact of Tower Height, Power in the Wind. Maximum Rotor efficiency, Speed control for Maximum Power, Average Power in the wind (Numerical). Wind Turbine Generators (WTG) - Synchronous and Asynchronous (block diagrams only), Wind Turbine Economics, Simple Estimates of Wind Turbine Energy, Environmental Impacts of Wind Turbines. Change in wind pattern and its effect on power generation. Control of wind turbine generator.

Unit 05: Solar Energy **(6 Hrs)**

Principles of solar radiations, solar constant, cloudy index and concentration ratio, measurement of solar radiation. Solar energy collectors (solar thermal applications), principle of energy conversion, collection systems and their features, types of collectors with comparison. Solar thermal power plants. Over view of recent development of PV technologies. A Generic

Photovoltaic Cell, The Simplest Equivalent Circuit for a Photovoltaic Cell From Cells to Modules to Arrays, Numerical on number of solar panel selection. The PV I–V Curve under Standard Test Conditions (STC), Impacts of Temperature and Insolation on I–V Curves, Shading Impacts on I–V curves, System: Introduction to the Major Photovoltaic System Types.

Unit 06: Other Sources and Grid Connection (6 Hrs)

Biomass energy, conversion to electricity, municipal solid waste to energy conversion, geothermal energy and ocean energy and Fuel cell Energy storage requirements and selection criteria, stand alone, hybrid stand alone and grid connected renewable systems and their requirements.

Industrial Visit: One industrial visit to conventional /non-conventional power plant is necessary. A separate report file should be maintained in the department.

Text Books:

[T1] P. K. Nag, "Power Plant Engineering", Tata McGraw Hill Publications.
[T2] Dr. P. C. Sharma, "Power Plant Engineering", S.K. Kataria Publications.
[T3] R. K. Rajput, "A text book on Power System Engineering", Laxmi Publications (P) Ltd.
[T4] Chakrabarti, Soni, Gupta, Bhatnagar, "A text book on Power System Engineering", DhanpatRai publication.
[T5] R.K. Rajput, "Non-Conventional Energy Sources and Utilization", S. Chand Publications.
[T6] M.M. Wakil, "Power Plant Engineering", McGraw Hill, Indian Edition.
[T7] G. D. Rai, "Renewable Energy Sources", Khanna Publications.
[T8] Chetan singh solanki " Solar Photovotaics: Fundamentals, Technology and Application" PHI Publications.

Reference Books:

[R1] Arora and Domkundwar, "A Course in Power Plant Engineering", DhapatRai Publication.
[R2] Dr. S. P. Sukhatme, "Solar Energy", Tata McGraw Hill Publication.
[R3] Mukund Patel, "Wind and Solar Power Plants", CRC Press.
[R4] Gilbert Masters John, "Renewable Energy", Wiley and sons' publications.
[R5] Robert Foster, Majid Ghassemi, Alma Cota "Solar Energy" CRC Press

Unit	Text Books	Reference Books
1	T1, T2, T3	R1
2	T1, T2, T3	R1
3	T1, T2, T3	R1
4	T6, T7	R3, R4
5	T5, T6, T8	R2, R3, R4, R5
6	T5, T7	R4

203142: Material Science

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week **Practical** : 04 Hrs/ Week	**Th**: 03 **PR**:02	**In Sem** : 30 Marks **End Sem** : 70 Marks **Term Work**: 25 Marks **Oral** : 25 Marks

Prerequisite:

Students should have knowledge of various classes of materials like solid, liquid, gaseous, conducting, insulating, magnetic and resistive along with their basic characteristics.

Course Objectives: The course aims to :

1. Explain classification,properties and characteristics of electrical engineering materials.
2. Describe applications and measuring methods for parameters of dielectric, insulating, magnetic, conducting and resistive materials.
3. Illustrate solving of simple problems based on dielectric, magnetic and conducting materials.
4. Impart knowledge of Nano-technology to electrical engineering.5. Demonstrate testing methods of dielectric, insulating, magnetic, conducting and resistive materials as per IS.
5. Enable students to create self learning resource material through active learning based on practical /case study/assignments.

Course Outcomes:

Upon successful completion of this course, the students will be able to :

CO1: Discuss classification,properties and characteristics of different electrical engineering materials.

CO2: State various applicationsmeasuring methods for parameters of different classes of electrical engineering materials.

CO3: Solve simple problems based on dielectric, magnetic and conducting materials.

CO4: Apply knowledge of Nano-technology to electrical engineering.

CO5: Execute tests ondielectric, insulating, magnetic, conducting, resistive materials as per IS to decide the quality of thematerials.

CO6: Create learning resource material ethically to demonstrate **self learning leading to** lifelong learning skills and usage of ICT/ online technology through collaborative/active learning activities.

Unit 01: Dielectric Properties of Insulating Materials: (6 Hrs)

Static Field, Parameters of Dielectric material [Dielectric constant, Dipole moment, Polarization, Polarizability], Introduction to Polar and Non- Polar dielectric materials. Mechanisms of Polarizations-Electronic, Ionic and Orientation Polarization (descriptive treatment only), Clausius Mossotti Equation, Piezo-Electric, Pyro-Electric & Ferro-Electric Materials, Dielectric loss and loss tangent, Concept of negative tan delta.

Unit 02: A) Dielectric Breakdown: (2 Hrs) Introduction, Concept of Primary and Secondary Ionization of Gases (descriptive treatment only), Breakdown Voltage, Breakdown Strength, Factors affecting Breakdown Strengths of Solid, Liquid and Gaseous dielectric materials.

Unit 02: B) Testing of Materials: (4Hrs) Explanation of following with objectives, equipment required, circuit diagrams and observations to be taken.

1. Measurement of dielectric loss tangent (tan δ) by Schering Bridge-IS 13585-1994.
2. Measurement of dielectric strength of solid insulating material-IS 2584.
3. Measurement of dielectric strength of liquid insulating material -IS 6798.
4. Measurement of dielectric strength of gaseous insulating material as per IS.

Unit 03 : Insulating Materials, Properties & Applications: (6 Hrs)

Introduction, Characteristics of Good Insulating Material, Classification, Solid Insulating Materials-Paper, Press Board, Fibrous Materials, Ceramics, Mica, Asbestos, Resins, Liquid Insulating Materials such as Transformer Oil, Varnish, Askarel. Insulating Gases like Air, SF_6.

Insulating Materials for Power and Distribution Transformers, Rotating Machines, Capacitors, Cables, Line Insulators and Switchgears.

Unit 04 : Magnetic Materials: (6 Hrs)

Introduction, Parameters of Magnetic material [Permeability, Magnetic Susceptibility, Magnetization], Classification of Magnetic Materials, Diamagnetism, Paramagnetism, Ferromagnetism, Ferri-magnetism, Ferro-magnetic behavior below Critical Temperature, Spontaneous Magnetization, Anti-ferromagnetism, Ferrites, Applications of Ferro magnetic Materials, Magnetic materials for Electric Devices such as Transformer Core, Core of Rotating Machines, Soft Magnetic Materials, Hard Magnetic Materials.

Unit 05 : Conducting Materials: (6 Hrs)

General Properties of Conductor, Electrical Conducting Materials - Copper, Aluminum and its applications, Materials of High and Low Resistivity-Constantan, Nickel-Chromium Alloy, Tungsten, Kanthal, Silver and Silver alloys, Characteristics of Copper Alloys (Brass & Bronze), Electrical Carbon Materials. Materials used for Lamp Filaments, Solders, Metals and Alloys for different types of Thermal Bimetal and Thermocouples.

Unit 06 : Nanotechnology: (6 Hrs)

Introduction, Concepts of Energy bands and various Conducting Mechanism in Nano-structures, Carbon Nano-structures, Carbon Molecules, Carbon Clusters, Carbon Nano-tubes and applications. Special Topics in Nano Technology such as Single Electron Transistor, Molecular Machines, BN Nanotubes, Nano wires. Nano materials used in Batteries, Photovoltaic Cells and in Supercapacitors.

Industrial Visit:

Minimum one visit should be arranged to an industry related to manufacturing of batteries, capacitors, cables, transformers, motors (Any one industry). A hand written report should be submitted by every student as a part of term work

***Guidelines for TW Assessment will be given later.**

There is **Term Work of 25 marks**for the subject.

Practical section will comprise of two parts: (Refer SE Structure 2019 Pattern)

PART A: 2 Hours per week:

Regular curriculum listed practical total 12 numbers out of which conduction of 8 numbers will be mandatory. Out of 25 marks of Term Work, **15 Marks** will be based on continuous assessment that should be carried out such as checking of previous experiment along with its mock oral session (minimum 4-5 questions to each student), while conducting new experiment.

PART B: 2 Hours a week:

Practical/case studies/assignments to enable active learning based on advances related to subject to bridge gap between curriculum and enhance practical knowledge required in field. **10 Marks**

<u>List of Experiments:</u>

Part A: Term Work **(TW): 15 Marks**

List of total 12 numbers of experiments out of which conduction of 8 numbers of experiments will be mandatory.

1. To measure dielectric strength of solid insulating material-IS 2584.
2. To measure dielectric strength of liquid insulating material-IS 6789.
3. To measure dielectric strength of gaseous insulating material as per IS using Sphere Gap-Unit.
4. To obtain hysteresis loop of the ferromagnetic material.
5. To understand the principle of thermocouple and to obtain characteristics of different thermocouples.
6. To measure insulation resistance and kVAr capacity of power capacitor.
7. To measure resistivity of high resistive alloys.
8. To observe development of tracks due to ageing on different insulating materials e.g. Bakelite, Perspex, polyesters, Mica, Fiberglass etc.
9. Testing of resins and polymers.
10. Measurement of Tangent of Dielectric Loss Angle (tan δ) of solid/liquid dielectric materials.
11. Measurement of Flux Density by Gauss-meter.
12. Write report on visit to an industry related to manufacturing of batteries, capacitors, cables,

transformers (Any one industry).

List of Experiments: Part B:Part B :2 Hours per week (**Term Work(TW) : 10 Marks) (Total 6 activities from the list below are mandatory for evaluation of Term Work for Part B. Activity numbers 1, 4 and 6 are compulsory)**

Practical/case studies/assignments to enable self,active, collaborative **learning leading to** lifelong learning, based on advances related to subject to bridge gap between curriculum and enhance application knowledge of the subject.

Guidance/monitoring/assessment/presentation/field visits /expert sessions related activity can be carried out in **'Part B'** practical schedules .

1) Review of research/on line literature from latest journal papers /transactions related to different insulating, magnetic, semiconducting and conducting materials, advanced material developments and their applications. Draft of paper, presentation among students, in conference /publishing it.
2) Detailed case study of complete insulation system in transformer, comparison of various types of solid, liquid materials and study of recent advances related with major and minor insulating materials.
3) Detailed study of patents on caster oil used in transformer, its properties and comparison with other liquid insulating material.
4) Mini project on development of prototype of various electrical gadgets right from draft of specifications,design, selection of conducting, magnetic and insulating material.
5) Testing and diagnosis of induction motor, cable, transformer insulation by measurement of Polarization index, Dielectric Absorption Ratio, Step Voltage, dielectric discharge and ramp testing using 5/10KV IR Tester.
6) Laboratory visits/survey/role play/games/debates/any activity focusing collaborative, student centrist, active learning on Industrial/ Social/ Sustainability/ Public Health/ Safety/Ethical/Cultural/ Societal and Environmental aspects related to advanced materials Presentations of industrial case studies related with material science.
7) Two - Three household appliances like mixer -motor, ceiling fan- motor etc can be opened up by students either individually or by group of students and analyzed w.r.t. the materials found in it. Name each material used and to which category of materials does it belong, other applications of the same materials can be listed.
8) Detailed study of insulation system of resin casted transformer, comparison of various resins, study of testing of insulation system with applicable IS/IEC /IEEE standards
9) Visit to NABL accredited Laboratory to study testing of oil for DGA, furan analysis, study of equipment's used, test procedure and applicable IS/IEEE/IEC standard and recommended limits.
10) Discussions/Presentations/any activity using or related to IS/ IEC /IEEE standards/Recent Patents related with insulating, conducting and magnetic materials .
11) Case study on failure modes of various insulating materials and measures to reduce failure. Recent advancement in testing and diagnostic of solid and liquid insulating materials.
12) Case study on recent advancement of magnetic materials, high temperature superconductors and its applications.
13) Any activity using advanced ICT tool like Virtual Labs/animations/simulations/advanced software/on line certificate course like NPTEL/on line quiz etc related to curriculum.

Guidelines for Instructor's Manual - Practical Sessions

Instructor's Manual should contain following things related to every experiment-

1. The circuit diagram of the experiment should be drawn at the start.
2. Aim, apparatus, theory related to that experiment should be written.
3. One sample calculation should be shown, result table should be made and graph should be plotted if required.
4. Conclusion based on calculations, result and graph (if any) should be written.
5. Five - six questions based on that experiment should be written at the end.

Guidelines for Student's Lab Journal

Student's Lab Journal should be **Hand Written/ Drawn** containing, following things related to every experiment-

1. The circuit diagram of the experiment should be drawn on the graph paper at the start of the experiment.
2. Aim, apparatus, theory related to that experiment should be written.
3. One sample calculation should be shown, result table should be made and graph should be plotted if required.
4. Conclusion based on calculations, result and graph (if any) should be written.
5. Students should write answers to five - six questions based on that experiment at the end.

Guidelines for Laboratory Conduction

1. The circuit diagram should be explained to students in such a way that they should be able to develop it at their own.
2. Detail explanation of the experiment along with its circuit diagram, observation table, calculations, result table and plotting of graphs (if any).
3. While conducting new experiment, assessment of previous experiment should be carried out by its checking along with its mock oral session (minimum 4 -5 questions to each student).

Text Books:

[T1] “A Course in Electrical Engineering Materials”, by S.P. Seth, Dhanpat Rai and Sons publication.
[T2] A Textbook of “Electrical Engineering Materials” by R.K.Rajput, Laxmi Publications (P) Ltd.
[T3] “Electrical Engineering Materials”, by T.T.T.I, Madras.
[T4] “Electrical Engineering Materials”, by K. B. Raina and S. K. Bhattacharya, S. K. Kataria Sons.
[T5] “Material Science for Electrical Engineering”, by P.K. Palanisamy, Scitech Pub. Pvt. Ltd., Chennai (India).
[T6] “Introduction to Nanotechnology” by Charles P. Poole, Jr. Frank & J. Ownes (Wiley Student Edition)

Reference Books:

[R1] “Electrical Power Capacitors-Design & Manufacture”, by D. M. Tagare, Tata McGraw Hill Publication.
[R2] “Electrical Engineering Materials”, by S. P. Chalotra and B. K. Bhattacharya, Khanna Publishers, Nath Market.
[R3] “Electrical Engineering Materials”, by C. S. Indulkar and S. Thiruvengadam, S. Chand and Company Ltd.
[R4] “High Voltage Engineering” by Kamraju and Naidu, Tata McGraw Hill Publication.
[R5] “Introduction to Material Science for Engineering”, Sixth Edition by James F. Shackelford & M. K. Muralidhara, Pearson Education.
[R6] “Insulation Technology Course Material” of IEEMA Ratner, Pearson Education.
[R7] “Materials Science for Engineering Students”, by Traugott Fischer, Elsevier Publications.
[R8]“Energy Conversion Systems”, by Rakosh Das Begamudre, New Age International Publishers.
[R9] “Advanced Nanomaterials and Their Applications in Renewable Energy”, by Jingbo Louise Liu, Sajid Bashir, ELSEVIER Publications.

Unit No.	Text Book	Reference Book
1	T1, T2	R1, R3, R8
2	T1, T2, T3	R1, R2, R4
3	T1, T2, T3, T4	R1, R3, R4, R6
4	T1, T2, T3, T4	R3, R5
5	T1, T2, T4	R7, R8
6	T6	R9

203143: Analog And Digital Electronics

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week **Practical** : 02 Hrs/ Week	**Th**: 03 **PR**:01	**In Sem** : 30 Marks **End Sem** : 70 Marks **Practical** : 50 Marks

Prerequisite: Basic Electronics Engineering, Numbering system, Logic Gates and flip flops,Diode and BJT

Course Objectives:

1) To use K map for Boolean algebra reduction and design digital circuit
2) To introduce digital memories and logical families.
3) To construct sequential and combinational circuits using flip flops and K map
4) To develop the concept of basics of operational Amplifier and its applications.
5) To design uncontrolled rectifier

Course Outcomes: Upon successful completion of this course, the students will be able to :-

CO1: Design logical, sequential and combinational digital circuit using K-Map.
CO2: Demonstrate different digital memories and programmable logic families.
CO3: Apply and analyze applications of OPAMP in open and closed loop condition.
CO4: Design uncontrolled rectifier with given specifications

Unit 01 : Design of combinational circuit:(6 hrs)

Booleans algebra, De-Morgan theory etc, Karnaugh map: structure for two, three and four Variables, SOP and POS form reduction of Boolean expressions by K-map. Design of combinational circuits using Boolean expression and K-map, encoder, decoder, half and full adder.

Unit 02: Design of sequential circuit:(6 hrs)

Introduction to sequential circuit. Design of synchronous (K-map) and asynchronous counters. Up down counters, N modulo counters, Shift registers, ring and twisted ring counters

Unit 03: Digital memories and logic families:(6 hrs)

A) Digital memories: SRAM, DRAM, ROM, EPROM
B) **Digital logic families:** PAL,PLA, CPLD, FPGA

Unit 04: Operational Amplifier Applications: (6 hrs)

Open loop and close loop configuration of Op-Amp. Applications of Op- Amp- zero crossing detectors, Comparator, Schmitt trigger, V-I and I-V converters, Instrumentation amplifier, peak detector, Waveform generation using Op-amp - sine, square, saw tooth and triangular generator,

Unit 05: Other Analog circuits:(6 hrs)

Active filters-Its configuration with frequency response, Analysis of first order low pass and high pass filters using OPAMP, IC 555 –construction, working and modes of operation- astable and monostable multi vibrators, Sequence generator, voltage regulators using IC78xx, 79xx, LM 317

Unit 06: Diode rectifier:(6 hrs)

Single phase half wave rectifier with R, RL loads. Single phase full wave rectifier-Center tap and bridge rectifier supplying R and RL load and performance parameters. Three phase full wave bridge rectifier with R load.

List of Experiments:

Perform any **eight (three experiment should be on bread board/trainer kit)** experiment from following list:

1. Design of logical circuit for display of decimal number on seven segment display. **(Hardware)**
2. Deign 3:8 decoder for binary to octal decoding.**(Hardware)**
3. Design three bit full adder using any open source software. **(Software)**
4. Design logical circuit to convert binary to EXCESS 3/Gray number system. **(Hardware)**
5. Design digital clock or stop watch using decade counter.(IC74192) **(Hardware)**
6. Find phase angle difference between same frequency signal using ZCD and AND gate. **(Hardware)**
7. Design of comparator and schmitt trigger. **(Hardware)**
8. Study of Instrumentation amplifier using three Op-amp, CMRR measurement **(Hardware)**

9. Design sine, and triangular wave generator. **(Hardware)**
10. Design first order high pass and low pass filter using OPAMP in any open source software. (For this provide one statement to each of four students to perform with desired cut-off frequency. Each group will demonstrate their result and prepare documentation) **(Software)**
11. Design of monostable mutivibrator using IC555 and digital circuit to count number of pulses. **(Hardware)**
12. Design astable multivibrator using IC-555. **(Hardware)**
13. Design of single phase bridge rectifier with output voltage and specified ripple.(this practical should be design by each students, perform in simulation and demonstrate with hardware in laboratory with design documents) **(Software and Hardware)**

Guidelines for Instructor's Manual Practical Sessions

The Instructor’s Manual should contain following related to every experiment: Brief theory related to the experiment,Connection diagram /circuit diagram, Observation table,,Sample calculations for one reading,Result table, Graph and Conclusions,,Data sheets of the ICs used. Few questions related to the experiment (10 marks) List of components required with their specifications .

Guidelines for Student's Lab Journal

The student's Lab Journal should contain following related to every experiment: Theory related to the experiment, Connection diagram /circuit diagram , Observation table, Sample calculations for one reading, Result table, Graph and Conclusions, Data sheets of the ICs used, List of components required with their specifications,

Guidelines for Lab Assessment

- There should be continuous assessment.
- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do connections on bread board and get the results.
- Timely submission of journal.

Guidelines for Laboratory Conduction

- First half an hour should be utilized for explaining the circuit diagram and theory related to the experiment.
- Next one hour for connection and conduction of the experiment.
- Remaining half an hour for continuous assessment and timely checking of the experiment (This time slot can be adjusted as per convenience)
- Separate breadboard should be provided for every student for those experiments which are compulsory to be performed on breadboard or trainer kit (**ready made set up is not allow**)

Books & Other Resources:

Text Books:

[T1] Floyd and Jain, “Digital Fundamentals”, Pearson Education.
[T2] R. P. Jain, “Digital Electronics”, Tata McGraw Hill, New Delhi.
[T3] Malvino, “Digital Computer Electronics- An Introduction to Microcomputers,” Tata McGraw Hill.
[T4] Gaikwad R., “Operational Amplifier”, PHI New Delhi.
[T5] Floyd, “Electronics Devices”, Pearson Education.
[T6] Mottershed, “Electronics Devices & Circuits”, PHI New Delhi
[T7] Muhammad H. Rashid, “Power Electronics: Circuits, Devices and Applications”, 3rd edition, Pearsons Education.
[T8] Fundamental of digital circuits, 4th Edition, by A Anand Kumar, PHI learning private limited publication

Reference Books:

[R1] Tokheim, “Digital Electronics-Principles and Application”, 6th edition, Tata McGraw Hill, New Delhi.
[R2] A Jaico and Charles H. Roth, “Fundamentals of Logic Design” Jr. Forth Edition.
[R3] K. R. Botkar, “Integrated Circuits”, Khanna Publication, New Delhi.
[R4] James, “Operational Amplifier and Linear Integrated Circuits Theory and Application.”
[R5] P John Paul, “Electronics Devices and circuits”, New Age international Publications.

[R6] P. S. Bimbhra, “Power Electronics”, Khanna Publications.
[R7] NPTEL course on Digital Electronics Circuit, IIT, Kharagpur.
https://nptel.ac.in/courses/108105132/
[R8] NPTEL course on Integrated circuit, MOSFET, OPAMP and there applications IISC Banglore. https://nptel.ac.in/courses/108/108/108108111/
[R9] NPTEL course on power electronics by IIT Kharagpur.
https://nptel.ac.in/courses/108/105/108105066/

Unit 01	**Test Books**	**References**
1	T1, T2, T8	R1, R7
2	T1, T2, T3, T8	R2, R7
3	T8	R7
4	T4, T5	R3, R4, R8
5	T4, T5	R3, R4, R8
6	T7	R6, R9

203144: Electrical Measurements and Instrumentation

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week **Practical** : 04 Hrs/ Week	**Th**: 03 **PR**:02	**In Sem** : 30 Marks **End Sem** : 70 Marks **Term Work**: 25 Marks **Practical** : 25 Marks

Course Objectives:

1. To understand the necessity and importance of measurement and instrumentation.
2. To know about various types of measurement techniques, instruments and sensors.
3. To learn to apply proper methods of measurement and use of sensors in instrumentation.

Course Outcomes:

After completion of this course, the students will be able to:

CO1: Define various characteristic and classify measuring instruments along with range extension techniques.

CO3: Apply measurement techniques for measurement of resistance, inductance and capacitance.

CO4: Demonstrate construction, working principle of electrodynamo type and induction type instruments for measurement of power and energy.

CO5: Make use of CRO for measurement of voltage, current and frequency.

CO6: Classify transducer and apply it for measurement of physical parameters in real time.

Unit 01: (7 Hrs)

A. Classification of Measuring Instruments: Characteristics of measuring instruments: static and dynamic, accuracy, linearity, speed of response, dead zone, repeatability, resolution, span, reproducibility, drifts. Necessity of calibration, standards and their classification, absolute and secondary instruments, types of secondary instruments: indicating, integrating, and recording, analog / digital. Ammeter and Voltmeter Theory: Essentials of indicating instruments deflecting, controlling and damping systems. Construction, working principle, torque equation, advantages and disadvantages of Moving Iron (MI) instruments (attraction and repulsion). block diagram and operation of digital ammeter & voltmeter.

B. Range Extension: Instrument Transformers : Construction, connection of CT & PT in the circuit, advantages of CT / PT for range extension of MI Instruments, transformation ratio, turns ratio, nominal ratio, burden, ratio and phase angle error.(descriptive treatment only)

Unit 02: (6 Hrs)

A. Measurement of Resistance: Measurement of low, medium and high resistance. Wheatstone bridge, Kelvin's double bridge, ammeter-voltmeter method, megger. Earth tester for earth resistance measurement.

B. Measurement of Inductance: Introduction, sources and detectors for A.C. bridge, general equation for bridge at balance. Maxwell's inductance, Maxwell's inductance – Capacitance Bridge, Anderson's bridge.

Unit 03: (6 Hrs)

Measurement of Power: Construction, working principle, torque equation, errors and their compensation, advantages and disadvantages of dynamometer type wattmeter, low power factor wattmeter, poly-phase wattmeter. Active & reactive power measurement in three phase system for balanced and unbalanced load using three wattmeter method, two wattmeter method & one wattmeter method.

Unit 04: (5 Hrs)

Measurement of Energy: Construction, working principle, torque equation of single phase conventional (induction type) energy meter. Block diagram and operation of single phase and three phase static energy meter. Calibration of static energy meter. TOD meter.

Unit 05: (6 Hrs)
A. Oscilloscope: Introduction, various parts, front panel controls, use of CRO for measurement of voltage, current, period, frequency. Phase angle & frequency by Lissajous pattern. Introduction to DSO.
B. Transducers: Introduction, classification, types: resistive, inductive, capacitive, basic requirements for transducers.
C. Pressure Measurement: Introduction, classification of pressure as low, medium & high, absolute, gauge, vacuum, static, dynamic & head pressure. High pressure measurement using electric methods, low pressure measurement by McLeod gauge and pirani gauge, capacitive pressure transducer.

Unit 06: (6 Hrs)
A. Level Measurement: Introduction and importance of level measurement, level measurement methods: mechanical, hydraulic, pneumatic, electrical, nucleonic and ultrasonic.
B. Displacement Measurement: LVDT & RVDT – construction, working, applications, specifications, advantages & disadvantages, effect of frequency on performance.
C. Strain Gauge: Introduction, definition of strain, types of strain gauge: wire strain gauge, foil strain gauge, semiconductor strain gauge; their construction, working, advantages and disadvantages.

Industrial Visit(s)

Minimum one visit should be arranged to electrical instrument manufacturing company or where electrical instruments are calibrated or where various measuring instruments (Electrical/Mechanical) can be seen or observed.

List of Experiments

Practical section will comprise of two part; part A and part B.
Practical examination will be conducted on Part A.
Distribution of term works marks; Part A : 10 Marks, Part B : 15 Marks.
Part A: Minimum eight experiments are to be conducted from the following experiments:
1. Extension of ammeter range using CT, voltmeter range using PT and watt meter range using CT / PT.
2. i) Measurement of medium resistance by Ammeter- Voltmeter method.
   ii) Measurement of low resistance using Kelvin's Double Bridge.
3. Measurement of inductance using Anderson's bridge / Maxwell's bridge.
4. Measurement of active & reactive power in three phase balanced circuit using one wattmeter method with two way switch.
5. Measurement of reactive power by one wattmeter with all possible connections of current coil and pressure coil.
6. Measurement of three phase active & reactive power by two wattmeter method procedure.
7. Measurement of active power in three phase, four wire system using three CTs & two wattmeter.
8. Calibration of single phase wattmeter at different power factors.
9. Calibration of single phase static energy meter at different power factors.
10. Measurement of voltage, current, time period, frequency & phase angle using CRO.
11. To study and plot the characteristics of LVDT.
12. Electrical methods for measurement of liquid level.

Part B: Minimum eight experiments / case studies are to be conducted from the following:
1. Study of various standards (IS/IEC) related to calibration process of various instruments and NABL accredited Test Laboratory visit.
2. Measurement of soil resistivity using four pin wenner method.
3. Study of programmable LCR meter; Measure L, C, R, Q, dissipation factor and power factor of given component.
4. Demonstration of Power analyser and multifunction meter for measurement of various

electrical quantities.

5. Study of Digital Storage Oscilloscope:
   a) Different modes in DSO such as Roll, Average, Peak detection.
   b) Capture transients
   c) FFT analysis
   d) Various MATH operations
6. Study and demonstration of net meter and four quadrant TOD Meter.
7. Detailed study of various temperature transducers, their selection procedure, specifications, characteristics and comparison, calibration process of temperature transducer.
8. Determination of polarities and ratio, phase angle and ratio error of various CTs and PTs.
9. Study and demonstration of DIAF / Woodward alternator synchronization relay used in industrial power system for synchronization of DG sets and Alternators.
10. Detailed study of on line Energy Monitoring System, various parameters, EMS software capabilities, trending with IOT applications. Demonstration of EMS system by inviting Expert.
11. Virtual instrument modeling using software like LABVIEW.
12. Study of advanced metering infrastructure in smart grid.

Guidelines for Instructor's Manual

- The instructor’s manual is to be developed as a hands-on resource and reference.
- The instructor's manual need to include prologue (about University / program / institute / department / foreword / preface etc), University syllabus, conduction and assessment guidelines, topics under consideration - concept, objectives, outcomes, list of experiments, references etc.
- The feedback seeking sheet for enhancement of instructor's manual may be added as annexure.

Guidelines for Student's Lab Journal

- The laboratory experiments are to be submitted by student in the form of journal.
- Journal consists of prologue, Certificate, table of contents, and write-up of each experiment (Title, Objectives, Outcomes, List of apparatus, Circuit diagram, Theory, Observation Table, Sample Calculation, Result Table, Conclusion / Analysis, exercises - MCQs, assignments, Date of Completion, Assessment grade and assessor's sign with date).

Guidelines for Lab /TW Assessment

- Each experiment will be assigned grade based on parameters with appropriate weightage.
- Suggested parameters include - timely completion, performance, innovation, punctuality and neatness.

Guidelines for Laboratory Conduction

- The instructor is expected to shortlist necessary experiments from the suggested list of experiments. During the practical session the instructor may divide the total students in groups of 4 to 5 students and assign them with different experiments to be performed.
- Proper safety instructions and demonstration of the experiment is to be given before asking the students to perform the experiment. The experiment is carried out by the students under the supervision of the instructor.
- The instructor should take utmost care towards safety of the students, self and other hazards that may be caused by improper operation of the equipment.
- The instructor may also design an experiment which is relevant to the subject and beyond the scope of syllabus.

Text Books

[T1] A. K. Sawhney, “A Course in Electrical and Electronic Measurements & Instrumentation”, Dhanpat Rai & Co.

[T2] J. B. Gupta, “A Course in Electronics and Electrical Measurements and Instrumentation”, S. K. Kataria & Sons,

[T3] R. K. Jain, “Mechanical and Industrial Measurements”, Khanna Publishers.

[T4] B. C. Nakra & K. K. Chaudhari, “Instrumentation Measurement and Analysis”, Tata

McGraw Hill.

Reference Books

[R1] E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments", Reem Publications.
[R2] Dr. Rajendra Prasad, "Electronic Measurements & Instrumentation", Khanna Publishers.
[R3] Arun K. Ghosh, "Introduction to Measurements and Instrumentation", PHI Publication.
[R4] M. M. S. Anand, "Electronics Instruments and Instrumentation Technology", PHI Publication.

Unit	Text Books	Reference Books
I	T1,T2,T3,T4	R1,R2,R3,R4
II	T1,T2	R1,R4
III	T1,T2	R1,R2
IV	T1,T2	R1,R2
V	T1,T2,T3,T4	R2,R3,R4
VI	T1,T2,T3	R2,R3

203150: Applications of Mathematics in Electrical Engineering

Teaching Scheme	Credits	Examination Scheme [Marks]
Practical : 02 Hrs/ Week	**Pr**:01	**Term Work**: 25 Marks

Prerequisite: Basic mathematics, Engineering Mathematics-I, II

Course Objective: Course Objectives are:

- To relate mathematics and electrical problems.
- To introduce software solution
- To develop mathematical and complex problem solving skill.

Course Outcome: At the end of this course, learner will be able to

CO1: Apply fundamentals of mathematics in solving electrical engineering problem

CO2: Analyze complex electrical engineering problem using mathematical techniques.

CO3: Implement program and simulation for problems in electrical engineering.

CO4: Demonstrate self lifelong learning skills with applications of mathematics in electrical engineering through software.

Perform any **Eight** experiments from following list using any professional software:

1. To solve ordinary differential equations in electrical circuits or DC motors:
2. To apply Laplace Transform for solving ordinary differential equations in electrical circuits or DC motors:
3. To analyze the waveform generated using Fourier series.
4. To solve difference equations using z-Transform:
5. To Perform convolution of two discrete signal using software programming:
6. To solve linear simultaneous equations from electrical network (KVL/KCL) using software programming:
7. To determine a phasor of AC signal using Discrete Fourier Transform.
8. To perform mathematical addition, subtraction, multiplication and division of electrical signals.
9. To calculate rms and average values of given waveform using software programming.
10. To calculate electrical power under sinusoidal and non sinusoidal voltage and current

Perform any **Two** experiments from following list using any professional software:.

1. To determine maxima and minima of single/two variable problem.
2. To convert three phase electrical signal quantities dq0 transformation.
3. To apply partial difference equation in Electromagnetic (Maxwell equation)
4. To apply graph theory in network analysis
5. To calculate poles and zeros in complex electrical network.

Guidelines for Instructor's Manual Practical Sessions

The Instructor Manual should contain following related to every program

- Theory related to the method
- Algorithm
- Three to four different sets of problem statement
- Solve numerical using appropriate method
- Ten questions based on experiment
- Expected Output

Guidelines for Student's Lab Journal

The student's Lab Journal should contain following related to every experiment:

- Theory related to the method
- Algorithm
- Problem statement
- Solve numerical using appropriate method
- Program printout with output
- Conclusion
- Ten questions based on experiment

Guidelines for Lab Assessment

- There should be continuous assessment
- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do programming
- Timely submission of journal

Guidelines for Laboratory Conduction

- Detail theory and numerical related to the method should be taken prior to the lab session
- Algorithm should be discussed in detail in the lab session
- Students are expected to do the program based on the discussed algorithm individually
- Printout of the program and output should be taken on the day when the program is performed

203151: Soft Skill

Teaching Scheme	Credits	Examination Scheme [Marks]
Practical : 02 Hrs/ Week	**Pr**:01	**Term Work**: 25 Marks

Course Objective: The course aims to:- □

- To possess knowledge of the concept of Self-awareness and Self Development. □
- To understand the importance of Speaking Skills, listening skills, Presentation Skills and leadership skills. □
- To gain the knowledge of corporate grooming & dressing, Email & telephone etiquettes, etiquette in social & office setting. □
- To get conversant with Team work, Team effectiveness, Group discussion, Decision making.
- To recognize the importance of time management and stress management.

Course Outcome: Students will be able to :- □

CO1: DoSWOC analysis. □

CO2: Develop presentation and take part in group discussion. □

CO3: Understand and implement etiquette in workplace and in society at large. □

CO4: Work in team with team spirit. □

CO5: Utilize the techniques for time management and stress management.

Unit 01 : Self-Awareness & self-Development: (4Hrs)

A) Self-Assessment , Self-Appraisal, SWOT, Goal setting - Personal & career - Self Assessment, Self-Awareness, Perceptions and Attitudes, Positive Attitude, Values and Belief Systems, Self-Esteem, Self-appraisal, Personal Goal setting,

B) Career Planning, Personal success factors, Handling failure, Depression and Habit, relating SWOT analysis & goal setting and prioritization.

Unit 02 : Communication Skill: (6 Hrs)

A) Importance of communication, types, barriers of communication, effective communication.

B) Speaking Skills: Public Speaking, Presentation skills, Group discussion- Importance of speaking effectively, speech process, message, audience, speech style, feedback, conversation and oral skills, fluency and self-expression, body language phonetics and spoken English, speaking techniques, word stress, correct stress patterns, voice quality, correct tone, types of tones, positive image projection techniques.

C) Listening Skills:Law of nature- you have 2 ears and 1 tongue so listen twice and speak once is the best policy, Empathic listening, Avoid selective listening

D) Group Discussion:Characteristics, subject knowledge, oral and leadership skills, team management, strategies and individual contribution and consistency.

E) Presentation skills:Planning, preparation, organization, delivery.

F) Written Skills: Formal & Informal letter writing, Report writing, Resume writing - Sentence structure, sentence coherence, emphasis. Paragraph writing. Letter writing skills – form and structure, style and tone. Inquiry letters, Instruction letters, complaint letters, Routine business letters, Sales Letters etc.

Unit 03 : Corporate / Business Etiquette: (2 Hrs)

Corporate grooming & dressing, Email & telephone etiquette, etiquette in social & office setting: Understand the importance of professional behavior at the work place, Understand and Implement etiquette in workplace, presenting oneself with finesse and making others comfortable in a business setting. Importance of first impression, Grooming, Wardrobe, Body language, Meeting etiquette (targeted at young professionals who are just entering business environment), Introduction to Ethics in engineering and ethical reasoning, rights and responsibilities.

Unit 04 : Interpersonal relationship: (4 Hrs)

A) Team work, Team effectiveness, Group discussion, Decision making – Team Communication. Team, Conflict Resolution, Team Goal Setting, Team Motivation Understanding Team Development, Team Problem Solving, Building the team dynamics. Multicultural team activity.

B) Group Discussion- Preparation for a GD, Introduction and definitions of a GD, Purpose of a GD, Types of GD, Strategies in a GD, Conflict management, Do's and Don'ts in GD

Unit 05 : Leadership skills: (2 Hrs)

Leaders' role, responsibilities and skill required - Understanding good Leadership behaviors, Learning the difference between Leadership and Management, Gaining insight into your Patterns, Beliefs and Rules, Defining Qualities and Strengths of leadership, Determining how well you perceive what's going on around you, interpersonal Skills and Communication Skills, Learning about Commitment and How to Move Things Forward, Making Key Decisions, Handling Your and Other People's Stress, Empowering, Motivating and Inspiring Others, Leading by example,effective feedback.

Unit 06 : Other skills: (2 Hrs)

A) Time management- The Time management matrix, apply the Pareto Principle (80/20 Rule) to time management issues, to priorities using decision matrices, to beat the most common time wasters, how to plan ahead, how to handle interruptions , to maximize your personal effectiveness, how to say "no" to time wasters, develop your own individualized plan of action.

B) Stress management- understanding the stress & its impact, techniques of handling stress.

C) Problem solving skill, Confidence building Problem solving skill, Confidence building

Term Work/Assignments: Term work will consist the record of any 8 assignments of following exercises

1. SWOT analysis
2. Personal & Career Goal setting – Short term & Long term
3. Presentation Skill
4. Letter/Application writing
5. Report writing
6. Listening skills
7. Group discussion
8. Resume writing
9. Public Speaking
10. Stress management
11. Team Activity-- Use of Language laboratory

Teaching Methodology:

Each class should be divided into three batches of 20-25 students each. The sessions should be activity based and should give students adequate opportunity to participate actively in each activity. Teachers and students must communicate only in English during the session. Specific details about the teaching methodology have been explained in every activity given below.

Practical Assignments (Term work)

Minimum 8 assignments are compulsory and teachers must complete them during the practical sessions within the semester. The teacher should explain the topics mentioned in the syllabus during the practical sessions followed by the actual demonstration of the exercises. Students will submit report of their exercise (minimum 8) assignments as their term work at the end of the semester but it should be noted that the teacher should assess their assignment as soon as an activity is conducted. The continual assessment process should be followed.

1. **SWOT analysis**: The students should be made aware of their goals, strengths and weaknesses, attitude, moral values, self-confidence, etiquettes, non-verbal skills, achievements etc. through this activity. The teacher should explain to them on how to set goals, SWOT Analysis, Confidence improvement, values, positive attitude, positive thinking and self-esteem. The teacher should prepare a questionnaire which evaluate students in all the above areas and make them aware about these aspects.
2. **Personal & Career Goal setting** – Short term & Long term
3. **Presentation Skills**: Students should make a presentation on any informative topic of their choice. The topic may be technical or non-technical. The teacher should guide them on effective presentation skills. Each student should make a presentation for at least 10 minutes.
4. **Letter/Application writing**: Each student will write one formal letter, and one application. The teacher should teach the students how to write the letter and application. The teacher should give proper format and layouts.
5. **Report writing**: The teacher should teach the students how to write report. The teacher should give proper format and layouts. Each student will write one report based on visit / project /

business proposal etc.

6. **Listening skills**: The batch can be divided into pairs. Each pair will be given an article (any topic) by the teacher. Each pair would come on the stage and read aloud the article one by one. After reading by each pair, the other students will be asked questions on the article by the readers. Students will get marks for correct answers and also for their reading skills. This will evaluate their reading and listening skills. The teacher should give them guidelines on improving their reading and listening skills. The teacher should also give passages on various topics to students for evaluating their reading comprehension.

7. **Group discussion**: Each batch is divided into two groups of 12 to 14 students each. Two rounds of a GD for each group should be conducted and teacher should give them feedback.

8. **Resume writing**: Each student will write one formal letter, and one application. The teacher should teach the students how to write the letter and application. The teacher should give proper format and layouts.

9. **Public Speaking**: Any one of the following activities may be conducted : A) Prepared speech(topics are given in advance, students get 10 minutes to prepare the speech and 5 minutes to deliver. B) Extempore speech (students deliver speeches spontaneously for 5 minutes each on a given topic) C) Story telling (Each student narrates a fictional or real life story for 5 minute search) D) Oral review(Each student orally presents a review on a story or a book read by them)

10. **Team Activity**-- Use of Language laboratory

Text Books:

[T1] Sanjay Kumar and PushpaLata, "Communication Skills", Oxford University Press.

[T2] Krishna Mohan, MeeraBanerji, "Developing Communication Skill", McMillan India Ltd.

[T3] Simon Sweeney, "English for Business Communication", Cambridge University Press

Reference Books:

[R1] Accenture, Convergys, Dell et.al, "NASSCOM-Global Business Foundation Skills, Foundation Books, Cambridge University Press.

[R2] E. H. McGraw, "Basic Managerial Skills for all", Eastern Economy Edition, Prentice hall

[R3] Barun K. Mitra, "Personality Development and Group Discussions", Oxford University Press.

[R4] PriyadarshiPatnaik, "Group Discussions and Interview Skills: Foundation Books", Cambridge University Press.

[R5] Napoleon Hill, "Thinks and Grow Rich", Ebury Publishing, ISBN 9781407029252.

[R6] Tony Robbins, "Awaken the Giant Within", Harper Collins Publishers, ISBN139780743409384. S.E. Electrical Engineering (2015 course) – Savitribai Phule Pune University 25

[R7] Wayne Dyer, "Change Your Thoughts, Change Your Life", Hay House India, ISBN-139788189988050.

[R8] Stephen Covey, "Habits of Highly Effective People", Pocket Books, ISBN139781416502494.

[R9] Dr. Joseph Murphy, "The Power of Your Subconscious Mind", MaanuGraphics, ISBN-13 9789381529560.

[R10] Daniel Coleman, "The new Leaders", Sphere Books Ltd, ISBN-139780751533811.

[R11] Richard Koch, "The 80/20 Principal", Nicholas Brealey Publishing , ISBN-13 9781857883992.

[R12] Julie Morgenstern, "Time management from inside out", Owl Books (NY),ISBN-13 9780805075908.

[R13] Shiv Khera, "You can win", Macmillan, ISBN-139789350591932.

[R14] Gopalaswamy Ramesh, Mahadevan Ramesh, "The Ace of Soft Skills: Attitude, Communication and Etiquette for Success"

203152 : Audit Course-III

List of three audit course is provided. Students can choose any one from 203152(A) 203152(B) and 203152(C)

203152 (A) : Solar Thermal System

Teaching Scheme Lectures: 2hrs/week	Credits No credit	Examination Scheme [Marks] Grade: PP/NP Quiz and term paper

Description: The course will introduce the basics of: solar energy, availability, applications, heat transfer as applied to solar thermal systems, various types of solar thermal systems, introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics. The following topics may be broadly covered in the classroom. The field visits will be designed for first-hand experience and basic understanding of the system elements.

Course Objective:

- To understand basics and types of solar thermal systems.
- To get knowledge of various types of concentrators.
- To make students aware of different Standards and certification for Concentrator Solar Power.

Course Outcome: Student will be able to

CO1: Differentiate between types of solar Concentrators

CO2: Apply software tool for solar concentrators

CO3: Design different types of Solar collectors and balance of plant

Course Contents:

- Sun, Earth and seasons
- Solar Radiation
- Basics of heat transfer
- Absorption, reflection and transmission of radiation
- Types of Solar thermal systems
- Basic design of different types of systems
- Applications of solar thermal systems and their economics
- Need for solar concentration
- Various types of solar concentrators
- Movement of Sun and tracking
- Control systems for solar tracking
- Concentrating solar thermal (CSP)
- Concentrating solar PV (CPV)
- Balance of plant for CSP
- Critical points in concentrating solar system installation
- Operation and maintenance of CSP
- Typical financial analysis of CSP
- Software tools for concentrating solar power
- Environmental impact assessment
- Standards and certification for CSP
- Basics of solar thermal (STH) systems
- Elements of various STH systems
- Design, materials and manufacturing of
  - Flat plate solar collector
  - Evacuated tube solar collector
  - Parabolic trough collector
  - Dish type solar concentrators
  - Concentrating PV systems
  - Balance of plant
- Manufacturing standards

- Quality assurance and standards
- Certification
- Special purpose machines and Automation in manufacturing
- Site assembly and fabrication
- Typical shop layouts
- Inventory management
- Economics of manufacturing

Assignment

- Design of solar thermal system for residential/ commercial building.

References:

1. Trainers Textbook Solar Thermal Systems Module, Ministry of New and Renewable Energy, Government of India
2. Students Workbook for Solar Thermal Systems Module, Ministry of New and Renewable Energy, Government of India

203152 (B) : C Language Programming

Teaching Scheme Lectures: 2hrs/week	Credits No credit	Examination Scheme [Marks] Grade: PP/NP Quiz and term paper

Course Objective:

- To give basic idea about C programming language
- To prepare students for writing algorithm, draw flow chart and program in C language
- To learn data types and syntax in C language.

Course Outcome: Student will be able to

CO1: Elaborate data types, arithmetic, logical and conditional operators

CO2: Apply control and looping statements in C programming

CO3: Write programming using C language with functions, arrays and pointers.

Course Contents:

Unit 01: The language of C : Phases of developing a running computer program in C, Data concepts in C :Constants, Variables, Expressions, Operators, and operator precedence in C., Statements : Declarations, Input-Output Statements, Compound statements, Selection Statements. Conditions, Logical operators, Precedence. Repetitive statements, While construct, Do-while Construct, For construct., Data types, size and values. Char, Unsigned and Signed data types. Number systems and representations. Constants, Overflow., Arrays. Strings. Multidimensional arrays and matrices.

Unit 02: Functions :The prototype declaration, Function definition.Function call : Passing arguments to a function, by value, by reference. Pointers : Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Examples. Accessing arrays through pointers. Pointer

Assignment

- Write C program for arithmetic operations such as +,-,*,/,%.
- Write C program for decision making statements such as if, else-if etc.
- Write C program for Representative statements such as for, while, do-while.
- Write C program to determine roots of an quadratic equation using functions.
- Write C program to enter matrix data and printing its inverse.
- Write C program to demonstrate use of pointers.

References:

1. A.R. Bradley, "Programming for Engineers", Ringer, 2011
2. Hankering and Chitchat, "The C Programming Language", (2nd ed.) Prentice Hall, 1988

203152(C) Japanese Language-I

Teaching Scheme	Credits	Examination Scheme [Marks]
Lectures: 2hrs/week	**No credit**	**Grade: PP/NP** **Quiz and term paper**

Course Objective:

- To meet the needs of ever growing industry with respect to language support.
- To get introduced to Japanese society and culture through language.

Course Outcome: On completion of the course student

- Will have ability of basic communication.
- Will have the knowledge of Japanese script.
- Will get introduced to reading , writing and listening skills
- Will develop interest to pursue professional Japanese Language course.

Course Contents:

Unit 1: Introduction to Japanese Language. Hiragana basic script, colors, Days of the week

Unit 2: Hiragana: modified Kana, double consonant, Letters combined with ya, yu, yo Long vowels, Greetings and expressions

Unit 3: Self Introduction, Introducing other person, Numbers, Months, Dates, Telephone numbers, Stating one's age.

References:

1. Minna No Nihongo, "Japanese for Everyone", Elementary Main Text book 1-1 (IndianEdition), Goyal Publishers & Distributors Pvt. Ltd.

Guidelines for Conduction

(Any one or more of following but not limited to)

- Guest Lectures
- Visiting lectures
- Language Lab

Guidelines for Assessment (Any one of following but not limited to)

- Written Test
- Practical Test
- Presentation
- Paper
- Report

203145: Power System-I

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week	**Th**: 03	**In Sem** : 30 Marks **End Sem** : 70 Marks

Prerequisite courses if any: Power Generation, Various insulating materials and properties, Knowledge of fundamentals of electrical circuit components and engineering mathematics.

Course Objectives:

1. To learn the basic structure of electrical power systems, various electrical terms related with power system and understand various types of tariff.
2. To understand the specifications and applications of various major electrical equipment present in power plant.
3. To get the knowledge of mechanical and electrical design of overhead and underground transmission system.
4. To learn representation of transmission lines for performance evaluation.

Course Outcomes:

Upon successful completion of this course, the students will be able to:

CO1: Recognize different patterns of load curve and calculate associated different factors with it and tariff.

CO2: Draft specifications of electrical equipment in power station.

CO3: Design electrical and mechanical aspects in overhead transmission and underground cables.

CO4: Evaluate the inductance and capacitance of different transmission line configurations.

CO5: Analyse the performance of short and medium transmission lines

Unit 01: Structure of Electrical Power Systems and Tariff [6Hrs]

A) **Structure of Electrical Power Systems:** Structure of electrical power system, Different factors associated with generating stations such as Connected load, Maximum demand, Demand factor, Average load, Load factor, Diversity factor, Plant capacity factor, Reserve capacity, Plant use factor, Load curve, Load duration curve, Concept of base load and peak load stations, Advantages of interconnected grid system, Fitting of available generating station into the area load duration curve. **[4 Hrs]**

B) **Tariff:** Introduction of Tariff, Tariff setting principles, desirable characteristics of tariff, various consumer categories and implemented tariff such as two part tariff, three part tariff(Numerical on two part and three part tariff), Time of day tariff for H.T and L.T industrial and commercial consumers, Introduction to Availability based tariff (ABT), kVAh tariff(Descriptive treatment only).[**2 Hrs**]

Unit 02 Major Electrical Equipment's in Power Station & Underground Cables [6Hrs]

A) Major Electrical Equipment's in Power Station: Descriptive treatment of ratings of various equipment used in power station, Special features, field of use of equipment like alternators, necessity of exciters, various excitation systems such as dc excitation, ac excitation and static excitation systems, Power transformers, voltage regulators, bus-bars, current limiting reactors, circuit breakers, protective relays. Current transformers, potential transformers, Lightning arresters, Earthing switches, isolators, Carrier current equipment's (P.L.C.C), Control panels, battery rooms, metering and other control room equipment in generating station**. [3Hrs]**

B)Underground Cables: Construction of Cables, Classification of cables, XLPE cables, Capacitance of single core and three core cable, Dielectric stresses in single core cable, Grading of cables, inter sheath grading, capacitance grading. **[3Hrs]**

Unit 03: Mechanical Design of Overhead lines and Insulators: [6Hrs]

A) Mechanical Design of Overhead lines: Main components of overhead lines, Various types of line supports, Conductor spacing, Length of span, Calculation of sag for equal and unequal supports and effect of ice and wind loading. **[3Hrs]**

B) Overhead Line Insulators: Types of insulators, its construction and their applications such as Pin type, Suspension type, Strain type, Shackle type, Post insulators, bushing. Potential distribution over suspension insulators, String efficiency, (Numerical on string efficiency and up to four discs only), Methods of improving string efficiency (Descriptive treatment only). **[3Hrs]**

Unit 04:Resistance and Inductance of Transmission Line: [6Hrs]

Resistance of transmission line, Skin effect and proximity effect, Factors responsible for production of these effects, Internal and external flux linkages of single conductor, Inductance of single phase two wire line, Necessity of transposition, Inductance of three phase line with symmetrical and unsymmetrical spacing with transposition, Concept of G.M.R and G.M.D, Inductance of bundled conductors.

Unit 05: Capacitance of Transmission Line: [6Hrs]

Electric potential at single charged conductor, Potential at conductor in a group of charged conductors, Capacitance of single phase line, Capacitance of single phase line with effect of earth's surface on electric field, Concept of G.M.R and G.M.D for capacitance calculations, need of transposition for capacitance calculations, Capacitance of three phase line with symmetrical and unsymmetrical spacing with transposition. Capacitance of single circuit and double circuit three phase line with symmetrical and unsymmetrical spacing considering transposition (without considering earth effect).

Unit 06: Performance of Transmission Line [6Hrs]

Classification of lines based on length and voltage levels such as short, medium and long lines, Performance of short transmission lines with voltage current relationship and phasor diagram, Representation of medium lines as 'Nominal Π' and 'Nominal T' circuits using R,L and C parameters, Ferranti effect, Representation of 'T' and 'Π' models of lines as two port networks, Evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of efficiency and regulation of short and medium lines**.**

Industrial Visit: Compulsory one visit to EHV substation is recommended

Text Books:

[T1] V.K.Meheta, Rohit Mehta, "Principles of Power System", S. Chand Publication.
[T2] J.B.Gupta, "Transmission and Distribution", S.K.Kataria and Sons, New Delhi.
[T3] J.B.Gupata,"Generation and Economic Considerations",S.K.Kataria & Sons, New Delhi.
[T4] Dr.B.R.Gupta, "Generation of Electrical Energy", S. Chand Publication.
[T5] A Chakraborty, M.L.Soni, P.V. Gupta, U.S.Bhatnagar,"A text book on Power System Engineering", Dhanpatrai & Co, Delhi.
[T6] S.N.Singh, "Electric Power Generation, Transmission and Distribution", Prentice Hall of India.

Reference Books:

[R1] Nagrath & Kothari, "Power System Engineering", Tata McGraw Hill Publications
[R2] D. Das," Electrical Power System", New Age Publication
[R3] W.D.Stevenson, "Power System Analysis", Tata McGraw Hill Publications.
[R4] M.V.Deshpande," Elements of Power Station Design", Wheeler Publishing.
[R5] I.J. Nagrath and D.P.Kothari," Modern Power System Analysis", Tata McGraw Hill
[R6] NPTEL course on Power System Engineering, IIT Kharagpur https://nptel.ac.in/courses/108/105/108105104/
[R7] NPTEL course on Power System Analysis, IIT Kharagpur https://nptel.ac.in/courses/108/105/108105067/
[R8] NPTEL Power System Analysis, IIT Kharagpur https://www.youtube.com/playlist?list=PLRWKj4sFG7-6gWwDMLI0Wy5DDRqyKP1uQ
[R9] MAHADISCOM Website for tariff: https://wss.mahadiscom.in/wss/wss?uiActionName=getEnergyBillCalculator
[R10] Maharashtra Electricity Regulatory Commission www.merc.gov.in

Units	Text Books	Reference Books
1	T1,T3,T6	R1,R3,R4,R8,R9,R10
2	T1,T4	R4,R6
3	T1,T5	R4,R6
4	T1,T2,T5,T6	R1,R7,R8
5	T1,T2,T5,T6	R1,R7,R8
6	T1,T2,T5	R3,R5,R7,R8

203146: Electrical Machines-I

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week **Practical** : 02 Hrs/ Week	**Th**: 03 **PR**:01	**In Sem** : 30 Marks **End Sem** : 70 Marks **Practical** : 50 Marks

Prerequisite:

- Magnetic circuit, mutual induced EMF, dynamically induced EMF, Direction of magnetic field in current carrying conductor, Flemings LHR & RHR, Electromechanical energy conversion.

Course Objective:

- To understand energy conversion process.
- To understand selection of machines for specific applications.
- To understand the construction, principle of operation of transformers, DC Machine & Induction Machine.
- To test & analyse the performance of machine.

Course Outcome: Upon successful completion of this course, the students will be able to:

CO1: Evaluate performance parameters of transformer with experimentation and demonstrate construction along with specifications as per standards.

CO2: Distinguish between various types of transformer connections as per vector groups with application and to perform parallel operation of single/three phase transformers.

CO3: Select and draft specifications of DC machines and Induction motors for various applications along with speed control methods.

CO4: Justify the need of starters in electrical machines with merits and demerits.

CO5: Test and evaluate performance of DC machines and Induction motors as per IS standard.

Unit 01: Transformers: (6 Hrs)

Single phase Transformer: Concept of ideal transformer. Corrugated core transformer. Toroidal core Transformer, Useful and leakage flux, its effects. Resistance, leakage reactance and leakage impedance of transformer windings & their effects on voltage regulation and efficiency. Exact and approximate equivalent circuits referred to L.V. and H. V. side of the transformer. Phasor diagrams for no-load and on load conditions. Transformer ratings. Losses in a transformer, their variation with load, voltage & Frequency on no load losses Efficiency and condition for maximum efficiency. All day Efficiency. Auto transformers, their ratings and applications. Comparison with two winding transformers with respect to saving of copper and size.

Unit 02: (6 Hrs)

Transformers:

Polarity test. Parallel operation of single-phase transformers, conditions to be satisfied, loadsharing under various conditions. & Welding Transformer

Three Phase Transformers:

Standard connections of three phase transformers and their suitability for various applications, voltage Phasor diagrams and vector groups. Descriptive treatment of Parallel operation of three phase transformers Scott connection and V connections. Three winding (tertiary windings) transformers

Unit 03: D.C. Machines (Part-1): (6 Hrs)

Construction, main parts, magnetic circuits, poles, yoke, field winding, armature core, Armature windings: Simple lap and wave winding, commutator and brush assembly. Generating action, E.M.F equation, magnetization curve, Flashing of Generator. Motoring action. Types of DC motors, significance of back E.M.F, torque equation, working at no-load and on-load. Losses, power flow diagram and efficiency. Descriptive treatment of armature reaction.

Unit 04: D.C. Machines (Part-2): (6 Hrs)

Characteristics and applications of D.C. Shunt and Series Motors, Starting of DC motors, study of starters for series and shunt motor, solid state starters, speed control of various types of DC motors.

Commutation: Process of commutation, time of commutation, reactance voltage, different form of commutations, causes of bad commutation and its remedies (Descriptive treatment only)

Unit 05: Three Phase Induction Motor: (6 Hrs)

Construction: Stator, Squirrel cage & wound rotors. Production of rotating mmf. Principle of working, simplified theory with constant air gap flux; slip, frequency of rotor emf and rotor currents, mmf produced by rotor currents, its speed w.r.t. rotor and stator mmf. Production of torque, torque-slip relation, condition for maximum torque, torque-slip Characteristics, effect of rotor resistance on torque-slip characteristics. Relation between starting torque, full load torque and maximum torque. Losses in three phase induction motor, power-flow diagram, Relation between rotor input power, rotor copper loss & gross mechanical power developed, efficiency.

Unit 06: Three Phase Induction Motor: (6 Hrs)

Induction motor as a generalized transformer; phasor diagram. Exact & approximate equivalent circuit. No load and blocked rotor tests to determine the equivalent circuit parameters and plotting the circle diagram. Computation of performance characteristics from the equivalent circuit and circle diagram. Performance curves. Necessity of starter for 3-phase induction motors. Starters for slip-ring and cage rotor induction motors, comparison of various starters. Testing of three phase induction motor as per IS 325 & IS 4029.

Industrial Visit:

Minimum One visit to above machines manufacturing industry (mentioned in syllabus) is recommended.

List of Experiments:

Compulsory Experiments:

1. O.C. and S.C. test on single phase Transformer
a. Determination of equivalent circuit parameters from the test data
b. Determination of voltage regulation and efficiency
2. Parallel operation of two single phase transformers and study of their load sharing under various conditions of voltage ratios and leakage impedance.
3. Speed control of D.C. Shunt motor and study of starters.
4. Load test on 3-phase induction motor.

Any four experiments are to be conducted of following experiments:

1. Polarity test on single phase and three phase transformer.
2. Brake test on D.C. Shunt motor
3. Load characteristics of D.C. series motor.
4. Hopkinson's test on D.C. shunts machines.
5. No load & blocked-rotor test on 3-phase induction motor:
a) Determination of parameters of equivalent circuit.
b) Plotting of circle diagram.
6. Calculation of motor performance from (a) & (b) above.
7. Determination of sequence impedance of the transformer
8. To study Sumpner's test.
9. Measurements of non-sinusoidal current waveform of transformer at no load
10. Swinburne Test on DC shunt Motor.

Text Books:

[T1] Edward Hughes "Electrical Technology", ELBS, Pearson Education.
[T2] Ashfaq Husain, "Electrical Machines", Dhanpat Rai& Sons.
[T3] S. K. Bhattacharya, "Electrical Machine", Tata McGraw Hill publishing Co. Ltd, 2nd Edition.
[T4] Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill.
[T5] Bhag S Guru, Husein R. Hiziroglu, "Electrical Machines", Oxford University Press.
[T6] K Krishna Reddy, "Electrical Machines- I and II", SCITECH Publications (India) Pvt. Ltd. Chennai.

Reference Books:

[R1] A.E. Clayton and N. N. Hancock, "Performance and Design of Direct Current Machines", CBS Publishers, Third Edition.
[R2] A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", TataMcGraw

Hill Publication Ltd., Fifth Edition.
[R3] A.S. Langsdorf, “Theory and performance of DC machines”, Tata McGraw Hill.
[R4] M.G. Say, “Performance and Design of AC. Machines”, CBS Publishers and Distributors.
[R5] Smarajit Ghosh, “Electrical Machines”, Pearson Education, New Delhi.
[R6] Charles I Hubert, “Electrical Machines Theory, Application, & Control”, Pearson Education, New Delhi, Second Edition.

Unit No.	Text Book	Book Reference
I	T1, T2, T3, T4	R2, R4, R5
II	T1, T2, T3, T4	R2, R4, R5
III	T2, T3, T4	R1, R3, R5
IV	T2, T3, T4	R1, R3, R5
V	T1, T3, T4, T5, T6	R4, R5, R6
VI	T1, T3, T4, T5, T6	R4, R5, R6

203147: Network Analysis

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week **Practical** : 02 Hrs/ Week	**Th**: 03 **PR**:01	**In Sem** : 30 Marks **End Sem** : 70 Marks **Term Work**: 25 Marks

Prerequisite:

Terminology of electrical networks, series and parallel combinations of resistance, Laplace transforms , linear differential equations.

Course Objective:

1. To develop the strong foundation for Electrical Networks.
2. To develop analytical qualities in Electrical circuits by application of various theorems.
3. To understand the behavior of circuits by analyzing the transient response using classical methods and Laplace Transform approach.
4. To apply knowledge of laws and Network theory for analysis of 2-port networks and design of other circuits like filters.

Course Outcome:

Upon successful completion of this course, the students will be able to :-

CO1: Calculate current/voltage in electrical circuits using simplification techniques, Mesh, Nodal analysis and network theorems.

CO2: Analyze the response of RLC circuit with electrical supply in transient and stead state.

CO3: Apply Laplace transform to analyze behaviour of an electrical circuit.

CO4: Derive formula and solve numerical of two port network and Design of filters

CO5: Applyknowledge of network theory to find transfer function, poles and zeroes location to perform stability analysis and parallel resonance

Unit 1 Types of Network, Mesh and Nodal analysis [6 Hrs]

Lumped and Distributed, Linear and Nonlinear, Bilateral and Unilateral, Time-variant and Time-invariant. Independent and Dependent (controlled) voltage and current sources. Concept of voltage and current divider, Source transformation and shifting. Network Equations: Network equations on Loop basis and Node basis, choice between Loop analysis and Nodal analysis. Concept of super node and super mesh, mutual inductance, Dot convention for coupled circuits, Concept of duality and dual networks.

Unit 2: Network Theorem:[6 Hrs]

Superposition, Thevenin, Norton, Maximum Power Transfer Theorem, Reciprocity, Millman theorems applied to electrical networks with all types of sources.

Graph Theory : Tree ,Co-tree, Incidence matrix ,F-cutest Matrix, Tie set B Matrix

Unit 3: Transients in RLC circuit[6 Hrs]

Solutions of differential equations and network equations using classical method for R-L, R-C and R-L-C circuits, Initial and Final Condition (series and parallel).

Unit 4: Laplace Transform[6 Hrs]

Basic Properties of Laplace Transform, Laplace Transform of Basic R, L and C components, Solutions of differential equations and network equations using Laplace transform method for RL, R-C and R-L-C circuits (series and parallel), Inverse Laplace transforms, transformed networks with initial conditions. Analysis of electrical circuits with applications of step, pulse, impulse & ramp functions, shifted & singular functions the convolution integral,application of initial and final value theorem.

Unit 5 Two port network and Filters [6 Hrs]

Two Port Network: Z, Y, H and transmission parameters, Interrelations between parameters. Introduction to passive filters, low pass filters, high pass filters and m-derived LPF and HPF filters and design.

Unit 6 Network Functions: [6 Hrs]

Poles and Zeros: Terminal pairs or ports, network functions for the one port and two ports, the calculation of network functions, general networks. Poles and zeros of network functions, Restrictions on poles and zeros locations for transfer functions and driving point function, Time –

domain behavior from the pole and zero plot. Stability of active networks. Parallel Resonance, Resonance frequency, Quality factor, Current and resonance.

List of Experiments: Any four experiments from the first five of the following and any four experiments from rest of the list. (Minimum four experiments should be based on simulation software along with hardware verification)

1. Verification of Superposition theorem in A.C. circuits.
2. Verification of Thevenin's theorem in A.C. circuits.
3. Verification of Reciprocity theorem in A.C. circuits.
4. Verification of Millmans' theorem.
5. Verification of Maximum Power Transfer theorem in A.C. circuits.
6. Determination of time response of R-C circuit to a step D.C. voltage input. (Charging and discharging of a capacitor through a resistor)
7. Determination of time response of R-L circuit to a step D.C. voltage input. (Rise and decay of current in an inductive circuit)
8. Determination of time response of R-L-C series circuit to a step D.C. voltage input.
9. Determination of parameter of Two Port Network.
10. Determination of current under parallel Resonance condition .
11. Determination of Resonance, Bandwidth and Q factor of R-L-C series circuit.

Guidelines for Instructor's Manual□

- Specify objective(s) of the experiment. □
- List out equipment required to perform the experiment with their ratings. □
- Include circuit diagram with specifications. □
- Related theory of the experiment must be included. □
- Include step by step procedure to perform the experiment. □
- Tabular representation of results taken from the experiment/observation table must be included wherever applicable. □
- It should include the formula required to calculate desired results. □ Instructions for plotting the graphs must be included wherever required. □
- Provide space to write conclusion on their own. □
- For simulation experiments using MATLAB, the Simulink diagram with proper details must be included.

Guidelines for Student's Lab Journal □

- Students are expected to write the journal in the following sequence: □
  - Aim □
  - Equipment □
  - Circuit diagram □
  - Theory
  - Procedure
  - Observation table□
  - Calculations □
  - Graphs□
  - Conclusion. □
- Students are expected to draw the circuit diagrams on 1mm graph paper. □
- For plotting the characteristics they must use 1mm graph papers. □
- Students should write conclusion. □
- Students should get the assignment and lab write up checked within 1 week after performing the experiment.

Guidelines for Lab

- TW Assessment should be on the basis of: □
- Neatness of circuit diagram. □
- Completed write up including theory, procedure. □
- The detail calculations to obtain results. □
- Graph with title, scale, labeling of axes etc. □
- Conclusion. □

- Punctuality, discipline, attendance, understanding and neatness of the journal. Few questions on the basis of the experiment can be asked to verify the understanding of the students about that experiment.

Guidelines for Laboratory Conduction □

- Give the safety instructions to students. □
- Allow 4-5 students per group for performing the experiment. □
- Explain theory related to the experiment to be conducted. □
- Introduce the equipment required to students. □
- Explain students the calibration process of equipment. □
- Explain the circuit diagram of the experiment. □
- Connections should be completed by the students according to circuit diagram. □ Perform the experiment in the presence of instructor. □
- Verify the results obtained.

Text Book:

[T1] Network Analysis Third Edition by M. E. Van Valkenburg, Prentice Hall of India Private Limited.

[T2] Network Analysis & Synthesis by G. K. Mittal, Khanna Publication.

[T3] Network Analysis and Synthesis by Ravish R Singh, McGraw Hill.

[T4] Introduction to Electric Circuits by Alexander & Sadiku, McGraw Hill.

[T5] Introduction to Electric Circuits by S. Charkarboorty, Dhanpat Rai & Co.

[T6] Fundamentals of Electrical Networks by B.R.Gupta & Vandana Singhal- S.Chand Publications 8. Electrical Circuit Analysis 2nd Edition by P. Ramesh babu, Scitech Publication India Pvt Ltd.

Reference Books:

[R1] Network Analysis by Cramer , McGraw Hill Publication.

[R2] Engineering Circuit Analysis by William H. Hayt, Jr. Jack E. Kemmerly, McGraw Hill Publication.

[R3] Schaum's Outline of Electric Circuits, McGraw-Hill Education; 7 edition

Unit	Text book	Reference
1	T1,T2, T3 T5	R1,R3
2	T1,T2, T3, T4	R1,R3
3	T2, T3,T5	R2,R3
4	T2, T3,T5	R2,R3
5	T2, T3, T4	R3
6	T5,T6	R3

203148: Numerical Methods and Computer Programming

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week **Practical** : 02 Hrs/ Week	**Th**: 03 **PR**:01	**In Sem** : 30 Marks **End Sem** : 70 Marks **Practical** : 25 Marks

Prerequisite:

1. Differentiation and integration of a single real variable, ordinary differential equations.
2. Programming and Problem solving.
3. Linear Algebra.

Course Objectives:

1. To emphasize the need of computational techniques and analyze errors involved in the computation.
2. To provide sound knowledge of various numerical methods.
3. To apply various numerical methods to obtain solution of different types of equations such as transcendental, simultaneous, ODE etc. and also for interpolation, integration and differentiation.
4. To impart skills to develop algorithms and programs for various numerical methods.

Course Outcomes:

On completion of the course, student will be able to

CO1: Demonstrate types of errors in computation and their causes of occurrence.

CO2: Calculate root of algebraic and transcendental equations using various methods.

CO3: Apply numerical methods for various mathematical problems such as interpolation, numerical differentiation, integration and ordinary differential equation.

CO4: Solve linear simultaneous equation using direct and indirect method.

CO5: Develop algorithms and write computer programs for various numerical methods.

Unit 01 : Numerical Computations, Errors and Concept of root of equation (6hrs)

A) Basic principle of numerical computation. Floating point algebra with normalized floating point technique, Significant digits. **Errors**: Different types of errors, causes of occurrence and remedies to minimize them, Generalized error formula (Derivation and Numerical)

B) **Concept of roots** of an equation. Descartes' rule of signs, Intermediate value theorem, Roots of Polynomial Equations using Birge-Vieta method.

Unit 02: Solution of Transcendental and polynomial equation and Curve Fitting: (6hrs)

A) Solution of Transcendental and polynomial equation using Bisection, Regula- Falsi, Newton-Raphson method for single variable and two variables.

B) Curve fitting using least square approximation – First order and second order

Unit 03: Interpolation (6hrs)

Forward, Backward, Central and Divided Difference operators, Introduction to interpolation.

A)Interpolation with equal Intervals - Newton's forward, backward interpolation formula (Derivations and numerical), Stirling's and Bessel's central difference formula (Only numericals)

B) Interpolation with unequal Intervals- Newton's divided difference formula and Lagrange's interpolation (Derivations and numerical).

Unit 04: Numerical Differentiation and Integration (6hrs)

A) **Numerical Differentiation** using Newton's forward and backward interpolation formula (Derivation and numerical).

B) Numerical Integration: Trapezoidal and Simpson's rules as special cases of Newton-Cote's quadrature technique for single integral. Numerical on double integrals using Trapezoidal and Simpson's $1/3^{rd}$ rule.

Unit 05:Solution of linear simultaneous equation (6hrs)

A) Solution of linear simultaneous equation: Direct methods - Gauss elimination method, concept of pivoting – partial and complete. Gauss Jordan method, Iterative methods – Jacobi method and Gauss Seidel method.

B)Matrix Inversion using Gauss Jordan method

Unit 06: Solution of Ordinary Differential Equation(ODE) (6hrs)

A) Solution of First order Ordinary Differential Equation (ODE) using Taylor's series method, Euler's method, Modified Euler's method (Derivation and numerical). Runge-Kutta fourth order method (Numerical).

B)Solution of Second order ODE using 4th order Runge-Kutta method (Numerical)

List of Experiments:

Develop computer program using **Python language**

Compulsory Experiments-1,2,3,4,7,10

Any one from 5 or 6 and any one from 8 or 9

1. Develop algorithm, draw flow chart and write a program to implement following:
   (a) for loop and while loop-- application in Descarte's rule of sign.
   (b) if-else and functions-- application in Intermediate value theorem.
   (c) 2DArray formation-- application in matrix data entry, transposition and printing matrix.
2. Develop algorithm, draw flow chart and write a program to implement Birge-Vieta method.
3. Develop algorithm, draw flow chart and write a program to implement Bisection/Regula falsi /Newton-Raphson method (single variable) in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Finding critical clearing angle in power system stability (give equation directly)
   (b) Relation between voltage and current in solar PV.
4. Develop algorithm, draw flow chart and write a program to implement curve fitting using least square approximation in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Voltage across capacitor during charging.
   (b) Relate temperature and resistance in thermocouple.
   (c) Current through inductor during excitation.
5. Develop algorithm, draw flow chart and write a program to apply Newton's forward/backward interpolation method in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Voltage across capacitor during charging
   (b) Relation of speed and armature voltage in DC motor.
   (c) Relation of breakdown voltage and thickness of insulation
6. Develop algorithm, draw flow chart and write a program to apply Newton's divided difference/Lagrange's interpolation method in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Power transfer equation to find power at particular angle
   (b) Transformer efficiency at particular loading (data of % loading and efficiency in known at a particular power factor)
   (c) Growth of electricity consumption in India (year Vs. Per capita electrical consumption).
7. Develop algorithm, draw flow chart and write a program to implement trapezoidal/ Simpson (1/3)rd rule in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) RMS/Average value of given waveform.
   (b) Finding current through first order circuit (RL series)
   (c) kWh consumption from load curve
   (d) Magnetic field intensity in overhead transmission line
8. Develop algorithm, draw flow chart and write a program to implement Gauss elimination/Jordan in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Electrical network using KVL
   (b) Electrical Network using KCL
9. Develop algorithm, draw flow chart and write a program to implement Gauss Jacobi/Seidel in following applications (formulate problem statement in any one of following area(but not limited to))
   (a) Electrical network using KVL
   (b) Electrical Network using KCL
10. Develop algorithm, draw flow chart and write a program to implement Modified Euler's/4^{th} order RK method in following applications (formulate problem statement in any one of following area(but not limited to)
    (a) Response of RC series circuit with DC
    (b) Response of RL circuit with DC
    (c) Deflection angle in MI type instrument

Guidelines for Instructor's Manual Practical Sessions

The Instructor Manual should contain following related to every program

- Theory related to the method
- Algorithm and Flowchart of the method
- Three to four different sets of problem statement for numerical method

- Solve numerical using appropriate method
- Ten questions based on method and related Python commands
- Expected Output

Guidelines for Student's Lab Journal

The student's Lab Journal should contain following related to every experiment:

- Theory related to the method
- Algorithm and Flowchart of the method
- Problem statement for numerical method
- Solve numerical using appropriate method
- Program printout with output
- Conclusion
- Ten questions based on method and related Python commands

Guidelines for Lab Assessment

- There should be continuous assessment
- Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to do programming
- Timely submission of journal

Guidelines for Laboratory Conduction

- Detail theory and numerical related to the method should be taken in the lecture prior to the lab session
- Algorithm should be discussed in detail in the lab session
- Students are expected to do the program based on the discussed algorithm individually
- Printout of the program and output should be taken on the day when the program is performed

Books & Other Resources:

Text Books:

[T1] M. K. Jain, S.R.K. Iyangar, R. K. Jain, “Numerical Methods for Scientific and Engineering Computations”, New Age Publications.

[T2] Dr. B. S. Grewal, “Numerical Methods in Engineering & Sciences”, Khanna Publishers.

[T3] P.P. Gupta & G.S Malik, “Calculus of Finite Difference and Numerical Analysis”, Krishna Prakashan Media Ltd, Meerut.

[T4] T. Veerarajan and T. Ramchandran, “Numerical Methods with Programs in C and C++”, Tata McGraw Hill Publication.

[T5] S Arumugam, “Numerical Methods” Scitech Publication

Reference Books:

[R1] J. B. Scarborough, “Numerical Mathematical Analysis”, Oxford & IBH, New Delhi.

[R2] Steven Chapra, Raymond P. Canale, “Numerical Methods for Engineers”, Tata McGraw Hill Publication.

[R3] S.S. Sastry, “Introductory methods of Numerical Analysis”, PHI Learning Private Ltd.

[R4] P. Thangaraj, “Computer oriented Numerical Methods”, PHI Learning Private Ltd.

[R5] Yashwant Kanitkar, “Let us Python”, pbp publications

[R6] NPTEL course on Numerical Analysis, IIT, Roorkee.
https://nptel.ac.in/courses/111107062/

[R7] NPTEL course on MATLAB Programming on Numerical Computation, IIT Madras
https://nptel.ac.in/courses/103106118/

[R8] NPTEL course on Python for Data Science, IIT Madras
https://nptel.ac.in/courses/106106212/

[R9]Jaan Kiusalaas, “Numerical methods in Engineering with Python”, Cambridge University Press

Unit No	Text Books	References
1	T5, T4	R2, R3, R6
2	T1, T5	R2, R3, R6
3	T3, T4, T5	R4, R2, R1, R6, R7
4	T2, T3,T5	R2, R3, R7
5	T2, T3,T5	R2, R3, R7
6	T2, T3,T5	R2, R3, R6, R7
Python	--	R5, R8,R9

203149: Fundamental of Microcontroller and Applications

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week **Practical** : 04 Hrs/ Week	**Th**: 03 **PR**:02	**In Sem** : 30 Marks **End Sem** : 70 Marks **Term Work**: 25 Marks **Oral** : 25 Marks

Prerequisite:

- Knowledge of numbering systems and Boolean algebra.
- Knowledge of combinational and sequential logic circuits.

Course Objective: Objectives of the course are to

- Explain the microcontroller architecture & describe the features of a typical microcontroller.
- To use the 8051 addressing modes and instruction set and apply this knowledge to develop programs in assembly language and C language.
- To define the protocol for serial communication and understand the microcontroller development systems.
- Explain the interrupt structure of the microcontroller and to develop programs related to interrupt handling
- To introduce students to Global System for Mobile Communication (GSM)
- To provide students with interfacing concepts and develop interfacing circuits for simple devices.

Course Outcome: Upon successful completion of this course, the students will be able to:-

CO1: Describe the architecture and features of various types of the microcontroller.

CO2: Illustrate addressing modes and execute programs in assembly language for the microcontroller.

CO3: Write programs in C language for microcontroller 8051.

CO4: Elaborate interrupt structure of 8051 and program to handle interrupt and ADC809

CO5: Define the protocol for serial communication and understand the microcontroller development systems.

CO6: Interface input output devices and measure electrical parameters with 8051 in real time.

Unit 01 : (6 Hrs)

Introduction to concept of microcontroller, Intel 8051 Functional block diagram, Functions of pins of 8051, Memory organization of 8051, PSW and Flag Bits, Stack and Stack pointer. Overview of special function registers,Data transfer instructions and programs in assembly language.

Unit 02 : (6 Hrs)

Arithmetic and logical instructions and programs in assembly language.Boolean and Program Branching instructions and programs in assembly language.Addressing modes of 8051.

Unit 03 : (6 Hrs)

8051 Programming in C , Data types in C . Ports of 8051, their use, and programming in C (Byte Level and Bit-level). Time delay programming in C.

Timers and counters in 8051, Timer modes 0,1,2 and its programming in C and counter-programming.

Unit 04 : (6 Hrs)

Interrupt structure of 8051 and SFR associated with interruptsProgramming of External hardware interrupts in C.Interfacing of ADC 0809 with 8051.

Unit 05 : (6 Hrs)

Serial port Structure in 8051. Programming of Serial port for transferring and receiving data in C in mode 1.

Introduction to GSM module, AT commands, Programming to send and read SMS.

Unit 06 : (6 Hrs)

Measurement of electrical parameters such as voltage, current (Theoretical Treatment only).

Interfacing of Stepper motor with 8051 and its programming in C.Interfacing and programming of single Key, LED, and Relay with 8051 in C.

Guidelines for Instructor's Manual
1. Commands to be followed to operate the 8051 microcontroller kit.
2. The architecture of the 8051 microcontroller kit-Functional block diagram & its explanation.
3. Pin Diagram of 8051 microcontrollers with a description of all the 40 pins.
4. Addressing modes-Explanation with an example.
5. Instruction set for Data transfer, Arithmetic, Logical, Branching & Bit manipulation along with an explanation.
6. User manuals of all the interfacing kits such as stepper motor, DC motor, DAC, ADC &LED.

Guidelines for Student's Lab Journal
1. Title of the program.
2. The program has to be written in the following format. Address- Instruction- Comment
3. Input data has to be specified.
4. Result of the program.
5. Flow Chart for each program has to be drawn on a separate page.

Guidelines for Laboratory Conduction
1. Each group in the lab should have not more than three students.
2. Each student within the group has to enter and execute the program turn wise.
3. A faculty member has to check the result of all the groups after the execution of the program.

List of Experiments:
PART A: [TW: 15 Marks]
Compulsory Experiments:
1. Study and use of 8051 Microcontroller trainer kit.
2. Assembly Language Program for the arithmetic operation of 8-bit numbers.
3. Assembly Language Program for finding the largest number and smallest number from a given an array of 8-bit numbers.
4. Assembly Language program to arrange 8-bit numbers stored in an array in ascending order and descending order.

Any four experiments are to be conducted of the following experiments using embedded C :
1. Implementation of Serial Communication by using 8051 serial ports.
2. Programming using a cross-assembler.
3. The blinking display of LED's interfaced with 8051.
4. Interfacing of 8 bit DAC 0808 with 8051 to generate various waveforms.
5. Interfacing of 8 bit ADC 0809 with 8051 Microcontroller.
6. Interfacing of the relay with 8051.
7. Stepper motor control by 8051 Microcontroller.
8. Interfacing of matrix keyboard/ 7 segment display with 8051.
9. Interfacing of LCD with 8051.

PART B: [TW: 10 Marks]
Prerequisite: Programming exercises of C language.
Compulsory Experiments:
1. Study of GSM Module SIM800/SIM900/QUECTEL M95 and AT Commands
2. Study of IoT system
3. Interfacing of GSM with a computer through COM port to Send and Receive SMS.
4. Interfacing GSM with 8051 trainer kit and develop a program to send AT commands.

Any two experiments are to be conducted of the following experiments:
1. Develop a program in C to read and send SMS from the GSM module.
2. Measurement of physical parameters (Temperature/Pressure/Humidity) using 8051 and send value to GSM after an interval of the specified interval.
3. Measurement of electrical parameters (Voltage/Current) using 8051 and send value to the GSM module after an interval of 10min.
4. Develop a program to turn on and turn off induction Motor using 8051 and GSM module.
5. Development of mobile app for various applications in electrical engineering.

Text Books:

[T1] Muhammad Ali Mazidi, J.G. Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearsons Publishers.
[T2] V Udayashankara and M S MallikarjunaSwamy, "8051 Microcontroller, Hardware, software and applications", TATA McGraw Hill.
[T3] Ajay Deshmukh, "Microcontroller 8051" –TATA McGraw Hill.
[T4] Theagrajan," Microprocessor and Microcontroller", BS Publication.
[T5] K. J. Ayala, "The 8051 Microcontrollers- Architecture, Programming and Applications", Peram International Publications.
[T6] SubrataGhoshal, "8051 microcontroller", Pearsons Publishers.
[T7] Han-Way Huang," Embedded System Design with C8051", Cengage Learning

Reference Books:

[R1] Scott Mackenzie, "8051 Microcontroller", Pearson Education.
[R2] Intel Microcontroller data book.
[R3] Intel Corporation 1990- 8 bit embedded controller handbook.

203152: Project Based Learning

Teaching Scheme	Credits	Examination Scheme [Marks]
Practical : 04 Hrs/ Week	**PR**:02	**Term Work**: 50 Marks

Preamble: For better learning experience, along with traditional classroom teaching and laboratory learning, project-based learning has been introduced to motivate students to learn by working in a group cooperatively to solve a problem. Project-Based Learning (PBL) is a student-centered and experimental approach to education promoting 'deeper learning' through active exploration of real-world problems and challenges. A central goal of PBL is to facilitate the deeper learning process and support students' acquisition of complex cognitive competencies, e.g., rigorous content knowledge and critical thinking skills. The PBL engages students in the problem definition, design process, contextual understanding, and systems thinking approaches. In the PBL approach, learning based on memorization is de-emphasized and more emphasis is given on understanding and application of engineering design principles. Because of frequent assessments throughout the course, plagiarism can be more easily controlled.

Course Objectives: Objectives of this course are to

1. Impart technical knowledge and skills, and develop deeper understanding to integrate knowledge and skills from various areas.
2. Build critical thinking, problem-solving, communication, collaboration and creativity, and innovation amongst students
3. Make students aware of their own academic, personal, and social developments.
4. Develop habits of self-evaluation and self-criticism, against self-competency and trying to see beyond own ideas and knowledge

Course Outcomes: At the end of this project-based learning, students will be able to

CO1: Identify, formulate, and analyze the simple project problem.

CO2: Apply knowledge of mathematics, basic sciences, and electrical engineering fundamentals to develop solutions for the project.

CO3: Learn to work in teams, and to plan and carry out different tasks that are required during a project.

CO4: Understand their own and their team-mate's strengths and skills.

CO5: Draw information from a variety of sources and be able to filter and summarize the relevant points.

CO6: Communicate to different audiences in oral, visual, and written forms.

Procedure: A group of 4-5 students will be assigned to a faculty member called a mentor. Based on the engineering knowledge of a group and societal and industry problems, the mentor has to guide a group to identify project problems and plan the work schedule. Here, the expected outcomes of the project must be noted. The complete work-plan should be divided in the form of the individual tasks to be accomplished with targets. Weekly review of the completed task should be taken and further guidelines are to be given to a group. The final activity will be presenting the work completed and submitting the report. A group should be promoted to participate in a competition or write a paper.

A problem needs to refer back to a particularly practical, scientific, social, and/or technical domain. The problem should stand as one specific example or manifestation of more general learning outcomes related to knowledge and/or modes of inquiry. There are no commonly shared criteria for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content, and the structure of the activity. It may have

- ✓ A few hands-on activities that may or may not be multidisciplinary.
- ✓ Use of technology in meaningful ways to help them investigate, collaborate, analyze, synthesize, and present their learning.
- ✓ Activities on solving real-life problems, investigation /study, and writing reports of in-depth study, fieldwork.

Assessment:

The department/mentor is committed to assess and evaluate both students' performance and course effectiveness. The progress of PBL is monitored regularly every week. During the process of monitoring, continuous assessment and evaluation the individual and team performances are to be measured by supervisor /mentor and authorities.

Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning, and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and students must actively participate in the assessment and evaluation processes. Groups may demonstrate their knowledge and skills by developing a solution to the problem, public product, and/or report and/or presentation.

- ✓ Individual assessment for each student (Understanding individual capacity, role, and involvement in the project)
- ✓ Group assessment (roles defined, distribution of work, intra-team communication and togetherness)
- ✓ Documentation and presentation

Evaluation and Continuous Assessment:

It is recommended that all activities are to be recorded in a PBL workbook regularly, regular assessment of work to be done and proper documents are to be maintained at the department level by both students as well as a mentor. Continuous Assessment Sheet (CAS) is to be maintained by all mentors/department. Recommended parameters for assessment, evaluation, and weightage are as follows.

- ✓ Idea Inception **(5%)**
- ✓ Outcomes of PBL/ Problem Solving Skills/ Solution provided/ Final product **(50%)** (Individual assessment and team assessment)
- ✓ Documentation (Gathering requirements, design and modeling, implementation/execution, use of technology and final report, other documents) **(25%)**
- ✓ Demonstration (Presentation, User Interface, Usability, etc.) **(10%)**
- ✓ Contest Participation/ publication **(5%)**
- ✓ Awareness /Consideration of -Environment/ Social /Ethics/ Safety measures/Legal aspects **(5%)**
- ✓ PBL workbook will serve the purpose and facilitate the job of students, mentors, and project coordinator. This workbook will reflect accountability, punctuality, technical writing ability and work flow of the work undertaken

203153: Audit Course-IV

List of three audit course is provided. Students can choose any one from 203153(A) 203153(B) and 203153(C)

203153(A): Solar Photovoltaic Systems

Teaching Scheme	Credits	Examination Scheme [Marks]
Lectures: 2hrs/week	**No credit**	**Grade: PP/NP** **Quiz and term paper**

Prerequisite: Completion of FE or equivalent

Description: The course will introduce the basics of: solar energy, availability, semiconductors as photovoltaic convertors and solar cells, applications of photovoltaic, various types of solar photovoltaic systems, and introduction to manufacturing of the systems, characterization, quality assurance, standards, certification and economics. The following topics may be broadly covered in the classroom. The practical will be designed for basic understanding of the system elements.

Course Objective:

- To learn Solar PV system and its appliances
- To get knowledge of balance of PV system, batteries, inverters etc.
- To understand grid tied SPV solar plants

Course Outcome: Students will be able to

CO1: design of Solar PV system for small and large installations

CO2: handle software tools for Solar PV systems

Course Contents:

- Physics of photovoltaic (PV) electricity
- Photodiode and solar cell
- Solar radiation spectrum for PV •
- Types of solar cell and comparison
- Introduction to various types of solar module manufacturing
- Basic system design and economics
- Types of systems
- Common applications of solar PV
- Introduction to solar PV (SPV) systems
- SPV appliances
- Small capacity SPV power plants
- Grid tied SPV power plants
- Large scale SPV power plants
- Balance of system
- Solar inverters
- Batteries
- Financial modelling of SPV
- Operation and maintenance of SPV
- Software tools for SPV
- Environmental impact assessment
- Standards and certification for SPV
- Basics of SPV systems
- Elements of SPV appliances and power plants Procurement versus production
- Bought-outs, assemblies, sub-assemblies
- Manufacturing and assembly
- Manufacturing standards
- Quality assurance and standards
- Certification
- Special purpose machines and Automation in manufacturing
- Site assembly and fabrication

- Typical shop layouts
- Inventory management
- Economics of manufacturing

Practical:

- PV characterization
- Batteries and energy storage
- PV system design

Assignment

- Design of solar PV system for department / college.

References:

[1] A.S.Kapur -A Practical Guide for Total Engineering of MW capacity Solar PV Power Project
[2] Solanki C.S- Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers- PHI
[3] Solanki C.S- SolarPhotovoltaics - Fundamentals, Technologies and Applications- PHI
[4] S. Sukhatme -Solar Energy : Principles of Thermal Collection and Storage- McGraw Hill

203153(B) Installation & Maintenance of Electrical appliances

Teaching Scheme	Credits	Examination Scheme [Marks]
Lectures: 2hrs/week	No credit	Grade: PP/NP Quiz and term paper

Prerequisite: Completion of FE/DEE or equivalent

Course Objective: This course has been designed to provide the knowledge of Repairing and Maintenance of home appliances. Students will be familiar with maintenance of everyday household necessities.

Course Outcome: At the end of the course the students will be having knowledge of: -

- Observing the safety precautions while working,
- Test line cord for continuity with test lamp/ multimeter
- Dismantle and reassemble an electric iron
- Heater, kettle, room heater, toaster, hair dryer, mixer grinder etc.
- Install a ceiling fan and the regulator
- Check a fluorescent lamp chock, starter and install it
- Domestic installation testing before energizing a domestic installation

Course Contents:

- General safety & electrical safety
  - ➢ What is safety, Why safety is needed
  - ➢ Tools for electrical safety
  - ➢ Safety rules
  - ➢ Precaution during electrical maintenance
- Crimping & crimping tool, soldering
  - ➢ What is crimping, crimping tool, How to use RJ-11 connector, telephone wire, UTP Cable
  - ➢ crimping technique, precaution during crimping
  - ➢ Soldering Iron, Soldering wire, Soldering Flux,
  - ➢ Soldering method, Zero defect soldering
- Earthing& types of Earthing
  - ➢ Introduction of Earthing
  - ➢ Need of Earthing, Hazard
  - ➢ Types of Earthing
  - ➢ Advantage of Earthing, working of Earthing
- Simple house wiring circuit
  - ➢ Introduction of Wiring ,types of wiring
  - ➢ need of wiring, advantage of wiring
  - ➢ wiring methods
  - ➢ electrical panel
  - ➢ cable type
- Install, service and repair of automatic electric iron, mixer grinder, ceiling and table fan, heater, iron, kettle, washing machine etc
  - ➢ Installation procedure of electric iron,
  - ➢ Installation procedure mixer grinder
  - ➢ Installation procedure of ceiling and table fan,
  - ➢ Installation procedure heater, iron, kettle
  - ➢ Installation procedure washing machine
  - ➢ fault finding & removal of faulty component in electric iron, mixer grinder, ceiling and table fan
  - ➢ fault finding & removal of faulty component in heater, iron, kettle, washing machine
- Assemble and install of a fluorescent lamp
  - ➢ Parts of fluorescent lamp,
  - ➢ Working principle of fluorescent lamp

- Assembling procedure of lamp
- Thermostat heat controls of Automatic electric iron, steam iron, spray irons.
  - Thermostat, Bimetal, Wax Pallet , Gas Expansion, Pneumatic,
  - Bimetallic Switching thermostat, Simple two wire thermostats
  - Combination heating/Cooling regulation, Heat Control of Steam Iron, Electric Iron
- Maintenance of decorative serial lamp for a required supply voltage
  - What is decorative lamp, Working of decorative lamp
  - Description of decorative serial lamp,
  - Maintenance of decorative serial lamp
- Introduction to re- winding Insulating material used
  - Material, Types of Material
  - Insulating Material, Types of Insulating Material
  - Need of insulating material, winding, re-winding

References:

[1] S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House
[2] B. K. N. Rao -Hand book of condition monitoring- Elsevier Advance Tech., Oxford (UK).
[3] Eric Kleinert-Troubleshooting and Repairing Major Appliances / Edition 3- McGraw Hill
[4] Service Manual of Electrical Home Appliances

203153(C) Japanese Language-II		
Teaching Scheme **Lectures: 2hrs/week**	**Credits** **No credit**	**Examination Scheme** [Marks] **Grade: PP/NP** **Quiz and term paper**

Course Objective:

- To meet the needs of ever growing industry with respect to language support.
- To get introduced to Japanese society and culture through language.

Course Outcome: On completion of the course student

- Will have ability of basic communication.
- Will have the knowledge of Japanese script.
- Will get introduced to reading , writing and listening skills
- Will develop interest to pursue professional Japanese Language course.

Course Contents:

Unit 1: Katakana basic Script, Denoting things (nominal & prenominal demonstratives)Purchasing at the Market / in a shop / mall (asking & stating price)

Unit 2: Katakana: Modified kana, double consonant, letters with ya, yu, yo, Long vowelsDescribing time, describing starting & finishing time (kara ~ made) Point in time (denoting the time when any action or the movement occurs)

Unit 3: Means of transport (Vehicles), Places, Countries, Stating Birth date, Indicating movement to a certain place by a vehicle

References:

1. Minna No Nihongo, “Japanese for Everyone”, Elementary Main Text book 1-1 (Indian Edition), Goyal Publishers & Distributors Pvt. Ltd.

Guidelines for Conduction

(Any one or more of following but not limited to)

- Guest Lectures
- Visiting lectures
- Language Lab

Guidelines for Assessment (Any one of following but not limited to)

- Written Test
- Practical Test
- Presentation
- Paper
- Report

Savitribai Phule Pune University, Pune

Faculty of Science and Technology

Board of Studies

Electrical Engineering

Syllabus

Third Year Electrical Engineering
(2019 course)
(w.e.f. 2021-22)

Savitribai Phule Pune University, Pune
Syllabus: Third Year (TE) Electrical Engineering (2019 course)
(w.e.f 2021-22)

SEMESTER-I

Course code	Course Name	Teaching Scheme				Examination Scheme						Credit				
		Th	Pr	Tu	SEM /PW /IN	ISE	ESE	TW	PR	OR	Total	Th	Pr	Tu	SEM /PW /IN	Total
303141	Industrial and Technology Management	3	0	0	0	30	70	0	0	0	100	3	0	0	0	3
303142	Power Electronics	3	4#	0	0	30	70	0	50	0	150	3	2	0	0	5
303143	Electrical Machines-II	3	2	0	0	30	70	25	25	0	150	3	1	0	0	4
303144	Electrical Installation Design and Condition Based Maintenance	3	4#	0	0	30	70	25	0	25	150	3	2	0	0	5
303145	Elective-I	3	0	0	0	30	70	0	0	0	100	3	0	0	0	3
303146	Seminar	0	0	0	1	0	0	50	0	0	50	0	0	0	1	1
303147	Audit course-V	2*	0	0	0	0	0	0	0	0	0	GRADE: PP/NP				0
Total		**15**	**10**	**0**	**1**	**150**	**350**	**100**	**75**	**25**	**700**	**15**	**5**	**0**	**1**	**21**

303145: Elective-I	303147 : Audit Course-V
303145A : Advanced Microcontroller and Embedded System	303147A : Energy storage systems
303145B : Digital Signal Processing	303147B : Start-up & Disruptive innovation
303145C : Open Elective	

SEMESTER-II

Course code	Course Name	Teaching Scheme				Examination Scheme						Credit				
		Th	Pr	Tu	SEM /PW /IN	ISE	ESE	TW	PR	OR	Total	Th	Pr	Tu	SEM /PW /IN	Total
303148	Power System-II	3	2	1	0	30	70	25	50	0	175	3	1	1	0	5
303149	Computer Aided Design of Electrical Machines	3	4#	0	0	30	70	50	0	25	175	3	2	0	0	5
303150	Control System Engineering	3	2$	1$	0	30	70	25	0	25	150	3	1	0	0	4
303151	Elective-II	3	0	0	0	30	70	0	0	0	100	3	0	0	0	3
303152	Internship	0	0	0	4	0	0	100	0	0	100	0	0	0	4	4
303153	Audit Course VI	2*	0	0	0	0	0	0	0	0	0	GRADE: PP/NP				0
Total		12	8	2	4	120	280	200	50	50	700	12	4	1	4	21

303151: Elective-II	303153 : Audit Course-VI
303151A : IoT and its Applications in Electrical Engineering	303153A: Ethical Practices for Engineers
303151B : Electrical Mobility	303153B :Project Management
303 151C: Cybernetic Engineering	
303151D: Energy Management	

#Practical consists of Part A & part B. PART A; Regular experiments & part B; to bridge the gap between theory & actual industrial practices. For subject 303144; there will be auto cad drawing on Electrical installation, Electrical wiring, cabling etc. For 303149, Part A, Regular drawing by hand & part B same drawing by AutoCAD.
$ tutorial credit merged with Practical.
* Conduct over and above these lectures.

303141: Industrial and Technology Management						
Teaching Scheme			**Credits**		**Examination Scheme**	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
					ESE	70 Marks

Course Objectives: This course aims to

- Possess knowledge of types of business organizations.
- Explore the fundamentals of Industrial economics and Management.
- Understand the basic concepts of Technology management and Quality management.
- Analyze and differentiate between marketing management and financial management.
- Recognize the importance of Motivation, Group dynamics, Teamwork, leadership skill and entrepreneurship.
- Explain the fundamentals of Human Resource management.
- Identify the importance of Intellectual property rights and understand the concept of patents, copy rights and trademarks.
- Software programming to construct and use simple mathematical model.
- Ability to carry out basic manufacturing and testing procedure.

Course Outcomes: At the end of this course, student will be able to

CO1	Differentiate between different types of business organizations and discuss the fundamentals of economics and management.
CO2	Explain the importance of technology management and quality management.
CO3	Explain the importance of IPR and role of Human Resource Management.
CO4	Understand the importance of Quality and its significance.
CO5	Describe the characteristics of marketing & its types and overview of financial Management.
CO6	Discuss the qualities of a good leader and road map to Entrepreneurship.

Unit 01 | Introduction to Management and Economics | 07 hrs

A) **Management:** Meaning, scope, function, and importance of management. Difference between administration and management.

B) **Industrial Economics:** Definition of economics, Demand and Supply concept, Demand Analysis. Types of Demand, Determinants of Demand, Law of demand and supply, Elasticity of demand and supply, Law of Diminishing Marginal utility, Demand forecasting: Meaning and methods.

C) **Business Organizations:** Line organization, Staff organization and Functional Organization, (Project, Matrix, Committee Organization.)

D) **Business Ownership and its Types:** Types of business ownership, Sole proprietorship, Partnership (Act 1934), LLP (Limited Liability Partnership) (Act 2008). One person company, Joint Stock Company: Public Limited and Private Limited, Public Sector Undertaking (PSU).

Unit 02 | Technology Management | 05 hrs

A) **Technology Management:** Definition of technology Management and its relation with society, development, application and its scope.

B) **Classification of Technology Management:** Classification of technology management at various levels- its importance on National Economy, Ethics in technology management, Critical factors in technology management.

Unit 03 | Intellectual Property Rights (IPR) & Human Resource Management (HRM) | 06 hrs

A) **Introduction to Intellectual Property Rights (IPR):** Meaning of IPR, Different forms of IPR, Patents, Criteria for securing Patents. Patent format and structure, Copy rights and trademark (Descriptive treatment only).

B) **Human Resource Management:** Introduction, importance, scope, HR planning, Recruitment, selection, training and development, Performance management.

Unit 04	Quality Management	06 hrs

A) Quality Management: Definition of quality, continuous improvement, Types of quality, Quality of design, Seven QC Tools, Poka Yoke (Mistake Proofing), Quality circles, Kaizen. TQM, 5S (Case study of Toyota, descriptive treatment). Six-Sigma.
Basic software used for inventory management and quality management like Zoho inventory, Oracal, Netsuite, Vyapar, Quick book commerce.

B) Quality Management Standards (Introductory aspects only):- The ISO9001:2000 Quality Management System Standard-The ISO14001:2004, ISO26000, ISO 10004:2012, ISO 9001:2012 ISO 9001:2016, Environmental Management System Standard.

Unit 05	Marketing and Financial Management	06 hrs

A) **Marketing Management**: Meaning of Market, Marketing strategy, motives, market characteristics and its types, Perfect Competition, Monopoly, Monopolistic completion and Oligopoly. New product development, Product life cycle, Marketing and selling, methods of selling, marketing planning. Market survey and market research, Online Marketing (Digital Marketing).

B) **Financial Management:** Definition of financial management, cost Concept, Types of costs (Fixed, Variable, average, marginal, and total cost) and methods of costing price, capital. Debit, credit, Profit and loss statement, Balance sheet, Depreciation Analysis, causes and significance, methods of calculation of depreciation, Taxation system, and type of taxes.

Unit 06	Motivational Theory and Entrepreneurship	06 hrs

A) Motivation: Introduction to Motivation, theories of work motivation, Content Theories: Maslow's Hierarchy of Needs, Herzberg's Two factor theory, McClelland's Three Needs Theory, McGregor's Theory X and Theory Y.
Process Theories: Adam's Equity Theory, Vroom's Expectancy Theory, Taylor's Motivation Theory

B) Leadership: Importance of Leadership, Types of Leadership: Autocratic, Democratic and Laissez-Faire Leadership, qualities of good Leader. Group dynamics: Types and interactions of groups, stages of group dynamics: Norming, Storming, Forming, Performing and Adjourning.

C) Entrepreneurship: Importance and limitations of rational decision making, Decision making under certainty, uncertainty and risk. Incentives for small business development, Government policies and incentives, Case study on Small scale industries in India.

Test Books:

[T1]	O. P. Khanna, industrial engineering and management, Dhanpat Rai and sons, New Delhi.
[T2]	E. H. McGraw, S. J. Basic managerial skill for all.
[T3]	Tarek Khalil, Management of Technology Tata McGraw Hill Publication Pvt. Ltd.
[T4]	Prabuddha Ganguli Intellectual Property rights Tata McGraw Hill Publication Company
[T5]	Management Accounting and financial management by M. Y.Khan and P.K. Jain, Tata Mcgraw Hill-Tata-ISBN.

Reference Books:

[R1]	C. B. Mamoria and V. S. P. Rao- Personnel Management , Himalaya Publishing House, 30th Edition 2014.
[R2]	Harold Koonlz and OD'onnel–Management. Tata McGraw Hill Publication1980.
[R3]	Philip Kotler-Marketing Management. Pearson Edition 2008.
[R4]	Robert Heller, Managing Teams, Dorling Kindersley, London.
[R5]	Kelly John M, Total Quality Management, InfoTech Standard, Delhi.
[R6]	Joseph M. Juran, Juran's Quality Handbook TATA McGraw-Hill.
[R7]	Dale H. Bester field and Carol Bester field Total Quality Management Prentice Hall of India Pvt. Ltd.
[R8]	Shiv Sahai Singh [Editor] The Law of Intellectual Property rights.
[R9]	N. R. Subbaram, What Everyone Should Know About Patents, Pharma Book Syndicate, Hyderabad.
[R10]	Principles and Practices of Management –Dr. P.C. Shejwalkar, Dr. Anjali Ghanekar, Deepak

	Bhivpathki.
[R11]	Financial Management by I. M. Pandey, Vikas Publishing House Pvt. Ltd., Delhi Philip Kotler-Marketing Management.

Unit	**Text Books**	**Reference Books**
Unit 1	T1	R2,R10
Unit 2	T1, T2,T3	R5
Unit 3	-	R3,R5,R6
Unit 4	T5	R3, R11
Unit 5	T1	R1,R2
Unit 6	T4	R8

303142: Power Electronics

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
Practical	04	Hr/Week/batch	**PR**	02	**ESE**	70 Marks
					PR	50 Marks

Prerequisite:

1. Knowledge of semiconductor material, basic electronics, diode, BJT, UJT, FET and its characteristics.
2. Working of Diode based rectifier, concept of RMS and average value
3. Use square notebooks for notes and plotting of waveforms.

Course Objectives: The course aims :-

To enable students to gain knowledge and understanding in the following aspects:

1. Fundamentals of power electronic devices and characteristics.
2. The concepts and operating principles of power electronics circuits.
3. Design procedures and techniques of power electronics systems.

Course Outcomes: At the end of this course, student will be able to

CO1	Develop characteristics of different power electronic switching devices.
CO2	Reproduce working principle of power electronic converters for different types of loads.
CO3	Choose the appropriate converter for different applications.

Unit 01	**Power Semi-Conductor Devices**	**06 hrs**

Construction, Static and dynamic Characteristics, specifications/rating of SCR , Triggering Circuits (R, R-C, UJT), Commutation Circuits (class C & D), Protection (over voltage, over current, and Thermal), Gate Turn Off (GTO) Thyristor (Construction, Working and Application), TRIAC- four mode operation, triggering of TRIAC using DIAC, Application-light dimmer.

Unit 02	**Transistor based Devices and DC-DC converter**	**06 hrs**

Transistor based Devices: MOSFET & IGBT- Construction, working, Static and Dynamic Characteristics

DC-DC converter: Principle of operation of chopper, classification on the basis of operating quadrants (A, B, C, D, E), Control techniques: CLC, TRC, PWM and FM Techniques. Analysis of Step-up Chopper and Numerical with RLE load. Buck Boost Chopper (Descriptive Treatment), Applications- Chargers for Battery operated vehicles.

Unit 03	**Single Phase AC-DC Converter**	**06 hrs**

Single phase Converter: Fully controlled converter, Half controlled converter (Semi- converter)- Operation of all converters with R & RL load, derivation of Average and RMS output voltage, power factor, THD, TUF. Numerical based on output voltage and current calculations, Single phase dual converter (Descriptive treatment only), Application-Speed control of DC motor.

Unit 04	**Three Phase Converter and AC Voltage Regulator**	**06 hrs**

Three phase converters: Fully controlled converter, Half controlled converter (Semi converter)- Operation of all converters with R, RL load, derivation of Average and RMS output voltage. Numerical based on output voltage and current calculations.

AC voltage regulator: Single phase AC Voltage regulator; operation with R and RL Load, derivation of Average and RMS output voltage. Concept of two stage AC voltage regulator (Descriptive treatment only).

Unit 05	**Single phase DC-AC Converter (Transistor based)**	**06 hrs**

Full bridge VSI, derivation of output voltage and current, Numerical, current source inverter with ideal switches and load commutated CSI, Voltage control techniques, Application- UPS.		
Unit 06	**Three phase DC-AC Converter (Transistor based)**	**06 hrs**
Three phase VSI for 120^0 and 180^0 modes of operation and their comparison, PWM based VSI, voltage control and harmonic elimination techniques (Single Pulse Modulation, Multilevel Control), Multilevel Converter concept its classification (Neutral Point Clamped Converter, Flying Capacitor Converter, cascaded multilevel converter) and their comparison, Application- Speed control of 3 phase Induction motor.		

Test Books:

[T1]	M. H. Rashid - Power Electronics 2nd Edition, Pearson publication.
[T2]	Ned Mohan, T.M. Undel and, W.P. Robbins - Power Electronics, 3rd Edition, John Wiley and Sons.
[T3]	B.W. Williams: Power Electronics 2nd edition, John Wiley and sons.
[T4]	Ashfaq Ahmed- Power Electronics for Technology, LPE Pearson Edition.
[T5]	Dr. P.S. Bimbhra, Power Electronics, Third Edition, Khanna Publication.
[T6]	K. Hari Babu, Power Electronics, Scitech Publication.

Reference Books:

[R1]	Vedam Subramanyam - Power Electronics , New Age International , New Delhi
[R2]	Dubey, Donalda, Joshi, Sinha, Thyristorised Power controllers, Wiley Eastern New Delhi.
[R3]	M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill.
[R4]	Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education, Asia.
[R5]	L. Umanand, Power Electronics – Essentials and Applications Wiley Publication.
[R6]	J. Michael Jacob – Power Electronics Principal and Applications.
[R7]	M. H. Rashid - Power Electronics Handbook, Butterworth-Heinemann publication, 3 edition
[R8]	V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press.

Online Resources:

[O1]	NPTEL Web course and video course on Power Electronics by Dr. B. G. Fernandis, IIT, Mumbai.

Unit	**Text Books**	**Reference Books**
Unit 1	T5, T6	R3, R8, O1
Unit 2	T4, T5, T6	R3, R5, R6, R9, O1
Unit 3	T1, T5	R3, O1
Unit 4	T5, T6	R1, R7, O1
Unit 5	T1, T2, T3	R3, O1
Unit 6	T1, T2, T3	R3, O1

List of Experiments

Part A:

Minimum 8 hardware experiments to be conducted

1. Static VI characteristic of SCR / GTO.
2. Static VI characteristic of TRIAC.
3. Study of Gate firing circuits of SCR (R, RC & UJT).
4. Single phase Half controlled converter with R and RL load.
5. Single phase fully controlled converter with R load.
6. Single Phase fully controlled converter with and without Free Wheeling diode with RL load.

7. Three phase AC-DC fully controlled bridge converter R and RL load.
8. Study of DC step down chopper.
9. Single phase A.C. voltage regulator with R and RL load.
10. Output and Transfer Characteristic of MOSFET and IGBT (Both).
11. Three phase voltage source inverter using 120^0 and 180^0mode
12. Study of three phase inverter (VSI).

Part B:

Any 8 experiments to be conducted (either hardware or simulation)

1. Fabrication of buck converter/inverter/ac voltage regulator. (compulsory)
2. Study of 1-ø bridge inverter SPWM.
3. Study of Forced commutation circuits of SCR (Class C and Class D).
4. Study and design of SMPS.
5. Study of PWM controls of a single-phase inverter.
6. Power Quality Analysis (Harmonic and PF measurement) at AC side of Single phase controlled Converter.
7. Power Quality Analysis (Harmonic and PF measurement) at AC side of Three phase controlled Converter.
8. Performance analysis of three phase diode clamped Multilevel inverter.
9. Performance analysis of three phase cascaded H-Bridge Multilevel inverter.
10. Study of three phase Active power filter.
11. Study of Standalone/ Grid connected converters for interfacing of renewable energy sources.
12. Industrial Visit to Power Electronics manufacturing unit/Renewable energy power plant.

Guidelines for Instructor's Manual:

- Title and circuit diagram of power electronic switching device and converter circuit.
- Working operation and output characteristics / output waveforms of power electronic switching device /converter circuit.
- Procedure to carry out the experiment.

Guidelines for Student's Lab Journal

- Title, aim, circuit diagram, procedure and theory of power electronic switching device or converter circuit.
- Equipment along with the specifications needed to carry out the experiment.
- Circuit diagram, observation table, calculations must be written on left side of the journal and aim, theory related to experiment and procedure must be written on right side.
- Analyze and interpret the experimental results and write the conclusions appropriately.

Guidelines for Laboratory conduction

- Each group in the lab should have not more than three students.
- All the students in the group must do the connections and perform the practical under the guidance of the staff member.
- Staff member must check the result of all the groups.

303143: Electrical Machines-II

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
Practical	02	Hr/Week/batch	**PR**	01	**ESE**	70 Marks
					PR	25 Marks
					TW	25 Marks

Prerequisite:

- Magnetic circuits, Force on current carrying conductor placed in magnetic field, Fleming Right Hand & Left Hand Rule.
- Working principle and construction DC Machines, transformer & 3-ph induction motor.
- Phasor diagram and equivalent circuit of single phase transformer.

Course Objectives: The course aims to:

- Learn construction & working principle of three phase synchronous machines and 1-ph induction motors.
- Calculate voltage regulation of Alternator by different methods.
- Study the applications of different machines in industrial, commercial & social sectors.
- Determine the performance indices of AC series & single phase motors by experimentation.

Course Outcomes: At the end of this course, student will be able to

CO1	Learn construction, working principle of three phase Synchronous Machines, Induction Motors, A.C. Series Motor and Special Purpose Motors.
CO2	Understand characteristics of three phase Synchronous Machines, Induction Motors, A.C. Series Motor and Special Purpose Motors.
CO3	Select the above machines in Power System, industrial, household & Military Engineering applications.
CO4	Testing of machines to evaluate the performance through experimentation.

Unit 01	Three phase Synchronous machines.	06 hrs

Three phase Synchronous machines:
Construction, rotating-field type and rotating-armature type, salient-pole and non-salient-pole type and their comparison. Excitation Methods.

Three phase Synchronous generator (cylindrical rotor type): Principle of operation. Emf equation and winding factors (No derivation), rating of generator. Generator on no-load and on balanced load. Armature reaction and its effect under different load power factors. Voltage drop due to armature resistance, leakage flux and synchronous reactance. Per phase equivalent circuit and Phasor diagram. Power - power angle relation.

Three phase Synchronous generator (salient pole type):
Armature reaction as per Blondel's two reaction theory for salient-pole machines, Direct-axis and quadrature-axis synchronous reactance's and their determination by slip test. Phasor diagram of salient-pole generator and calculation of voltage regulation.

Unit 02	Voltage regulation of Three phase Synchronous generator	06 hrs

Performance of open circuit and short circuit test on synchronous generator, determination of voltage regulation by emf, mmf, and Potier triangle methods. Determination of voltage regulation by direct loading. Short circuit ratio.

Parallel operation of 3-phase alternators:
Necessity, conditions, Load sharing between two alternators in parallel (Descriptive treatment only). Process of synchronizing alternator with infinite bus-bar by lamp method (one dark & two equally

bright lamp method) and by the use of synchroscope, Synchronizing current, power and torque (no numerical).		
Unit 03	**Three phase synchronous motor**	**06 hrs**
Principle of operation. Methods of starting. Equivalent circuit, significance of torque angle, Losses, efficiency and Power flow chart. Operation of 3-phase Synchronous motor with constant load and variable excitation ('V' curves and 'inverted V' curves). Phenomenon of hunting and its remedies. Applications of 3-phase synchronous motors. Comparison of 3 phase synchronous motor with 3-phase induction motor.		
Unit 04	**3-ph induction motor, Induction generator and special purpose motors**	**06 hrs**
Speed control of three phase induction motor by various methods (Stator side and rotor side controls). Action of 3-phase induction motor as induction generator, applications of induction generator. Introduction to Energy Efficient three phase Induction Motor and Super Conducting Generator. **Special Purpose Motors :** Construction, principle of working, characteristics, ratings and applications of Brush less D.C. motors, Stepper motors (permanent magnet and variable reluctance type only), Permanent Magnet motor (A.C. & D.C.).		
Unit 05	**A.C. series motor**	**06 hrs**
Operation of D.C. series motor on a.c. supply, nature of torque developed, problems associated with AC. operation and remedies. **Compensated series motor:** Compensating winding, conductively and inductively compensated motor. Approximate phasor diagram. Use of compoles for improving commutation. Ratings and applications of Compensated Series motors. **Universal motors:** Ratings, performance and applications, comparison of their performance on A.C. and D.C. supply.		
Unit 06	**Single phase induction motor**	**06 hrs**
Construction of single phase induction motor, double field revolving theory. Equivalent circuit and torque-slip characteristics on the basis of double revolving field theory. Tests to determine the parameters of equivalent circuit and calculation of performance characteristics of motor. Methods of self-starting. Types of single phase induction motors: Split-phase motors (Resistor split-phase motor, Capacitor-start motor, Capacitor start and capacitor run motor and permanent capacitor motor). Comparison of 1-phase induction motor with 3-phase induction motor.		

Test Books:

[T1]	Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill.
[T2]	S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill.
[T3]	A.S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw Hill
[T4]	P. S. Bimbhra, Electric Machinery, Khanna Publications.
[T5]	B.R. Gupta and Vandana Singhal -Fundamentals of Electric Machines, New Age International (P) Ltd.
[T6]	B. L Theraja –Electrical Technology, Vol II , S. Chand publication.
[T7]	V. K. Mehta and Rohit Mehta, Principles of Electrical Machines, S Chand Publication
[T8]	Krishna Reddy –Electrical Machines Vol.II and III, SCITECH publications.
[T9]	Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co.
[T10]	M V Deshpande, Electrical Machines, Prentice Hall of India

Reference Books:

[R1]	M.G. Say, Performance and Design of A.C. Machines (3rd Ed.), ELBS
[R2]	J B Gupta - Theory and performance of Electrical Machines, S K Kataria Publications
[R3]	Samarjit Ghosh, Electrical Machines, Pearson Publication.
[R4]	Bhag S Guru and Huseyin R Hiziroglu, Electrical Machinery and Transformer, 3rd Edition, Oxford University Press.
[R5]	E G Janardanan, Special Electrical Machines, Prentice Hall of India.
[R6]	Suvarnsingh Kalsi Application of high Temperature super conductors to electric power equipment (Rotating Machines) Wiley publication.

Unit	**Text Books**	**Reference Books**
Unit 1	T1,T2,T6,T7,T9	R3
Unit 2	T4, T6,T7,T9	R2
Unit 3	T1,T4, T6,T7	R2,R4
Unit 4	T4, T6,T7,T9	R5,R6
Unit 5	T4,T6,T3	R1,R2
Unit 6	T2,T3, T6,T7,T9	R2,R3

Industrial Visit:

Compulsory visit to Synchronous Machines / Induction motor manufacturing company.

List of Experiments: **To perform any eight experiments from the following list.**

Compulsory experiments:

1. Determination of voltage regulation of cylindrical rotor alternator by a) EMF method b) MMF method.
2. Determination of voltage regulation of cylindrical rotor alternator by Potier method.
3. Determination of voltage regulation of salient pole alternator by slip test.
4. V and inverted V curve of synchronous motor at constant load.
5. Speed control of three phase induction motor by V/F method.

B) Optional experiments (any three)

1. Determination of voltage regulation of alternator by direct loading.
2. Load test on three phase synchronous motor.
3. Load test on Single -phase induction motor.
4. Load test on Single-phase series motor.
5. No load and blocked-rotor test on a single phase Capacitor-start induction motor and Determination of its equivalent circuit parameters.
6. Synchronization of three phase alternator by Lamp and Synchroscope methods.
7. Simulation of three phase induction motor on MATLAB to obtain its performance.
8. Speed control of three phase induction motor by rotor resistance control method.
9. Speed control of BLDC Motor.

Guidelines for Instructor's Manual:

Prepare 3/4 sets of standard experiments. It must contain title of the experiment. Also, Aim, Apparatus including name of machines with their specifications, rheostats, ammeter, voltmeter, wattmeter if used along with their ratings / ranges etc.

Theory: Brief theory explaining the experiment.

Circuit / connection diagram or construction diagram must be drawn either manually using geometrical instruments or using software on A-4 size quality graph paper / plain white paper.

Procedure: Write down step by step procedure to perform the experiment.

Observation table:

Sample calculation: For obs. number ---

Result table:

Nature of graph:
Conclusion:
Questions / Answers: Write minimum 4 /5, questions / answers based on each experiment.
Theory part must be typed on A-4 good quality paper on single side. Put these pages of experiments / circuit diagram in plastic folder and provide it to a group of 4/5 students.

Guidelines for Student's Lab Journal

1. Students should write the journal in his own hand writing.
2. Circuit / Connection diagram or construction diagram must be drawn either manually using or using software. [Do not use Xerox copy of standard journal]
3. Hand writing must be neat and clean.
4. Journal must contain certificate indicating name of the institute, student, department, subject, class/ year, number of experiments completed, signature of staff, Head of the department and the Principal.
5. Index must contain sr. number, title of the experiment, page number, and the signature of staff along with date.
6. Put one blank page in between two experiments. Prepare the parallelogram at the center of page and write experiment number, date and title of the experiment in separate line.

(Use black or blue ink pen for writing.)

Guidelines for Laboratory conduction

1. Check the whether the MCB / main switch is off.
2. Students should go through the name plates of machines.
3. Make connections as per circuit diagram. Use flexible wire for connection of voltmeter and pressure coil connection of wattmeter. For rest of the connections, use thick wire. Do not keep loose connection. Get it checked from teacher / Lab Assistant.
4. Perform the experiment only in presence of teacher or Lab Assistant.
5. Do the calculations and get it checked from the teacher.
6. After completion of experiment, switch off the MCB / main switch.
7. Write the experiment in the journal and get it checked within week.

303144: Electrical Installation, Design and Condition Based Maintenance

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
Practical	04	Hr/Week/batch	**PR**	02	**ESE**	70 Marks
					OR	25 Marks
					TW	25 Marks

Prerequisite:

Basic Electrical Engg, Power System 1, Electrical Machines I and Electrical Machines II.

Course Objectives: The course aims: -

1. To classify different types of distribution supply system and determine economics of distribution system.
2. To compare and classify various substations, bus-bars and Earthing systems.
3. To demonstrate the importance and necessity of maintenance.
4. To analyze and test different condition monitoring methods.
5. To carry out estimation and costing of internal wiring for residential and commercial installations.
6. To apply electrical safety procedures.

Course Outcomes: At the end of this course, student will be able to

CO1	Classify different types of distribution supply system and determine economics of distribution system. compare and classify various substations, bus-bars and Earthing systems.
CO2	Demonstrate the importance and necessity of maintenance.
CO3	Analyse and test different condition monitoring methods.
CO4	Carry out estimation and costing of internal wiring for residential and commercial installations.
CO5	Apply electrical safety procedures.

Unit 01	**Economics of Distribution Systems:**	**06 hrs**

Classification of supply systems (State Only)
(i) DC, 2-wire system, (ii) Single phase two wire ac system, (iii) Three phase three wire ac supply system, iv) Three phase four wire ac supply system. Comparison between overhead and underground systems (For above mentioned systems) on the basis of volume requirement for conductor. AC Distribution System: Types of primary and secondary distribution systems, calculation of voltage drops in ac distributors (Uniform and Non Uniform Loading) (Numerical). Economics of power transmission: Economic choice of conductor (Kelvin's law) (Derivation and Numerical). Distribution Feeders: Design considerations of distribution feeders; radial and ring types of primary feeder's voltage levels, energy losses in feeders.

Unit 02	**Substation and Earthing**	**06 hrs**

Substation: Classification of substations, Various equipment used in substation with their specifications, Bus bar arrangements in the substation: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams.
Earthing: Necessity of Earthing, Types of Earthing system (Equipment and Neutral), and Maintenance Free Earthing system. Methods of testing earth resistance, Different electrode configurations (Plate and Pipe electrode), Tolerable step and touch voltages, Steps involved in design of substation Earthing grid as per IEEE standard 80-2013.

Unit 03	**Maintenance and Condition Monitoring**	**08 hrs**

Importance and necessity of maintenance, different maintenance strategies like breakdown maintenance, planned/preventive maintenance and condition based maintenance. Planned and preventive maintenance of transformer, Induction motor and Alternators. Insulation stressing factors,

Insulation deterioration, polarization index, dielectric absorption ratio. Concept of condition monitoring of electrical equipment. Advance tools and techniques of condition monitoring, Thermography. Failure modes of transformer, Condition monitoring of oil as per the IS/IEC standards, Filtration/reconditioning of insulating oil, Condition monitoring of transformer bushings, on load tap changer, dissolved gas analysis, degree of polymerization. Induction motor fault diagnostic methods – Vibration Signature Analysis, Motor Current Signature Analysis. Hot Line Maintenance - Meaning and advantages, special types of non-conducting Materials used for tools for hot line maintenance.		
Unit 04	**Basics of Estimation and Costing**	**04 hrs**
Purpose of estimating and costing, qualities of good estimator, essential elements of estimating and costing, tender, guidelines for inviting tenders, quotation, price catalogue, labor rates, schedule of rates and estimating data (only theory),		
Unit 05	**Installation and estimation of distribution system**	**06 hrs**
Introduction cable sizing, Estimation and conductor size calculations of internal wiring for Residential and Commercial (Numerical) installations and estimate for underground LT service lines.		
Unit 06	**Testing and Electrical Safety**	**06 hrs**
Understanding CAT Ratings & Using CAT rated Instrument, Electrical Installation Testing Procedures- Insulation resistance test between installation and earth, Insulation resistance test between conductors (use of GUARD Terminal in IR test & Application) (methods used for IR Testing) Testing of polarity, Testing of earth continuity paths (Applications of PAT Tester "Portable Appliance Tester" in commercial like hotels, hospital & Industry also) and Earth resistance test (methods for earth testing 2-pole, 3-pole new methods clamp on type where we can performs test in Live) Contents of first aid box, treatment for cuts, burns and electrical shock. Procedures for first aid (e.g. removing casualty from contact with live wire and administering artificial respiration). Various statutory regulations (Electricity supply regulations, factory acts and Indian electricity rules of Central Electricity Authority (CEA), Classification of hazardous area. *(Introduction to OSHA)*		
Test Books:		
[T1]	B. R. Gupta- Power System Analysis and Design, 3rd edition, Wheelers publication.	
[T2]	S. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna publishers.	
[T3]	S. L. Uppal - Electrical Power - Khanna Publishers Delhi.	
[T4]	Hand book of condition monitoring by B. K. N. Rao, Elsevier Advance Tech., Oxford (UK).	
[T5]	S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House.	
[T6]	B. V. S. Rao – Operation and Maintenance of Electrical Equipment – Asia Publication.	
[T7]	Hand book on Electrical Safety.	
Reference Books:		
[R1]	P.S. Pabla –Electric Power Distribution, 5th edition, Tata McGraw Hill.	
[R2]	S. L. Uppal, Electrical Wiring and Costing Estimation, Khanna Publishers, New Delhi.	
[R3]	Surjit Singh, Electrical wiring, Estimation and Costing, Dhanpat Rai and company, New Delhi.	
[R4]	Raina K.B. and Bhattacharya S.K., Electrical Design, Estimating and Costing, Tata McGraw Hill, New Delhi	
[R5]	B.D. Arora-Electrical Wiring, Estimation and Costing, - New Heights, New Delhi.	
[R6]	M.V. Deshpande, Elements of Power Station design and practice, Wheelers Publication.	
[R7]	S. Sivanagaraju and S. Satyanarayana, Electric Power Transmission and Distribution, Pearson Publication .	
[R8]	Power Equipment Maintenance and Testing (Power Engineering Book 32) by Paul Gill	

Unit	Text Books	Reference Books
Unit 1	T1, T3	R1, R7
Unit 2	T1, T2, T3	R1, R4, R6
Unit 3	T2, T4, T5, T6	R6, R7, R8
Unit 4	--	R2, R3, R4, R5
Unit 5	T1, T3	R2, R3, R4, R5
Unit 6	T7	R8

List of Experiments

Part-A: (Any Eight of the following)

1) Measurement of Dielectric Absorption Ratio and Polarization Index of insulation.
2) Study of thermograph images and analysis based on these images.
3) Practice of Earthing and Measurement of Earth resistance of Campus premises by using 4 Pole, 3 Pole, new technology practicing in industry clamp on method.
4) Single Line diagram of 132 or 220 or 400 kV substation (based on actual field visit) Symbols, Plate or Pipe Earthing. (Drawing sheets 1 using AutoCAD or other CAD software)
5) Assignment on design of Earthing grid for 132/220 kV substation.
6) Design and estimation of light and power circuit of labs/industry.
7) Measurement of insulation resistance of motors and cables.
8) Precautions from Electric shock and method of shock treatment.
9) Using of Installation Multifunction Testers for RCD testing, Phase Sequence Indication, Insulation resistance measurement, Continuity testing.
10) Use REVIT / any BOQ (Bill of Quantity) estimation software for estimation and costing
11) Design and estimation of light and power circuit of residential wiring.

Part-B:(Any 4 out of these)

1) Estimation and costing for 11 kV feeders and substation. (voltage drop calculation, SLD, substation layout)
2. Study of troubleshooting of electrical equipment based on actual visit to repair workshop (**Any one**). i) Three phase induction motor ii) Transformer iii) Power Cable
3. Trouble shooting of household equipment – Construction, working and troubleshooting of any two household Electrical equipment's (Fan, Mixer, Electric Iron, Washing Machines, Electric Oven, Microwave - Limited to electrical faults) (Here we perform Practical by using PAT Testers)
4) Design, Estimation and costing of Earthing pit and Earthing connection for computer lab, Electrical Machines Lab.
5) Wiring installation and maintenance of pump motor.
6) Activity: Interview of Electrical maintenance personnel/Technician/Electrician.
7) Activity: Safety awareness for housing societies/schools/Junior colleges.
8) Activity: Preparation of Tender notice and studying the Tender notices published in newspapers.
9) Any innovative activity related to EIDCBM syllabus.

Industrial Visit (if any): Visit to substation/ installation sites.

303145A: Elective-I: Advanced Microcontroller and Embedded System

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
					ESE	70 Marks

Prerequisite:

1. Knowledge of Number system and Basic logic components.
2. Programming basics of C language.
3. Advantage of Microcontroller over Microprocessor.

Course Objectives: The course aims to:

1. Help Students understand Architecture of PIC 18F458 microcontroller.
2. Create and enhance ability to write and Interpret Assembly and C language for PIC 18F458.
3. Make students understand procedure to interface peripherals with PIC 18F458 for various Applications.

Course Outcomes: At the end of this course, student will be able to

CO1	Explain architecture of PIC 18F458 microcontroller, its instructions and the addressing modes.
CO2	Use Ports and timers for peripheral interfacing and delay generation.
CO3	Interface special and generate events using CCP module.
CO4	Effectively use interrupt structure in internal and External interrupt mode.
CO5	Effectively use ADC for parameter measurement and also understand LCD interfacing.
CO6	Use Serial Communication and various serial communication protocols.

Unit 01	**PIC Architecture and Embedded C**	**07 hrs**

Comparison of CISC and RISC Architectures, Data and Program memory organization, Program Counters, Stack pointer, Bank Select Register, Status register, Embedded C concepts, Header and source files and pre-processor directives, Data types, data structures, Control loops, functions, bit operations.

Unit 02	**Port and Timer 0 Programming**	**05 hrs**

I/O Ports and related SFRs, I/O port programming in C. PIC 18 Timer 0 Programing in C. Delay programming (with and without Timer0). LED Interfacing and its programming.

Unit 03	**CCP Module and its applications**	**06 hrs**

CCP module in PIC 18 microcontroller, Timers required for CCP Applications, Applications of CCP mode Generation of Square waveform using Compare mode of CCP module. Period measurement of unknown signal using Capture mode in CCP module, Speed control of DC motor using PWM mode of CCP module.

Unit 04	**Interrupt structure and its Programming**	**05 hrs**

Interrupt Programming, Programming of Timer0 interrupts, Programming of External interrupts INT0.

Unit 05	**ADC structure and LCD interfacing**	**07 hrs**

PIC ADC, Programming of ADC using interrupts, Measurement of temperature and Power. Using PIC microcontroller. Interfacing of LCD (16x2) in 4 bit mode.

Unit	**Serial Communication and its protocols**	**06 hrs**

06		
Serial Communication structure and its programming (Data transmit and Receive), Introduction to Communication protocols as SPI and MODE BUS		
Test Books:		
[T1]	PIC Microcontroller and Embedded Systems Using Assembly and C for PIC18 by Muhammad Ali Mazidi, Rolind D. McKinley, Danny Causey, Pearson Education.	
[T2]	Fundamentals of Microcontrollers and Applications in Embedded Systems with PIC by Ramesh Gaonkar, Thomson and Delmar learning, First Edition.	
[T3]	Programming And Customizing the PIC Microcontroller by Myke Predko, TATA McGraw-Hill.	
[T4]	PIC microcontroller: An introduction to software and Hardware interfacing by Han-Way-Huang Thomson Delmar Learning.	
[T5]	Microcontroller Theory and Applications with PIC18F, M. Rafiquzzaman, John Wiley and Sons	
Reference Books:		
[R1]	PIC18F458 datasheet	
[R2]	MPLAB IDE user guides	
[R3]	MICROCHIP Technical Reference Manual of 18F4520 Embedded Design with PIC 18F452 Microcontroller by John B. Peatman, Prentice Hall	

Unit	**Text Books**	**Reference Books**
Unit 1	T1,T2,T3,T4	R1
Unit 2	T1, T2,T3,T4,T5	R1,R2
Unit 3	T1,T4,T5	R1
Unit 4	T1,T2,T3,T4	R1
Unit 5	T1,T2,T3,T4	R1
Unit 6	T1,T2,T3,T4	R1,R3

303145B: Elective-I: Digital Signal Processing

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
					ESE	70 Marks

Prerequisite:

Knowledge of basic signals and systems

Course Objectives: The course aims:

1. To introduce discrete signals and systems.
2. To ability to analyse DT signals with Z transform, DTFT and DFT.
3. To introduce Digital filters and analyze the response.
4. To explore DSP Applications in electrical engineering.

Course Outcomes: At the end of this course, student will be able to

CO1	Analyse discrete time signals and systems.
CO2	Construct frequency response of LTI system using Fourier Transform.
CO3	Design and realize IIR and FIR filters.
CO4	Apply concepts of DSP in applications of electrical engineering.

Unit 01 | **Discrete time signal and system** | **06 hrs**

Analog, Discrete-time and Digital signals, Basic sequences and sequence operations, Discrete time systems, Properties of D. T. Systems and Classification, Linear Time Invariant Systems, impulse response, linear convolution and its properties, properties of LTI systems: stability, causality, Periodic Sampling, Sampling Theorem, Frequency Domain representation of sampling, reconstruction of a band limited Signal, A to D Conversion Process: Sampling, quantization and encoding.

Unit 02 | **Z and Inverse Z transform** | **06 hrs**

Revision of Z-transform, Numerical of Z transform, Inverse Z transform using partial fraction and power series method, Linear constant coefficient difference equations, solution of difference equation, stability and causality using ROC of Z-transform.

Unit 03 | **Discrete Time Fourier Transform** | **06 hrs**

Representation of Sequences by Fourier Transform, Symmetry properties of D. T., F. T. theorems: Linearity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, Frequency response analysis of first and second order system, steady state and transient response.

Unit 04 | **Discrete Fourier Transform** | **06 hrs**

Sampling in frequency domain, The Discrete Fourier Transform, Relation with z transform Properties of DFT: Linearity, circular shift, duality, symmetry, Circular Convolution, Linear Convolution using DFT, Effective computation of DFT and FFT, DIT FFT, DIF FFT.

Unit 05 | **Design of IIR filter** | **06 hrs**

Ideal frequency selective filters, Concept of filtering, specifications of filter, IIR filter design from continuous time filters: Characteristics of Butterworth and Chebyshev, impulse invariant and bilinear transformation techniques, Design examples (Butterworth low pass filter) , Basic structures for IIR Systems: direct form, cascade form

Unit 06 | **Design of FIR Filter and DSP Applications** | **06 hrs**

A) Specifications of properties of commonly used windows, Design Examples using rectangular and hanning windows. Basic Structures for FIR Systems: direct form. Comparison of IIR and FIR Filters. B) Applications: Measurement of magnitude and phase of voltage, current, power, frequency and power factor correction, harmonic Analysis and measurement, applications to machine control, DSP based protective relaying.

Test Books:

[T1]	Proakis J., Manolakis D., “Digital signal processing”, 3rd Edition, Prentice Hall, ISBN 81-203-0720-8.
[T2]	P. Ramesh Babu, “Digital Signal Processing”, 4th Edition SciTech Publication.

[T3]	Dr. S. D. Apte, "Digital Signal Processing",2nd Edition Wiley India Pvt. Ltd ISBN: 97881-265-2142-5
[T4]	W. Rebizant, J. Szafran, A. Wiszniewski, "Digital Signal Processing in Power system Protection and Control", Springer 2011 ISBN 978-0-85729-801-0
Reference Books:	
[R1]	Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, 1998, ISBN 0-07-044705-5
[R2]	A.V. Oppenheim, R. W. Schafer, J. R. Buck, "Discrete Time Signal Processing", 2nd Edition Prentice Hall, ISBN 978-81-317-0492-9
[R3]	Steven W. Smith, "Digital Signal Processing: A Practical Guide for Engineers and Scientists",1st Edition Elsevier, ISBN: 9780750674447

Unit	Text Books	Reference Books
Unit 1	T1,T2	R1, R2, R3
Unit 2	T1,T2	R2, R3
Unit 3	T1,T2	R2, R3
Unit 4	T1,T2	R2, R3
Unit 5	T1,T2,T3	R1,R2,R3
Unit 6	T2, T4	R3

303146: Seminar						
Teaching Scheme			**Credits**		**Examination Scheme**	
SEM	01	Hr/Week	**SEM**	01	**TW**	50 Marks

Course Objectives:

1. Gaining of actual knowledge (terminology, classification, methods and advanced trends)
2. Learning fundamental principles, generalization or theories.
3. Discussion and critical thinking about topics of current intellectual importance.
4. Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to the course.

Course Outcomes: At the end of this course, student will be able to

CO1	Relate with the current technologies and innovations in Electrical engineering.
CO2	Improve presentation and documentation skill
CO3	Apply theoretical knowledge to actual industrial applications and research activity.
CO4	Communicate effectively.

Seminar should be based on a detailed study of any topic related to the advance areas/applications of Electrical Engineering. Topic should be related to Electrical Engineering. However, it must not include contents of syllabus of Electrical Engineering. It is expected that the student should collect the information from journals, internet and reference books in consultation with his/her teacher/mentor, have rounds of discussion with him/her. The report submitted should reveal the student assimilation of the collected information. Mere compilation of information from the internet and any other resources is discouraged.

Format of the Seminar report should be as follows:

1. The report should be neatly typed on white paper. The typing shall be with normal spacing, Times New Roman (12 pt) font and on one side of the paper. (A-4 size).
2. Illustrations downloaded from internet are not acceptable.
3. The report should be submitted with front and back cover of card paper neatly cut and bound together with the text.
4. Front cover: This shall have the following details with Block Capitals
    a. Title of the topic.
    b. The name of the candidate with roll no. and Exam. Seat No. at the middle.
    c. Name of the guide with designation below the candidate's details.
    d. The name of the institute and year of submission on separate lines at the bottom.
5. Certificate from institute as per specimen, Acknowledgement and Contents.
6. The format of the text of the seminar report should be as follows
    I. The introduction should be followed by literature survey.
    II. The report of analytical or experimental work done, if any.
    III. The discussion and conclusions shall form the last part of the text.
    IV. They should be followed by nomenclature and symbols used.
    V. The Reference Books are to be given at the end.
7. The total number of typed pages, excluding cover shall from 20 to 25 only.
8. All the pages should be numbered.
9. Two spiral bound copies of the seminar report shall be submitted to the college.
10. Candidate shall present the seminar before the examiners.
11. The total duration of presentation and after-discussion should be about 30 minutes.

The assessment for the subject shall be based on:

1. Content. 2. Presentation 3. Report

Rubrics for assessment

	Does not meet criterion	Meets criterion somewhat	Meets criterion fully
Content			
Background/Intro is sufficient to understand how this project fits into larger field	0	1	2
Description of methodology is sufficient for audience to understand the procedure	0	1	2
Explanations are understandable/clear	0	1	2
Conclusions stated are supported to topic	0	1	2
References/Sources are cited correctly	0	1	2
Audience questions are answered honestly (i.e. no bluffing or guessing)	0	1	2
Presentation Quality			
Speaking is understandable/clear	0	1	2
Speaker can answer questions professionally	0	1	2
Speaker makes eye contact with audience	0	1	2
Speaker uses professional body language	0	1	2
Visuals/PPT are clear and readable	0	1	2
Visuals/PPT have appropriate amount of text, diagrams	0	1	2
Visuals/PPT are free of errors/typos	0	1	2
Report Writing			
Abstract is meaningful	0	1	2
Graphs/diagrams are labeled completely	0	1	2
References/Sources are cited correctly	0	1	2
At least one reference is from a journal	0	1	2
Grammar is correct	0	1	2
Spelling is correct	0	1	2
Report format is clear	0	1	2
Total	_____/40 (convert to 50)		

303147A: Audit Course V: Energy Storage System						
Teaching Scheme			**Credits**		**Examination Scheme**	
Theory	02	Hr/Week	**TH**	00	**GRADE**	PP/NP

Prerequisite:

Batteries, Inductor and Capacitor.

Course Objectives:

To elaborate various energy storage systems

To be familiar with various aspects such as hybridization, selection of storage system.

Course Outcomes: At the end of this course, student will be able to

CO1	Explain and differentiate various types of energy storage for suitable applications
CO2	Understand battery recycling techniques

Unit 01	**Energy Storage Fundamentals**	**12 hrs**

(A) Battery: Energy Density, Power Density, Cycle life, C-rate, State of Charge (SoC), State of Health (SoH), Depth of Discharge (DoD), Characteristic.

(B) Types of Batteries: Nickel Metal Hydrate, Nickel Cadmium, Lithium ion, Lithium Polymer, Flow Batteries (Vanadium, Zinc, Manganese)

(C) Super capacitor, Superconducting Magnetic Energy Storage, Compressed Air Energy Storage, Flywheel storage

(D) Hybridization of energy storage

Energy storage sizing, Selection of storage as per application

Unit 02	**Recent Trends in Storage**	**12 hrs**

Solid state batteries, Aluminum air and Aluminum ion batteries, Lithium ion Capacitor, Advances in Thermal energy storage systems. Batteries recycling techniques and policies, Case studies.

Reference Books:

[R1]	Handbook of Energy Storage: Demand, Technologies, Integration Michael Sterner, Ingo Stadler.
[R2]	Energy Storage: Fundamentals, Materials and Applications, Robert Huggins.

Industrial Visit: Manufacturing industry of battery or Capacitor.

303147B: Start-up and Disruptive Innovations

Teaching Scheme			Credits		Examination Scheme	
Theory	02	Hr/Week	**TH**	00	**GRADE**	PP/NP

Prerequisite:

Course Objectives:

To learn fundamentals related to Start-up and initiatives taken by government along with policies.
To understand Disruptive technologies.

Course Outcomes: At the end of this course, student will be able to

CO1	Describe role of incubation for Startup and recent national policy.
CO2	Identify various types of Startups.
CO3	Explain impacts of disruptive innovation and Differentiate between disruptive innovation and disruptive technology

Unit 01	**Start-up**	**12 hrs**

Startup Fundamentals

Startup: Stages of startup life cycle, business model, business plan, Business incubation, Startup financing life cycle, Funding options for startup, Market, Market Segments.

Entrepreneurship: Types of Entrepreneurship: Social, Rural, Women, Agri-preneurship. Factors affecting Entrepreneurship Growth

Government Initiatives and Policies

Initiatives taken by the government, Startup India Scheme, National Innovation and Startup Policy 2019, Approvals and other regulatory processes, Challenges faced by startups in India, Students Startup, Faculty Startup.

Types of Startups and Case Studies

Types of Startups: E-commerce Startups, EdTech Startups, FinTech Startups, Food and Beverages Startups, Health Care Startups, Block chain Startups etc.

Case study : Airbnb, Paytm, Byju, Zomato, Red bus, Ola, Razorpay

Unit 02	**Disruptive Technologies**	**12 hrs**

Disruptive Innovation Fundamental

What is invention? What is innovation? Defining Disruptive Innovation, Sustaining Innovation, Disruptive Innovation Theory, Disruptive innovation model, Disruptive strategy, Impact of Disruptive Innovation, Requirements of Disruptive Innovation, Types of Disruptive Innovations.

Inventor vs. Entrepreneur vs. Manager: Schumpeter's Trumpeters

Schumpeter's "creative destruction"

Maslow's Hierarchy of Needs Revisited, Disrupting Brands, Disrupting Religion.

Disruptive Technologies

Agricultural Revolution, Scientific Revolution, Industrial Revolution, Digital Revolution

Disruptive Innovation Vs Disruptive Technology

IoT, AI, Cloud Computing, Digital Twin, CRISPR, Block chain, 3D printing, Advanced Energy Storage, Hyperloop, Autonomous Vehicles, Nano technology, Industrial Automation (Industry 4.0)

Reference Books:

[R1]	The $100 Startup : Reinvent the Way you Make a Living, Do What You Love and Create a New Future, Chris Guillebeau
[R2]	Creating a Successful Business Plan, Entrepreneur Magazine
[R3]	Thomas Kuhn and The Theory of Scientific Revolutions revisited, CRC Press
[R4]	P. Armstrong. Disruptive Technologies: Understand, Evaluate, Respond Kogan Page Publishers. (2017)
[R5]	Innovator's Solution: Creating and Sustaining Successful Growth – Clayton Christensen, 16 December 2013
[R6]	Digital Disruption: Unleashing the Next Wave of Innovation – James McQuivey, 26

	February 2013
Online Resources:	
[O1]	https://ipindia.gov.in/
[O2]	https://www.wipo.int/about-ip/en/
[O3]	https://www.weforum.org/agenda/2016/06/what-is-disruptive-innovation/

303148: Power System-II

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
Practical	02	Hr/Week/batch	**TU**	01	**ESE**	70 Marks
Tutorial	01	Hr/Week/batch	**PR**	01	**PR**	50 Marks
					TW	25 Marks

Note: TW marks: 15 for Tutorial and 10 for continuous assessment of lab work

Prerequisite:

Power Generation Technology, Power System-I, Electrical machine I and II

Course Objectives:

1) Develop analytical ability for Power system.
2) Introduce concept of EHVAC and HVDC System.
3) Demonstrate different computational methods for solving problems of load flow.
4) Analyze the power system under symmetrical and Unsymmetrical fault conditions.

Course Outcomes: At the end of this course, student will be able to

CO1	Solve problems involving modelling, design and performance evaluation of HVDC and EHVAC power transmission lines.
CO2	Calculate per unit values and develop Y bus for solution power flow equations in power transmission networks
CO3	Calculate currents and voltages in a faulted power system under both symmetrical and asymmetrical faults, and relate fault currents to circuit breaker ratings.

Unit 01	Performance of Transmission Lines	06 hrs

Evaluation of ABCD constants and equivalent circuit parameters of Long transmission line. Concept of complex power, power flow using generalized constants, surge impedance loading, Line efficiency, Regulation and compensation, basic concepts. Numerical based on: ABCD constants of Long transmission line, Power flow.

Unit 02	EHVAC Transmission	05 hrs

Role of EHV-AC transmission, standard transmission voltages, average values of line parameters, power handling capacity and line losses, phenomenon of corona, disruptive critical voltages, visual critical voltages, corona loss, factors and conditions affecting corona loss, radio and television interference, reduction of interference, Numerical Based on Corona, Corona loss and power handling capacity.

Unit 03	Per Unit System and Load Flow Analysis	07 hrs

Per unit system: Single line diagram, Impedance and reactance diagrams and their uses, per unit quantities, relationships, selection of base, change of base, reduction to common base, advantages and application of per unit system. Numerical based on network reduction by using per unit system.

Load Flow Analysis: Network topology, driving point and transfer admittance, concept of Z-bus and formulation of Y-bus matrix using bus incidence matrix method, Numerical based on Y bus Matrix, power- flow equations generalization to n bus systems, classification of buses, Newton- Raphson method (polar method) Decoupled and Fast decoupled load flow (descriptive treatment only).

Unit 04	Symmetrical Fault Analysis	06 hrs

3-phase short-circuit analysis of unloaded alternator, sub-transient, transient and steady state current and impedances, D.C. Offset, and effect of the instant of short-circuit on the waveforms, estimation of fault current without pre-fault current for simple power systems, selection of circuit-breakers and current limiting reactors and their location in power system (Descriptive treatment Only) Numerical

Based on symmetrical fault analysis.		
Unit 05	**Unsymmetrical Fault Analysis**	**07 hrs**
Symmetrical components, transformation matrices, sequence components, power in terms of symmetrical components, sequence impedance of transmission line and zero sequence networks of transformer, solution of unbalances by symmetrical components, L-L, L-G, and L-L-G fault analysis of unloaded alternator and simple power systems with and without fault impedance. Numerical based on symmetrical components and unsymmetrical fault calculation.		
Unit 06	**HVDC Transmission**	**05 hrs**
Classification and components of HVDC system, advantages and limitations of HVDC transmission, comparison with HVAC system, introduction to HVDC control methods - constant current, constant ignition angle and constant extinction angle control, HVDC systems in India, recent trends in HVDC system.		
Test Books:		
[T1]	I.J. Nagrath and D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New Delhi.	
[T2]	B R Gupta , "Power System Analysis and Design", S. Chand.	
[T3]	Ashfaq Hussain, "Electrical Power Systems", CBS Publication 5th Edition.	
[T4]	J. B. Gupta. "A course in power systems" S.K. Kataria Publications.	
[T5]	P.S.R. Murthy, "Power System Analysis", B.S. Publications	
Reference Books:		
[R1]	H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi.	
[R2]	G. W. Stagg and El- Abiad – Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi.	
[R3]	M. E. El- Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.	
[R4]	Rakash Das Begamudre, "Extra High voltage A.C. Transmission Engineering", New age publication.	
[R5]	M. A. Pai, Computer Techniques in Power System Analysis, Tata McGraw Hill Publication.	
[R6]	Stevenson W.D. Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi.	
[R7]	K. R. Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi.	
[R8]	Olle I. Elgard – Electric Energy Systems Theory – Tata McGraw Hill, New Delhi.	
[R9]	V. K. Chandana, Power Systems, Cyber tech Publications.	
[R10]	P. Kundur, Power System Stability And Control, McGraw Hill	
Online Resources:		
[O1]	NPTEL Course on power system engineering:Debpriya Das https://nptel.ac.in/courses/108/105/108105104/	
[O2]	NPTEL Course on power system analysis By Dr. A.K. Sinha https://nptel.ac.in/courses/108/105/108105067/	
[O3]	NPTEL Course on power system analysis By Dr. Debpriya Das https://nptel.ac.in/noc/courses/noc20/SEM2/noc20-ee72/	

Unit	Text Books	Reference Books
Unit 1	T1, T4	R1, R2, R3, R10
Unit 2	T2	R3, R4
Unit 3	T1, T3, T4	R1, R2, R3, R6, R8, R10
Unit 4	T3, T4	R1, R2, R3, R6, R8, R9, R10
Unit 5	T3	R1, R2, R3, R6, R8
Unit 6	T2, T3, T4	R3, R7, R9, R10

Industrial Visit:

Compulsory visit to EHV-AC substation/ HVDC substation

List of Tutorial: (Minimum 10 Tutorial should be conducted) (Maintain Record in file or separate notebook)

(Such types of numerical also in INSEM and ENDSEM examination)
1) ABCD parameters of long transmission line--(3 numerical)
2) power flow using generalized constant--(3 numerical)
3) power flow and losses in EHVAC transmission line for specified ratings. --(3 numerical)
4) Determination of Y-bus for three, four and five bus system--(3 numerical)
5) Load flow analysis using NR method for three bus system (1 numerical)
6) Calculation of symmetrical fault current and determine value of current limiting reactor suitable for given circuit breaker rating (2 numerical)
7) Determination of line/phase current, voltage and power calculation using symmetrical component. (4 numerical)
8) Calculation of unsymmetrical fault current (4 numerical)
9) Write a report on different HVDC project in India / world wide
10) Solve challenging questions related to syllabus (5 numerical)
11) Receiving end Power Circle diagram (1 Numerical)

List of Experiments

List of Experiments (Compulsory experiments):
1. Measurement of ABCD parameters of a medium transmission line with magnitude and angle.
2. Measurement of ABCD parameters of a long transmission line with magnitude and angle.
3. Performance study of the effect of VAR compensation using capacitor bank on the transmission line.
4. Formulation and calculation of Y- bus matrix of a given system using software.
5. Static measurement of sub-transient reactance of a salient-pole alternator.
6. Measurement of sequence reactance of a synchronous machine (Negative and zero).

Any three experiments are to be performed out of following:
1. Plotting of receiving end circle diagram to evaluate the performance of medium transmission line.
2. Solution of a load flow problem using Newton-Raphson method using software.
3. Simulation of Symmetrical fault of single machine connected to infinite bus.
4. Simulation of Unsymmetrical fault of single machine connected to infinite bus.
5. Simulation of HVDC system.

Guidelines for Instructor's Manual:

The Instructor's Manual should contain following related to every experiment –
- Brief theory related to the experiment.
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram.
- Observation table/ simulation waveforms.
- Sample calculations for one/two reading.
- Result table.

- Graph and Conclusions.
- Few questions related to the experiment.

Guidelines for Student’s Lab Journal

Guidelines for Student’s Lab Journal

The Student's Lab Journal should contain following related to every experiment –

- Theory related to the experiment.
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram.
- Observation table/ simulation waveforms.
- Sample calculations for one/two reading.
- Result table.
- Graph and Conclusions.
- Few short questions related to the experiment.

Guidelines for Laboratory conduction

There should be continuous assessment for the TW.

- Assessment must be based on understanding of theory, attentiveness during practical.
- Session, how efficiently the student is able to do connections and get the results.
- Timely submission of journal.

303149: Computer Aided Design of Electrical Machines

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
Practical	04	Hr/Week/batch	**TU**	00	**ESE**	70 Marks
Tutorial	00	Hr/Week/batch	**PR**	02	**OR**	25 Marks
					TW	50Marks

Prerequisite:

1. Knowledge of fundamentals of electrical engineering.
2. Knowledge of various materials used in electrical machines.
3. Knowledge of types, construction and working of transformer.
4. Knowledge of types, construction and working of three phase induction motor.

Course Objectives: The course aims to:-

1. Design of transformer based on specifications.
2. Determine performance based on the parameters of transformer.
3. Design of Induction motor based on specifications.
4. Determine performance based on the parameters of Induction motor.
5. Apply computer aided design techniques to transformer and induction motor design.

Course Outcomes: At the end of this course, student will be able to

CO1	Summarize temperature rise, methods of cooling of transformer and consider IS 2026 in transformer design.
CO2	Design the overall dimensions of the transformer.
CO3	Analyze the performance parameters of transformer.
CO4	Design overall dimensions of three phase Induction motor
CO5	Analyze the performance parameters of three phase Induction motor.
CO6	Implement and develop computer aided design of transformer and induction motor.

Unit 01 | **Transformer Design: Part 1** | **06 hrs**

Modes of heat dissipation. Heating and cooling curves. Calculations of heating and cooling time constants. Methods of cooling of transformer. Types and constructional features of core and windings used in transformer. Transformer auxiliaries such as tap changer, pressure release valve, breather and conservator. Specifications of three phase transformers as per IS 2026 (Part I). Introduction to computer aided design

Unit 02 | **Transformer Design: Part 2** | **06 hrs**

Output equation with usual notations, optimum design of transformer for minimum cost and loss. Design of core, estimation of overall dimensions of frame and windings of transformer. Design of tank with cooling tubes.

Unit 03 | **Performance parameters of Transformer** | **06 hrs**

Estimation of resistance and leakage reactance of transformer. Estimation of no-load current, losses, efficiency and regulation of transformer. Calculation of mechanical forces developed under short circuit conditions, measures to overcome this effect. Computer aided design of transformer, generalized flow chart for design of transformer.

Unit 04 | **Three phase Induction Motor Design:Part1** | **06 hrs**

Specifications and constructional features. Types of ac windings. Specific electrical and magnetic loadings, ranges of specific loadings. Output equation with usual notations. Calculations for main dimensions, turns per phase and number of stator slots.

Unit 05 | **Three phase Induction Motor Design:Part2** | **06 hrs**

Suitable combinations of stator and rotor slots. Selection of length of air gap, factors affecting length of air gap. Design of rotor slots, size of bars and end rings for cage rotor. Conductor size, turns and area of rotor slots for wound rotor.

Unit 06 | **Performance parameters of Three Phase Induction motor** | **06 hrs**

Leakage flux and leakage reactance: Slot, tooth top, zig - zag, overhang. Leakage reactance calculation for three phase machines. MMF Calculation for air gap, stator teeth, stator core, rotor teeth and rotor core, effect of saturation, effects of ducts on calculations of magnetizing current, calculations of no-load current. Calculations of losses and efficiency. Computer aided design of induction motor, generalized flow chart for design of induction motor.

Test Books:

[T1]	M. G. Say–Theory and Performance and Design of A.C. Machines,3rd Edition, ELBS London.
[T2]	A.K. Sawhney–A Course in Electrical Machine Design, -Dhanpat Rai and sons New Delhi
[T3]	K. G. Upadhyay- Design of Electrical Machines, New age publication
[T4]	R. K. Agarwal–Principles of Electrical Machine Design, S. K. Katariya and sons.
[T5]	Indrajit Dasgupta –Design of Transformers–TMH

Reference Books:

[R1]	K. L. Narang, A Text Book of Electrical Engineering Drawings, Reprint Edition, Satya Prakashan, New Delhi.
[R2]	A Shanmuga sundaram,G. Gangadharan, R. Palani,-Electrical Machine Design Data Book,3rd Edition, 3rd Reprint 1988- Wiely Eastern Ltd.,- New Delhi
[R3]	Vishnu Murti, “Computer Aided Design for Electrical Machines”, B. S. Publications.
[R4]	Bharat Heavy Electricals Limited, Transformers - TMH.

Unit	Text Books	Reference Books
Unit 1	T1,T2,T4,T5	R1,R2,R4
Unit 2	T1,T2,T4,T5	R1,R4
Unit 3	T2,T5	R3,R4
Unit 4	T1,T2,T3,T4	R1,R2,R3
Unit 5	T2	R3
Unit 6	T2	R3

Industrial Visit:

Industrial visit to a transformer and Induction motor manufacturing/repairing unit.

List of Experiments

1. Details and assembly of transformer with design report. (Sheet in CAD)
2. Details and layout of single layer three phase winding with design report. (Sheet in CAD)
3. Details and layout of double layer three phase winding with design report. (Sheet in CAD)
4. Details and layout of three phase mush winding with design report. (Sheet in CAD)
5. Assembly of three phase induction motor. (Sheet in CAD)
6. Use of Finite Element Analysis(FEA) software for analysis of electrical machines, the report should include:
   a. Schematic diagram (Diagram/FEA model/Layout)
   b. Current/Flux/Force/Heat distribution.
   c. Analysis by variation of design parameters.
7. Report based on transformer manufacturing/repairing unit.
8. Report based on induction motor manufacturing/repairing unit.

Guidelines for Instructor’s Manual:

Theinstructor'smanualshouldcontainfollowingrelatedtoeverydrawingsheet-

1. Brief theory related to the concerned sheet.
2. Apparatus with their detail specification as per IS code.
3. Design as per problem statement.
4. Reference tables used for design purpose.
5. Design parameters details in tabular form.

6. Few short questions related to design.
7. A3 size sheet to be used for CAD drawing.

Guidelines for Student's Lab Journal

TheStudent'sLabJournalshouldcontainfollowingrelatedtoeverydrawingsheet-

1. Brief theory related to the concerned sheet.
2. Apparatus with their detail specification as per IS code.
3. Design as per problem statement.
4. Reference tables used for design purpose.
5. Design parameters details in tabular form.
6. Few short questions related to design.
7. A3 size sheet to be used for CAD drawing.

Guidelines for Laboratory conduction

1. There should be continuous assessment for the Lab/TW
2. Assessment must be based on understanding of theory, attentiveness during practical session, how efficiently the student is able to design as per the problem statement.
3. Timely submission of design report and sheet.

303150: Control System Engineering

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
Practical	02	Hr/Week/batch	**TU**	01	**ESE**	70 Marks
Tutorial	01	Hr/Week/batch	**PR**		**OR**	25 Marks
					TW	25 Marks

Prerequisite:

Laplace Transform, Ordinary differential equations.

Course Objectives: The course aims to:-

- To understand basic concepts of the classical control theory.
- To model physical systems mathematically.
- To analyze behavior of system in time and frequency domain.
- To design controller to meet desired specifications.

Course Outcomes: At the end of this course, student will be able to

CO1	Construct mathematical model of Electrical and Mechanical system using differential equations and transfer function and develop analogy between Electrical and Mechanical systems.
CO2	Determine time response of systems for a given input and perform analysis of first and second order systems using time domain specifications.
CO3	Investigate closed loop stability of system in s-plane using Routh Hurwitz stability criteria and root locus.
CO4	Analyze the systems in frequency domain and investigate stability using Nyquist plot and Bode plot
CO5	Design PID controller for a given plant to meet desired time domain specifications.

Unit 01	**Basics of Control System**	**07 hrs**

Basic concepts of control system, classification of control systems, types of control system: feedback, tracking, regulator system, feed forward system, transfer function, concept of pole and zero, modeling of Electrical and Mechanical systems (Only series linear and rotary motion) using differential equations and transfer function , analogy between electrical and mechanical systems, block diagram algebra, signal flow graph, Mason's gain formula.

Unit 02	**Time domain analysis**	**06 hrs**

Concept of transient and steady state response, standard test signals: step, ramp, parabolic and impulse signal, type and order of control system, time response of first and second order systems to unit impulse, unit step input, time domain specifications of second order systems, derivation of time domain specifications for second-order under-damped system for unit step input, steady state error and static error coefficients.

Unit 03	**Stability analysis and Root Locus**	**05 hrs**

Concept of stability: BIBO, nature of system response for various locations of poles in S-plane. Routh's-Hurwitz criterion. Root Locus: Angle and magnitude condition, Basic properties of root locus. Construction of root locus, Stability analysis using root locus.

Unit 04	**Frequency domain analysis-I**	**06 hrs**

Introduction, Frequency domain specifications, correlation between time and frequency domain specifications, polar Plot, Nyquist plot, stability analysis using Nyquist plot.

Unit	**Frequency domain analysis-II**	**06 hrs**

05		

Introduction to Bode plot, Asymptotic approximation: sketching of Bode plot, stability analysis using Bode plot.

Unit 06	**PID controllers and Control system components**	**06 hrs**

Basic concept of P, PI, PID controller, design specifications in time domain and frequency domain. design of PID controller by Root Locus, tuning of PID controllers using Ziegler-Nichol Methods Control System Components: Working principle and transfer function of Lag network, lead network, potentiometer, DC servo motors.

Test Books:

[T1]	I.J. Nagrath, M. Gopal, “Control System Engineering”, New Age International Publishers, 6th edition, 2017.
[T2]	Katsuhiko Ogata, “Modern control system engineering”, Prentice Hall, 2010.
[T3]	Nise N. S. “Control Systems Engineering”, John Wiley & Sons, Incorporated, 2011
[T4]	R. Anandanatrajan and P. Ramesh Babu, “Control Systems Engineering”, Scitech Publication,3rd edition, 2011
[T5]	C. D. Johnson, “Process Control Instrumentation Technology, 8th edition, PHI Learning Pvt. Ltd., 2013

Reference Books:

[R1]	B. C. Kuo, “Automatic Control System”, Wiley India, 8th Edition, 2003.
[R2]	Richard C Dorf and Robert H Bishop, “Modern control system”, Pearson Education, 12th edition, 2011.
[R3]	D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.
[R4]	B. Wayne Bequette, “Process Control: Modeling, Design and Simulation”, PHI, 2003.

Unit	Text Books	Reference Books
Unit 1	T1,T2,T3	R1,R2
Unit 2	T1,T2,T3	R1,R3
Unit 3	T1,T2,T3	R2,R3
Unit 4	T1,T2,T3	R1,R3
Unit 5	T1,T2,T3	R1,R3
Unit 6	T1,T2,T5	R4

List of Tutorial:

Tutorial (Minimum ten tutorials should be conducted)

1. Reduce the given block diagram and determine overall transfer function.
2. Determine transfer function of the system represented by signal flow graph using Mason’s gain formula.
3. Determine time domain specifications of given second order systems.
4. Determine static error constants and steady state error for the given systems.
5. Investigate closed loop stability of a given systems using Routh Hurwitz stability criterion.
6. Sketch the root locus of a given systems and comment on stability.
7. Sketch the polar plot of given systems.
8. Sketch the Nyquist plot of a given system, determine stability margins and comment on stability.
9. Sketch the Bode plot of a given systems, determine stability margins and comment on stability.
10. Determine the tuning parameters of PID controller using open loop step response and closed loop ultimate cycle methods of Ziegler and Nichol.
11. Design the PID controller for desired specifications using root locus approach.

List of Experiment

A) Minimum five experiments should be conducted.

1. Experimental determination of DC servo motor parameters for mathematical modeling and transfer function
2. Experimental study of time response characteristics of R-L-C second order system. Validate the results using software simulation.
3. Experimental determination of frequency response of Lead compensator.
4. Experimental determination of frequency response of Lag compensator.
5. PID control of level/ Temperature/speed control system.
6. Experimental determination of transfer function of any one physical systems (AC Servomotor/ Two Tank System/ Temperature control/ Level control)
7. Experimental analysis of D.C. Motor Position control System.

B) Minimum three experiments should be conducted (perform using software)

1. Stability analysis using a) Bode plot, b) Root locus and c) Nyquist plot.
2. Effect of P, PI and PID controllers on time response of second order system.
3. Analysis of closed loop DC position control system using PID controller.
4. Effect of addition of pole-zero on root locus of second order system.
5. Effect of addition of dominant and non-dominant poles on step response of second order system.
6. PID controller for speed/position control of DC servomotor.

Guidelines for Instructor's Manual:

Instructor's Manual should contain following related to every experiment –

- Theory related to the experiment
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram
- Basic MATLAB instructions for control system/ Simulink basics
- Observation table/ Expected simulation results
- Sample calculations for one/two reading
- Result table

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment –

- Theory related to the experiment
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram/Simulink diagram/MATLAB program
- Observation table/ simulation results
- Sample calculations for one/two reading
- Result table, Conclusion
- Software program and result (if applicable)
- Few short questions related to the experiment.

Guidelines for Laboratory conduction

- Assessment must be based on understanding of theory, attentiveness during practical session.
- Assessment should be done how efficiently student is able to perform experiment/simulation and get the results. Understanding fundamentals and objective of experiment, timely submission of journal

303151A: Elective II: IoT and Its Applications in Electrical Engineering

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
					ESE	70 Marks

Prerequisite:

Basics of Electrical generation, transmission, distribution and utilization, Fundamentals of logic circuits, C, C+.

Course Objectives: The course aims to

1. Understand the architecture of Internet of Things
2. Evaluate the electrical systems for making them IoT enable
3. Assess the automated processes and retrofit it for enhancement is user accessibility.

Course Outcomes: At the end of this course, student will be able to

CO1	Build circuits for signal acquisition and conditioning
CO2	Experiment with sensors and actuators and choose the right sensor for application
CO3	Determine the performance of IoT based automated process
CO4	Design and develop IoT based applications

Unit 01	**Introduction to IoT**	**06 hrs**

Fundamental components of IoT, Evolution of Connected Devices, Basic Architecture of IoT, ISO and IEC Standards, IoT categories, IoT gateways, challenges, Security concerns and hurdles, Overview of applications - home automation, agriculture, Industrial, health care, Smart Grid.

Unit 02	**IoT Development platforms**	**06 hrs**

Basics of Microcontroller and Microprocessor, Introduction to Edge devices e.g. Arduino, Node MCU, Raspberry Pi. Comparative analysis of the Platforms.

Unit 03	**Programming the hardware**	**06 hrs**

Introduction to Integrated Development Environment, Overview of different IDE's, Example of programs using Arduino IDE, Basics of Python, Example of programs using Python.

Unit 04	**Sensing and Actuation**	**06 hrs**

Sensors, Types of sensors – Digital and Analog, characteristics, choosing right sensor for Application, Interfacing Sensor with Node MCU, Reading data from Sensors like LM35, DHT 11, Ultrasonic Sensor, IR Sensor, sound sensor, touch sensor, LDR, Potentiometer, Current and voltage Sensor, Connecting actuators - relay, stepper motor.

Unit 05	**Communication Technologies and Cloud**	**06 hrs**

Introduction to communication Technologies like Wi-Fi, Bluetooth, RFID, Z-Wave, Zigbee, 6LoWPAN, LORA, Wireless HART, MQTT, Introduction to cloud platforms.

Unit 06	**Development of IoT based Application**	**06 hrs**

Reading sensor data and sending it to cloud platform, Visualization and analysis of the data on cloud, actuation and control, case study – Home automation

Test Books:

[T1]	Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications
[T2]	Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
[T3]	Parikshit N. Mahalle & Poonam N. Railkar, “Identity Management for Internet of Things”, River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (e-book).
Reference Books:	
[R1]	Hakima Chaouchi, “ The Internet of Things Connecting Objects to the Web”, ISBN : 978-1-84821-140-7, Willy Publications
[R2]	Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications.
[R3]	Daniel Kellmereit, Daniel Obodovski, “The Silent Intelligence: The Internet of Things”. Publisher: Lightning Source Inc; 1st edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978-0989973700.
[R4]	Fang Zhaho, Leonidas Guibas, “Wireless Sensor Network: An information processing approach”, Elsevier, ISBN: 978-81-8147-642-5.
[R5]	Michael Margolis, Arduino Cookbook, 2nd Edition, O'Reilly Media, Inc, 2011.
[R6]	Alex Bradbury & Ben Everard, Learning Python with Raspberry Pi, 1st Edition, John Wiley & Sons, Feb 2014.
[R7]	Charles Bell, Beginning Sensor Networks with Arduino and Raspberry Pi, 1st Edition, Apress, 2014.

303151B: Elective-II: Electric Mobility

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
					ESE	70 Marks

Prerequisite:

Basic concept of Batteries, Electrical Motors, Power Electronics

Course Objectives: This course aims to

1. To make students understand the need & importance of Electric & Hybrid Electric vehicles.
2. To differentiate and analyze the various energy storage devices.
3. To impart the knowledge about architecture and performance of Electric and Hybrid Vehicles
4. To classify the different drives and controls used in electric vehicles.

Course Outcomes: At the end of this course, student will be able to

CO1	Analyze the concepts of Hybrid and Electric vehicles.
CO2	Describe the different types of energy storage systems
CO3	Comprehend the knowledge of the battery charging and management systems.
CO4	Classify the different mode of operation for hybrid vehicle.
CO5	Apply the different Charging standards used for electric vehicles.
CO6	Differentiate between Vehicle to home & Vehicle to grid concepts.

Unit 01 | Introduction to Hybrid and Electric vehicles | 06 hrs

Need and importance of Electric Vehicle and Hybrid Electric Vehicles, Environmental importance of Hybrid and Electric vehicles. Hybrid Electric vehicles: Concept and architecture of HEV drive train (Series, parallel and series-parallel). Micro Hybrid, Mild Hybrid, Full Hybrid, Plug-in Hybrid, Electric vehicles: Components, configuration, performance, tractive effort, Advantages and challenges in EV.

Unit 02 | Energy Storage Systems | 06 hrs

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery specifications, Battery based energy storage and its analysis, Classification of lithium-ion batteries, Aluminum Air and Aluminum ion battery. Fuel Cell based energy storage, Super Capacitor based energy storage, Hybridization of Ultra capacitor and Battery. Selection methodology for the energy storage.

Unit 03 | Battery Charging and Management Systems | 06 hrs

introduction: Different Charging algorithms and Charging method, Cell Balancing methods.
Battery Management System: Functions of BMS, Block diagram of BMS. SoC Estimation methods, Thermal Management of Battery.

Unit 04 | Hybrid Power Train and mode of operation | 06 hrs

Control Strategies and Design of the Major Components: Series and Parallel Hybrid Electric Drive Train. Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Regenerative braking

Unit 05 | Drives and Charging Infrastructure | 06 hrs

Selection of drives for Electric vehicle: PMSM drive and BLDC drive, Sizing of motor, Charging Levels: 01,02 and 03, Charging Standards: CCS, CHAdeMO, SAE J1772, IEC 60309, Bharat DC 001, Bharat AC 001, Electric Vehicle Supply Equipment (EVSE).

Unit 06 | Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid | 06 hrs

Vehicle to Home: Introduction, applications, V2H with demand response, Case Study of V2H.
Vehicle to Grid: Introduction of V2G, V2G infrastructure in the smart grid, Role of aggregator for V2G, Case study of V2G, Vehicle to Vehicle: Introduction of V2V, Concept & structure.

Test Books:

[T1] “Electrical Vehicle”, James Larminie and John Lowry, John Wiley & Sons, 2012.

[T2]	“Electric and Hybrid-Electric Vehicles”, Ronald K. Jurgen, SAE International Publisher.
[T3]	“Energy Systems for Electric and Hybrid Vehicles”, K T Chau, The institution of Engineering and Technology Publication
[T4]	“Batteries for Electric Vehicles”, D.A.J Rand, R Woods & R M Dell ,Research studies press Ltd, New York, John Willey & Sons
[T5]	Electric & Hybrid Vehicles-Design Fundamentals, CRC press
Reference Books:	
[R1]	“Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and design”, Mehrdad Ehsani, Yimin Gao and Ali Emadi. CRC Press, 2009.
[R2]	“Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid”, Junwei Lu & Jahangir Hossain et al (eds), IET Digital Library.
[R3]	“Automobile Electrical and Electronic systems”, Tom Denton, SAE International publications.
[R4]	“Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011.
[R5]	The Electric Vehicle Conversion handbook –Mark Warner, HP Books, 2011.
Online Resources:	
[O1]	https://www.theiet.org/resources/books/transport/vehicle2grid.cfm?
[O2]	https://www.sae.org/publications/books/content/pt-143.set/
[O3]	http://nptel.ac.in/courses/108103009/

303151C:Elective-II: Cybernetics Engineering

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
					ESE	70 Marks

Prerequisite:

Laplace transform, basics of matrices, computer programming and fundamentals.

Course Objectives: This course aims to

1. Introduce the concept of engineering cybernetics.
2. Give basic knowledge of key topics in cybernetics, such as system theory, control engineering, embedded computer systems, mathematical modeling, simulation, and optimization.

Course Outcomes: At the end of this course, student will be able to

CO1	Define cybernetics in terms of control and how is it used in controlling technical, biological, and other processes.
CO2	Understand various matrix operations.
CO3	Describe different types of control system configurations and their applications.
CO4	Carry out mathematical modeling and simulation of simple processes.
CO5	Appreciate the essential requirements for computers and computer equipment that are intended to operate in dedicated applications and industrial environments.
CO6	Know intelligent optimization techniques.

Unit 01	**Introduction to Cybernetics**	**06 hrs**

History of Cybernetics, various definitions of cybernetics, Control or regulation in machines, Control or regulation in human affairs.

Unit 02	**Linear system theory**	**06 hrs**

Vector Spaces, Bases, Coordinate Transformation, Invariant Subspaces, Inner product, Norms, Rank, Types of Matrices, Eigenvalues, Eigenvectors, Diagonalization, Matrix Factorization.

Unit 03	**Control Engineering**	**06 hrs**

Introduction to control systems, basic terminologies, Linearization. Laplace transform and transfer functions, types of control systems, introduction of nonlinear control system, adaptive control system, optimal control system, multivariable control system and their examples and applications.

Unit 04	**Mathematical Modeling and Simulation**	**06 hrs**

Mathematical modeling of physical processes, Differential equations of physical systems, such as electrical, mechanical, fluid, linear approximation, solution of ordinary differential equations using ODE solvers.

Unit 05	**Embedded computer systems**	**06 hrs**

Design of embedded computer systems. Computer architectures and system components for embedded and industrial applications. Microcontrollers and specialized microprocessors. Parallel and serial bus systems. Data communication in industrial environments. Analog/digital interfaces.

Unit 06	**Modern Optimization Methods**	**06 hrs**

Definition, applications, types of methods for optimization, Introduction to modern optimization techniques, Genetic algorithm, Simulated Annealing method, Particle Swarm Optimization, Ant Colony method.

Test Books:

[T1]	https://asc-cybernetics.org/foundations/history.htm [Online available on 30.05.2021]
[T2]	Dan C. Marinescu, “Complex Systems and Clouds A Self-Organization and Self-Management Perspective”, Elsevier, United States, 2017
[T3]	C-T Chen, “Linear System Theory and Design”, Oxford University Press, 1999
[T4]	Richard C. Dorf, Robert H. Bishop, “Modern Control System”, Pearson Education Limited, 2011
[T5]	Hassan K. Khalil, “Nonlinear Control”, Pearson Education Limited, 2011

[T6]	Karl Johan Astrom, Bjorn Wittenmark, “Adaptive Control”, Dover Publications Inc., New York 2008
[T7]	Y. S. Apte, “Linear Multivariable Control Systems”, McGraw-Hill, 1981
[T8]	Nirmala Sharma, “Computer Architecture”, Laxmi Publication, 2009
[T9]	Soliman Abdel- Hady Soliman, Abdel-Aal Hassan Mantawy, “Modern Optimization Techniques with Applications in Electric Power Systems” Springer

303151D:Elective-II Energy Management						
Teaching Scheme			**Credits**		**Examination Scheme**	
Theory	03	Hr/Week	**TH**	03	**ISE**	30 Marks
					ESE	70 Marks

Prerequisite:

Various electrical equipment and specifications, Construction and operation of different equipment/process like HVAC, Pumps, Compressors etc.

Course Objectives: The course aims to:-

1. Understand importance of energy Conservation and energy security and impact of energy use on environment.
2. Follow format of energy management, energy policy.
3. Understand demand side management tools and impact of tariff on demand management.
4. Importance of Data Analytics in Energy audit and audit process.
5. Calculate energy consumption and saving options with economic feasibility.
6. Use of appropriate energy conservation measure in field applications or industry.

Course Outcomes: At the end of this course, student will be able to

CO1	Describe BEE Energy policies, Energy ACT.
CO2	List and apply demand side management measures for managing utility systems.
CO3	Explore and use simple data analytic tools.
CO4	Use various energy measurement and audit instruments.
CO5	Evaluate economic feasibility of energy conservation projects.
CO6	Identify appropriate energy conservations methods for electric and thermal utilities.

Unit 01 | Energy Scenario | 06 hrs

Classification of Energy resources, Commercial and noncommercial sources, primary and secondary sources, commercial energy production, final energy consumption. Energy needs of growing economy, short terms and long terms policies, energy sector reforms, energy security, importance of energy conservation, energy and environmental impacts, introduction to CDM, UNFCCC, Paris treety, emission check standard, salient features of Energy Conservation Act 2001 and Electricity Act 2003. Latest amendments in Electricity Act. Indian and Global energy scenario. Introduction to IE Rules. Study of Energy Conservation Building Code (ECBC).

Unit 02 | Energy Management | 06 hrs

Definition and Objective of Energy Management, Principles of Energy management, Energy Management Strategy, Energy Manager Skills, key elements in energy management, force field analysis, energy policy, format and statement of energy policy, Organization setup and energy management. Responsibilities and duties of energy manager under the latest Act. Energy Efficiency Programs. Energy monitoring systems.

Unit 03 | Demand Management | 06 hrs

Supply side management (SSM), Generation system up gradation, constraints on SSM. Demand side management (DSM), advantages and barriers, implementation of DSM. Use of demand side management in agricultural, domestic and commercial consumers. Demand management through tariffs (TOD). Power factor penalties and incentives in tariff for demand control. Apparent energy tariffs. Role of renewable energy sources in energy management, direct use (solar thermal, solar air conditioning, biomass) and indirect use (solar, wind etc.) Introduction to ISO 50001- Energy Management.

Unit 04 | Energy Audit | 06 hrs

Definition, need of energy audits, types of audit, procedures to follow, data and information analysis, Introduction to Data Analytics, data quality processing, clustering techniques, pattern mining, regression and classification. Relevance of Data Analytics in Audit, energy audit instrumentation,

energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit reporting format – Executive Summary , Detailing of report.		
Unit 05	**Financial Analysis**	**06 hrs**
Financial appraisals; criteria, simple payback period, return on investment, net present value method, time value of money, break even analysis, sensitivity analysis and numerical based on it, cost of energy, cost of generation Energy Audits case studies – Sugar Industry, Steel Industry, Paper and Pulp industry.		
Unit 06	**Energy Conservation**	**06 hrs**
a) Motive power (motor and drive system). b) Illumination c) Heating systems (boiler and steam systems) d) Ventilation(Fan, Blower and Compressors) and Air Conditioning systems e) Pumping System f) Cogeneration and waste heat recovery systems g) Utility industries (T and D Sector) and Performance Assessments.		
Test Books:		
[T1]	Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 1, General Aspects (available on line)	
[T2]	Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 2 – Thermal Utilities (available on line)	
[T3]	Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 3- Electrical Utilities (available on line)	
[T4]	Guide books for National Certification Examination for Energy Managers/Energy Auditors Book 4 (available on line)	
Reference Books:		
[R1]	Success stories of Energy Conservation by BEE (www. Bee-india.org)	
[R2]	Utilization of electrical energy by S.C. Tripathi, Tata McGraw Hill.	
[R3]	Energy Management by W.R. Murphy and Mackay, B.S. Publication.	
[R4]	Generation and utilization of Electrical Energy by B.R. Gupta, S. Chand Publication	
[R5]	Energy Auditing made simple by Balasubramanian, Bala Consultancy Services.	
[R6]	A General Introduction to Data Analytics by Andre Carvalho and Tomáš Horváth Wiley Inc First Edition 2019.	
Online Resources:		
[O1]	www.energymanaertraining.com	
[O2]	www.em-ea.org	
[O3]	www.bee-india.org	
[O4]	https://www.iso.org/iso-50001-energy-management.html	

Unit	**Text Books**	**Reference Books**
Unit 1	T1	O1, O2
Unit 2	T1	O1, O2
Unit 3	T1	R4, O4
Unit 4	T1	R4, R5 and O1 and O2, R6
Unit 5	T1 and T4	R1, R2, R3, R5 O1 and O2
Unit 6	T2, T3 and T4	R1, R5 and O1 and O2

303152: Internship

Teaching Scheme			Credits		Examination Scheme	
IN	04	Hr/Week	IN	04	TW	100 Marks

Preamble

Internship is a short-term industrial working experience for the students. The internship aims at providing entry-level exposure to a particular industry. It is expected that students should spend time working on relevant projects or part of the project and acquire learning about the field, along with developing industry connections, and employability skills.

Course Objectives:

1. Encourage and provide opportunities to the students to acquire professional learning experiences.
2. Empower students to relate and then apply the theoretical knowledge in real-life industrial situations.
3. Provide exposure for handing and using various tools, measuring instruments, meters, and technologies used in industries.
4. Enable students to develop professional and employability skills and expand their professional network.
5. Empower students to apply the internship learnings to the academic courses and project completions.
6. Impart professional and societal ethics in students through the internship.
7. Make students aware of social, economic, and administrative aspects influencing the working environment of the industry.

Course Outcomes: At the end of this course, student will be able to

CO1	Understand the working culture and environment of the Industry and get familiar with various departments and practices in the industry.
CO2	Operate various meters, measuring instruments, tools used in industry efficiently and develop technical competence.
CO3	Apply internship learning in other course completions and final year project management, i.e. topic finalization, project planning, hardware development, result interpretations, report writing, etc.
CO4	Create a professional network and learn about ethical, safety measures, and legal practices.
CO5	Appreciate the responsibility of a professional towards society and the environment.
CO6	Identify career goals and personal aspirations.

Guidelines: The guidelines related to the internship are given below.

Duration: Guidelines related to duration are as follows.

1. The internship should be started after semester 5 and should be completed before the commencement of semester 6.
2. It should be for at least 4 to 6 weeks.
3. It should be assessed and evaluated in semester 6.

2. Internship Identification:

A student may choose to undergo an Internship at Industries, Government organizations, NGOs, Micro-Small-Medium enterprises, startups, Innovation and Incubation Centers, Institutes of National interests, organizations working for rural development, organizations promoting IPR and Entrepreneurship, etc. Approaching various industries for Internships and finalizing the same should be initiated in the 5^{th} semester in consultation with Institute's Training and Placement Cell, Industry-Institute Cell, or Internship Cell. This will help students to start their internship work on time. Also, it will allow students to work in a vacation period after their 5^{th}-semester examination and before the start of the 6^{th} semester. Student can take internship work in the form of Online/Onsite work from any of the following but not limited to:

1. Working for consultancy or the funded research project of the institute/Department.
2. Contributing at Incubation, Innovation, Entrepreneurship Cell, Institutional Innovation Council, Start-up Cell of Institute where students will get learning opportunities on projects.
3. Learning at Departmental Lab leading to lab development and modernization, Tinkering Lab, Institutional workshop for prototyping and model development, etc.
4. Working at Industry or Government Organization on project or part of the project.
5. Internship through Internshala, AICTE, Government initiatives, etc.
6. In-house product or working model development, intercollegiate, inter-department research under research lab or research group, etc.
7. Working at micro-small-medium enterprises on solving their specific problems.
8. Research internship under professors at IISc, IIT's, NIT's, Research organizations, etc.
9. Working with NGOs or Social Internships, Rural Internship, etc.

Further, other internship opportunities should be discussed and finalized in consultation with Department/Institute constituted committees for Internship.

3. Internship Record Book:
Students must maintain an Internship record book. The main purpose of maintaining a record book is to nurture the habit of documenting and keeping records by students. The students should maintain the record of daily activities completed which may include, field visits, important discussions, observations, project work completed, suggestions received, etc. The record book should be signed every day by the supervisor or in-charge where the student is undergoing an internship. The internship record book and well-drafted Internship Report should be submitted by the students to the department faculty coordinator within a week after the completion of the internship.

4. Internship Evaluation:
The evaluation of activities recorded in the Internship Record Book will be done by Program Head, Cell In-charge, Project Head, faculty mentor, or Industry Supervisor based on the overall compilation of internship activities, sub-activities, the level of achievement expected, and the duration for certain activities. Assessment and Evaluation are to be done in consultation with the internship supervisors (Internal from the institute and External from industry).

5. Evaluation and Assessment of Internship:
Internship Record Book – 25 Marks + Internship Report - 25 Marks + Post Internship Internal Evaluation-50 Marks = Total 100 Marks

5.1 Internship Record Book: The attendance record of the student along with the evaluation sheet, duly signed and stamped by the industry should be submitted by the industry Supervisor or Mentor to the Institute/Department after the completion of the internship. The internship record book may be evaluated based on the following criteria:

- Proper and timely documented entries
- Adequacy and quality of information
- Data, observations, discussions recorded
- Thought process and recording techniques used
- Organization of the information

5.2 Internship Report: After completion of the Internship, the student should prepare a comprehensive report to indicate what he/she has observed and learned in the internship period. The report shall be presented covering the following recommended fields but not limited to:

- Title/Cover Page
- Internship certificate with details like company name, location, duration, supervisor, etc.
- Institute Certificate
- Declaration
- Abstract
- Index/Table of Contents
- List of Figures/Tables
- **Chapter 1:** Introduction: Brief about company, industry or organization, objectives, motivation, organization of the report
- **Chapter 2:** Problem Identification/Problem statement/objectives and scope/expected outcomes
- **Chapter 3:** Methodological details
- **Chapter 4:** Results / Analysis /inferences and conclusion
- **Chapter 5:** Suggestions/Recommendations for improvement to industry, if any
- Attendance Record
- Acknowledgement
- List of reference (Library books, magazines, and other sources)

5.3 Post Internship Internal Evaluation: The student will give a presentation based on his Internship report before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

1. Internship Identification and Selection
2. Problem Studied with objectives and expected outcomes
3. Consideration of Environment/ Social /Ethics/ Safety measures/Legal aspects.
4. Methodology/System/Procedure Q&A
5. Block-diagram, flow-chart, algorithm, system description Q&A
6. Final results, discussions, suggestions, comments, etc. Q&A
7. Presentation and Communication

6. Feedback from internship supervisor (External and Internal)

Post internship, the faculty Internship coordinator should collect feedback about the student on the following suggested parameters from Industry Supervisor.

- Technical knowledge,
- Discipline and Punctuality,
- Work Commitment,
- Willingness to do the work,
- Communication skills, etc.

<table>
<tr><th colspan="7">303153A: Audit Course IV: Ethical Practices for Engineers</th></tr>
<tr><td colspan="3">Teaching Scheme</td><td colspan="2">Credits</td><td colspan="2">Examination Scheme</td></tr>
<tr><td>Theory</td><td>02</td><td>Hr/Week</td><td>TH</td><td>00</td><td>GRADE</td><td>PP/NP</td></tr>
<tr><td colspan="7">Prerequisite:</td></tr>
<tr><td colspan="7">Basic understanding of business management</td></tr>
<tr><td colspan="7">Course Objectives: This course aims to</td></tr>
<tr><td colspan="7">Create awareness to serve the public by strictly adhering to codes of conduct and placing paramount the health, safety and welfare of public.</td></tr>
<tr><td colspan="7">Course Outcomes: At the end of this course, student will be able to</td></tr>
<tr><td>CO1</td><td colspan="6">Understand for their professional responsibilities as Engineers.</td></tr>
<tr><td>CO2</td><td colspan="6">Recognize and think through ethically significant problem situations that are common in Engineering.</td></tr>
<tr><td>CO3</td><td colspan="6">Evaluate the existing ethical standards for Engineering Practice.</td></tr>
<tr><td>Unit 01</td><td colspan="5">Introduction: Justice and Moral</td><td>12 hrs</td></tr>
<tr><td colspan="7">Introduction to Ethical Reasoning and Engineer Ethic, Professional Practice in Engineering, Ethics as Design - Doing Justice to Moral Problems, Central Professional Responsibilities of Engineers.</td></tr>
<tr><td>Unit 02</td><td colspan="5">Rights and Responsibility</td><td>12 Hrs</td></tr>
<tr><td colspan="7">Computers, Software, and Digital Information, Rights and Responsibilities Regarding Intellectual Property, Workplace Rights and Responsibilities, Responsibility for the Environment.</td></tr>
<tr><td colspan="7">Test Books:</td></tr>
<tr><td>[T1]</td><td colspan="6">Ethics in Engineering practice and Research (2nd Edition) by Caroline Whitbeck Cambridge</td></tr>
<tr><td>[T2]</td><td colspan="6">Ethics in Engineering MW Martin and R Schinzinger MC Graw Hill</td></tr>
<tr><td>[T3]</td><td colspan="6">Engineering Ethics and Environment P a Vesilind and AS Gunn Cambridge</td></tr>
<tr><td colspan="7">Online Resources:</td></tr>
<tr><td>[O1]</td><td colspan="6">NPTEL course on “Ethics in Engineering Practice”, By Prof. Susmita Mukhopadhyay, IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc19_hs35/preview</td></tr>
</table>

<table>
<tr><th colspan="8">303153B:Audit Course VI: Project Management</th></tr>
<tr><td colspan="3">Teaching Scheme</td><td colspan="2">Credits</td><td colspan="3">Examination Scheme</td></tr>
<tr><td>Theory</td><td>02</td><td>Hr/Week</td><td>TH</td><td>00</td><td>GRADE</td><td colspan="2">PP/NP</td></tr>
<tr><td colspan="8">Prerequisite:</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Course Objectives: This course aims to</td></tr>
<tr><td colspan="8">1. Plan a successful project through project management.
2. Select the right members of a team for a project.</td></tr>
<tr><td colspan="8">Course Outcomes: At the end of this course, student will be able to</td></tr>
<tr><td>CO1</td><td colspan="7">Elaborate importance of project management and its process.</td></tr>
<tr><td>CO2</td><td colspan="7">Learn about the role of high performance teams and leadership in project management.</td></tr>
<tr><td>Unit 01</td><td colspan="6">Basics of Project Management:</td><td>12 hrs</td></tr>
<tr><td colspan="8">Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles</td></tr>
<tr><td>Unit 02</td><td colspan="6">Project Identification, Selection, planning:</td><td>12 hrs</td></tr>
<tr><td colspan="8">Project Identification, Selection Introduction, Project Identification Process, Project Initiation, Pr-Feasibility Study, Feasibility Studies, Project Break-even point
Project Planning: Introduction, Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS)</td></tr>
<tr><td colspan="8">Test Books:</td></tr>
<tr><td>[T1]</td><td colspan="7">Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold Kerzner.</td></tr>
<tr><td>[T2]</td><td colspan="7">Guide to Project Management: Getting it right and achieving lasting benefits by Paul Roberts.</td></tr>
<tr><td colspan="8">Online Resources:</td></tr>
<tr><td>[O1]</td><td colspan="7">https://www.coursera.org/learn/project-planning?specialization=project-management</td></tr>
<tr><td>[O2]</td><td colspan="7">Project management for managers By Prof. Mukesh Kumar Barua, IIT Roorkee
https://onlinecourses.nptel.ac.in/noc20_mg48/preview</td></tr>
</table>

SAVITRIBAI PHULE PUNE UNIVERISTY, PUNE

Faculty of Science and Technology

Board of Studies

Electrical Engineering

Syllabus

Final Year Electrical Engineering (2019 Course) (w.e.f. 2022-2023)

BE Electrical (2019 Course)

SEM-I

Course Code	Course Name	Teaching Scheme				Examination Scheme						Credit				
		Th	Pr	Tu	PW	ISE	ESE	TW	PR	OR	Total	Th	Pr	Tu	PW	Total
403141	Power System Operation & Control	3	2	–	–	30	70	25	–	25	150	3	1	–	–	4
403142	Advanced Control System	3	2	–	–	30	70	–	–	50	150	3	1	–	–	4
403143	Elective-I	3	2	–	–	30	70	–	–	25	125	3	1	–	–	4
403144	Elective-II	3	–	2*	–	30	70	25	–	–	125	3	–	1	–	4
403145	Project Stage-I	–	–	–	4	–	–	50	–	50	100	–	–	–	2	2
403146	MOOCs	–	–	–	–	–	–	50	–	–	50	–	–	–	2	2
403147	Audit Course-VII	2#	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total		**12**	**6**	**2**	**4**	**120**	**280**	**150**	**–**	**150**	**700**	**12**	**3**	**1**	**4**	**20**

403143: Elective-I	403144: Elective-II	403147: Audit Course-VII
403143A: PLC and SCADA 403143B: Power Quality Management 403143C: High Voltage Engineering 403143D: Robotics and Automation	403144A : Alternate Energy System 403144B : Electrical & Hybrid Vehicle 403144C : Special-purpose Machines 403144D: HVDC & FACTS	403147 A: German Language I 403147B: Engineering Economics I 403147C: Sustainability(IGBC)

SEM-II

Course Code	Course Name	Teaching Scheme				Examination Scheme						Credit				
		Th	Pr	Tu	PW	ISE	ESE	TW	PR	OR	Total	Th	Pr	Tu	PW	Total
403148	Switchgear and Protection	3	2	–	–	30	70	25	–	50	175	3	1	–	–	4
403149	Advanced Electrical Drives & Control	3	2	–	–	30	70	25	50	–	175	3	1	–	–	4
403150	Elective-III	3	–	–	–	30	70	–	–	–	100	3	–	–	–	3
403151	Elective-IV	3	–	–	–	30	70	–	–	–	100	3	–	–	–	3
403152	Project stage II	–	–	–	12	–	–	100	–	50	150	–	–	–	6	6
403153	Audit course VIII	2#	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Total		12	4	–	12	120	280	150	50	100	700	12	2	–	6	20

403150: Elective-III	403151: Elective-IV	403153: Audit Course-VIII
403150 A : Digital Control System 403150 B : Restructuring and Deregulation 403 150 C: Smart Grid 403150 D: SensorTechnology (Open Elective)	403151A: EHV AC Transmission 403151B : Illumination Engineering 403151C: Electromagnetic Fields 403151D: AI and ML (Open Elective)	403153A: German Language II 403153B: Engineering Economics II 403153C: Green Building

*** For the tutorial, one credit is given. # Audit Course: Conduct over and above these lectures.**

403141: Power System Operation and Control

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Practical	02	Hrs/Week/Batch	Practical	01	ESE	70
					Oral	25
					Term work	25

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Course Objectives:

This course aims to:

1. Study the different types of angle, voltage and frequency stability of the power system and methods to improve the stability of the power system.
2. Impart knowledge about various advanced controllers such as FACTs controllers with its evolution, principle of operation, circuit diagram and applications.
3. Introduce frequency control in a single area and two area system.
4. Understand the formulation of unit commitment and economic load dispatch.
5. Illustrate various ways of interchange of power between interconnected utilities.

Course Outcomes:

At the end of this course, students will be able to:
CO1: Summarize angle, voltage and frequency stability in the power system control (UN).
CO2: Illustrate various ways of interchange of power between interconnected utilities (AP).
CO3: Analyze stability and optimal load dispatch using different techniques (AN).
CO4: Select appropriate FACTS devices for stable operation of the system (EV).
CO5: Evaluate the stability of the system and suggest the methods to improve it (EV).

Unit 01	**Power System Stability (Angle Control):** Introduction to stability, dynamics of synchronous machine, swing equation, power angle equation and curve, types of power system stability (concepts of steady state, transient, dynamic stability), equal area criterion, applications of equal area criterion (sudden change in mechanical input, effect of clearing time on stability, critical clearing angle, short circuit at one end of line, short circuit away from line ends and reclosure), methods to improve steady state and transient stability, numerical based on equal area criteria.	08 hrs
Unit 02	**Reactive Power Control:** The necessity of reactive power control, production and absorption of reactive power, reactive power requirements for power factor control and voltage regulation and the loading capability curve of a synchronous generator, types of FACTS controller. **Series compensation:** reactor and capacitor, TCSC, SSSC. **Shunt compensation:** reactor and capacitor, STATCOM, FC-TCR. **Series and shunt compensation:** UPFC. (FACTS devices: working principle, circuit diagram, VI characteristics, applications)	08 hrs
Unit 03	**Automatic Generation Control (Frequency Control):** Introduction to the concept of AGC; complete block diagram representation of load-frequency control of an isolated power system; steady state and dynamic response;	08 hrs

	control area concept; two-area load-frequency control; Schematic and block diagram of the alternator voltage regulator scheme.	
Unit 04	**Economic Load Dispatch and Unit Commitment (Cost Control):** ● **Part A: Economic load dispatch:** Introduction, revision of cost curve, incremental cost curve of thermal, method of Lagrange multiplier, exact coordinate equation (penalty factor), economic scheduling of thermal plant considering effect of transmission losses using Bmn coefficient. (Numerical on method of Lagrange multiplier, penalty factor, Bmn coefficient) ● **Part B: Unit commitment:** Concept of unit commitment, constraints in unit commitment – spinning reserve, thermal and hydro constraints, methods of unit commitment – priority list and dynamic programming, Numerical on priority list and dynamic programming method.	08 hrs
Unit 05	**Energy Control:** Interchange of power between interconnected utilities (numerical), economic interchange evaluation, interchange evaluation with unit commitment, types of interchange, capacity and diversity interchange, energy banking, emergency power interchange, inadvertent power exchange, power pools.	06 hrs
Unit 06	**Voltage Stability:** Basic concepts related to voltage stability: transmission system characteristics (PV curve), generator characteristics (QV curve), and load characteristics. Voltage collapse, classification of voltage stability, static and dynamic stability, analysis techniques for dynamic voltage stability, voltage stability indexing.	07 hrs

Text Books:	
[T1]	I. J. Nagrath, D. P. Kothari, "Modern Power System Analysis", 4^{th} Edition, Tata McGraw Hill Publishing Co. Ltd. (Edition 2)
[T2]	T. J. E. Miller, "Reactive power control in electric systems," Willey.
[T3]	Hadi Saadat, "Power System Analysis," Tata McGraw's Hill
[T4]	S. Sivanagaraju, G. Sreenivasan, "Power System Operation and Control," Pearson Education India, 2009.
[T5]	P. S. R. Murthy, "Power System Operation and Control," Tata McGraw-Hill Publishing Co., Ltd.
[T6]	Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control," Prentice Hall of India.
[T7]	Narain G. Hingorani and Laszlo Gyugyi, "Understanding FACTs," IEEE Press.
[T8]	Dr. B.R. Gupta, "Power System-Analysis and Design", S. Chand Publication.

Reference Books:	
[R1]	Allen J. Wood and Bruce F. Wollenberg, "Power Generation, Operation, and Control," Wiley India Edition.
[R2]	R. Mohan Mathur, Rajiv K. Varma, "Thyristor based FACTS controller for electrical transmission systems", by John Wiley and Sons, Inc.

[R3]	Olle I. Elgerd, "Electrical Energy System Theory", 2nd Edition, Tata McGraw-Hill Publishing Co. Ltd.
[R4]	Dr. K. Uma Rao, "Power System Operation and Control," Wiley India
[R5]	Prabha Kundur, "Power System Stability and Control," Tata McGraw's Hill
[R6]	"Electrical Power System Handbook", IEEE Press
[R7]	James Momoh, "Smart Grid: Fundamentals of design and analysis," Wiley, IEEE Press
Online Resources:	
[O1]	https://www.youtube.com/playlist?list=PL86E9AC8CFBA00ADB
[O2]	https://onlinecourses.nptel.ac.in/noc19_ee62/preview
[O3]	https://www.youtube.com/watch?v=uy9lZCdkQIM&list=PLD4ED2FAF3C155625
[O4]	http://nptel.ac.in/courses/108101040/ (PSOC webcourse)
[O5]	https://nptel.ac.in/courses/108101004
[O6]	https://onlinecourses.nptel.ac.in/noc21_ee16/preview

Mapping:

Unit	Text Books	Reference Books
01	T1, T3, T6, T8	R4, R5
02	T2, T4, T7	R2, R4
03	T1, T3, T4, T5	R1, R3, R4, R5
04	T1, T3, T4	R1, R4
05	T1	R1
06	T8	R4, R5, R7

List of Experiments:

A)The following experiments are ***compulsory***:

1. To apply equal area criteria for stability analysis under a fault condition (three-phase fault at the middle point of a parallel transmission line).
2. To study the Lagrange multiplier technique for economic load dispatch (to find the optimal loading of generators).
3. To study load frequency control using an approximate and exact model.
4. To study reactive power compensation using STATCOM.

B) From the following list, perform ***any four*** experiments.

5. To solve the Unit Commitment problem by priority list method/ dynamic programming (DP) approach
6. Plot a swing curve using the point-by-point/4th order Runge-Kutta method.

7. To apply equal area criteria for analysis stability under a sudden rise in mechanical power input.
8. To study load frequency control with proportional and integral control.
9. To study the two area of load frequency control.
10. To study reactive power compensation using simulation of TCR or TCSC.
11. To study the optimum loading of generators considering transmission losses (penalty factor).

Guidelines for the Instructor's Manual:

- The Instructor's Manual should contain the following things related to every experiment:
- Specify prerequisite and objective(s) of experiment
- Include a circuit diagram with specifications (for hardware experiments).
- A related theory of the experiment must be included.
- The circuit diagram of the experiment should be drawn at the beginning.
- For simulation experiments using MATLAB/EMTP, the Simulink diagram with proper details must be included in the write up. For programming, take a printout of the program and the result.
- A conclusion based on calculations, results, and graphs (if any) should be written.

Industrial Visit:

An industrial visit is mandatory to the Load Dispatch Center/Power Station Control Room.

Guidelines for Students' Lab Manual:

- Students should write the journal in their own handwriting, particularly the results, diagrams, conclusions, questions, answers, etc.
- A circuit or connection diagram or construction diagram must be drawn either manually using or using software on graph paper.
- Handwriting and figures must be neat and clean.

Guidelines for Laboratory Conduction:

- Do the continuous assessment. The experiments performed in a particular week must be checked in the next turn in next week.
- During assessment, the teacher should make the remark by writing the word "Complete" and not simply "C". Put the signature along with the date at the end of the experiment and in the index.

403142: Advanced Control System						
Teaching Scheme			**Credits**		**Examination Scheme**	
Theory	03	Hrs/Week	Theory	03	ISE	30
Practical	02	Hrs/Week/Batch	Practical	01	ESE	70
					Oral	50

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Prerequisite:		
Control System Engineering, Matrix Algebra, Z-transform, and Laplace transform.		
Course Objectives:		
This course aims to: 1. Introduce concepts of modern control theory, analysis, and design. 2. Provide an overview of the digital control system and nonlinear control system. 3. Explore advanced control techniques at an introductory level.		
Course Outcomes:		
At the end of this course, students will be able to: CO1: Explain compensation networks, common nonlinearities, the concept of state, sampling and reconstruction, and concepts of advanced controls (Understanding) CO2: Determine transfer function from state model (Applying) CO3: Test controllability and observability properties of the system (Evaluating) CO4: Design compensators, state feedback controls, and observers for the system (Creating)		
Unit 01	Compensator Design in Frequency Domain	06 hrs
approach to control system design, cascade compensation networks, phase-lead and phase-lag compensator designs using bode plot, physical realization of compensators.		
Unit 02	Nonlinear Control Systems	07 hrs
introduction to nonlinear systems, common nonlinearities, describing function method, describing function of an ideal relay, stability analysis with describing function, introduction to Lyapunov stability analysis (basic concepts, definitions, and stability theorem)		
Unit 03	Introduction to State-Space	08 hrs
Concept of state, state-space representation of dynamical systems in physical variable form, phase variable forms and Jordon / diagonal canonical form, conversion of the transfer function to state-space model and vice versa, state equation and its solution, state transition matrix and its properties, computation of state transition matrix by Laplace transform and Caley Hamilton method.		
Unit 04	State-Space Design	08 hrs

The concept of controllability and observability, Kalman's and Gilbert's tests for controllability and observability, effect of pole-zero cancellation, duality property, control system design using pole-placement using transformation matrix, direct substitution, and Ackermann's formula, State observers, design of a full-order observer.		
Unit 05	Introduction to Digital Control System	08 hrs
Basic block diagram of the digital control system, sampling and reconstruction, Shannon's Sampling theorem, zero-order hold and its transfer function, First-order hold (no derivation), characteristics equation, mapping between s-plane and z-plane, stability analysis in z-plane.		
Unit 06	Advanced control system topics	08 hrs
Concept of sliding mode control, equivalent control, chattering, sliding mode control based on reaching law, Introduction to adaptive control, adaptive schemes, and control problems Optimal control-linear quadratic regulator problem.		

Text Books:

[T1]	Norman S. Nise, *Control System Engineering*, Sixth Edition, John Wily and Sons, Inc. 2011.
[T2]	Richard C. Dorf, Robert H. Bishop, *Modern Control Systems*, Twelfth Edition, Pearson Education.
[T3]	Benjamin C. Kuo, *Digital Control System*, Second Edition, Oxford University Press, 2003.
[T4]	I. J. Nagarath, M. Gopal, *Control System Engineering*, Fourth Edition, New Age International (P) Limited, Publishers
[T5]	A. Nagoor Kani, *Advanced Control Theory*, Third Edition, CBS Publishers and Distributes, 2020.

Reference Books:

[R1]	Katsuhiko Ogata, *Modern Control Engineering*, Fifth Edition, Prentice-Hall, 2010.
[R2]	M. Gopal, *Digital Control and State Variable Methods*, Tata McGraw-Hill.
[R3]	K. Ogata, *Discrete-Time Control System*, Second Edition, PHI Pvt. Ltd. 2006
[R4]	M. Gopal, *Modern Control Systems Theory*, Second Edition, New Age International (P) Limited, Publishers
[R5]	Karl J. Åström, Björn Wittenmark, *Adaptive Control*, Second Edition, Dover Publications, Inc. New Yark
[R6]	C Edwards, Sarah K. Spurgeon, S Spurgeon, *Sliding Mode Control: Theory And Applications*, Taylor and Francis, 1998
[R7]	Jean-Jacques E. Slotine, Jean-Jacques E.. Slotine, Weiping Li, *Applied Nonlinear Control*, Prentice Hall, 1991.

Online Resources:

[O1]	https://nptel.ac.in/courses/108102043
[O2]	https://nptel.ac.in/courses/108102113

Mapping:

Unit	Text Books	Reference Books
01	T1	R1
02	T4, T5	R4
03	T2	R1
04	T2	R1
05	T3	R2,R3
06	T2,T3	R4,R5,R6

List of Experiments:

[Perform any 8 experiments using any simulation software]

1. Simulation of a lead or lag compensator for a given system and comparison of compensated and uncompensated systems responses.
2. Simulation of the closed-loop system with ideal real as a nonlinearity.
3. Software program for determining a state-space model for a given transfer function and vice versa.
4. Software program for determining the state transition matrix.
5. Software program for checking the observability and controllability of a given system.
6. Simulation of state feedback control design using software.
7. Simulation of a full-order observer-based state feedback control system.
8. Effect of sampling and verification of sampling theorem by simulation.
9. Converting a continuous-time system to a discrete-time system and checking the response using the software.
10. Design of a linear quadratic regulator for a given system using simulation.

Industrial Visit:

Industrial visit to a process industry or control and automation industry

Guidelines for the instructor's manual:

Guidelines for the instructor’s manual are given below:

- It should have a title, learning outcomes, aim, software requirement, theory, the problem with the solution, simulation results, comparison (result table, if any), and conclusion.
- All the experiments should have at least one numerical problem, which should be solved analytically, then it should be verified by the simulation. For that matter, theory can be restricted to only definitions and concepts (no detailed explanation).
- Simulation printouts should have readable and self-explanatory block diagrams and figures.
- To develop a proper understanding of all the experiments, it is suggested to take figures with the same physical system (or numerical problem) for all the experiments.

Guidelines for Student’s Lab Manual:

Guidelines for the students' lab manual are given below.

- Students should write the theory, the problem with a solution, and the conclusion on their own in their own handwriting.
- Students should write a program on their own and should compare analytical and simulated results.
- Students should try using different values of the parameters in the numerical problem and should observe the changes in the results.
- Hand writing must be clean and neat.

Guidelines for Laboratory Conduction:

Guidelines for laboratory conduction are as follows:

- At the beginning, the instructor should state the learning outcomes of the experiment and should provide a problem statement to the students.
- Students should solve the problem and then simulate the experiment.
- To have variations in the numerical problem, different parameters can be set for different students.

403143A: PLC and SCADA

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Practical	02	Hrs/Week/Batch	Practical	01	ESE	70
					Oral	25

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Course Objectives:

This course aims to:

1. To make the students understand the fundamentals of automation and various automation systems used in the industry, such as PLC.
2. To provide knowledge levels needed for PLC programming and operating.
3. To develop the architecture of SCADA, explaining each unit in detail.
4. To apply knowledge gained about PLCs and SCADA systems to real-life industrial applications.

Course Outcomes:

At the end of this course, students will be able to:
CO1:Develop and explain the working of a PLC with the help of a block diagram.
CO2:Classify input and output interfacing devices with PLC.
CO3:Design PLC based application by proper selection criteria, developing GUI and ladder program.
CO4:Execute, debug, and test the programs developed for digital and analog operations.
CO5:Develop the architecture of SCADA and explain the importance of SCADA in critical infrastructure.
CO6:Describe the SCADA protocols and digital control systems, along with their architecture for automation.

Unit 01	Introduction to PLC	07 hrs

Role of automation in Industries, benefits of automation, Necessity of PLC, History and evolution of PLC, Definition as per NEEMA (National Electrical Engineering Manufacturers' Association), types – fixed/modular/dedicated, Overall PLC system, PLC Input and output modules (along with Interfaces), CPU, programmers and monitors, power supplies, selection criterion, advantages and disadvantages, specifications, comparison of various PLCs manufactured by Allen Bradley, Siemens, ABB, Mitsubishi, GE, Fanuc and Schneider.

Unit 02	Interfacing of PLC with I/O devices	08 hrs

Input ON/OFF switching devices, Input analog devices, Output ON/OFF devices, Output analog devices Sensors-temperature, pressure, flow, level Actuators-Electrical, pneumatic, hydraulic Encoders-Incremental, Absolute Transducers, Limit switches, proximity sensors Control Elements- Mechanical, Electrical, Fluid valves

Unit 03	Programming of PLC	08 hrs

Programming languages for PLC, Ladder diagram fundamentals, Rules for proper construction of ladder diagram Timer and counter- types along with timing diagrams, Reset instruction, latch instruction MCR (master control relay) and control zones Developing ladder logic for Sequencing of motors, ON OFF, Tank

level control, ON OFF temperature control, elevator, bottle filling plant, car parking, traffic light controller.		
Unit 04	Advance function and Applications of PLC	08 hrs
Analog PLC operation and PLC analog signal processing, PID principles, typical continuous process control curves, simple closed loop systems, closed loop systems using Proportional, Integral and Derivative (PID), PID modules, PID tuning, tuning methods including the “Adjust and observe” method AC Motor Controls: AC Motor Starter, AC Motor Overload Protection, DC Motor Controller, Variable Speed (Variable Frequency) AC Motor Drive. PLC Applications in developing systems- Tank level controller using analog signals, temperature controller using RTD, speed control of electric motor.		
Unit 05	SCADA Systems	07 hrs
Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system architecture, important definitions HMI, MTU, RTU, communication means, Desirable properties of the SCADA system, advantages, disadvantages, and applications of SCADA. SCADA generations (First generation - Monolithic, Second generation - Distributed, Third generation – Networked Architecture), SCADA systems in operation and control of interconnected power system, functions and features of SCADA systems, Automatic substation control, Energy management systems (EMS), System operating states, SCADA systems in critical infrastructure: Petroleum Refining Process, Conventional electric power generation, Water Purification System, Chemical Plant.		
Unit 06	SCADA Protocols and Distributed Control Systems	07 hrs
Open systems interconnection (OSI) Model, TCP/IP protocol, Modbus model, DNP3 protocol, IEC 60870-5-101 (IEC101), Control and Information Protocol (CIP), Ether 01111111111111Net/IP, Flexible Function Block process (FFB), Process Field bus (Profibus). Distributed Control System: Introduction to DCS- its working & operation, Architecture , Features, Advantages & Applications of DCS, Comparison between DCS & PLC.		
Text Books:		
[T1]	John W. Webb, Ronald A. Reis, “Programmable Logic Controllers: Principles and Application”, PHI Learning, New Delhi, 5th Edition	
[T2]	John R. Hackworth, Frederick D., Hackworth Jr., “Programmable Logic Controllers Programming Methods and Applications”, PHI Publishers.	
[T3]	Ronald L. Kurtz, “Securing SCADA Systems," Wiley Publishing.	
[T4]	Stuart A. Boyer, “SCADA supervisory control and data acquisition”, ISA, 4th Revised edition.	
[T5]	Gary Dunning, “Introduction to Programmable Logic Controllers”, Thomson, 2nd Edition.	
[T6]	Curtis Johnson, “Process Control Instrumentation Technology," Prentice-Hall of India.	
Reference Books:		
[R1]	Gordan Clark, Deem Reynders, “Practical Modern SCADA Protocols," ELSEVIER	
[R2]	Batten G. L., “Programmable Controllers," McGraw Hill Inc., Second Edition	

[R3]	Bennett Stuart, “Real Time Computer Control," Prentice Hall, 1988
[R4]	Krishna Kant, “Computer Based Industrial Control," PHI
[R5]	P. K. Srivstava, “Programmable Logic Controllers with Applications," BPB Publications
[R6]	Distributed Computer Control systems in Industrial Automation, D Popovic & Vijay Bhatkar.

Online Resources:

[O1]	NPTEL Course: Electrical Measurement And Electronic Instruments By Prof. Avishek Chatterjee, Dept. of Electrical Engineering, IIT Kharagpur:- Web link https: // nptel.ac.in /courses /108 /105 / 108105153/
[O2]	NPTEL Course: Industrial Instrumentation By Prof. Alok Barua, IIT Kharagpur:-Web linkhttps://nptel.ac.in/courses/108/105/108105064/

Mapping:

Unit	Text Books	Reference Books
01	T1	R1
02	T1, T2, T6	R3, R4
03	T1, T5	R5
04	T1, T2, T6	R2, R5
05	T3, T4	R1
06	T3	R1, R6

List of Experiments:

Minimum 11 experiments should be conducted. 6 experiments should be on PLC and 5 experiments should be on SCADA.
a) Experiments No. ***1 to 5*** are ***compulsory.***
b) ***Any 1*** experiment should be conducted from experiment number ***6 to 9.***
c) Experiments No. ***10 to 13*** are compulsory.
d) ***Any 1*** experiment should be conducted from experiment number ***14 to 17.***

1. Interfacing of lamp and button with PLC for ON and OFF operation. Verify all logic gates.
2. Set / Reset operation: one push button for ON and other push button for OFF operation.
3. Delayed operation of lamp by using push button.
4. UP/DOWN counter with RESET instruction.
5. Combination of counter and timer for lamp ON/OFF operation.
6. DOL starter and star delta starter operation by using PLC.
7. PLC based thermal ON/OFF control.
8. Interfacing of Encoder with PLC
9. PLC based speed, position, flow, level, pressure measurement system.
10. PLC interfaced with SCADA and status read/command transfer operation.
11. Parameter reading of PLC in SCADA.
12. Alarm annunciation using SCADA.
13. Reporting and trending in the SCADA system.

14. Tank level control by using SCADA.
15. Temperature monitoring by using SCADA.
16. Speed control of Machine by using SCADA.
17. Pressure control by using SCADA.

Guidelines for Instructor's Manual:

- Specify objective(s) of the experiment.
- Include a ladder diagram.
- Related theory of the experiment must be included.
- Include step by step procedure to perform the experiment.
- Tabular representation of results taken from the experiment/observation table must be included wherever applicable.
- Provide space to write conclusions.

Guidelines for Student's Lab Manual:

Students are expected to write the journal in the following sequence:

- Aim –
- Ladder diagram –
- Theory –
- Conclusions
- Students are expected to draw the ladder diagrams on 1mm graph paper.
    - ➢ They should take the print out or draw SCADA HMI.
    - ➢ Students should write conclusions.
    - ➢ Students should get the assignment and lab write up checked within 1 week after performing the experiment.

Guidelines for Laboratory Conduction:

- Give the safety instructions to students.
- Allow 4-5 students per group to perform the experiment.
- Explain theory related to the experiment to be conducted.
- Introduce PLC and SCADA in detail with specifications to students.
- Explain the ladder diagram of the experiment.
- Ladder diagram should be completed by the students.
- Perform the experiment in the presence of an instructor.
- Verify the results obtained.

403143B: Power Quality Management						
Teaching Scheme			**Credits**		**Examination Scheme**	
Theory	03	Hrs/Week	Theory	03	ISE	30
Practical	02	Hrs/Week/Batch	Practical	01	ESE	70
					Oral	25

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Prerequisite:

Fundamentals of Power Systems and Power Electronics

Course Objectives:

This course aims to:

1. Develop understanding of power quality attributes.
2. Make students describe problems associated with poor power quality.
3. Make students describe mitigation techniques for improving power quality.
4. Learn various equipment of monitoring and assessment.

Course Outcomes:

Student will be able to

CO1: Understand power quality and attribute of power quality

CO2: Describe voltage flicker and mitigation of it

CO3: Analyze the effect of power system events on voltage sag and its characteristics.

CO4: Identify the sources of harmonics and harmonics produced

CO5: Select proper method for harmonic mitigation along with methods of power quality monitoring.

CO6: Carry out power quality monitoring using power quality analyzers.

Unit 01	Basics of Power Quality	07 hrs

Importance of power quality, terms and definitions of power quality as per IEEE std. 1159-2019 such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding, grounding and power quality, recommended grounding practices for noise and power quality control.

Unit 02	RMS Voltage variations, Flickers and Transient Over-Voltages	07 hrs

RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Ferro-resonance Various means to reduce flickers. Flicker meter and monitoring. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages.

Unit 03	Voltage Sag, Swell and Interruption	07 hrs
Definitions of voltage sag and interruptions. Voltage sags versus interruptions. Economic impact of voltage sag, Major causes and consequences of voltage sags. Voltage sag characteristics. Voltage sag assessment. Influence of type of fault, fault location and fault level on voltage sag. Phase angle jumps. Types of sags (Type 1 to type 7). Areas of vulnerability. Assessment of equipment sensitivity to voltage sags. Voltage sag limits for computer equipment, CBEMA, ITIC, SEMI F 42 curves. Measurement of voltage sag half cycle RMS, one cycle rms methods. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions.		
Unit 04	Harmonics-I	07 hrs
Definition of harmonics, inter-harmonics, sub-harmonics. Causes and effects of harmonics. Voltage versus current distortion. Overview of Fourier analysis. Harmonic indices and other indices for assessing impacts of harmonics. A.C. quantities under non-sinusoidal conditions. Triplen harmonics characteristics and non characteristics harmonics. Power assessment under waveform distortion conditions. Harmonic sources and harmonic generation from lighting loads, Computer and allied load including SMPS, household equipment, Office automation devices, Utility equipment like transformer, synchronous machines and FACTS devices. Industrial equipment – induction machines, AC and Dc drives, Arc Furnaces.		
Unit 05	Harmonics-II	7 hrs
Harmonics resonances - series and parallel resonances. Consequences of harmonic resonance. Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Modifying the system frequency response. Harmonic filtering, IEEE 1531 standard for key design criteria for filters. Passive filters, Notch filter, Tuned filters, Broadband filters and active filters. IEEE Standard 519-2014 for Harmonic control.		
Unit 06	Power Quality Monitoring & Assessment	07 hrs
Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality instrumentation. Power quality analyser specification requirement as per EN50160 Standard. Selection of power quality equipment for cost effective power quality monitoring, Selection of power quality monitors, selection of monitoring location and period. Selection of transducers. Harmonic monitoring, Transient monitoring, event recording and flicker monitoring. Power Quality assessment, Power quality indices and standards for assessment disturbances, waveform distortion.		

Text Books:

[T1]	R. C. Dugan, Mark F. McGranaghan, Surya Santoso, and H. Wayne Beaty, “Electrical Power System Quality”, 2nd Edition, McGraw-Hill Publication.
[T2]	C.Sankaran, “Power Quality”, CRC Press.
[T3]	M. H. J. Bollen, “Understanding Power Quality Problems, Voltage Sag and Interruptions”, New York: IEEE Press, 2000, Series on Power Engineering.
[T4]	Arrillaga, M. R. Watson, and S. Chan, “Power System Quality Assessment," John Wiley and Sons.

Reference Books:

[R1]	Enriques Acha, Manuel Madrigal, "Power System Harmonics: Computer Modeling and Analysis," John Wiley and Sons Ltd.
[R2]	Ewald F. Fuchs, Mohammad A. S. Masoum, "Power Quality in Power Systems and Electrical Machines," Elsevier Publication.
[R3]	Arrillaga, M. R. Watson, "Power System Harmonics", John Wiley and Sons.
[R4]	G. J. Heydt, "Electric Power Quality", Stars in Circle Publications.
[R5]	EN50160 and IEEE 1100, 1346, 519, and 1159 standards.

Mapping:

Unit	Text Books	Reference Books
01	T1,T2, T3,T4	R1,R2,R4, R5
02	T1,T2	R2, R4, R5
03	T1,T2, T3	R2, R4, R5
04	T1,T2	R1, R2, R3, R4, R5
05	T1,T2	R1, R2, R3, R4, R5
06	T1,T2,T5	R1, R2, R3, R4, R5

List of Experiments:

A minimum of 9 experiments are to be performed from the following list:
Compulsory experiments:

1. Study of the power quality analyzer and measurement of various power quality parameters.
2. Measurement of harmonic distortion of various non linear loads.
3. Harmonic analysis of SMPS based Equipment such as UPS /AC/DC drive.
4. Harmonic compliance of institute as per IEEE 519-2014 standard and sizing of hybrid (Active + detuned filter).
5. Power quality audit of institute or department.

Any 4 experiments from following list:

1. Harmonic analysis of transformer for various conditions (no load, inrush, full load etc.)
2. Harmonic analysis of UPS/ DC Drive/AC Drive.
3. Analysis of performance of induction motor/transformer operated with sinusoidal supply and under distorted supply conditions supplied by 3 phase inverter.
4. Measurement of voltage sag magnitude and duration by using digital storage oscilloscope/ power quality analyzer.
5. Design of 7% detuned Passive Filter.
6. Simulation study of transient and/or flicker measurement.
7. Simulation studies of harmonic generation sources such as VFD, SVC, STATCOM and FACTS devices and harmonic measurement (THD) by using professional software like MATLAB.
8. Harmonic load flow analysis by using professional software such as ETAP, PSCAD, ATP.

Guidelines for the Instructor's Manual:

The Instructor's Manual shall have

- Brief relevant theory.

- Equipment with specifications.
- Connection diagram/methodology.
- Format of observation table and sample results.

Guidelines for Students' Lab Manual:

The Student's Lab Journal should contain the following related to every experiment –

- Theory related to the experiment.
- Apparatus with their detailed specifications.
- Connection diagram or circuit diagram.
- Observation table/simulation waveforms.
- Sample calculations for one or two readings.
- Result table.
- Graph and conclusions
- Few short questions related to the experiment.

Guidelines for Laboratory Conduction:

- Read and understand the power quality analyzer manual completely.
- Make sure that connections of the power analyzer are done as per manual.
- Follow safety protocols while doing a power quality audit.

403143C: High Voltage Engineering

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Practical	02	Hrs/Week/Batch	Practical	01	ESE	70
					Oral	25

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Course Objectives:

This course aims:

- To make students to know and compare the various processes of breakdown in solid, liquid and gaseous dielectric materials.
- To make students understand and apply various methods of generation and measurement of DC, AC, impulse voltage and current.
- To enable students to understand the charge formation and separation phenomena in clouds, the causes of overvoltage and lightning phenomena,
- To develop the ability among learners to execute testing on various high-voltage equipment as per standards.
- To introduce students to the design, layout, safety precautions, earthing, and shielding of HV laboratory.

Course Outcomes:

At the end of this course, students will be able to:

CO1: Identify, describe and analyze the breakdown theories of gaseous, solid and liquid materials.

CO2: Analyze the occurrence of over voltage and to provide remedial solutions

CO3: Describe and use of various methods of generation of high AC, DC, impulse voltage and current.

CO4: Demonstrate the methods of measurement of high AC, DC, impulse voltage and current, tests on high voltage equipment and devices

CO5: Study design of high voltage laboratory with all safety measures.

Unit 01	Breakdown in Gas	07hrs

Ionization process in gas, Townsend's Theory, current growth equation in presence of primary and secondary ionization processes, Townsend's breakdown criterion, primary and secondary ionization coefficients, limitations of Townsend's theory, Streamer mechanism of breakdown, Paschen's Law and its limitations, Corona discharges for point plane electrode combination with positive and negative pulse application, time lag for and factors on which time lag depends. (Numerical on Townsend's theory and Paschen's law).

Unit 02	Breakdown in Liquid and Solid Dielectrics	07 hrs

- **Breakdown in Liquid Dielectrics:** Pure and commercial liquids, Different breakdown theories: Breakdown in Pure liquid and breakdown in commercial liquids: Suspended Particle theory, Cavitations and bubble theory, Thermal mechanism of breakdown and Stressed Oil volume theory.
- **Breakdown in Solid Dielectrics:** Intrinsic breakdown: electronic breakdown, avalanche or streamer breakdown, electromechanical breakdown, thermal breakdown, treeing and tracking phenomenon, Chemical and electrochemical breakdown, Partial discharge,Composite dielectric material,

	Properties of composite dielectrics, breakdown in composite dielectrics. (Numerical on theories of liquid and solid dielectric materials)	
Unit 03	Lightning and Switching Over Voltages	07 hrs
Lightning phenomenon, Different types of lightning strokes and mechanisms of lightning strokes, Charge separation theories, Wilson theory, Simpson theory, Reynolds and Mason theory. Causes of over voltages and its effects on power systems, Over voltage due to switching surges and methods to minimize switching surges. Statistical approach of insulation coordination.		
Unit 04	Generation of High Voltages and Current	07 hrs
Generation of high ac voltages-Cascading of transformers, series and parallel resonance system, Tesla coil. Generation of impulse voltages and current-Impulse voltage definition, wave front and wave tail time, Multistage impulse generator, Modified Marx circuit, Tripping and control of impulse generators, Generation of high impulse current .		
Unit 05	Measurement of High Voltage and High Currents	07 hrs
Sphere gap voltmeter, electrostatic voltmeter, generating voltmeter, peak reading voltmeter, resistive, capacitive and mixed potential divider, capacitance voltage transformer, cathode ray oscilloscope for impulse voltage and current measurement, Measurement of dielectric constant and loss factor, partial discharge measurements. Measurement of high power frequency a.c using current transformer with electro-optical signal converter, Radio interference measurements.		
Unit 06	High Voltage Testing of Electrical Apparatus and EHV Laboratories	07 hrs
Testing of insulators and bushings, Power capacitors and cables testing, testing of surge arresters. Design, planning and layout of High Voltage laboratory:-Classification and layouts, earthing and shielding of H.V. laboratories.		
Text Books:		
[T1]	C. L. Wadhwa, “High Voltage Engineering”, New Age International Publishers Ltd.	
[T2]	M. S. Naidu, V. Kamaraju, “High Voltage Engineering”, Tata McGraw Hill Publication Co. Ltd. New Delhi	
Reference Books:		
[R1]	E. Kuffel, W. S. Zaengl, J. Kuffel, “High Voltage Engineering Fundamentals”, Newnes Publication	
[R2]	Prof. D. V. Razevig Translated from Russian by Dr. M. P. Chourasia, “High Voltage Engineering", Khanna Publishers, New Delh	
[R3]	Ravindra Arora, Wolf Gang Mosch, “High Voltage Insulation Engineering”, New Age International	
[R4]	High Voltage Engineering Theory and Practice by M. Khalifa Marcel Dekker Inc. New York and Basel	
[R5]	Subir Ray, “An Introduction to High voltage Engineering” PHI Pvt. Ltd. New Delhi	

[R6]	IS 731-1971:Porcelain insulator for overhead power lines with nominal voltage > 1000 Volt
[R7]	Bushings :IS2099-1986,specification for bushings for A.C. Voltages > 1000 Volts
[R8]	Pollution test :IEC 60507-1991 on external and internal insulator
[R9]	High voltage test techniques, general definitions and test requirements: IS 2071(part 1) 1993,IEC Pub 60-1(1989)

Online Resources:

[O1]	https://nptel.ac.in/courses/108104048

Mapping:

Unit	Text Books	Reference Books
01	T1,T2	R1,R2,R3,R6
02	T1,T2	R1,R2,R3,R5,R6
03	T1,T2	R1,R2,R3,R5,R6
04	T1,T2	R1,R2,R3,R4,R5,R6
05	T1,T2	R1,R2,R3,R4,R5,R6
06	T1,T2	R1,R2,R3,R7,R8,R9

List of Experiments:

[Minimum eight experiments to be conducted from the given list]

1. To find the constants of the breakdown equation of transformer oil.(Analytical and graphical method)
2. Measurement of unknown high a.c. voltage using sphere gap
3. To obtain breakdown strength of composite insulation systems, and observe the effect of parameters like no. of layers, thickness of layer, effect of interfacing.
4. To find out the breakdown of air in uniform and non uniform fields and compare it.
5. To study surface flashover on corrugated porcelain/polymeric insulation systems.
6. To understand the basic principle of corona and obtain audible and visible corona inception and extinction voltage under non uniform field.
7. To perform an experiment on horn gap arrester and understand arc quenching phenomenon.
8. To observe development of tracks and trees on polymeric insulation systems.
9. Parametric analysis of Impulse current generator using virtual Laboratory.
10. To perform an experiment on rod gap arresters.
11. To Study effect of barrier on breakdown voltage of air/ transformer oil.
12. Simulation of lightning and switching impulse voltage generator using any simulation software.
13. To perform various HV insulation tests on cables as per IS.
14. Study of layout /earthing/safety of HV installation /lab in any industry by visit /virtual lab.

Industrial Visit: Industrial visit to high voltage equipment manufacturing industry/EHV substation/High Voltage Testing Lab.

Guidelines for Instructor’s Manual:

The Instructor's Manual should contain following related to every experiment

- Brief theory related to the experiment.
- Circuit diagram and apparatus with their detail specification as per IS code.
- Students should be encouraged to visit industries/HV laboratories/HV installations.
- Students should be encouraged to use virtual labs.
- Few short questions related to each practical.
- Assignments based on use of IS and IEC.

Guidelines for Student's Lab Manual:

The Students lab journal should contain:

- Brief theory related to the experiment.
- Circuit diagram and apparatus with their detail specification as per IS code.
- Observations, result tables and proper inferences/ conclusions from each experiment conducted.
- Reports on visit to industries/HV laboratories/HV installations.
- Simulations and print outs of use of virtual labs.
- Few short questions and answers related to each practical.
- Assignments based on use of IS and IEC.

Guidelines for Laboratory Conduction:

There should be continuous assessment for the TW.

- Assessment must be based on understanding of theory, attentiveness during practicals.
- Session, how efficiently the student is able to do connections and get the results.
- Timely submission of journal.

403143D: Robotics and Automation

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Practical	02	Hrs/Week/Batch	Practical	01	ESE	70
					Oral	25

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Course Objectives:

This course aims to:

- To know the basic parts of a typical industrial robot system with its anatomy similar to the human body.
- To analyze mathematically the kinematic and dynamic modeling of a typical robot manipulator.
- To select an appropriate type of robot with given specifications for different industrial applications.
- To know the basics of actuators, sensors, and control of an industrial robot for different applications.

Course Outcomes:

At the end of this course, students will be able to:
CO1: differentiate between types of robots based on configuration, method of control, types of drives, sensors used, etc.
CO2: apply mathematical modeling of a robot for a specific application with given specifications.
CO3: analyze the robot arm dynamics for calculation of torques and forces required for different joints of robots for control of the robot arm.
C04 : apply knowledge of Robot for their various applications

Unit 01	Robotics fundamentals	07 hrs

historical development of robotics, Definitions of Industrial Robot, Types of Robots, Asimov's Laws of Robotics, robot components, Robot specifications: repeatability, spatial resolution, compliance, degree of freedom, load carrying capacity, speed of response, work volume, work envelope, reach, etc,Robot configurations, Classification of Robots: Control Method: Servo controlled and non-servo controlled, their comparative study, form of motion: P-T-P (point to point), C-P (continuous path), pick and place etc. and their comparative study.

Unit 02	Mathematical Modeling and Dyananics of Robots	07 hrs

Direct Kinematics, Coordinate and vector transformations using matrices, Rotation matrix, Inverse Transformations, Composite Rotation matrix, Homogeneous Transformations, The Robotic Manipulator Joint Coordinate System, inverse, Jacobian Transformation in Robotic Manipulation. **Robot Dynamics:** Lagrange's Equation, Kinetic and potential energy Equations, and Euler-Lagrange analysis for a single prismatic joint working against gravity and a single revolute joint. equation of motion.

Unit 03	Forward and Inverse Kinematics	07 hrs

Denavit-Hartenberg (D-H) representation of kinematic chains. Rules for establishing link coordinate frames.

Forward solution of robotic manipulator for SCARA Robot and PUMA Robot. Forward 67i solution for simple robot systems. **Inverse Kinematics:** Concept of Inverse Kinematics, general properties of inverse solution such as existence and uniqueness of solution, inverse solution by direct approach, Geometric approach, inverse solution for simple SCARA Robots, numericals for simple three axis robots based on direct approach.		
Unit 04	Robotics Sensors	07hrs
Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors- Proximity Sensors, Photo Electric Sensors, Laser Scanners, Position sensors – Piezo Electric Sensor, LVDT, Resolvers. Encoders: Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors Range Sensors: Range Finders, Laser Range Meters, Touch Sensors, Force and torque sensors. Safety Sensor: Light Curtain, Laser Area Scanner, Safety Switches; Machine vision		
Unit 05	Differential motion and control	07 hrs
Manipulator Differential Motion: Concept of linear and angular velocity, Relationship between transformation matrix and angular velocity, manipulator Jacobian, Jacobian for prismatic and revolute joint, Jacobian Inverse, Singularities. **Control of Robot Arm:** Modeling of DC motor and load, closed loop control in position servo, the effect of friction and gravity, control of a robotic joint, position velocity and acceleration profiles for trapezoidal velocity profile. **Control of Robot manipulator:** joint position controls (JPC), resolved motion position controls (RMPC) and resolved motion rate control (RMRC).		
Unit 06	Various applications of Robots	07 hrs
Pick and place the robot, Application of Robots in Arc Welding Robots, assembly and mega-assembly Robots perform continuous arc welding, spot welding, spray painting, and assembly operations. Robots for Inspection: Robotic vision systems, image representation, object recognition and categorization, depth measurement. Other industrial applications: coating, deburring, cleaning, Die Casting, Molding, Material handling, Picking, palletizing, packaging, hospitals and patient care, F&B industry, sports and recreation, defense and surveillance industry, home automation, mining industry. A robot-based manufacturing system, robot cell design considerations and the selection of robots, Robot Economics, Functional Safety in Robotic Applications		
Text Books:		
[T1]	Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, and Ashish Dutta, “Industrial Robotics:Technology, Programming and Applications," Tata-McGraw-Hill Education Private Limited, New Delhi, 2012.	
[T2]	Richard D. Klafter, Thomas A. Chemielewski, Michael Neign, “Robotic Engineering – An IntegralApproach”, Prentice Hall of India Pvt. Ltd., New Delhi. Eastern Economic Edition.	
[T3]	Robert J. Schilling, “Fundamentals of Robotics: Analysis and Control”, Prentice Hall of India, New Delhi	
Reference Books:		
[R1]	K. S. Fu, R. C. Gonzalez, and C. S. G. Lee, “Robotics: Control Sensing, Vision, and Intelligence”,	

	International Edition, McGraw-Hill Book Co.
[R2]	John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education
[R3]	R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw-Hill Publishing Company Ltd., New Delhi.
[R4]	Saeed b. Niku, "Introduction to Robotics: Analysis, Control, Applications", Wiley Publication, 2011.

Online Resources:

[O1]	NPTEL Course on "Robotics": https://nptel.ac.in/courses/112/105/112105249/
[O2]	NPTEL Course on "Introduction to Robotics": https://nptel.ac.in/courses/107/106/107106090/

Mapping:

Unit	Text Books	Reference Books
01	T1,T2	R3
02	T1,T2,T3	R1, R2,R3,R4
03	T1,T2,T3	R1,R3,R4
04	T1,T2,T3	R1,R3,R4
05	T2, T3	R1,R2, R3
06	T2	R1

A List of Experiments:

Experiment 9 is compulsory.

List of Laboratory Experiments

1.Identify and selection of Sensors such as IR sensors, Proximity Sensor, Ultrasonic Sensor, White line sensor, Temperature Sensor, Touch sensor, Tilt Sensor, Accelerometer, Gyroscopic Sensor etc. based on given application

2. Identify and selection of Actuators and related hardware such as DC motor, Servo motor, Stepper Motor, Motor drivers based on application
3. Demonstration of various robotic configurations using industrial robot
4. Design and selection of Gripper / End effector
5. One Programming exercise on lead through programming
6. MATLAB program for simple and inverse kinematics of simple robot configuration
7. To demonstrate simple robotic system using Matlab/ MscAdam / RoboAnalyser software
8. Study of various applications of Robots
9. One Industrial visit for Industrial robotic application

Guidelines for the Instructor's Manual:

The Instructor's Manual should contain the following things related to every experiment:

- Specify prerequisite and objective(s) of experiment.
- A related theory of the experiment must be included.

- The circuit diagram of the experiment should be drawn at the beginning.
- For simulation experiments, the Simulink diagram with proper details must be included in the write up. For programming, take a printout of the program and the result.
- A conclusion based on calculations, results, and graphs (if any) should be written.

Guidelines for Students' Lab Manual:

- Students should write the journal in their own handwriting, particularly the results, diagrams, conclusions, questions, answers, etc.
- A circuit or connection diagram or construction diagram must be drawn either manually using or using software on graph paper.
- Handwriting and figures must be neat and clean.

Guidelines for Laboratory Conduction:

- Do the continuous assessment. The experiments performed in a particular week must be checked in the next turn in next week.
- During assessment, the teacher should make the remark by writing the word “Complete” and not simply “C”. Put the signature along with the date at the end of the experiment and in the index.

403144A: Alternate Energy System

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Tutorial	02	Hrs/Week/Batch	Tutorial	01	ESE	70
					Term work	25

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Course Objectives:

This course aims to:
1. Develop a fundamental understanding of solar thermal and photovoltaic systems.
2. Provide the knowledge of development and operation of wind energy system
3. Discuss bio-energy resource assessment.
4. Introduce different storage systems, Integration and Economics of Renewable Energy Systems.

Course Outcomes:

At the end of this course, students will be able to:
CO1:Analyze the performance of solar thermal and photovoltaic systems.
CO2:Determine wind turbine performance.
CO3:Explain and evaluate biomass resources in an Indian context.
CO4:Illustrate the importance of storage systems.
CO5:Analyze the economics of renewable energy sources.

Unit 01	Solar Energy-I	08 hrs

Solar radiation at the earth’s surface, Solar constant, Spectral distribution, Extraterrestrial Radiation, Solar Terrestrial Radiation, Solar radiation geometry, Computation of cosθ for any location having any orientation, Empirical equations for predicting the availability of solar radiation: Monthly average daily and hourly global and diffuse radiation, Beam and Diffuse radiation under cloudless skies, Solar radiation on tilted surfaces : a)Beam radiation, b)Diffuse radiation, c)Reflected radiation, d)Flux on tilted surface.
Instruments for measuring solar radiation, Devices for thermal collection and storage, Thermal applications, Introduction to concentrating solar power (CSP) plants using technologies like a) Parabolic troughs b) Linear Fresnel reflector, c) Parabolic Dish, etc.

Unit 02	Solar Energy-II	06 hrs

Introduction to family of solar film technology, Single c-Si, Poly c-Si PV Cell, Module and Array, Array Design (factors influencing the electrical design of the solar array) : a) Sun Intensity, b)Sun Angle, c) Shadow Effect, d) Temperature Effect, e) Effect of Climate, f) Electrical Load Matching, g) Sun Tracking, Peak Power Point Operation, Electrical characteristics of Silicon PV Cells and Modules, PV System Components, Efficiency of PV system, MPPT of solar system, PV system design for various applications(residential, commercial and industrial)

Unit 03	Wind Energy	08 hrs

Power Contained in Wind, Thermodynamics of Wind Energy, Efficiency Limit for Wind Energy

Conversion, the maximum energy obtained for a Thrust-operated converter (Efficiency limit), Design of Wind Turbine Rotor, Power-Speed Characteristics, Torque-Speed Characteristics, Wind Turbine Control Systems: a) Pitch Angle Control, b) Stall Control, c) Power Electronics Control, d) Yaw Control, Control Strategy, Wind Speed Statistics, Statistical Wind Speed Distributions, Site and Turbine Selection, Extraction of wind energy and wind turbine power. Introduction to Offshore Wind Energy System and its comparison with Wind Energy System,		
Unit 04	Biomass Energy	06 hrs
Biomass Classification, Biomass Resources and their Energy Potential, Biomass Conversion Technologies: Anaerobic Digestion, Ethanol Fermentation, Biomass Gasification: Gasifiers, Fluidized Bed Gasifier, Biogas Technologies and their factor affecting Biogas Production, Biogas Plants: Floating and Fixed Dome type, designing of biogas plant, Introduction to Biodiesel, Power Generation from Municipal Solid Waste (MSW), Landfill Gas, Liquid Waste.		
Unit 05	Fuel Cells and Storage Systems	08 hrs
A. Fuel Cells: Operating principles of Fuel Cell, Fuel and Oxidant Consumption, Fuel Cell System Characteristics, Introduction to Fuel Cell Technology and its type, application and limits. B. Storage systems: Hydrogen storage: Hydrogen production, relevant properties, Hydrogen as an Engine Fuel, methods of Hydrogen storage. Batteries: Introduction to Batteries, Elements of Electro-Chemical Cell, Battery classification, Battery Parameters, Factors affecting battery performance. Introduction to other storage technologies: pump storage, SMES, compressed air storage.		
Unit 06	Integration of RES	06 hrs
A. Integration of RES with grid, Grid codes. B. Economics of RES: Simple, Initial rate of return, time value, Net present value, Internal rate of return, Life cycle costing, Effect of fuel Escalation, Annualized and levelized cost of energy.		
Text Books:		
[T1]	S.P. Sukhatme, "Solar Energy", Tata McGraw Hill	
[T2]	Chetan Singh Solanki, "Solar Photovoltaics-Fundamentals, Technologies and Applications", PHI Second Edition	
[T3]	Godfrey Boyle, "Renewable Energy", Third edition, Oxford University Press	
[T4]	H. P. Garg, J. Prakash, "Solar Energy-Fundamentals and Applications", Tata McGraw hill Publishing Co. ltd., First Revised Edition.	
[T5]	Mukund R. Patel, "Wind and Power Solar System", CRC Press	
[T6]	Gilbert M. Masters, "Renewable and Efficient Electrical Power Systems", Wiley - IEEE Press, August 2004	
Reference Books:		
[R1]	D.P.Kothari, K.C.Singal, Rakesh Rajan,"Renewable Energy Sources and Emerging Technologies", PHI Second Edition	
[R2]	Tapan Bhattacharya, "Terrestrial Solar Photovoltaics", Narosa Publishing House	
[R3]	Paul Gipe, "Wind Energy Comes of Age", John Wiley & Sons Inc.	

[R4]	Donald L.Klass, “Biomass for Renewable Energy, Fuels, and Chemicals, Elsevier, Academic Press
[R5]	Thomas Ackermann, “Wind Power in Power Systems”, Wiley Publications.
[R6]	B T.Nijaguna, “Biogas Technology”, New Age International Publishers.
[R7]	Tony Burton, Nick Jenkins, David Sharpe, “Wind Energy HandBook-Second Edition”, John Wiley & Sons, Ltd., Publication

Online Resources:

[O1]	A review on non-edible oil as a potential feedstock for biodiesel: physicochemical properties and production technologies.
[O2]	Fabrication and Design of Solar cooker.

Mapping:

Unit	Text Books	Reference Books
01	T1, T2	R1, R2
02	T2, T3, T4	R1
03	T5	R3, R5,R7
04	T6	R4, R6
05	T3,T6	R1
06	T6	R1

List of Tutorial:

It is expected to take ***minimum 8 tutorials*** from the following list:

1. Report on Renewable Energy Scenario in India/ across the Globe.
2. Designing of standalone Solar PV systems for various loads(2 numericals).
3. Report on analysis of Indian solar radiation data/ Wind data.
4. Performance analysis of concentrating solar collector/ solar cooker/ solar air heaters
1. Study of Wind Electric Generators with Grid Integration.
2. Performance of Wind generation (2 or 3 numericals).
3. Design of a community biogas plant for a village in India(1 or 2 numericals).
4. Analysis of Non Edible oil as an alternate energy source.
5. Performance of storage devices(3/4 numericals).
6. Economics of renewable energy sources(2 or 3 numericals).
7. Design of Hybrid system using HOMER demo software

Guidelines for Assessment of Tutorial:

- Maintain Record in file or separate notebook.
- Timely submission of tutorials.
- Assessment of the report must be based on understanding, presentation and contents.

403144B: Electric and Hybrid Vehicle

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Tutorial	02	Hrs/Week/Batch	Tutorial	01	ESE	70
					Term work	25

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Course Objectives:

This course aims to:
1. To gain knowledge of Li-ion battery protection.
2. To learn HEV Subsystems and Configurations.
3. To understand Mathematical Model of Li-ion battery.
4. To familiarize with Hybridization of drivetrains.
5. To learn Star Labeling Schemes for Li-ion Packs.

Course Outcomes:

At the end of this course, students will be able to:
CO1: Analyze the Life Cycle Assessment of Li-ion battery.
CO2 : Describe the different types of Li-ion charging methods
CO3 : Comprehend the knowledge of drivetrain hybridization.
CO4 : Evaluate EV motor sizing.
CO5 : Classify Battery Recycling methods.

Unit 01	Li-ion Battery	07 hrs

Materials used for Li-ion battery, Nanostructured Electrode Materials for Li-Ion Batteries, Li-ion battery protection, Wireless charging of EV, Life Cycle Assessment of Li-ion battery, Solid-state Battery, Panasonic 18650 & 2170 cell,

Unit 02	Battery Charging and Modelling	07 hrs

TSCC/CV charging and CVCC/CC charging of Li-Ion battery, BMS standards,
SoC Estimation methods (Kalman Filter, Neural Network, Fuzzy logic), Public EV charging stations, Solar Powered Charging Stations, Modeling of Lithium-ion batteries, Thermal Modeling of Li-ion battery.

Unit 03	Electric Vehicle Technologies	07 hrs

Battery Swapping System, EV Fleet Management, Sensors for Electric Vehicles
Electric bus, Electric trucks, Fuel cell vehicles, Introduction of EV Subsystems and Configurations, Energy management strategies and its general architecture.

Unit 04	Plug-In Hybrid Electric Vehicles	07 hrs

Hybridization of drivetrains in HEVs, Hybridization of energy sources in EVs, Power Flow control in hybrid drive train topologies, Power Management Strategies in HEV, Introduction of HEV Subsystems and Configurations, Vehicle Dynamics Fundamentals and HEV Modeling (Series Hybrid), Fuel

efficiency analysis.		
Unit 05	EV Components Design	07 hrs
Criteria for battery selection , Forces on EV calculation, Power for EV calculation, Sizing the Power Converter, Sizing of Electric Machine for EVs and HEVs, Motor Torque Calculation, Induction motor control, PMSM motor control, Battery pack design, In vehicle networks- CAN		
Unit 06	Electric Vehicle Policies and Startups	07 hrs
FAME-II Policy , Charging Infrastructure for Electric Vehicles - Revised Guidelines and Standards , Star Labeling Schemes for Li-ion Packs- BEE India, EV Tariff, EV Startup examples, Li-ion Battery Recycling Policy and Standards		
Text Books:		
[T1]	Energy Systems for Electric and Hybrid Vehicles Edited by K.T. Chau	
[T2]	Iqbal Hussain, “Electric & Hybrid Vehicles – Design Fundamentals”, Second Edition, CRC Press, 2011	
[T3]	Electric and Hybrid Vehicles by Tom Denton	
Reference Books:		
[R1]	Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals”, CRC Press, 2010	
[R2]	James Larminie, “Electric Vehicle Technology Explained”, John Wiley & Sons, 2003..	
Online Resources:		
[O1]	NPTEL Course : Electric Vehicles - Part 1 by Prof. Amit	
List of Tutorials:		
Any 8 of the following 1. Introduction to battery modeling MATLAB Simulink 2. Introduction to BLDC motor control MATLAB Simulink 3. Introduction to Induction Motor control MATLAB Simulink 4. Power Converter selection in MATLAB Simulink 5. Study of EV subsidies in different states. 6. Visit to the Electric Vehicle Charging Station. 7. Study of Thermal Modeling in Ansys software 8. Study of Harmonics issues of EV charging. 9. Fuel efficiency evaluation of a series HEV in city and high-way. 10. Various strategies for improving vehicle energy/fuel efficiency regenerating braking. 11. Study of various Battery Recycling Methods.		
Guidelines for Assessment of Tutorial:		
● Maintain Record in file or separate notebook. ● Timely submission of tutorials. ● Assessment of the report must be based on understanding, presentation and contents.		

403144C: Special-Purpose Machines						
Teaching Scheme			**Credits**		**Examination Scheme**	
Theory	03	Hrs/Week	Theory	03	ISE	30
Tutorial	02	Hrs/Week/Batch	Tutorial	01	ESE	70
					Term work	25

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Course Objectives:

The course aims:-
1. To gain knowledge of operation and performance of synchronous reluctance motors.
2. To learn the operation and performance of stepping motors.
3. To understand operation and performance of switched reluctance motors.
4. To familiarize with operation and performance of permanent magnet brushless D.C. motors.
5. To illustrate operation and performance of permanent magnet synchronous motors.

Course Outcomes:

At the end of this course, students will be able to:
CO1:Reproduce principal of operation of PMSM, Stepper motor, SRM, Switch reluctance and linear motors.
CO2: Develop torque - speed and performance characteristics of above motors.
CO3: Enlist application of above motors.
CO4: Demonstrate various control strategies.

Unit 01	**Generalized Machine Theory**	06 hrs

Energy in singly excited magnetic field systems, determination of magnetic force and torque from energy. Determination of magnetic force and torque from co-energy, Forces and torques in systems with permanent magnets. MMF of distributed winding, Magnetic fields production of EMFs in rotating machines.

Unit 02	**Permanent Magnet Synchronous and brushless D.C. Motor Drives**	06 hrs

Synchronous machines with PMs, machine configurations. Types of PM synchronous machines Sinusoidal and Trapezoidal. EMF and torque equations Torque - speed characteristics, Concept of electronic commutation, Comparative analysis of sinusoidal and trapezoidal motor operations. Applications.

Unit 03	**Control of PMSM Machine**	06 hrs

abc-$\alpha\beta$ and $\alpha\beta$-dq transformations, significance in machine modeling, Mathematical Model of PMSM (Sinusoidal), Basics of Field Oriented Control (FOC), Control Strategies: constant torque angle, unity power factor.

Unit 04	**Reluctance Motor**	06 hrs

Principle of operation and construction of Switch Reluctance motor, Selection of poles and pole arcs, Static and dynamics Torque production, Power flow, effects of saturation, Performance, Torque speed characteristics, Synchronous Reluctance, Constructional features; axial and radial air gap motors; operating principle; reluctance torque; phasor diagram; motor characteristics Introduction to control of Reluctance Drive. Applications.		
Unit 05	**Stepper Motor**	06 hrs
Construction and operation of stepper motor, hybrid, Variable Reluctance and Permanent magnet, characteristics of stepper motor, Static and dynamics characteristics, theory of torque production, figures of merit; Concepts of lead angles, micro stepping, Applications selection of motor.		
Unit 06	**Linear Electrical Machines**	06 hrs
Introduction to linear electric machines. Types of linear induction motors, Constructional details of linear induction motor, Operation of linear induction motor. Performance specifications and characteristics Applications.		

Text Books:

[T1]	K. Venkatratnam, 'Special Electrical Machines', University Press
[T2]	A.E. Fitzgerald Charles Kingsley, Stephen Umans, 'Electric Machinery', Tata McGraw Hill Publication
[T3]	T.J.E. Miller, 'Brushless Permanent magnet and Reluctance Motor Drives' Clarendon Press, Oxford 1989
[T4]	V. V. Athani, 'Stepper Motors: Fundamentals, Applications and Design', New age International, 1997.
[T5]	P.S. Bhimbra, Generalized Theory Of Electrical Machines

Reference Books:

[R1]	R Krishnan, 'Permanent Magnet Synchronous and Brushless D.C. Motor Drives' CRC Press.
[R2]	Ion Boldea, 'Linear Electric Machines, Drives and maglevs' CRC press.
[R3]	Ion Boldea S. Nasar, 'Linear Electrical Actuators and Generators', Cambridge University Press.

Online Resources:

[O1]	NPTEL video lectures on all the special purpose machines can be observed.

Mapping:

Unit	Text Books	Reference Books
01	T2	R1

02	T1, T3	R1
03	T1, T5	R1
04	T1	R1
05	T1, T4	R1
06	T5	R2,R3

List of Tutorials: Minimum eight tutorials are to be performed out of the list mentioned as below:

1. Experimental analysis of PMSM motor drive
2. Experimental analysis of BLDC (Trapezoidal Motor) Drive
3. Experimental analysis of Switched Reluctance Motor Drive.
4. Experimental analysis of Synchronous Reluctance Motor Drive
5. Experimental analysis of Stepper Motor Drive.
6. Laboratory demonstration of Linear Induction Motor.
7. Simulation for the performance analysis of PMSM/BLDC drive. (Any software can be used)
8. Simulation of Switched Reluctance Drive.
9. Software programming for abc-αβ and αβ-dq transformations

Guidelines for Assessment of Tutorial:

- Maintain Record in file or separate notebook.
- Timely submission of tutorials.
- Assessment of the report must be based on understanding, presentation and contents.
- Prepare tutorial assessment sheet which may be used for the term work marks.

403144D: HVDC and FACTs						
Teaching Scheme			**Credits**		**Examination Scheme**	
Theory	03	Hrs/Week	Theory	03	ISE	30
Tutorial	02	Hrs/Week/Batch	Tutorial	01	ESE	70
					Term work	25

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Course Objectives:

This course aims to:

1. To develop understanding of modern trends in power transmission.
2. To make students describe the operation of HVDC System and Control.
3. To make students describe applications of power electronics in the control of power transmission.
4. To understand fundamentals of FACTS Controllers.

Course Outcomes:

At the end of this course, students will be able to:

CO1:Choose a proper FACTS controller for the specific application based on system requirements.
CO2:Analyze shunt, series, and combined controllers to explore different benefits.
CO3:Compare EHVAC and HVDC systems and to describe various types of DC links.
CO4:Describe various methods for the control of HVDC systems and to perform power flow analysis in AC/DC systems.

Unit 01	HVDC -I	07 hrs

EHVAC versus HVDC transmission, power flow through HVDC link, Graetz circuit, equation for HVDC power flow bridge connection, control of DC voltage and power flow, effects of angle of delay and angle of advance commutation, CIA, CC and CEA control.

Unit 02	HVDC – II	07 hrs

Twelve pulse converter operation, Harmonics in HVDC systems. HVDC system layout and placement of components, HVDC protection, grounding, multi terminal HVDC systems, configurations and types.

Unit 03	VSC based HVDC System	07 hrs

Introduction to VSC transmission, power transfer characteristics, structure of VSC link, VSC DC system control, HVDC light technology. HVDC plus, introduction, construction, operation and applications to renewable energy sources Principles of DC Link Control in a VSC based HVDC system: Power flow and dc voltage control. Reactive Power Control / AC voltage regulation using VSC. Real and Reactive power control using a VSC.

Unit 04	Fundamentals of FACTS Controllers	08 hrs

Basics, Challenges and needs of Power Electronic Controllers, Review of rectifiers and inverters, back to back converter, dc link converter, static Power converter structures, AC controller based structures, DC link converter topologies, converter output and harmonic control, power converter control. Reactive power

control in electrical power transmission, principles of conventional reactive power compensators. Introduction to FACTS, flow of power in AC parallel paths, meshed systems, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers.		
Unit 05	Shunt and Series Controllers	08 hrs
Shunt compensation – objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators – SVC, STATCOM, SVC and STATCOM comparison. Series compensation – objectives of series compensation, thyristor switched series capacitors (TCSC), static series synchronous compensator (SSSC), power angle characteristics, and basic operating control schemes. Comparison between STATCOM and SVC, V –I and V –Q Characteristics, Transient stability, Response Time. Comparison between TSCS and SSSC		
Unit 06	Unified Power Flow Controller and advanced controllers	08 hrs
Unified power flow controller (UPFC) – Introduction, operating principle, independent real and reactive power flow controller and control structure. Interline power flow controller (IPFC), Introduction to Active power filtering, Concepts relating to Reactive power compensation and harmonic current compensation using Active power filters.		
Text Books:		
[T1]	S Kamakshaiah and V Kamaraju, "HVDC Transmission," TMH Publications, 2011.	
[T2]	K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011	
[T3]	Hingorani ,L.Gyugyi, "Concepts and Technology of Flexible AC Transmission System", IEEE Press, New York, 2000, ISBN –0780334588.	
[T4]	Padiyar K.R., "FACTS Controllers for Transmission and Distribution systems", New Age International Publishers, 1st Edition, 2007.	
Reference Books:		
[R1]	Jos Arrillaga, "High Voltage Direct Current Transmission", IET Power and Energy Series 29	
[R2]	Erich Uhlmann, "Power Transmission by Direct Current," Springer International	
[R3]	Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.	
[R4]	Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho 'FACTS" —Modeling and simulation in Power Networks, John Wiley & Sons, 2002.	
[R5]	J. Arrillaga, "High Voltage Direct Current Transmission," Peter Peregrinus Ltd., London, UK	

Mapping:

Unit	Text Books	Reference Books
01	T1, T2	R1, R2, R5
02	T1, T2	R1, R2, R5

03	T1, T2	R1, R2, R5
04	T3, T4	R3, R4
05	T3, T4	R3, R4
06	T3, T4	R3, R4

List of Tutorials:

1. Study of various HVDC transmission system components and its applications.
2. Study of AC/DC side voltage and current waveforms of a six-pulse converter system under variable RL load using simulation. (Hint: input PF, THD, converter efficiency, reactive power flow, etc.).
3. Study of AC/DC side voltage and current waveforms of a twelve-pulse converter system under variable R-L load using simulation. (Hint: input PF, THD, converter efficiency, reactive power flow, etc.).
4. Study of Reactive Power Control in an HVDC Transmission system
5. Study of various types of multi-terminal HVDC transmission systems
6. Study of DC link control in VSC-based HVDC transmission systems.
7. Study of various passive filters used in LCC-based HVDC transmission systems
8. Operation of VSC for power factor correction at AC side of HVDC system using sinusoidal pulse width modulation.

Guidelines for Assessment of Tutorial:

- Maintain Record in file or separate notebook.
- Timely submission of tutorials.
- Assessment of the report must be based on understanding, presentation and contents.

403145: Project Stage I

Teaching Scheme			Credits		Examination Scheme	
SEM/PW/IN	4	Hrs./Week	SEM/PW/IN	2	ORAL	50
					Term work	50

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Preamble:

Project is an important part of the engineering curriculum covered in the final year. It is divided into Project Stage I and Project Stage II at Semesters I and II of the Final Year. This project is a substantial piece of work that will require creative activity and original thinking. The project aims to provide students with a transitional experience from the academic world to the professional world. The objectives, outcomes, and guidelines for Project Stage I are given below.

Course Objectives:

The objectives of this course are to:

1. Provide an opportunity to learn new software, interdisciplinary theory, concepts, technology, etc. not covered in earlier subjects.
2. Empower students to use engineering knowledge and skills learned in previous courses to deliver a product that has passed through the design, analysis, testing, and evaluation.
3. Encourage multidisciplinary project work through the integration of knowledge.
4. Allow students to develop problem-solving, analysis, synthesis, and evaluation skills.
5. Encourage teamwork.
6. Improve students' communication skills by asking them to produce both a professional report and to give an oral presentation.

Course Outcomes:

Course outcomes can be different for the different projects undertaken by the student groups. However, in general, the course outcomes for Project Stage-I can be stated as follows.
At the end of this course, students should be able to:
CO1:Define the project problem statement and identify the scope of the project.
CO2:Search the appropriate research papers, standards and e-resources and write a literature survey.
CO3:Identify tools, techniques, methods, concepts, measuring devices, and instruments required for the project to define the methodology of the project.
CO4:Justify the selection of electrical, electronic and mechanical components for the project prototyping
CO5:Simulate or develop a system for software or hardware verification.
CO6:Write a project report with proper interpretation of results.

Guidelines for students:

1. Form a group of 3-4 students.
2. Select a project problem statement based on an industrial or societal issue and ideate on it.
3. Research on the project topic through existing theories, literature, technology, patents, etc.
4. Define objectives, scope, and outcomes of the project in the 1st presentation.
5. Maintain a notebook to keep records of all the meetings, discussions, notes, etc. This is to be done by the individual student.
6. Some of the parameters mentioned in the above table will be evaluated and assessed at the group

level and some at an individual level.

Guidelines:

Term work evaluation guidelines are given below.

Sr. No.	Activity	Deadline (Semester I)	Parameters for Evaluation
1.	Topic Approval Presentations	Up to 3rd Week	• Problem definition clearly stated (YES/NO) • Objectives clearly defined (YES/NO) • The overall project idea is feasible (YES/NO)
2.	Progress Review-1 Presentation	Up to 8th Week	• Problem Definition (5) • Scope & Objectives (10) • Literature Review (10) • Methodology (10) • Block Diagram / Architecture (10) • Project Planning (5) • **Total Marks (50)**
3.	Progress Review-2 Presentation	Up to 12th Week	• Requirement Specification (10) • Literature Review (revised) (5) • Detailed Design (10) • Experimental Setup/Simulation (10) • Performance Parameters (10) • Partial Conclusion (5) • **Total Marks (50)**
4.	Submission of Project Stage –I Report	Up to 14th Week	• Timely submission (5) • Formatting and Report Writing Style (5) • Abstract, Literature Survey, Conclusion (5) • Refereed References (5) • Grammatical correctness in the report (5) • **Total Marks (25)** **(Review 1+ Review 2) conversion to 25 marks +Report (25 marks) = 50 Marks**

403146: MOOCs

Teaching Scheme			Credits		Examination Scheme	
SEM/PW/IN	–	Hrs./Week	SEM/PW/IN	2	ORAL	–
					Termwork	50

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Preamble:

Massive Open Online Courses (MOOCs) is essentially an asynchronous teaching learning platform. To enhance the students learning and to motivate self learning, MOOCs have been added in the BE Electrical 2019 course. It is advised to students that they have to registers MOOCs courses thorough SWAYAM-NPTEL platform.

Course Objectives:

The objectives of this course are to:

1. Provide an opportunity to learn new software, interdisciplinary theory, concepts, technology, etc. not covered in earlier subjects.
2. Make students employable in the industry or pursue a suitable higher education program.
3. Exposure to relevant tools and technologies.
4. Enrich the learning experience by using audio video and multimedia and state of the are pedagogy.

Course Outcomes:

At the end of this course, students should be able to:
CO1:Enables the students to directly engage and learn from the best faculty in the country in order to strengthen the fundamentals.
CO2:Explore new areas of interest in a relevant field.
CO3:Enable self learning initiative in learners..
CO4:Develop critical thinking to solve complex problems in engineering, science and humanities.
CO5:Improve communication skills by interacting with peers and course teachers.

Guidelines:

Guidelines for students:

1. Students have to register on the SWAYAM portal.
2. Through the SWAYAM portal, explore the courses available by NPTEL coordinator.
3. The minimum duration of the NPTEL course to be registered by the students has to be 8/12 weeks. (as per the course offered in the semester.)
4. Students can register the courses of engineering, science, humanities, management, and multidisciplinary in the NPTEL portal.
5. Students have to submit the assignments as per schedule given by NPTEL course structure and take part in a self assessment test.
6. Students have to register for the certificate examination of NPTEL by paying the required fees.
7. Students will be awarded credits of MOOCs only when they earn the certificate of the registered course.

7. Students have to submit proof (certificate) to the department in order to get credits.

Guidelines for institute:

1. It is advised that the institute should register for the NPTEL local chapter.
2. Keep the track of student registration in SWAYAM-NPTEL course.
3. Check the certificate authenticity submitted by student through online portal

Guidelines for Assessment:

1. The NPTEL will give percentage grades in certificates out of 100.
2. The percentage obtained needs to be converted to 50 marks and submitted as term work marks to university. (if someone got 75% marks then TW calculation will be 75/2=37.5=38 (out of 50) and round up the nearest integer.)
3. External examiner appointed by the university will assess certificates and marks obtained physically at the institute.

403147A: German Language-I

Teaching Scheme			Credits		Examination Scheme		
Theory	02	Hrs/Week	Theory	–	ISE		–

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Course Objectives:

This course aims to:

1. Get introduced to the Culture, Routine of the German Society through language.
2. Meet the needs of ever growing German industry with respect to language support.

Course Outcomes:

At the end of this course, students:

CO1: Will have the ability of basic communication.

CO2: Will have the knowledge of German script.

CO3: Will get introduced to reading ,writing and listening skills

CO4: Will develop interest to pursue profession in Indo-German Industry.

Unit 01	Introduction to the German Language-I	06 hrs

Introduction of German Alphabets, Spell the names, Addresses, Numbers, Telephone numbers, Ordinal Numbers, Pin code Numbers, Dates, Birthdates, Age, days of the week, Months.

Unit 02	Introduction to the German Language-II	06 hrs

Basic Greetings, Personal Pronouns, Possessive Pronouns.

Unit 03	Introduction to the German Language-III	06 hrs

Self-Introduction, Introducing other people, about family, friends, course mates, seasons, and seasons in Germany and in neighboring countries.

Text Books:

[T1] Netzwerk A-1 (Deutsch als Fremdsprache) Goyal Publishers & Distributors Pvt. Ltd.

Reference Books:

[R1] Tipps und Uebungen A1

Online Resources:

[O1] Practice Material like Listening Module, reading Texts

403147B: Engineering Economics-I

Teaching Scheme			Credits		Examination Scheme		
Theory	02	Hrs/Week	Theory	–	ISE		–

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Course Objectives:

This course aims to:

1. Describe basics of economics and its application in engineering.
2. Explain the concept of Time value of Money and Cash flow

Course Outcomes:

At the end of this course, students will be able to:
CO1:Discuss concepts related to business and its impact on enterprise.
CO2:Illustrate time value of money in economic analysis.

Unit 01	Engineering Economics	10 hrs

Nature and scope, General concepts on micro & macro economics. The Theory of demand, Demand function, Law of demand and its exceptions, Elasticity of demand, Law of supply and elasticity of supply. Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product, Design selection for a product, Process planning.

Unit 02	Time Value of Money and Cash flow analysis	10 hrs

Time value of money: Simple and compound interest, Nominal Interest rate, Effective Interest rate, Principle of economic equivalence.
Cash Flow – Diagrams, Categories & Computation
Depreciation: Meaning Causes, Factors affecting depreciation, Methods of providing depreciation, Straight Line Method & Diminishing Balance Method

Text Books:

[T1]	Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India.
[T2]	D.M. Mithani, Principles of Economics. Himalaya Publishing House

Reference Books:

[R1]	Sasmita Mishra, “Engineering Economics & Costing “, PHI
[R2]	Sullivan and Wicks, “ Engineering Economy”, Pearson
[R3]	R. Paneer Seelvan, “ Engineering Economics”, PHI

403147C: Sustainability

Teaching Scheme			Credits		Examination Scheme		
Theory	02	Hrs/Week	Theory	–	ISE		–

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Course Objectives:

This course aims to:

- Increase awareness among students about sustainability.
- Understand role of engineering and technology within sustainable development.

Course Outcomes:

At the end of this course, students will be able to:
CO1: Understand different types of environmental pollution problem.
CO2: Suggest solutions for sustainable development.
CO3: Develop a broader perspective in thinking for sustainable practices by utilizing engineering principle and knowledge

Unit 01	Sustainability Introduction		11 hrs

Introduction, need and concept of sustainability, social, environmental and economical sustainability concepts, sustainable development, 17 goals defined by UN, Nexus between technology and sustatinable development and its challenges, multilateral environmental agreements and protocols-CDM, Environmental legislations in India-Water Act, Air Act.
Air, water and solid waste pollution sources and impacts, Sustainable water treatment. Zero waste concept. Global environmental issues, climate change, global warming, ozon layer depletion.

Unit 02	Sustainable Solution		11 hrs

Carbon credits and trading, carbon foot print, Green engineering, sustainable urbanization, industrialization and poverty reduction, Industrial process: Material selection, pollution preventions, industrial ecology and symbiosis, Global institutions: UNEP, IPCC, UNDP, WHO, Kyoto protocols. Certification and labelling in energy and carbon: Energy Star, Compliance and voluntary carbon credits, Green-e. Tools and techniques: ISO 14001, ISO26000, ABCD planning method.Assessment measurement: Indicators, F2B2, LCA, LCC, ROI.

Text Books:

[T1]	Allen D. T. and Shonnard D. R. “Sustainable Engineering: Concept design and case studies”, Prentice hall
[T2]	Environmental Impact Assessment Guidelines, Notification of Government of India 2006
[T3]	Mackenthun K. M. “Basic Concept of Environmental Management”, Lewis publication London 1998
[T4]	ECBC code 2007, BEE, New Delhi, BEE publication, TERI publication

[T5]	Ni Bin Chang, "Systems Analysis for sustainable engineering: Theory and Applications ", Mc-Graw-Hill Professional
Reference Books:	
[R1]	"Sustainable Excellence Associate: Study Guide" International society of sustainability professional, https://community.sustainabilityprofessionals.org/store/viewproduct.aspx?id=13043928
Online Resources:	
[O1]	https://www.globalgoals.org/goals/

403148: Switchgear and Protection

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Practical	02	Hrs/Week/Batch	Practical	01	ESE	70
					Oral	50
					Termwork	25

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Course Objectives:

This course aims to:

- Acquaint about construction and working principles of different types of HVCBs.
- Elaborate the need for protective relaying and the operating principles of different types of relays.
- Explain the different types of faults in the transformer, alternator, and 3-phase induction motor and the various protective schemes related to them.
- Impart knowledge about transmission line protection schemes and the characteristics of different types of distance relays.

Course Outcomes:

At the end of this course, students will be able to:
CO1:Understand the fundamentals of protective relaying.
CO2:Demonstrate the arc interruption and analyze the RRRV in circuit breakers
CO3:Demonstrate the construction and working principle of air brake circuit breakers, SF6 circuit breakers, and a vacuum circuit breaker.
CO4:Explain the characteristics of static and digital relays and their applications in power systems.
CO5:Apply the differential protection scheme to large transformers, alternators, and induction motors.
CO6:Apply distance protection, three stepped protection for transmission line.

Unit 01	Fundamentals of protective relaying	08hrs

Need for protective system, nature and causes of fault, types of faults, effects of faults, evolution of protective relaying, classification of relays, zones of protection, primary and backup protection, essential qualities of protective relaying. Trip circuit of circuit breaker, zone of protection. Various basic operating principles of protection- over current, (current graded and time graded), directional over current, differential, distance, induction type relay, torque equation in induction type relay, current and time setting in induction relay, Numericals on TSM , PSM and operating time of relay.

Unit 02	Fundamentals of arc interruption	07 hrs

Ionization of gasses, deionization, Electric arc formation , Current interruption in AC circuit breaker, high and low resistance principles, arc interruption theories, arc voltage, recovery voltage, derivation and definition of restriking voltage and RRRV, current chopping, interruption of capacitive current, resistance switching, Numerical on RRRV, current chopping and resistance switching.

Unit 03	Circuit Breaker	08 hrs

Different ratings of circuit breaker (like rated voltage, rated current, rated frequency, rated breaking capacity – symmetrical and unsymmetrical breaking, making capacity, rated interrupting duties, rated operating sequence, short time rating). Classification of high voltage circuit breakers. Working and constructional features of ACB, SF6 , VCB- advantages, disadvantages and applications. Auto reclosing, Testing of circuit breakers. Introduction to GIS , its advantages over conventional substation		
Unit 04	Static and Digital Relaying	06 hrs
Overview of Static relay, block diagram, operating principle, merits and demerits of static relay. Numerical Relays :-Introduction and block diagram of numerical relay, Sampling theorem, Anti –Aliasing Filter, Block diagram of PMU and its application.		
Unit 05	Equipment protection	08 hrs
I. Power Transformer Protection: Types of faults in transformer, Percentage differential protection in transformers, Restricted E/F protection, incipient faults, Buchholz relay, protection against over fluxing, protection against inrush current. II. 3 Phase Induction Motor Protection: Abnormal conditions and causes of failures in 3 phase Induction motor, single phasing protection, Overload protection, Short circuit protection. III. Synchronous Generator (Alternator) Protection: Various faults in Alternator, abnormal operating conditions- stator faults, longitudinal percentage differential scheme and transverse percentage differential scheme. Rotor faults- abnormal operating conditions, inter turn fault, unbalance loading, over speeding, loss of excitation, protection against loss of excitation using offset Mho relay, loss of prime mover.		
Unit 06	Transmission line protection	08 hrs
Over current protection for feeder using directional and non directional over current relays, Introduction to distance protection, impedance relay, reactance relay, mho relay and Quadrilateral Relays, three stepped distance protection, Effect of arc resistance, and power swing on performance of distance relay. Realization of distance relays(impedance, reactance, and mho relay) using numerical relaying algorithm(flowchart, block diagram), Introduction to PLCC, block diagram, advantages, disadvantages, Introduction to Wide Area Measurement (WAM) system.		
Text Books:		
[T1]	Badri Ram, D. N. Vishwakarma, "Power System Protection and Switchgear", Tata McGraw Hill Publishing Co. Ltd.	
[T2]	Y. G. Paithankar, S. R. Bhide, "Fundamentals of Power System Protection", Prentice Hall of India	
[T3]	Bhavesh Bhalja,R.P. Maheshwari, N.G. Chothani," Protection and Switchgear", Oxford University Press, 2011 Edition.	
[T4]	J.B.Gupta " Switchgear and Protection", S.K. Kataria and Sons.	
[T5]	Power system protection and switchgear by Oza, Nair, Mehta, Makwana	
Reference Books:		
[R1]	S. Rao, "Switchgear Protection and Power Systems", Khanna Publications	

[R2]	J Lewis Blackburn , “Protective Relaying- Principles and Applications”, Dekker Publications.
[R3]	A.G. Phadke, J.S. Thorp ,Computer relaying for Power System , Research Studies Press LTD, England.(John Willy and Sons Inc New York)
[R4]	Mason C.R., “Art and Science of Protective Relaying”, Wiley Eastern Limited.
[R5]	Arun Ingole, “Switchgear and Protection”, Pearson.
[R6]	Bhuvanesh Oza, “Power System Protection and Switchgear”, McGraw Hill Education.

Online Resources:

[O1]	Prof. Dr S.A. Soman, IIT Mumbai, A Web course on “Digital Protection of power System” http://www.cdeep.iitb.ac.in/nptel/Electrical%20Engineering/Power%20System%20Protection/Course_home_L27.html
[O2]	NPTEL Course on power system protection.

Mapping:

Unit	Text Books	Reference Books
01	T1,T2,T4	R1, R2, R6
02	T1,T3,T4	R1, R6
03	T1,T4	R1, R6
04	T2,T3,T4	R3, R4, R6
05	T1 , T5	R1 ,R5, R6
06	T1,T4	R1,R2, R5, R6

List of Experiments:

A) Compulsory Experiments

1. Study of switchgear testing kit.
2. Protection of Transmission line using Impedance relay

B) Minimum 6 Experiments to be performed from the following list:

1. Study and testing of fuse , MCB.
2. Study and testing of contactors.
3. Study and testing of ACB.
4. Study and testing of MCCB.
5. Study and testing of thermal overload relay for Induction Motor protection.
6. Study and plot Characteristics of IDMT type Induction over current relay
7. Study and plot Characteristics of digital over current relay
8. Percentage differential protection of transformer (Merz Price Protection).
9. Protection of alternators.

Guidelines for Instructor's Manual:

Lab manual must contain;

- Title of the experiment
- Aim
- Apparatus.
- Theory: Brief theory explaining the experiment
- Circuit / connection diagram or construction diagram must be drawn either manually using geometrical instruments or using software on A-4 size quality graph paper / plain white paper.
- Detailed constructional diagram with nomenclature:
- Procedure: Write down step by step procedure to perform the experiment.
- Specifications of Switchgear:
- Observation table:
- Graph:
- Conclusion:

Guidelines for Student's Lab Manual:

- Students should write the journal in his own handwriting using A4 size both side ruled paper.
- Circuit / Connection diagram or construction diagram must be drawn either manually or using software. [Do not use Photocopy of standard journal] on A4 size blank/graph paper.
- Hand writing must be neat and clean.
- Journal must contain a certificate indicating the name of the institute, student, department, subject, class/ year, number of experiments completed, signature of staff, Head of the department and the Principal.
- Index must contain Sr. number, title of the experiment, page number, and the signature of staff along with date.
- Use black or blue ink pen for writing.

Guidelines for Laboratory Conduction:

- Check whether the MCB / main switch is off.
- Make connections as per circuit diagram. Do not keep loose connections. Get it checked by the teacher / Lab Assistant.
- Perform the experiment only in the presence of a teacher or Lab Assistant.
- After completion of the experiment, switch off the MCB / main switch.
- Write the experiment in the journal and get it checked within a week.

Industrial Visit:

Industrial visit to switchgear training center /or switchgear/relay manufacturing unit/ or 220 kV substation visit and report to be submitted.

Assignments:

Minimum 2 assignments (at least 4 to 6 questions in each) to be submitted as a part of term-work.

403149: Advanced Electrical Drives and Control

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
Practical	02	Hrs/Week/Batch	Practical	01	ESE	70
					Practical	50
					Termwork	25

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Course Objectives:

This course aims to:

- Understand motor load dynamics. ·
- Study and analyze the operation of the converter fed and chopper fed dc drives. ·
- Study and understand braking methods of D.C. and Induction motor drive.
- Study vector control of induction motors. ·
- Study synchronous and BLDC motor drive. ·
- Study classes and duty of motor. ·
- Understands the modes of operation of drive in various applications.

Course Outcomes:

At the end of this course, students will be able to:
CO1: Explain motor load dynamics and multi quadrant operation of drives.
CO2: Analyze operation of converter fed and chopper fed DC drives.
CO3: Apply different braking methods of D.C. and induction motor drive.
CO4: Elaborate vector control for induction motor and BLDC drives.
CO5: Elaborate synchronous motor, reluctance motor drive.
CO6: Differentiate between classes and duty cycles of motors and select suitable drives in various industrial applications.

Unit 01	Electrical Drives	07 hrs

A. Definition, components of electric drive system, types of electrical drives (DC and AC), selection of drive parameters, List of Industrial Applications
B. Motor-Load dynamics, speed-torque conventions and multi-quadrant operation, equivalent values of drive parameters, load torque components, nature and classification of load, constant power operation of a drive, steady-state stability.

Unit 02	DC Motor Drives:	08 hrs

A. Single-phase and three-phase fully controlled converter drives and performance of converter fed separately excited DC Motor for speed control operations, 12 pulse converter drives.
B. Chopper controlled drives for separately excited and series DC Motor operations. Closed-loop speed control of DC motor below and above base speed for starting, speed control and braking

Unit 03	Induction Motor Drives:	08 hrs

Regenerative braking, dynamic braking, Plugging, Numerical based on braking and speed control, voltage source inverter (VSI) control, Steady State Analysis. Current source inverter (CSI) control-open and closed loop, Regenerative braking and multi quadrant operation of Induction motor drives, Principle of vector control, Block diagram of Vector control of induction motor, Failure modes of Drives.		
Unit 04	BLDC drive:	07 hrs
Construction (Block diagram) and working for motoring and regenerative braking, Speed and torque Characteristics, closed loop control of BLDC drive (PI controller) , vector control of BLDC drive, Applications in EV (descriptive treatment)		
Unit 05	Synchronous Motor drives:	08 hrs
A. PMSM Drive: Construction (Block diagram) and working for motoring and regenerative braking, Speed and torque Characteristics, closed loop control of PMSM drive (PI controller) , vector control of PMSM drive. B. Synchronous Reluctance Motor -Introduction, working of SRM , application in EV (descriptive treatment)		
Unit 06	Drive Application	07 hrs
A. Classes of motor duty, types of enclosures for motor. B. Specific requirement and choice of drives for following applications: Machine tools , Textile mills, Steel rolling mills, Sugar mills, Traction drives, Crane and hoist drives, Solar and battery powered drives		
Text Books:		
[T1]	G. K. Dubey, “Fundamentals of Electric Drives”, 2nd Edition, Narosa Publishing House	
[T2]	N. K. De, P. K. Sen, “Electric Drives”, Prentice Hall of India Eastern Economy Edition	
[T3]	S. K. Pillai, “Analysis of Thyristor Power Conditioned Motors”, University Press	
[T4]	G.K. Dubey, “Power Semiconductor controlled drives”, PHI publication	
[T5]	B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education	
Reference Books:		
[R1]	R. Krishnan, “Electric Motor Drives – Modeling Analysis and Control”, PHI India	
[R2]	B. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education	
[R3]	V. Subrahmanyam, “Electric Drives: Concepts and Application”, Tata Mc-Graw Hill (An imprint of Elsevier)	
[R4]	M.D. Singh and Khanchandani “Power Electronics”, Tata Mc-Graw Hill	
[R5]	Austin Huges, “Electrical motor and drives: Fundamental, types and applications”, Heinemann Newnes, London	

[R6]	Tyagi MATLAB for engineers oxford (Indian Edition)
[R7]	Malcolm Barnes, “Practical Variable Speed Drives and Power Electronics”, Elsevier Newnes Publications

Online Resources:

[O1]	NPTEL online course on Fundamentals of Electric Drives, I.I.T. Kanpur by Dr. S.P. Das.
[O2]	NPTEL online course on advanced Electric Drives, I.I.T. Kanpur by Dr. S.P. Das.
[O3]	Allen Bradley Powerflex 700 AC Drives User manual.

Mapping:

Unit	Text Books	Reference Books
01	T1	R3
02	T1,T5	R2,R4
03	T1,T4	R1,R5
04	T1,T2,T5	R1,R2
05	T1,T3,T5	R1,R6
06	T1,T2	R3,R5,R7

List of Experiments:

Total 9 experiments to be conducted from the following list of practical.

A) Following 5 experiments are compulsory (Hardware based)

1. Electrical braking of D.C. Shunt motor (Rheostatic, Plugging).
2. Speed control characteristics of single phase fully converter fed separately excited D.C. motor
3. VSI fed 3 phase Induction motor (using V/f control PWM inverter) speed control characteristics.
4. Chopper fed D.C. series/separately motor speed control characteristics.
5. Electrical braking of 3 phases Induction Motor (DC Dynamic Braking, Plugging, Regenerative Braking).

B) Any 4 experiments from following (Hardware/software)

6. Speed control characteristics of 3-ph fully converter fed separately excited D.C. motor.
7. Simulation of Induction Motor Vector Control.
8. Study of constant torque and constant power characteristic of induction motor.
9. Study of speed control of BLDC / PMSM drive.
10. Simulation of closed loop control of BLDC / PMSM drive.
11. Simulation of vector control of PMSM/BLDC motor

Guidelines for Instructor’s Manual:

- Title and circuit diagram of power electronic controlled drives/ electrical machine circuit. ·
- Working operation and output characteristics / output waveforms of power electronic switching device /converter circuit used to control the electric motor.
- Procedure to carry out the experiment

Guidelines for Student's Lab Manual:

- Title, aim, circuit diagram, procedure and theory of power electronic switching device or converter circuit and expected machine performance with speed torque characteristics.
- Equipment along with the specifications needed to carry out the experiment.
- Circuit diagram, observation table, calculations must be written on the left side of the journal and aim, theory related to experiment and procedure must be written on the right side.
- Analyze and interpret the experimental results and write the conclusions appropriately.

Guidelines for Laboratory Conduction:

- Each group in the lab should have not more than three students. ·
- All the students in the group must do the connections and perform the practical under the guidance of the staff member. ·
- Staff member has to check the results of all the groups.

403150A: Digital Control System

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
					ESE	70

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Course Objectives:

This course aims to:

- Make students elaborate basic concepts of discrete signals and systems.
- Educate students to analyze the stability of discrete systems.
- Explain formulation of state space discrete model and design the digital controllers.
- Elaborate digitize analog controllers using various numerical methods.
- Explore application of the theory of digital control to practical problems.

Course Outcomes:

At the end of this course, students will be able to:
CO1: Analyze digital control system and its stability.
CO2: Differentiate between various control systems
CO3: Present system in state space format.
CO4: Design observer for system.
CO5: Understand digital controllers
CO6: Elaborate applications such as digital temperature control and position control

Unit 01	Discrete systems and Signals	07 hrs

Standard discrete test signals, Basic operations on signals. Classification of discrete systems. Detail analysis of frequency aliasing and quantization, Brief review of Sampling theorem, Ideal low pass filter. Transfer function of ZOH, Frequency domain characteristics of ZOH, First order hold, frequency domain characteristics of first order hold.

Unit 02	State - Space analysis	07 hrs

Conversion of Pulse transfer functions to State space model and vice a versa. Solution of LTI Discrete – time state equation; State Transition Matrix (STM) and properties of STM; Computation of STM by Z-transform method, by power series expansion method, by Cayley Hamilton theorem, by Similarity transformation method, Discretization of continuous time state space equation

Unit 03	Design using state space	07 hrs

Controllability and observability of linear time invariant discrete-data system, Tests for Controllability and observability; Principal of Duality; Effect of pole- zero cancellation; Relationship between controllability, observability and stability. Pole placement design using linear state-feedback.

Unit 04	Design of State Observers	07 hrs

Full order state observer, reduced order state observer, State estimation and full order observer design. Ackermann's formula. Compensator design by the separation principle, State feedback with integral control, State regulator design.		
Unit 05	State space model and digitizing analog controllers	07 hrs
State space model of digital systems: Transformation of state-space model to various forms (controllable, observable, diagonal and Jordan canonical forms). Numerical approximation of differential equations, Euler's forward and backward method, Trapezoidal method, Bilinear transformation with frequency warping. Numerical differentiation, Matching step and other response. Pole-zero matching		
Unit 06	Digital control system applications	07 hrs
Hybrid system simulation, Computer program structure for simulation of discrete time control of continuous time plant. Digital temperature control, position control, Stepper motor control, Block diagram presentation and control algorithms.		

Text Books:

[T1]	K. Ogata, "Discrete Time Control System", 2nd Edition, PHI Learning Pvt. Ltd. 2009
[T2]	B. C. Kuo, "Digital Control Systems", 2nd Edition, Oxford University Press
[T3]	M. Gopal, "Digital Control Engineering", New Age International Publishers
[T4]	M. Gopal, "Digital Control and State Variable Methods", 3rd Edition The McGraw Hill Co.

Reference Books:

[R1]	Load D. Landau, Gianluca Zito, 'Digital Control Systems: design, Identification and Implementation' Springer.
[R2]	Mohammed Santina, Allen Stubberud, Gene Hostetter 'Digital control System Design', Sanders College publishing
[R3]	K.J. Astrom, B Wittenmark 'Computer Controlled Systems: Theory and Design' Prentice-Hall Inc New Jersey, 2011 Dover.

Mapping:

Unit	Text Books	Reference Books
01	T2, T2	R3
02	T2	R3
03	T1, T2	R3
04	T1,T2	R1, R2
05	T1,T3	R1, R2
06	T2,T4	R3

403150B: Restructuring and Deregulation

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
					ESE	70

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Course Objectives:

This course aims to:

- Give brief introductions about the various institutions and their roles in the Indian Power sector and introduce the restructured power system .
- Introduce Fundamentals of Power Sector economics.
- Educate about the process and operation of restructuring of power systems and tariff setting principles.
- Explain Power Sector Restructuring Models and to introduction concept of energy trading
- Introduce the concept of electricity markets and various operations involved in the market .
- Explain the fundamental concept of congestion, its management and transmission pricing and concept of transmission pricing.

Course Outcomes:

At the end of this course, students will be able to:

CO1: Identify the various institutions in the Indian power sector and explain their role in the Indian power sector .

CO2: Explain the various fundamentals of power sector economics

CO3: Describe the regulatory process in India and list the steps involved in tariff determination and explain the phases of tariff determination

CO4: Describe and explain different power sector restructuring models and explain the concept of energy trading

CO5: Explain the types of electricity markets and compare the types of electricity markets .

CO6: State different transmission pricing methods and describe and compare various congestion management methods.

Unit 01	Power Sector in India	07hrs

Introduction to various institutions in the Indian Power sector such as the Ministry of Power ,MNRE, CEA, Planning Commissions, PGCIL, PFC, CERC, SERC, Load dispatch centers (National, regional and state) and their roles. Critical issues / challenges before the Indian power sector, Need of regulation and deregulation of the power industry. Conditions favoring deregulation in the power sector. An overview of the restructured power system, Difference between integrated power system and restructured power system

Unit 02	Fundamentals of Power Sector Economics	07hrs

Introduction, Consumer behaviour, Supplier behaviour, Short-run and Long-run costs, Various costs of production, Relationship between short-run and long-run average costs, Typical cost components and cost structure of the power sector, Concept of life cycle cost, annual rate of return .Elasticity of demand and

supply curve, Market equilibrium, Consumer and supplier surplus. Perfectly competitive market. Key Indices for assessment of utility performances.(Generation, transmission and distribution).Financial tools to compare investment options.		
Unit 03	Power Sector Regulation	07hrs
Regulatory process in India, types and methods of Regulation - rate of return regulation, benchmarking or yardstick regulation, performance-based regulation. Role of regulatory commission. Considerations of socio economic aspects in regulation. Principles of Tariff setting, Phases of Tariff determination. Consumer tariff structures and considerations, different consumer categories. Comparison of different tariff structures for different load patterns. The Electricity Act 2003, The Electricity Act 2010, National Electricity policy. Recently Amended Electrical policy.		
Unit 04	Introduction to Power Sector Restructuring Models and Introduction to energy trading	07hrs
Introduction, models based on energy trading or structural models – monopoly, single buyer, wholesale competition, retail competition. Models based on contractual arrangements – pool model, bilateral dispatch, pool and bilateral trades, multilateral trades, ownership models, ISO models. Introduction to energy exchange , Day ahead market (DAM) and Term ahead market (TAM), procedure adopted in energy exchanges and trading of Renewable energy credits and carbon credits.		
Unit 05	Electricity markets	07hrs
Rules that govern electricity markets, peculiarity of electricity as a commodity. Various electricity markets such as spot markets, forward contracts and forward markets , future contracts and future markets .Market operation – settlement process , market clearing price (MCP) , Market efficiency . Market power Electricity markets under imperfect competition Sources of market power, Effect of market power, Identifying market power, HHI Index, Entropy coefficient, Lerner index, Market power mitigation, Effects of contract for differences.		
Unit 06	Transmission Pricing and Congestion Management	07hrs
Cost components of transmission system, cost allocation of transmission system, Transmission pricing methods, physical transmission rights, Open access. Congestion in power networks, reasons for congestion, congestion management methods . Non-market methods, Market based methods. Definition of terms - Total transfer capability (TTC), Available transfer capability (ATC), Transmission Reliability Margin (TRM), Capacity Benefit Margin (CBM), Existing Transmission Commitments (ETC). Locational marginal Pricing (LMR), Firm Transmission Right (FTR)		
Text Books:		
[T1]	Know Your Power: A citizen Primer on the electricity Sector, Prayas Energy Group, Pune	
[T2]	Daniel S. Kirschen, Goran Strbac, “Power System Economics” John Wiely and Sons Publication Ltd. August 2006	
[T3]	Mohammad Shahidehpour, Muwaffaq Alomoush, “Restructured Electrical Power Systems: Operation Trading and Volatility” CRC Press, 06-J	
Reference Books:		
[R1]	Steven Stoft, “Power System Economics: Designing Markets for Electricity”, John Wiley and Sons, 2002	

[R2]	Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc
[R3]	Geoffrey Rothwell, Tomas Gomez, "Electricity Economics Regulation and Deregulation" A John Wiley and Sons Publication 2003
[R4]	Mohammad Shahidehpour, Hatim Yamin, Zuyi Li, "Market operations in Electric Power System" A John Wiley and Sons Publication
[R5]	Deregulation in Power Industry – A course under continuing Education Program, Department of Electrical Engineering , IIT Bombay
Online Resources:	
[O1]	http://www.cercind.gov.in/Function.html
[O2]	www.cercind.gov.in/serc.html
[O3]	http://www.power.gov.ng/index.php/about-us/our-functions
[O4]	http://planningcommission.nic.in/reports/genrep/arep9920/ar9920role.htm
[O5]	http://www.cea.nic.in/functions.html
[O6]	https://nptel.ac.in/courses/108101005
[O7]	https://posoco.in/
[08]	https://www.iexindia.com/

Mapping:

Unit	Text Books	Reference Books
01	T1	[O1]-[O6]
02	T1	R3
03	T1	R1
04	T2	R5,[O8]
05	T2	R5,R2,R4
06	T3	R1

403150C: Smart Grid

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
					ESE	70

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Course Objectives:

This course aims to:

- Explain the concept of Smart Grid, compare with conventional grid, and identify its opportunities and barriers.
- Describe the concept of Smart Meter, Smart Appliances, Automatic Meter Reading, Outage Management System, Plug in Hybrid Electric Vehicles, Vehicle to Grid, Smart Sensors, Home and Building Automation, Phase Shifting Transformers.
- Elaborate the concept of Substation Automation, Feeder Automation. Intelligent Electronic Devices, Smart storage like Battery, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System, Phase Measurement Unit.
- Elaborate the concept of microgrid.

Course Outcomes:

At the end of this course, students will be able to:
CO1: Apply the knowledge to differentiate between Conventional and Smart Grid
CO2: Describe importance of Supercapacitors.
CO3: Identify the need of Smart metering.
CO4: Apply the communication technology in smart grid.
CO5: Comprehend the issues of micro grid.

Unit 01	Introduction to Smart Grid	07 hrs

Concept of Smart Grid, Need of Smart Grid, Functions of Smart Grid, Opportunities and Barriers of Smart Grid, Drivers of SG in India, Functionalities and key components of smart grid, Difference between conventional and smart grid, Smart Grid Vision and Roadmap for India, Concept of Resilient and Self-Healing Grid, Smart Grid National Policies, Smart Cities, Pilot projects in India

Unit 02	Smart Grid Technologies	07 hrs

Intelligent Electronic Devices (IED), Phase Measurement Unit (PMU). Smart Substations, Substation and Feeder Automation, application for monitoring, protection and control, Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid (V2G), Energy Storage Technologies and applications – Battery (flow and advanced), SMES, Super Capacitors, Compressed Air Energy Storage (CAES) and its comparison.

Unit 03	Smart Meters and Advanced Metering Infrastructure	07 hrs

Introduction to Smart Meters, Prepaid meters, Net Metering, Advanced Metering Infrastructure (AMI), Real Time Pricing, Automatic Meter Reading (AMR), Outage Management System (OMS), Smart Substation , IEC 61850, Smart Sensors, Geographic Information System (GIS), IS 16444, LowPAN RF meter

Unit 04	Communication Technology for Smart Grid	07 hrs
Communication Architecture of SG, Wide Area Measurement Protection and Control (WAMPAC), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN)., ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing and Cyber Security for Smart Grid, LORaWAN, NB-IoT, SigFox.		
Unit 05	Microgrids	07 hrs
Concept of Microgrid, need and applications of Microgrid, Microgrid Architecture, DC Microgrid, Hybrid Microgrid, Formation of Microgrid, Issues of interconnection, protection and control of Microgrid, Integration of renewable energy sources, Smart Microgrid, Microgrid and Smart Grid Comparison, Renewable Energy based Microgrid system		
Unit 06	Power Quality issues and Challenges	07 hrs
Power Quality and EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources , Smart Grid data analytics, Distributed Generation, Reliability Indices (CAIDI, CAIFI, MAIDI, MAIFI), Load Forecasting Methods, Smart Appliances, Home and Building Automation.		
Text Books:		
[T1]	Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”,CRC Press	
[T2]	Stuart Borlase, “Smart Grids-Infrastructure, Technology and Solutions”, CRC Press, Taylor and Francis group	
[T3]	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley Publications.	
[T4]	Nikos Ziargyriour, “Micro grid, Architecture and Control”, IEEE Press, Wiley Publications.	
Reference Books:		
[R1]	Yang Xiao, “Communication and Networking in Smart Grids”, CRC Press, Taylor and Francis group	
Online Resources:		

403150D: Sensor Technology (Open Elective)

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
					ESE	70

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Course Objectives:

This course aims to:

Course Outcomes:

At the end of this course, students will be able to:
CO1: Understand the characteristics of sensors used for system monitoring and protection.
CO2: Interface the various position sensors to microcontrollers.
CO3: Demonstrate the characteristics of sensors used for light and image sensing.

Unit 01	Sensor fundamentals and characteristics	06 hrs

Sensor Classification, Performance and Types, Error Analysis characteristics

Unit 02	Optical Sources and Detectors	06 hrs

Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs.

Unit 03	Light & image sensing	06 hrs

Sensors and sensing AFEs for capturing a broad range of wavelengths introduction, 3D Depth Sensor, Near Infrared spectroscopy, OPT3007 Light Sensor, Optical Isolators.

Unit 04	System monitoring & protection sensing	06 hrs

Principle of operation and application of following sensors for Real-time system protection, feedback control and high-accuracy system monitoring: LM35 Temperature Sensor, INA240 current sense amplifier, DRV5053 Hall Effect based current sensor, HDC1080 / HDC1010 / HDC2010 Humidity Sensor.

Unit 05	Position Sensing	06 hrs

Absolute and relative position sensing solutions including: angular, presence, proximity, distance, flow, level, and velocity basics, DRV 5032 Hall Effect Sensor, mmWave Sensor, AFE5805 Ultrasonic sensor, Encoder, Resolver, Inductive position sensor, Capacitive Position Sensor, LVDT.

Unit 06	Special Sensors -	06 hrs

GPS, Bluetooth, smart sensor - film sensor, MEMS and nano sensors, laser sensors, touch screen sensors, heading sensors - compass gyroscope inclinometer, application of sensors in drone.	
Text Books:	
[T1]	Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York. 2. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.
[T2]	Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.
Reference Books:	
[R1]	Gerd Keiser,"Optical Fiber Communications", 2012, 4th edition, McGraw-Hill Science, Delhi.
[R2]	John G Webster, "Measurement, Instrumentation and sensor Handbook", 2014, 2nd edition, CRC Press, Florida.
[R3]	Eric Udd and W.B. Spillman, "Fiber optic sensors: An introduction for engineers and scientists", 2013, 2nd edition, Wiley, New Jersey.
[R4]	Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition, John Wiley, New York.
Online Resources:	
[O1]	https://www.ti.com
[O2]	https://www.mouser.in/

Mapping:

Unit	Text Books	Reference Books
01	[01]	[R1]
02	[02]	[R2],[R4]
03	[01],[02]	[R3]
04	[01],[02]	[01] Online
05	[01],[02]	[02] online
06	[01],[02]	[R2],[R4]

403151A: EHV AC Transmission

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
					ESE	70

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Course Objectives:

This course aims to:

- Explain the need of EHV and UHV systems.
- Describe the impact of such voltage levels on the environment.
- Identify problems encountered with EHV and UHV transmissions.
- Describe methods of governance on the line conductor design, line height and phase etc.

Course Outcomes:

At the end of this course, students will be able to:
CO1:Highlight need for EHV ac transmission.
CO2:Calculate line and ground parameters.
CO3:Enlist problems encountered in EHV transmission.
CO4:Describe the effect of electric and magnetic fields on human beings.

Unit 01	EHVAC Transmission	07 hrs

Need for EHV transmission lines, Power handling capacity and line loss, Mechanical considerations in line performance, Vibrations. Traveling wave equations, transmission reflection attenuation and distortion of traveling waves, transmission and reflection coefficients and examples.

Unit 02	Calculation of line and ground parameters	07 hrs

Resistance of conductors, effect of temperature on overhead conductors, temperature rise of conductors and current carrying capacity, Properties of bundled conductors, Inductance of current carrying single conductor, Inductance of EHV line configurations, Line capacitance calculations

Unit 03	Voltage Gradient of Conductor	07 hrs

Electrostatic Field of a point charge and its properties, Field of sphere gap, Field of line charges and their properties, charge potential relations for multi-conductor lines, Maximum charge condition on three phase line.
Surface voltage gradient on conductors-single conductor, two conductors and multi-conductor bundle, Maximum surface voltage gradient, Mangoldt formula, design of cylindrical cage for corona gradients.

Unit 04	Electrostatic and magnetic fields of EHV lines	07hrs

Electric shock and threshold currents, Effects of high electrostatic fields on humans, animals and plants, Calculation of electrostatic field of single circuit of three phase line, Profile of electrostatic field of line at ground level.
Electrostatic induction on an un-energized circuit of a double circuit line. Insulated ground wire and induced voltage in insulated ground wires. Magnetic field calculation of horizontal configuration of single circuit of

three phase lines, Effects of power frequency magnetic fields on human health.		
Unit 05	Corona and its effects	07 hrs
Corona formation, corona inception voltage, visual corona voltage, critical field for corona inception and for visual corona under standard operating condition and conditions other than standard operating conditions. Power loss due to corona, corona loss formulae, corona current waveform, charge-voltage diagram and corona loss. Audible noise operation and characteristics limits for audible noise, AN measurement and meters, microphone, weighting networks.		
Unit 06		07 hrs
A. Design of EHV line: Design of EHV lines based upon steady state limits and transient over voltages, design factors under state. Design examples: steady state limits. Line insulation design based on transient over voltages. B. Extra high voltage cable transmission: Classification of cables, Electrical characteristics of EHV Cables, Properties of cable insulation materials.		
Text Books:		
[T1]	Rakosh das Begamudre "Extra high voltage transmission", New Age International publishers.	
Reference Books:		
[R1]	S. Rao , "EHV AC and DC Transmission" Khanna publication.	

Mapping:

Unit	Text Books	Reference Books
01	T1	R1
02	T1	–
03	T1	–
04	T1	R1
05	T1	R1
06	T1	R1

403151B: Illumination Engineering

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
					ESE	70

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Course Objectives:

This course aims to:

- To explain conventional and modern lamps and their accessories.
- To get detailed insight of indoor and outdoor illumination system components, control and design aspects.
- To know the requirements of energy efficient lighting.
- To introduce the modern trends in the lighting

Course Outcomes:

At the end of this course, students will be able to:
CO1: Define and reproduce various terms in illumination.
CO2: Identify various parameters for illumination system design.
CO3: Design indoor and outdoor lighting systems.
CO4: Enlist state of the art illumination systems.

Unit 01	Importance of Lighting in Human Life	07 hrs

Optical systems of human eye, Dependence of human activities on light, performance characteristics of human visual system, External factors of vision-visual acuity, contrast, sensitivity, time illuminance, colour, visual perception, optical radiation hazards, Good and bad effects of lighting and perfect level of illumination, Artificial lighting as substitute to natural light, Ability to control natural light, Production of light, physics of generation of light, Properties of light, Quantification and Measurement of light.

Unit 02	Light Sources and Electrical Control of Light Sources	08 hrs

Light Sources- Lamp materials: Filament, glass, ceramics, gases, phosphors and other metals and non-metals. Discharge Lamps: Theory of gas Discharge phenomena, lamp design considerations, characteristics of low and high pressure mercury and Sodium vapour lamps, Low Vapour Pressure discharge lamps - Mercury Vapour lamp, Fluorescent Lamp, Compact Fluorescent Lamp (CFL)
High Vapour Pressure discharge lamps - Mercury Vapour lamp, Sodium Vapour lamp, Metal halide Lamps, Solid Sodium Argon Neon lamps, SOX lamps, Electro luminescent lamps, Induction lamps.
Ballast, ignitors and dimmers for different types of lamps
Control of Light Sources
Photometric Control of Light Sources and their Quantification: Types of Luminaries, factors to be considered for designing luminaries Types of lighting fixtures. Optical control schemes, design procedure of reflecting and refracting type of luminaries. Lighting Fixture types, use of reflectors and refractors, physical protection of lighting fixtures, types of lighting fixtures according to installation type, types of lighting fixtures according to photometric usages, luminaries standard (IEC-598-Part I).

Unit 03	Design Considerations for illumination schemes	07 hrs
Zonal cavity method for general lighting design, determination for zonal cavities and different shaped ceilings using COU (coefficient of utilization), beam angles and polar diagrams. Factors to be considered for design of indoor illumination scheme		
Unit 04	Design of lighting schemes-I	07 hrs
Indoor illumination design for following installations Residential (Numerical) Educational institute Commercial installation Hospitals Industrial lighting Special purpose lighting schemes Decorative lighting Theatre lighting Aquarium, swimming pool lighting		
Unit 05	Design of lighting schemes-II	07 hrs
Factors to be considered for design of outdoor illumination scheme Outdoor Lighting Design: Road classifications according to BIS, pole arrangement, terminology, lamp and luminaries' selection, different design procedures, beam lumen method, point by point method, isolux diagram, problems on point by point method. Outdoor illumination design for following installations: Road lighting (Numerical) Flood lighting (Numerical) Stadium and sports complex Lighting for advertisement/hoardings		
Unit 06	Modern trends in illumination	07 hrs
LED luminary designs Intelligent LED fixtures Natural light conduiting Organic lighting system LASERS, characteristics, features and applications, non-lighting lamps Optical fiber, its construction as a light guide, features and applications		
Text Books:		
[T1]	H. S. Mamak, "Book on Lighting", Publisher International lighting Academy.	
[T2]	Joseph B. Murdoch, "Illumination Engineering from Edison's Lamp to Lasers" Publisher -York, PA : Visions Communications	
[T3]	M. A. Cayless, A. M. Marsden, "Lamps and Lighting", Publisher-Butterworth Heinemann (ISBN 978-0-415-50308-2)	

[T4]	Designing with light: Lighting Handbook., Anil Valia; Lighting System 2002
Reference Books:	
[R1]	"BIS, IEC Standards for Lamps, Lighting Fixtures and Lighting", Manak Bhavan, New Delhi.
[R2]	D. C. Pritchard, "Lighting", 4th Edition, Longman Scientific and Technical, ISBN 0-582-23422-0.
[R3]	"IES Lighting Handbook", (Reference Volume 1984), Illuminating Engineering Society of North America.
[R4]	"IES Lighting Handbook", (Application Volume 1987), Illuminating Engineering Society of North America
[R5]	IESNA lighting Handbook., Illuminating Engineering Society of North America 9th edition 2000
[R6]	Applied Illumination Engineering, Jack L. Lindsey FIES (Author), Scott C. Dunning PHD PECEM (Author) ,ISBN-13: 978-0824748098 ISBN-10: 0824748093, 3rd Edition.
[R7]	IS 3646: Part I: 1992, Code of practice for interior illumination.
[R8]	Organic Light Emitting Diodes (OLEDs): Materials, Devices and Applications, Alastair Buckley, University of Sheffieid, UK, ISBN: 978-0-85709-425-4

Mapping:

Unit	Text Books	Reference Books
01	T1, T4	R6
02	T3, T4	R1, R3, R4, R8
03	T2, T4	R2, R3, R7
04	T3, T4	R2,R3, R4, R5, R7
05	T2, T3, T4	R3, R4, R6, R7
06	T1, T2, T4	R2, R3, R5, R8

403151C: Electromagnetic Fields						
Teaching Scheme			**Credits**		**Examination Scheme**	
Theory	03	Hrs/Week	Theory	03	ISE	30
					ESE	70

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Course Objectives:

This course aims to:

- To impart knowledge on the basics of electric and magnetic fields and their applications for utilization in the development of the theory for power transmission lines and electrical machines.
- To describe how materials affect electric and magnetic fields
- To discuss the boundary conditions
- To analyze the relation between the fields under time varying situations
- To give insight to Maxwell's equations in different form and media

Course Outcomes:

At the end of this course, students will be able to:
CO1: Describe time varying Maxwell's equations and their applications in electromagnetic problems
CO2: Interpret electric and magnetic field with the help of associated laws
CO3: Solve simple electrostatic and magnetic boundary conditions
CO4: Determine the relationship between time varying electric and magnetic fields and electromotive force
CO5: Solve electromagnetic problems with the help of mathematical tools.

Unit 01	Introduction	07 hrs

Sources and effects of Electro-Magnetic Fields, Scalar and vector, Unit vector, Mathematical operations of Vector, Scalar and vector fields, Different Coordinate System, Operator Del, Physical interpretation of gradient, divergence and curl, Conversion between coordinate system, Expression for gradient, divergence and curl in three coordinate system.

Unit 02	Basic Electrostatics	07 hrs

Coulomb's law, Electric field, Electric Field Intensity (EFI), EFI due to - point charge, line charge, surface charge and volume charge, Electric displacement, Electric flux density, Gauss's law (scalar and vector form), Applications of Gauss law, Electric field due to – point charge, infinite long straight conductor and infinite plane sheet of charge, Divergence theorem, Stoke's theorem

Unit 03	Applied Electrostatics	07 hrs

Electric Potential, Relationship between E and V, Equipotential surfaces, Electric dipole and flux lines, Electric field due to dipole, Energy density in electrostatic field, Energy stored in terms of D and E, Convection and Conduction currents, Current and current density, Continuity equation for current, Poisson's and Laplace's equations, Capacitor and its capacitance, Parallel plate capacitor, Capacitors with multiple dielectrics, Spherical capacitor, Coaxial capacitor.

Unit 04	Magnetostatics and Applications	07 hrs

Magnetic flux density, Magnetic field intensity (MFI), Magnetic permeability, Biot-Savart's law, Applications of Biot-Savart's law, MFI due to - infinite long straight filament, finite length element, on the axis of circular loop, Ampere's Circuital law, Field due to – infinite line current, coaxial cable, uniform current sheet density, Magnetic flux density, Scalar magnetic potential, Vector magnetic potential, Poisson's Equations for Magnetostatic field, Derivations of BiotSavart law and Ampere's law based on magnetic potential, Forces due to magnetic field, Magnetic dipole.		
Unit 05	Boundary Conditions and Analysis	07 hrs
Conductors, Ohm's law employing mobility, Dielectrics, Polarization in Dielectrics, Dielectric constants and strength, Relaxation time, Boundary conditions : Dielectric-Dielectric boundary conditions, Conductor – Dielectric boundary conditions, Conductor – Free space boundary conditions, Boundary conditions for Magnetostatic fields		
Unit 06	Time Varying Fields and Maxwell's equations	07 hrs
Faraday's law, Transformer and motional EMFs – stationary loop in time varying B field, moving loop in static B field and moving loop in time varying field, Displacement current, Maxwell's equations in point form and integral form, Power and Poynting theorem, Time varying potentials, Time Harmonic Field, Maxwell's equations in point form and integral form for harmonic field, Concept of uniform plane wave.		

Text Books:

[T1]	W. H. Hayt and J. A. Buck, "Engineering Electromagnetics", Tata McGraw Hill.
[T2]	Mathew Sadiku, "Elements of Electromagnetics", Oxford University Press

Reference Books:

[R1]	R. K. Shevgaonkar, "Electromagnetic Waves", Tata McGraw Hill.
[R2]	Liang Chi Shen, Jin Au Kong, Amalendu Patnaik, "Engineering Electromagnetics", CENGAGE Learning
[R3]	K. B. Madhu Sahu, "Electromagnetic Fields", SciTech Publication.
[R4]	N. N. Rao, " Elements of Engineering Electromagnetics", Pearson Education.
[R5]	Edminister J. A., " Electromagnetics", Tata McGraw Hill.

Mapping:

Unit	Text Books	Reference Books
01	T2	R2, R3, R4
02	T1, T2	R1, R2, R3
03	T1, T2	R2, R3, R4, R5
04	T1, T2	R2, R3
05	T2	R1, R4, R5
06	T1, T2	R2, R3, R4

403151D: Artificial Intelligence and Machine Learning

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hrs/Week	Theory	03	ISE	30
					ESE	70

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Course Objectives:

This course aims to:

- Understand the basic concept of AI, strength and weakness of problem solving and search.
- Know about various Expert System tools and applications.
- Understand the basic concepts of machine Learning and apply different dimensionality reduction techniques.
- Optimize the different linear methods of regression and classification.
- Interpret the different supervised classification methods of support vector machine.
- Acquire the knowledge of different generative models through unsupervised learning.

Course Outcomes:

At the end of this course, students will be able to:

CO1: Evaluate Artificial Intelligence (AI) and Machine Learning(ML) methods and describe their foundations.

CO2: Demonstrate knowledge of reasoning and knowledge representation for solving real world problems.

CO3: Illustrate the construction of learning and expert system Discuss current scope and limitations of AI and societal implications

CO4: Distinguish between different types of learning types.

CO5: Apply the different supervised, unsupervised and reinforcement learning methods.

Unit 01	Introduction to AI	07 hrs

Definitions – Foundation and History of AI, Evolution of AI - Applications of AI, Classification of AI systems with respect to environment. Artificial Intelligence vs Machine learning, Statistical Analysis: Relationship between attributes: Covariance, Correlation Coefficient, Chi Square. Intelligent Agent: Concept of Rationality, nature of environment, structure of agents.

Unit 02	Problem Solving	07 hrs

Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Bestfirst Search; Problem Reduction. Constraint Satisfaction problem: Interference in CSPs; Back tracking search for CSPs; Local Search for CSPs; structure of CSP Problem. Beyond Classical Search: Local search algorithms and optimization problem, local search in continuous spaces, searching with nondeterministic action and partial observation, online search agent and unknown environments.

Unit 03	Knowledge and Reasoning	07 hrs

Knowledge and Reasoning: Building a Knowledge Base: Propositional logic, first order Logic, situation calculus. Theorem Proving in First Order Logic, Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks. Probabilistic reasoning over time: time and uncertainty, hidden Markova models, Kalman filter, dynamic bayesian network, keeping track of many objects

Unit 04	Introduction to ML and Supervised Learning	07 hrs
Introduction to Machine Learning, Examples of Machine Learning Applications, Learning Types **Supervised Learning** -Learning a Class from Examples, Vapnik-Chervonenkis (VC) Dimension, Probably Approximately Correct (PAC) Learning,Noise, Learning Multiple Classes, Regression, Model Selection and Generalization, **Dimensions of a Supervised Machine Learning** Algorithm Dimensionality Reduction-Introduction,Subset Selection, Principal Components Analysis, Factor Analysis, Multidimensional Scaling, Linear Discriminant Analysis,Isomap, Locally Linear Embedding		
Unit 05	Linear Regression	08 hrs
Introduction, Linear Regression Models and Least Squares, Subset Selection, Shrinkage Methods-Ridge Regression, Lasso Regression, Least Angle Regression, Methods Using Derived Input Directions-Principal Components Regression, Partial Least Squares, A Comparison of the Selection and Shrinkage Methods , Multiple Outcome Shrinkage and Selection, More on the Lasso and Related Path Algorithms, Logistic Regression-Fitting Logistic Regression Models, Quadratic Approximations and Inference, L1 Regularized Logistic Regression		
Unit 06	Unsupervised and reinforcement learning	08 hrs
Introduction, Association Rules-Market Basket Analysis, The Apriori Algorithm, Unsupervised as Supervised Learning,Generalized Association Rules, Cluster Analysis. Proximity Matrices, Clustering Algorithms-K-mean, Gaussian Mixtures as Soft K-means Clustering. **Reinforcement Learning:** Introduction, Single state case, elements of reinforcement learning, model based learning, Temporal difference learning		
Text Books:		
[T1]	Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall	
[T2]	J. Gabriel, Artificial Intelligence: Artificial Intelligence for Humans (Artificial Intelligence, Machine Learning), Create Space Independent Publishing Platform, First edition , 2016	
[T3]	Introduction to Machine Learning Edition 2, by Ethem Alpaydin	
[T4]	The Elements of Statistical Learning. Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009.	
[T5]	Machine Learning. Tom Mitchell. First Edition, McGraw- Hill, 1997	
Reference Books:		
[R1]	Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI.,2010 2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011	
[R2]	Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill	
[R3]	Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson	
[R4]	Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT	

[R5]	Pattern Recognition and Machine Learning. Christopher Bishop. Springer. 2006.
[R6]	Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.
[R7]	Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017.
Online Resources:	
[O1]	https://nptel.ac.in/courses/106/106/106106139/
[O2]	https://nptel.ac.in/courses/106/106/106106202/
[O3]	https://nptel.ac.in/courses/106/106/106106198/
[O4]	https://nptel.ac.in/courses/106/105/106105152/
[O5]	https://nptel.ac.in/courses/106/106/106106213/
[O6]	https://www.coursera.org/learn/machine-learning

Mapping:

Unit	Text Books	Reference Books
01	T1, T2	R1, R2, R3
02	T1, T2	R1, R2, R3
03	T1, T2	R1, R2, R3
04	T3, T4, T5	R4, R5, R6, R7
05	T3, T4, T5	R4, R5, R6, R7
06	T3, T4, T5	R4, R5, R6, R7

403152: Project Stage II

Teaching Scheme			Credits		Examination Scheme	
SEM/PW/IN	12	Hrs./Week	SEM/PW/IN	6	ORAL	50
					Termwork	100

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Preamble:

Project is an important part of the engineering curriculum covered in the final year. It is divided into Project Stage I and Project Stage II in Semesters I and II of the Final Year. This project is a substantial piece of work that will require creative activity and original thinking. The project aims to provide students with a transitional experience from the academic world to the professional world. The objectives, outcomes, and guidelines for Project Stage II are given below.

Course Objectives:

The objectives of this course are to:

1. Provide an opportunity to learn new software, interdisciplinary theory, concept, technology, etc. not covered in earlier subjects
2. Empower students to use engineering knowledge and skills learned in previous courses to deliver a product that has passed through the design, analysis, testing, and evaluation
3. Encourage multidisciplinary project work through the integration of knowledge
4. Allow students to develop problem-solving, analysis, synthesis, and evaluation skills.
5. Encourage teamwork.
6. Improve students' communication skills by asking them to produce both a professional report and to give an oral presentation
7. Exposed to the project management skills and ethical practices in project

Course Outcomes:

Course outcomes can be different for the different projects undertaken by the student groups. However, in general, the course outcomes for Project Stage-II can be stated as follows.

At the end of this course, students should be able to:

CO1: Identify tools, techniques, methods, concepts, measuring devices, and instruments required for the project to define the methodology of the project

CO2: Justify the selection of electrical, electronic and mechanical components for the project prototyping

CO3: Select the appropriate testing method for system performance evaluation

CO4: Interpret results obtained by simulation, and hardware implementation and decide on further action or write a conclusion

CO5: Write a project report and research paper on the project work

Guidelines:

Termwork evaluation guidelines are given below.

Sr. No.	Activity	Deadline (Semester II)	Parameters for Evaluation
1	Progress Review-3 Presentation	Up to 6th Week	Revised Final Design (10) Tools and Techniques Used with justification (10) Partial Implementation/ development (15) Partial Results (15)

			Total Marks (50)
2	Progress Review-4 Presentation	Up to 12th Week	Implementation Status of project (10) Testing and Evaluation (10) Intermediate Results (15) Conclusion (10) Future Scope (5) **Total Marks (50)**
3	Submission of Project Stage –II Report	Up to 14th Week	Timely submission (5) Formatting and Report Writing Style (5) Abstract, Literature Survey, Conclusion (10) Grammatical correctness in the report (5) Publication/participation in project exhibition (20) **Total Marks (50)** **Review 3+ Review 4+ Final Project Report = 150 Rounded to 100 Marks**

Guidelines to students:

1. Continue with the same group and identify opportunities for self-learning and upgrading skills.
2. Actively participate in all the activities related to the project.
3. Document the project in the form of a hard-bound report at the end and submit it to the department.
4. Attempt to make a prototype, working model, and demonstration of the project to display during the final presentation.
5. Participate in project competitions, paper presentations, etc.
6. Maintain an institutional culture of authentic collaboration, self-motivation, peer learning, and personal responsibility.
7. Maintain a notebook to keep records of all the meetings, discussions, notes, etc. This is to be done by the individual student and submitted at the end to the supervisor or guide.
8. Some parameters, mentioned in the above table, will be evaluated and assessed at a group level and some at an individual level.

403153A: German Language-II							
Teaching Scheme			**Credits**		**Examination Scheme**		
Theory	02	Hrs/Week	Theory	–	ISE		–

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Course Objectives:
This course aims to: • Get introduced to the Culture, Routine of the German Society through language. • Meet the needs of ever growing German industry with respect to language support.
Course Outcomes:
At the end of this course, students: CO1: Will have the ability of advanced communication. CO2: Will develop reading, writing and listening skills. CO3: Will understand tenses in German Language. CO4: Will develop interest to pursue a German language course.

Unit 01	Introduction of Cases:	06 hrs
Introduction of Cases: Nominative, Akkusative, Dative. Personal & Possessive Pronouns in Nominative, Akkusative, Dative.		
Unit 02	Prepositions:-	06 hrs
Prepositions:- Akkusative & Dative.		
Unit 03	Tenses:-	06 hrs
Tenses:- Past tense of sein & haben Verbs, Perfect tense		

Text Books:	
[T1]	Netzwerk A-1 (Deutsch als Fremdsprache), Goyal Publishers & Distributors Pvt. Ltd.
Reference Books:	
[R1]	Tipps und Uebungen A1
Online Resources:	
[O1]	Practice Material like online Worksheets regarding the Grammar, listening Module, reading Texts.

403153B: Engineering Economics-II

Teaching Scheme			Credits		Examination Scheme		
Theory	02	Hrs/Week	Theory	–	ISE		–

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Course Objectives:

This course aims to:

1. Describe basics methods of Engineering Economic Analysis
2. Explain inflation and its impact on business decisions.

Course Outcomes:

At the end of this course, students will be able to:
CO1:Apply various techniques for evaluation of engineering projects.
CO2:Assess cash flow under risk with varying parameters.

Unit 01	Engineering Economic Analysis	10 hrs

Internal Rate Of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Public Sector Economic Analysis (Benefit Cost Ratio Method).Introduction to Lifecycle Costing, Introduction to Financial and Economic Analysis.Case Study – Tata Motors

Unit 02	Inflation and Risk Analysis	10 hrs

Concept of Inflation., Measuring Inflation, Equivalence Calculation Under Inflation, Impact of Inflation on Economic Evaluation.
Sources of Project Risks, Methods of Describing Project Risks, Sensitivity Analysis, Break Even Analysis, Scenario Analysis, Probability Concept of Economic Analysis, Decision Tree and Sequential Investment Decisions

Text Books:

[T1]	Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India.
[T2]	D.M. Mithani, Principles of Economics. Himalaya Publishing House

Reference Books:

[R1]	Sasmita Mishra, “Engineering Economics & Costing “, PHI
[R2]	Sullivan and Wicks, “ Engineering Economy”, Pearson
[R3]	R. Paneer Seelvan, “ Engineering Economics”, PHI
[R4]	Chan S. Park, Contemporary Engineering Economics, Prentice Hall, Inc.

403153C: GREEN BUILDING

Teaching Scheme			Credits		Examination Scheme		
Theory	02	Hrs/Week	Theory	--	ISE		--

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Course Objectives:

This course aims to:

- To learn the principles of planning and orientation of buildings.
- To acquire knowledge on various aspects of green buildings.

Course Outcomes:

At the end of this course, students will be able to:
CO1:Design green and sustainable techniques for both commercial and residential buildings.
CO2:Design water, lighting, energy efficiency plan using renewable energy sources.
CO3:Explain the principles of building planning, its bylaws and provide facilities for rainwater harvesting
CO4:Understand the concepts of green buildings

Unit 01	Sustainability and Building design	06 hrs

Sustainability, objectives of sustainable development, Sustainable aspects of habitat design, sustainable buildings, principles, approaches and characteristics, climate data, climate parameters and zones, comparative analysis of various climatic zones, site planning recommended checklist for identifying site characteristics, site development and layout. Efficient water management and waste water treatment, solid waste management.

Unit 02	Energy efficiency	06 hrs

Solar passive techniques in building design to minimize load on conventional systems i.e. heating, cooling, ventilation and lighting. Designing Energy efficient lighting and HVAC systems. Use of renewable energy systems to meet part of building load. Green building certification. Overview of various green buildings in India. Policy and regulatory mechanisms.

Text Books:

[T1]	Seven Wonders of Green Building Technology: Karen Sirvaitis, Twenty-First Century Books.
[T2]	Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009.
[T3]	Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010.
[T4]	Fundamentals of Integrated Design for Sustainable Building By Marian Keeler, Bill Burke

Reference Books:

[R1]	Sustainable Building Design Manual, Volume 2, TERI, New Delhi
[R2]	Energy Efficient Buildings in India, TERI, New Delhi
[R3]	Sustainable Building Design Manual, Volume 1 TERI, New Delhi
[R4]	Mili Majumdar, “Energy-efficient buildings in India” Tata Energy Research Institute, 2002.
[R5]	TERI “Sustainable Building Design Manual- Volume I & II” Tata Energy Research Institute, 2009.
Online Resources:	
[O1]	https://nptel.ac.in/courses/105102175
[O2]	https://theect.org/energy-efficiency-buildings-distance-learning/
[O3]	https://www.udemy.com/topic/energy-management/
[O4]	https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-ce13/
[O5]	https://beeindia.gov.in/content/certification
[O6]	https://elearning.iea.org/
[O7]	https://onlinecourses.nptel.ac.in/noc20_ce08/preview

JSPM’s Bhivarabai Sawant Institute of Technology &Research, Wagholi, Pune (412207)

CRITERION 1 - CURRICULAR ASPECTS

1.3

Curriculum Enrichment

1.3.2

Number of courses that include experiential learning through project work/field work/internship during the year

DEPARTMENT OF MECHANICAL ENGINEERING

Savitribai Phule Pune University
Faculty of Science & Technology

Curriculum/Syllabus
for
Second Year
Bachelor of Engineering
(Choice Based Credit System)
Mechanical Engineering and Automobile Engineering
(2019 Course)

Board of Studies - Automobile and Mechanical Engineering
(With Effect from Academic Year 2020-21)

Savitribai Phule Pune University

Board of Studies - Automobile and Mechanical Engineering

Undergraduate Program - Automobile Engineering & Mechanical Engineering (2019 pattern)

Course Code	Course Name	Teaching Scheme (Hours/ Week)			Examination Scheme and Marks						Credit			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
Semester-III														
202041	Solid Mechanics	4	2	-	30	70	-	50	-	150	4	1	-	5
202042	Solid Modeling and Drafting	3	2	-	30	70	-	50	-	150	3	1	-	4
202043	Engineering Thermodynamics	3	2	-	30	70	-	-	25	125	3	1	-	4
202044	Engineering Materials and Metallurgy	3	2	-	30	70	25	-	-	125	3	1	-	4
203156	Electrical and Electronics Engineering	3	2	-	30	70	25	-	-	125	3	1	-	4
202045	Geometric Dimensioning and Tolerancing Lab	-	2	-	-	-	25	-	-	25	-	1	-	1
202046	Audit Course - III	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**16**	**12**	**-**	**150**	**350**	**75**	**100**	**25**	**700**	**16**	**6**	**-**	**22**
Semester-IV														
207002	Engineering Mathematics - III	3	-	1	30	70	25	-	-	125	3	-	1	4
202047	Kinematics of Machinery	3	2	-	30	70	-	-	25	125	3	1	-	4
202048	Applied Thermodynamics	3	2	-	30	70	-	-	25	125	3	1	-	4
202049	Fluid Mechanics	3	2	-	30	70	-	-	25	125	3	1	-	4
202050	Manufacturing Processes	3	-	-	30	70	-	-	-	100	3	-	-	3
202051	Machine Shop	-	2	-	-	-	50	-	-	50	-	1	-	1
202052	Project Based Learning - II	-	4	-	-	-	50	-	-	50	-	2		2
202053	Audit Course - IV	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**12**	**1**	**150**	**350**	**125**	**-**	**75**	**700**	**15**	**6**	**1**	**22**

Abbreviations: TH: Theory, **PR**: Practical, **TUT**: Tutorial, **ISE**: In-Semester Exam, **ESE**: End-Semester Exam,**TW**: Term Work, OR: Oral

Note: Interested students of SE (Automobile Engineering and Mechanical Engineering) can opt for any one of the audit course from the list of audit courses prescribed by BoS (Automobile and Mechanical Engineering)

Instructions

- Practical/Tutorial must be conducted in three batches per division only.
- Minimum number of required Experiments/Assignments in PR/ Tutorial shall be carried out as mentioned in the syllabi of respective subjects.
- Assessment of tutorial work has to be carried out as a term-work examination. Term-work Examination at second year of engineering course shall be internal continuous assessment only.
- Project based learning (PBL) requires continuous mentoring by faculty throughout the semester for successful completion of the tasks selected by the students per batch. While assigning the teaching workload of 2 Hrs/week/batch needs to be considered for the faculty involved. The Batch needs to be divided into sub-groups of 5 to 6 students. Assignments / activities / models/ projects etc. under project based learning is carried throughout semester and Credit for PBL has to be awarded on the basis of internal continuous assessment and evaluation at the end of semester.
- Audit course is mandatory but non-credit course. Examination has to be conducted at the end of Semesters for award of grade at institute level. Grade awarded for audit course shall not be calculated for grade point & CGPA.

202041 - Solid Mechanics

Teaching Scheme	Credits	Examination Scheme
Theory : 04 Hr./Week Practical : 02 Hr./Week	**05** Theory : 04 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Practical : 50 Marks

Prerequisite Courses

Engineering Mathematics- I and II, Systems in Mechanical Engineering, Engineering Mechanics

Course Objectives

1. To acquire basic knowledge of stress, strain due to various types of loading.
2. To draw Shear Force and Bending Moment Diagram for transverse loading.
3. To determine Bending, Shear stress, Slope and Deflection on Beam.
4. To solve problems of Torsional shear stress for shaft and Buckling for the column.
5. To apply the concept of Principal Stresses and Theories of Failure.
6. To utilize the concepts of Solid Mechanics on application based combined mode of loading.

Course Outcomes

On completion of the course, learner will be able to

CO1. DEFINE various types of stresses and strain developed on determinate and indeterminate members.

CO2. DRAW Shear force and bending moment diagram for various types of transverse loading and support.

CO3. COMPUTE the slope & deflection, bending stresses and shear stresses on a beam.

CO4. CALCULATE torsional shear stress in shaft and buckling on the column.

CO5. APPLY the concept of principal stresses and theories of failure to determine stresses on a 2-D element.

CO6. UTILIZE the concepts of SFD & BMD, torsion and principal stresses to solve combined loading application based problems.

Course Contents

Unit I — Simple stresses & strains — [10 Hr.]

Simple Stress & Strain: Introduction to types of loads (Static, Dynamic & Impact Loading) and various types of stresses with applications, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants, Stress-strain diagram for ductile and brittle materials, factor of safety, Stresses and strains in determinate and indeterminate beam, homogeneous and composite bars under concentrated loads and self-weight, Thermal stresses in plain and composite members

Unit II — Shear Force & Bending Moment Diagrams — [08 Hr.]

SFD & BMD: Introduction to SFD, BMD with application, SFD & BMD for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load, couple and combined loading, Relationship between rate of loading, shear force and bending moment, Concept of zero shear force, Maximum bending moment, point of contra-flexure

Unit III — Stresses, Slope & Deflection on Beams — [12 Hr.]

Bending Stress on a Beam: Introduction to bending stress on a beam with application, Theory of Simple bending, assumptions in pure bending, derivation of flexural formula, Moment of inertia of common cross section (Circular, Hollow circular, Rectangular, I & T), Bending stress distribution along the same cross-section

Shear Stress on a Beam: Introduction to transverse shear stress on a beam with application, shear stress distribution diagram along the Circular, Hollow circular, Rectangular, I & T cross-section

Slope & Deflection on a Beam: Introduction to slope & deflection on a beam with application, slope, deflection and Radius of Curvature, Macaulay's Method, Slope and Deflection for all standard beams

Unit IV	Torsion, Buckling	[08 Hr.]

Torsion of circular shafts: Introduction to torsion on a shaft with application, Basic torsion formulae and assumption in torsion theory, Torsion in stepped and composite shafts, Torque transmission on strength and rigidity basis, Torsional Resilience

Torsion on Thin-Walled Tubes: Introduction of Torsion on Thin-Walled Tubes Shaft and its application

Buckling of columns: Introduction to buckling of column with its application, Different column conditions and critical, safe load determination by Euler's theory. Limitations of Euler's Theory

Unit V	Principal Stresses, Theories of Failure	[08 Hr.]

Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses

Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory

Unit VI	Application based combined loading & stresses (Based on load and stress condition studied in Unit I to Unit V)	[08 Hr.]

Introduction to the Combined Loading and various stresses with application, Free Body Diagram and condition of Equilibrium for determining internal reaction forces, couples for 2-D system, Combined stresses at any cross-section or at any particular point for Industrial and Real life example for the following cases: Combined problem of Normal type of Stresses (Tensile, Compressive and Bending stress), Combined problem of Shear type of stresses (Direct and Torsional Shear stresses), Combined problem of Normal and Shear type of Stresses

Books & Other Resources

Text Books

1. R. K. Bansal, "Strength of Materials", Laxmi Publication
2. S. Ramamurtham, "Strength of material", Dhanpat Rai Publication
3. S.S. Rattan, "Strength of Material", Tata McGraw Hill Publication Co. Ltd.
4. B.K. Sarkar, "Strength of Material", McGraw Hill New Delhi
5. Singer and Pytel, "Strength of materials", Harper and row Publication
6. R. C. Hibbeler, "Mechanics of Materials", Prentice Hall Publication

Reference Books

1. Egor. P. Popov, "Introduction to Mechanics of Solids",Prentice Hall Publication
2. G. H. Ryder, "Strength of Materials", Macmillan Publication
3. Beer and Johnston, "Strength of materials", CBS Publication
4. James M. Gere, "Mechanics of Materials", CL Engineering
5. Timoshenko and Young, "Strength of Materials", CBS Publication, Singapore
6. Prof. S.K. Bhattacharyya, IIT Kharagpur , "NPTEL Web course material"
   https://drive.google.com/file/d/1N2Eyv9ofPimIT2OSMZeMrSxe68Ulclei/view?usp=sharing

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work

The Termwork shall consist of completion of Practicals, Self-learning Study Assignments and Presentations. Practical examination shall be based on the Termwork undertaken during the semester.

Practical *(Any 6 experiments out of experiment no 1 to 8 from the following list whereas experiment no. 9 and 10 are mandatory. Minimum One experiment must be performed on IoT platform- Virtual Lab)*:

1. Tension test for Ductile material using extensometer on Universal Testing Machine.
2. Compression test for Brittle material on Universal Testing Machine.
3. Shear test of ductile material on Universal Testing Machine.
4. Tension test of Plastic/Composite material on low load capacity Tensile Testing Machine.
5. Measurement of stresses and strains using strain gauges.

6. Experimental verification of flexural formula in bending for cantilever, Simple supported beam.
7. Study and interpretations of stress distribution pattern using Polariscope for Plastic/Acrylic.
8. Experimental verification of torsion formula for circular bar.
9. Verification of results of any two from experiments no 1-8 using any FEA software tools.
10. **Self-learning study practical**: *Following topics are distributed among the group of 3-5 Students and groups need to present and also submit the slides/poster on TW file*.
    a. Experimental stress analysis, Strain Gauges rosette with case study.
    b. Residual stresses and Fatigue life with case study.
    c. Effect of heat treatment on the mechanical properties of a metal with case study.
    d. Mechanical properties of materials, Stresses and Design of components with case study.
    e. Failure Mode Analysis and Stresses with case study.

202042 - Solid Modeling and Drafting		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Practical : 50 Marks

Prerequisite Courses

Systems in Mechanical Engineering, Engineering Graphics, Engineering Mathematics - I and II

Course Objectives

1. To understand basic structure of CAD systems and their use to create geometric models of simple engineering parts
2. To introduce the curves and surfaces and their implement in geometric modeling
3. To apply basic concepts of 3D modeling, viewing and evaluate mass properties of components and assemblies
4. To apply geometrical transformations in CAD models
5. To understand data exchange standards and translators for various applications
6. To create engineering drawings, design documentation and use in manufacturing activities

Course Outcomes

On completion of the course, learner will be able to

CO1. UNDERSTAND basic concepts of CAD system, need and scope in Product Lifecycle Management

CO2. UTILIZE knowledge of curves and surfacing features and methods to create complex solid geometry

CO3. CONSTRUCT solid models, assemblies using various modeling techniques & PERFORM mass property analysis, including creating and using a coordinate system

CO4. APPLY geometric transformations to simple 2D geometries

CO5. USE CAD model data for various CAD based engineering applications viz. production drawings, 3D printing, FEA, CFD, MBD, CAE, CAM, etc.

CO6. USE PMI & MBD approach for communication

Course Contents

Unit I — Fundamentals of 3D Modeling — [08 Hr.]

Introduction, Product Life Cycle, CAD tools in the design process of Product Cycle, Scope of CAD, Software Modules - Operating System (OS) module, Geometric module, application module, programming module, communication module, Computer Aided Design - Features, requirements and applications

3D Modeling approach - Primitive, Features and Sketching, Types of Geometric models - 2½ extrusions, axisymmetric, composite, 3D objects, difference between wireframe, surface & solid modeling, Modeling strategies

Model viewing: VRML web-based viewing

Unit II — Curves & Surfaces — [08 Hr.]

Curves: Methods of defining Point, Line and Circle, Curve representation - Cartesian and Parametric space, Analytical and Synthetic curves, Parametric equation of line, circle, ellipse, Continuity (C^0, C^1 & C^2), Synthetic Curves - Hermit Cubic Spline, Bezier, B-Spline Curve, Non-Uniform Rational B-Spline curves (NURBS)

Surfaces: Surface representation, Types of Surfaces, Bezier, B-Spline, NURBS Surface, Coons patch surface, Surface Modeling

Reverse Engineering: Introduction, Point Cloud Data (PCD), PCD file formats, Quality issues in PCD, Requirements for conversion of surface models into solid models, Applications of PCD

Unit III — Solid Modeling — [08 Hr.]

Introduction, Geometry and Topology, Solid entities, Solid representation, Fundamentals of Solid modeling, Half spaces, Boundary representation (B-Rep), Constructive Solid Geometry (CSG), Sweep representation, Analytical solid modeling, Parametric solid modeling, feature based modeling, etc., Euler Equation (Validity of 3D solids), Mass Property Calculations

Introduction to Assembly Modeling, Assemblies (Top-down and Bottom-up approach), Design for Manufacturing [DFM], Design for Easy Assembly & Disassembly [DFA], Design for Safety

Unit IV **Geometric Transformation** **[08 Hr.]**

Introduction, Geometric Transformations, Translation, Scaling, Rotation, Reflection/Mirror, Shear, Homogeneous Transformation, Inverse Transformation, Concatenated Transformation (limited to 2D objects with maximum 3 points only), Coordinate systems - Model (MCS), Working (WCS), Screen (SCS) coordinate system, Mapping of coordinate systems

Projections of geometric models - Orthographic and Perspective projections, Design and Engineering applications

Unit V **CAD Data Exchange** **[08 Hr.]**

Introduction, CAD Kernels, CAD Data File, Data interoperability, CAD Data Conversions, challenges in CAD data conversions/remedies, Direct Data Translators, Neutral 3D CAD file formats (DXF, IGES, PDES, STEP, ACIS, Parasolid, STL, etc.), Data Quality

Requirements of CAD file format for 3D Printing (Additive Manufacturing), CAE, FEA, CFD, CAM (Subtractive Manufacturing), Multi-Body Dynamics (Motion Simulations), Computer Aided Inspection (CAI), Computer Aided Technologies (CAx), AR/VR applications, etc., Introduction to CAD Geometry Clean-up for different applications

Unit VI **CAD Customization & Automation** **[08 Hr.]**

Introduction, Limitations of 2D drawings, Introduction to Product and Manufacturing Information (PMI), Model Based Definitions (MBD), Applications of PMI & MBD

CAD Customization: Introduction, advantages and disadvantages, Applications of Customization Interfaces, Product Customization Approaches - Part Modeling Customization, Assembly Modeling Customization, Drawing sheets & PMI Customization, CAD Automation

Introduction to Application Programming Interface (API), Structures of APIs, Coding/Scripting for customization, Introduction to CAD API Development, CAD Files & application handling

Books & Other Resources

Text Books

1. Zeid, I and Sivasubramania, R., (2009), "CAD/CAM : Theory and Practice", 2nd edition, McGraw Hill Education, ISBN-13: 978-0070151345
2. Rao, P. N., (2017), "CAD/CAM: Principles and Applications", 3rd edition, McGraw Hill Education, ISBN-13: 978-0070681934
3. Chang, Kuang-Hua, (2015), "e-Design: Computer-Aided Engineering Design", Academic Press, ISBN-13: 978-0123820389

Reference Books

1. Lee, Kunwoo, (1999), "Principles of CAD/CAM/CAE Systems", Pearson/Addison-Wesley, ISBN-13: 978-0201380361
2. Bordegoni, Monica and Rizzi, Caterina, (2011), "Innovation in Product Design: From CAD to Virtual Prototyping", Springer, ISBN-13: 978-1447161875
3. Vukašinovic, Nikola and Duhovnik, Jože, (2019), "Advanced CAD Modeling: Explicit, Parametric, Free-Form CAD and Re-engineering", Springer, ISBN-13: 978-3030023980
4. Um, Dugan, (2018), "Solid Modeling and Applications: Rapid Prototyping, CAD and CAE Theory", 2nd edition, Springer, ISBN-13: 978-3319745930
5. Rogers, D. and Adams, J. A., (2017), "Mathematical Elements for Computer Graphics", 2nd edition, McGraw Hill Education, ISBN-13: 978-0070486775
6. Hearn, D. D. and Baker, M. P., (2013), "Computer Graphics with OpenGL", 4th edition, Pearson Education India, ISBN-13: 978-9332518711
7. Gokhale, N. S., Deshpande, S. S., Bedekar, S. V. and Thite, A. N., (2008), "Practical Finite Element Analysis", Finite to Infinite, Pune, India, ISBN-13: 978-8190619509
8. Lee Ambrosius, (2015), "AutoCAD® Platform Customization: User Interface, AutoLISP®, VBA, and Beyond", John Wiley & Sons, Inc., IN, ISBN-13: 978-1118798904

9. Bucalo, Joe and Bucalo, Neil, (2007), "Customizing SolidWorks for Greater Productivity", Sheet Metal Guy, LLC, ISBN-13: 978-0979566608
10. Ziethen, Dieter R. (2012), "CATIA V5: Macro Programming with Visual Basic Script", McGraw-Hill Companies, Inc./Carl Hanser Verlag München, ISBN-13: 978-0071800020, ISBN: 978-007180003-7
11. Programming Manuals of Softwares

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work Journal

Practical

The student shall complete the following Practical in laboratory using suitable CAD modeling software. Learner will demonstrate skills to communicate drawings as per industry standards.

1. 2-D sketching with geometrical and dimensional constraints
2. Solid & Surface modeling for simple mechanical components (Output file as Production drawing and Model Based Definition (MBD)
   (a) Sheet-Metal
   (b) Machining
   (c) Fabrication
   (d) Casting
   (e) Forgings
   (f) Plastic Molding
3. Assembly modeling (Output file as Assembly drawing and detailing) of the parts modeled in Practical assignment-2 using proper assembly constraint conditions and generation of exploded view for assemblies like Couplings, Clutches, Gear Assemblies, Engine/Pump/Turbine Components, Valves, Machine Tools, Automobile Components, Gear-Box, Pressure Vessels, etc.
4. Reverse Engineering of surface/solid modeling using Point Cloud Data.
5. Assembly Modeling by importing parts/components from free online resources like CAD and Product development software websites, forums, blogs, etc.
6. Demonstration on CAD Customization (with introduction to programming languages, interfacing)

202043 - Engineering Thermodynamics

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Oral : 25 Marks

Prerequisite Courses

Higher Secondary Science courses, Engineering Mathematics - I and II, Engineering Physics, Engineering Chemistry

Course Objectives

1. To introduce the fundamentals of thermodynamics.
2. To understand the concepts of laws of thermodynamics.
3. To apply the concepts of thermodynamics towards open and closed systems.
4. To be acquainted with Entropy generation and Exergy Analysis.
5. To understand the behaviour of a Pure substance and to analyze Vapour power cycles.
6. To undertake the performance analysis of a steam generator.

Course Outcomes

On completion of the course, learner will be able to

CO1. DESCRIBE the basics of thermodynamics with heat and work interactions.
CO2. APPLY laws of thermodynamics to steady flow and non-flow processes.
CO3. APPLY entropy, available and non available energy for an Open and Closed System,
CO4. DETERMINE the properties of steam and their effect on performance of vapour power cycle.
CO5. ANALYSE the fuel combustion process and products of combustion.
CO6. SELECT various instrumentations required for safe and efficient operation of steam generator.

Course Contents

Unit I — Fundamentals of Thermodynamics — [07 Hr.]

Introduction, Review of basic definitions, Zeroth law of Thermodynamics, Macro and Microscopic Approach, State Postulate, State, Path, Process and Cycles, Point function and Path function, quasi static process, Equilibrium, **Temperature** (concepts, scales, international fixed points and measurement of temperature), Constant volume gas thermometer and constant pressure gas thermometer, mercury in glass thermometer.

First Law of Thermodynamics: Concept of heat and work, Sign convention and its conversion. First law of thermodynamics, Joules experiments, Equivalence of heat and work. Application of first law to flow and non-flow Processes and Cycles. Steady flow energy equation (SFEE), Applications of SFEE to various devices such as Nozzle, Turbine, Compressors, Boilers etc. PMM-I kind.

Unit II — Ideal Gas and Second law of Thermodynamics — [08 Hr.]

Properties and Processes of Ideal Gas: Ideal Gas definition, Gas Laws: Boyle's law, Charle's law, Avagadro's Law, Equation of State, Ideal Gas constant and Universal Gas constant, Ideal gas Processes- on P-v and T-s diagrams, Constant Pressure, Constant Volume, Isothermal, Adiabatic, Polytropic, Throttling Processes (Open and Closed systems), Calculations of Heat transfer, Work done, Internal Energy.

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, Heat Engine, Refrigerator and Heat pump: Schematic representation, Efficiency and Coefficient of Performance (COP), Kelvin-Planck & Clausius Statement of the Second law of Thermodynamics; PMM-II kind, Equivalence of the two statements; Clausius Inequality, Concept of Reversibility and Irreversibility, Carnot Theorem/Principles, Carnot Cycle.

Unit III — Entropy and Availability — [08 Hr.]

Entropy: Entropy as a property, Clausius Inequality, Principle of increase of Entropy Principle, Entropy changes for an Open and Closed System, Change of Entropy for an ideal gas and Pure Substance, Concept of Entropy generation. Entropy - a measure of Disorder.

Availability: Available and Unavailable Energy, Concept of Availability, Availability of heat source at constant temperature and variable temperature, Availability of non-flow and steady-flow Systems.

Unit IV Properties of Pure substances & Thermodynamics of Vapour Cycle [07 Hr.]

Properties of Pure substances: Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-v, T-s and h-s plots (Mollier Chart) for steam, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling and combined) Non-flow and Steady flow Vapour Processes, Change of Properties, Work and Heat transfer.

Thermodynamics of Vapour Cycle: Rankine Cycle, Comparison of Carnot cycle and Rankine cycle, Introduction to Steam power Plant, Efficiency of Rankine Cycle, Relative Efficiency, Effect of Varying operating parameters like Superheat, Boiler and Condenser Pressure on performance of Rankine cycle, Modified Rankine Cycle.

Unit V Fuels and Combustion [07 Hr.]

Types of fuels, Proximate and ultimate analysis of fuel, Combustion theory, Combustion Equations, Theoretical and Excess air requirements, Equivalence ratio, Analysis of products of combustion, Calorific value - HCV & LCV. Bomb and Boys gas Calorimeters. Flue Gas Analysis using Orsat Apparatus, Exhaust Gas analyser, Enthalpy of formation, Adiabatic flame temperature.

Unit VI Steam Generators & Boiler Draught [08 Hr.]

Steam Generators: Classification, Constructional details of low pressure boilers, Primary Features of high pressure (Power) boilers, Location, Construction and working principle of boiler, Boiler mountings and accessories, Instrumentations required for safe and efficient operation, Introduction to IBR Act, Boiler performance Calculations-Equivalent Evaporation, Boiler efficiency, Heat balance Sheet.

Boiler Draught: Classification, Necessity of Draught, Natural draught, Determination of Height of chimney, Diameter of chimney, condition for maximum discharge, Forced draught, Induced draught, Balanced draught, Draught losses.

Books & Other Resources

Text Books

1. P. K. Nag, “Engineering Thermodynamics”, Tata McGraw Hill Publications
2. R. K. Rajput, “Engineering Thermodynamics”, EVSS Thermo, Laxmi Publications
3. P. L Ballaney, “Thermal Engineering”, Khanna Publishers
4. C.P. Arora, “Thermodynamics”, Tata McGraw Hill
5. Domkundwar, Kothandaraman and Domkundwar,“Thermal Engineering”,Dhanpat Rai Publishers
6. M M Rathore, “Thermal Engineering”, Tata McGraw-Hill

Reference Books

1. Rayner Joel, “Basic Engineering Thermodynamics”, AWL-Addison Wesley
2. Cengel and Boles, “Thermodynamics an Engineering Approach”, McGraw Hill
3. G.VanWylen, R.Sonntag and C.Borgnakke, “Fundamentals of Classical Thermodynamics”, John Wiley & Sons
4. Holman J.P, “Thermodynamics”, McGraw Hill
5. M Achuthan, “Engineering Thermodynamics”, PHI
6. Steam Tables/Data book

Guidelines for Laboratory Conduction

The student shall complete the following activity as Term Work

The Term work shall consist of successful completion of Practicals, and Industrial Visits. Oral Examination shall be based on the term work.

Practical

1. Joule’s experiment to validate, first law of thermodynamics.
2. Survey of temperature sensors used in various thermal systems.
3. Determination of dryness fraction of steam using combined separating and throttling calorimeter.
4. Determination of HCV of solid or gaseous fuel using Bomb or Junker’s calorimeter respectively.

5. Demonstration on Orsat Apparatus.
6. Trial on boiler to determine boiler efficiency, equivalent evaporation and Energy Balance.
7. Thermodynamic Analysis of any System / Model by using any Computer Software.
8. Energy and Exergy analysis of contemporary steam generator.

Industrial Visits

Visit to any Process Industry/Plant having Boiler equipped with Accessories.

The visit report consists of

- Details about the Industry/Process Plant.
- Operational description of the Equipment with specification, its use, capacity, application etc.

202044 - Engineering Materials and Metallurgy

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Term Work : 25 Marks

Prerequisite Courses

Higher Secondary Science courses, Engineering Physics, Engineering Chemistry, Systems in Mechanical Engineering

Course Objectives

1. To impart fundamental knowledge of material science and engineering.
2. To establish significance of structure property relationship.
3. To explain various characterization techniques.
4. To indicate the importance of heat treatment on structure and properties of materials.
5. To explain the material selection process.

Course Outcomes

On completion of the course, learner will be able to

CO1. COMPARE crystal structures and ASSESS different lattice parameters.

CO2. CORRELATE crystal structures and imperfections in crystals with mechanical behaviour of materials.

CO3. DIFFERENTIATE and DETERMINE mechanical properties using destructive and non-destructive testing of materials.

CO4. IDENTIFY & ESTIMATE different parameters of the system viz., phases, variables, component, grains, grain boundary, and degree of freedom. etc.

CO5. ANALYSE effect of alloying element & heat treatment on properties of ferrous & nonferrous alloy.

CO6. SELECT appropriate materials for various applications.

Course Contents

Unit I — Crystal Structures and Deformation of Materials — [08 Hr.]

Crystal Structures: Study of Crystal structures BCC, FCC, HCP and lattice parameters & properties, Miller indices, Crystal imperfections, and Diffusion Mechanisms

Material Properties: Mechanical (Impact, hardness, etc.), Electrical, optical and Magnetic properties

Deformation of Materials: Elastic deformation, Plastic deformation: slip, twinning, work hardening, baushinger effect, recovery, re-crystallization and grain growth, Fracture: Types of fractures (brittle, ductile), Creep & Fatigue failures

Unit II — Material Testing and Characterization Techniques — [06 Hr.]

Destructive Testing: Impact test, Cupping test and Hardness test

Non-Destructive Testing: Eddy current test, Sonic & Ultrasonic testing, X-ray Radiography testing (Principle and Applications only)

Microscopic Techniques: Sample Preparation and etching procedure, optical microscopy, Electronic microscopy - only SEM, TEM and X-ray diffraction (Principle and Applications only)

Macroscopy: Sulphur printing, flow line observation, spark test

Unit III — Phase Diagrams and Iron-Carbon Diagram — [09 Hr.]

Solid solutions: Introduction, Types, Humerothery rule for substitutional solid solutions

Solidification: Nucleation & crystal growth, solidification of pure metals, solidification of alloys.

Phase Diagrams: Cooling curves, types of phase diagrams, Gibbs phase rules

Iron-Carbon Diagram: Iron-carbon equilibrium diagrams in detail with emphasis in the invariant reactions

Unit IV **Heat Treatments** **[08 Hr.]**

Austenite transformation in steel: Time temperature transformation diagrams, continuous cooling transformation diagrams. Retained austenite and its effect

Steps in Heat treatment and Cooling Medium

Heat Treatment Processes: Introduction, Annealing (Full annealing, Process annealing, Spheroidise annealing, isothermal annealing, stress relief annealing), Normalising, Hardening, Tempering, Austempering, Martempering, Sub-Zero Treatment, Hardenability

Surface Hardening: Classification, Flame hardening, Induction hardening, Carburising, Nitriding, Carbonitriding

Unit V **Ferrous Materials** **[07 Hr.]**

Carbon Steel: Classification, types & their composition, properties and Industrial application

Alloy Steels: Classification of alloy steels & Effect of alloying elements, examples of alloy steels, (Stainless steel, Tool steel) sensitization of stainless steel

Designation of carbon steel and alloy steels as per IS, AISI, SAE Standards

Cast Iron: Classification, types & their composition, properties and Industrial application of (White CI, Gray CI, SG CI, Malleable Cast and alloy Cast Iron)

Microstructure and property relationship of various ferrous Materials

Unit VI **Non-Ferrous Materials** **[07 Hr.]**

Classification of Non-Ferrous Metals: Study of Non-ferrous alloys with Designation, Composition, Microstructure

Mechanical & other properties for Industrial Applications: Copper and its Alloys (Gilding Metal, Cartridge Brass, Muntz Metal, Tin Bronze, Beryllium Bronze), Aluminium and its Alloy (LM5, Duralumin, Y-Alloy, Hinduminum), Nickel and its Alloys (Invar, Inconel), Titanium and its Alloys (α Alloys, α-β Alloys), Cobalt and its Alloys (Stellite Alloys, Alnico), Bearing Alloys (Classification, lead based alloys, tin based alloys), Age Hardening

Microstructure and Property relationship of various Non-ferrous Materials

Recent Material used in Additive Manufacturing: Properties, Composition and Application only

Books & Other Resources

Text Books

1. Dr. V. D. Kodgire & S. V. Kodgire, “Material Science & Metallurgy For Engineers”, Everest Publication.
2. William D. Callister, “Materials Science and Engineering an Introduction”, Jr, John Wiley & Sons, Inc.

Reference Books

1. A. K. Bhargava, C.P. Sharma, “Mechanical Behaviour & Testing of Materials”, P H I Learning Private Ltd.
2. Raghvan V., “Material Science & Engineering”,Prentice Hall of India, New Delhi. 2003
3. Avner, S.H., “Introduction to Physical Metallurgy”, Tata McGraw-Hill, 1997.
4. Higgins R. A., “Engineering Metallurgy”, Viva books Pvt. Ltd.
5. George Ellwood Dieter, “Mechanical Metallurgy”, McGraw-Hill 1988
6. Smith, W.F, Hashemi, J., and Prakash, R., “Materials Science and Engineering in SI Units”, Tata McGraw Hill Education Pvt. Ltd.

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work Journal

Total 10 experiments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Assignments, and Industrial Visits.

Practical *(Any Seven)*

1. Destructive testing - Hardness testing (Rockwell/Vickers) Hardness conversion number
2. Brinell and Poldi hardness Test

3. Impact Test for Steel, Aluminum, Brass and Copper (Charpy/Izod)
4. Non Destructive testing - Dye Penetrant Test/ Magnetic Particle test/ Ultrasonic Test
5. Steps for Specimen Preparation for microscopic examination & Demonstration of Optical Metallurgical microscope
6. Observation and Drawing of Microstructure of Steels, Cast Iron of various compositions
7. Observation and Drawing of Microstructure of Non Ferrous Metals of various compositions
8. Heat Treatment of steels based on relative hardness
9. Jominy End Quench Test for hardenability

Miniature commitment or Assignments *(Any Two)*

1. Exploration of engineering Alloy (Name, composition, properties, microstructure, Heat treatment, Designation & specific applications)- One student one Alloy or material
2. Examine aspects of component form material and manufacturing process point of view (Name, Material, Drawing, Manufacturing Process, properties, microstructure, Heat treatment, & specific applications) - For example spur gear, Needle etc. One student one component
3. Creep and Fatigue Test (Virtual Lab IIT Bombay)
4. Fluorescence Microscope (Virtual Lab IIT Bombay)

Industrial Visits

To provide awareness and understanding of the course, Compulsory Industrial Visit must be arranged for the students.

The Industrial Visit must be preferably to

- Material & Metallurgy related like Engineering Cluster, NDT Lab, and Nearby NABL lab or
- Any manufacturing unit with material orientation

Student must submit a properly documented Industrial Visit Report.

Guidelines for Instructor's Manual

The Instructor's Manual should contain following related to every experiment:

1. Brief theory related to the experiment
2. Apparatus with their detailed specifications
3. Standard ASME/ IS numbers of test procedure
4. Schematic, Layout/diagram
5. Observation table/graphs.
6. Sample calculations for one/two reading
7. Result table, Graph and Conclusions.
8. 3/4 questions related to the experiment
9. Relevance of practical in industry with recent software of image analysis

Guidelines for Student's Lab Journal

The Student's Lab Journal should contain following related to every experiment:

1. Theory related to the experiment
2. Apparatus with their detailed specifications
3. Schematic, Layout/diagram
4. Observation table/simulation plots/graphs
5. Sample calculations for one/two reading
6. Result table. Graph and Conclusions
7. 3/4 questions related to the experiment
8. Attach Photo of experiment or image related to Experiment

Guidelines for Lab/TW Assessment

1. There should be continuous assessment for the TW
2. Assessment must be based on understanding of theory, attentiveness during practical, and understanding
3. Session, how efficiently the student is able to do connections and get the results
4. Online evolutions of practical with objective type of Questions
5. Timely submission of journal

203156 - Electrical and Electronics Engineering

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Term Work : 25 Marks

Prerequisite Courses

Basic Electrical Engineering, Basic Electronics Engineering, Systems in Mechanical Engineering

Course Objectives

1. To understand Arduino IDE; an open source platform and its basic programming features
2. To interface Atmega328 based Arduino board with different devices and sensors
3. To study principle of operation of DC machines and speed control of DC motors
4. To know about three phase induction motor working and its applications
5. To get acquainted with Electric Vehicle (EV) technology and subsystems
6. To get familiar with various energy storage devices and electrical drives

Course Outcomes

On completion of the course, learner will be able to

CO1. APPLY programming concepts to UNDERSTAND role of Microprocessor and Microcontroller in embedded systems

CO2. DEVELOP interfacing of different types of sensors and other hardware devices with Atmega328 based Arduino Board

CO3. UNDERSTAND the operation of DC motor, its speed control methods and braking

CO4. DISTINGUISH between types of three phase induction motor and its characteristic features

CO5. EXPLAIN about emerging technology of Electric Vehicle (EV) and its modular subsystems

CO6. CHOOSE energy storage devices and electrical drives for EVs

Course Contents

Unit I — Introduction to Arduino — [08 Hr.]

Introduction to microcontroller and microprocessors, role of embedded systems, open source embedded platforms, Introduction to Arduino IDE- features, IDE overview, Programming concepts: variables, functions, conditional statements, Concept of GPIO in Atmega328 based Arduino board, digital input and output

Unit II — Peripheral Interface — [07 Hr.]

Interfacing of Atmega328 based Arduino board with LED and LCD/serial monitor, serial communication using Arduino IDE, Concept of ADC in Atmega328 based Arduino board, interfacing of Atmega328 based Arduino board with temperature sensor (LM35), LVDT, strain gauge

Unit III — DC Machines — [08 Hr.]

Generating and motoring action, Constructional features of a DC machine, EMF equation of DC machine and its significance in motor

Concept of torque developed by motor and it's equation, Concept of load torque, Types of loads and dynamics of motor and load combination, Characteristics of DC shunt motor, Speed control methods of DC shunt motor, Reversal of direction of rotation of DC motor, Braking in DC motor and its types, Regenerative braking in DC shunt motor

Unit IV — Three Phase Induction Motors — [07 Hr.]

Constructional features, working principle of three phase induction motor, types, torque equation, torque-slip characteristics, effect of rotor resistance on characteristics, modification in squirrel cage motor with deep bar rotor construction

Power stages, efficiency, starters (DOL starter and Star Delta starter), Methods of speed control- voltage and frequency control, variable frequency drive, applications

Unit V	Electric Vehicle (EV) Technology	[08 Hr.]

Brief history of Electric Vehicle (EV), Components of EV, Benefits of EV

Types of EVs such as Battery EV, Hybrid EV, Plug-in EV, Fuel Cell EV and their comparison, Challenges faced by EV technology

Subsystems and configurations of EV, Subsystems of Hybrid EV, Configurations of series, parallel and series-parallel Hybrid EV

Impact of EV on grid, Vehicle to grid technology- block diagram

Unit VI	Energy Storage Devices and Electric Drives	[07 Hr.]

Storage Devices: Cell construction and working of batteries like Lithium- Iron Phosphate (LFP), Lithium Nickel-Manganese-Cobalt (NMC) and Lithium- Manganese Oxide (LMO), Voltage, Impedance, Ah and Wh Capacity, Cycle Life, Energy density, Power, C-rate and safety aspects

Use of supercapacitor and hydrogen fuel cell in EVs- necessity, advantages and specifications

Factors used in selection of energy storage device in case of EVs, Vehicle Battery Management System - block diagram

Electric Drives: Factors used for selection of the electric motor in EVs

BLDC hub motor drive for EVs, characteristics and speed control of BLDC motor, three phase induction motor drive for EVs

Books & Other Resources

Text Books

1. Barret Steven F, "Arduino Microcontroller Processing for Everyone!", 3rd Ed, Morgan and Claypool Publishers
2. Michael Margolis, "Arduino Cookbook", 2nd Ed, O'Reilly Media
3. Hughes Edward, "Electrical and Electronic Technology", Pearson Education
4. Ashfaq Husain, "Electric Machines", 3rd Ed, Dhanpat Rai & Sons
5. Bhattacharya S. K., "Electrical Machine", 3rd Ed, Tata McGraw Hill
6. Nagrath & Kothari, "Electrical Machines", Tata McGraw Hill
7. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press
8. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 2nd Ed, CRC Press

Reference Books

1. Deshmukh Ajay, "Microcontrollers Theory and Applications", Tata McGraw Hill
2. Massimo Banzi, "Getting Started with Arduino", 2nd Ed, Maker Media, Inc.
3. Brad Kendall, "Getting Started With Arduino: A Beginner's Guide", Justin Pot and Angela Alcorn (Editors)
4. Lowe, "Electrical Machines", Nelson Publications
5. [A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans, "Electrical Machines", 5th Ed, Tata McGraw Hill
6. Pillai S. K., "A First Course on Electrical Drives", New Age International (P) Ltd.
7. James Larminie, John Lowry, , "Electric Vehicle Technology Explained", Wiley
8. Dhameja Sandeep, "Electric Vehicle Battery Systems", Newnes
9. R. Krishnan,"Permanent Magnet Synchronous and Brushless DC Motor Drives", CRC Press

Web References

1. www.arduino.cc *(for downloading Arduino IDE and information)*
2. www.alldatasheet.com *(for datasheets of components)*
3. https://spoken-tutorial.org/tutorial-search/ *(for video tutorials on Arduino)*
4. https://swayam.gov.in/NPTEL *(for e-learning courses and video lectures)*

Guidelines for Laboratory Conduction
The student shall complete the following activity as a Term Work

Total 10 experiments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Assignments using Virtual Laboratory & Detailed Industrial Visit Report and Group Assignment using Case Study/Product Survey.

Practical - Electronics Engineering Laboratory *(Any four experiments to be performed)*
Atmega328 based Arduino board can be used for following interfaces:

1. Interfacing of LED to blink after every 1 sec
2. Display data using serial communication with PC
3. Interfacing of LCD to display given message
4. Interfacing of temperature sensor (LM35) and display output on LCD/serial monitor
5. Interfacing of strain gauge sensor to measure parameters like pressure, weight, etc., and display the measured value
6. Interfacing of LVDT sensor to measure the displacement and display the measured value

Practical - Electrical Engineering Laboratory *(Any four experiments to be performed)*

7. Demonstration of use of starters for DC motor and three phase induction motor along with understanding of specifications on name plates of these machines
8. Brake test on DC shunt motor
9. Study of power electronic converter based DC motor drive
10. Study of electrical braking of DC shunt motor (Rheostatic/ Plugging/regenerative)
11. Load test on three phase induction motor
12. Torque- speed characteristics of three phase induction motor

Assignments using Virtual Laboratory
Virtual Labs project is an initiative of the Ministry of Human Resource Development (MHRD), Government of India under the aegis of National Mission on Education through Information and Communication Technology (NMEICT). Please visit the following link for exploring experiments on Electrical Machines: http://www.vlab.co.in/broad-area-electrical-engineering

Assign following experiments by applying Virtual Labs:

1. Speed control of DC shunt motor by armature and field resistance control
2. Speed control of slip ring induction motor by rotor resistance control

Please refer http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/Sadhya/experimentlist.html

Assignments using Case Study/Product Survey
Each group consisting of maximum five number of students should carry out a case study/product survey focused on various EVs available in Indian market. *Forming groups and allotment of specific task to the students group should be done at the beginning of semester so that students get sufficient time to carry out the survey and prepare a presentation.*

Students must

- Compare various models in each class.
- Study various main components of EVs
- A formal presentation on case study/product survey must be arranged before class/batch.

Industrial Visits
An industrial visit must be arranged to one of the following establishments during the semester.
The Industrial Visit must be preferably to

- Automation/Manufacturing industries
- Battery/EV Charging Stations
- Retro-fitting Workshops of ICE vehicle to EVs
- EV Service Stations

Student must submit properly documented Detailed Industrial Visit Report in his/her own words.

Instructions for Laboratory Conduction

Electronics Engineering Laboratory

1. The instructor is expected to shortlist necessary experiments from the suggested list of experiments.

2. During the practical session the instructor may divide the total students in groups of 4 to 5 students and assign them different experiments.
3. Each student in the group is supposed to execute the program.
4. The faculty should check the result of all the groups.

Electrical Engineering Laboratory

1. Check whether the MCB / ELCB / main switch is off while preparing the set-up.
2. Make connections as per circuit diagram. Use flexible wire for connection of voltmeter and pressure coil connection of wattmeter. For the rest of the connections, use thick wires. Do not keep the connections loose. Get it checked by the faculty / Lab Assistant.
3. Perform the experiment only in presence of faculty or Lab Assistant.
4. Do the calculations and get these checked from the faculty.
5. After completion of experiment, switch off the MCB / ELCB / main switch.
6. Write the experiment in the journal and get it checked regularly after conducting

Guidelines for Instructor's Manual

The Instructor's Manual should contain following related to every experiment:

1. Brief theory related to the experiment.
2. Connection diagram /circuit diagram
3. Observation table
4. Sample calculations for one reading
5. Result table
6. Graph and Conclusions.
7. Data sheets of the ICs used(if any)

Guidelines for Student's Lab Journal

Electronics Engineering Laboratory

1. Title of the program should be mentioned
2. The algorithm of the program must be written
3. Flow Chart for each program has to be drawn on separate page
4. Input data has to be specified
5. Result of the program should be highlighted

Electrical Engineering Laboratory

1. Lab journal should be hand written
2. Circuit diagrams can be drawn on graph paper
3. Specifications of the instruments/machines used for conduction of practical should be mentioned in respective write-up
4. Conclusion of each experiment should be written by student at the end

Guidelines for Lab/TW/PR Assessment

1. Continuous assessment should be carried out time to time.
2. During assessment, faculty should put the remark by writing the word "Complete" and not simply "C". Put the signature along with the date at the end of experiment and also in the index.
3. Assess each laboratory experiment/virtual lab assignment/report of industrial visit/case study for 10 marks each as per following details:
   Attendance in practical - 02 marks
   Timely completion of journal -03 marks
   Presentation of write-up and results - 02 marks
   Depth of understanding - 03 marks
4. Maintain a continuous assessment sheet on the basis of which final TW marks can be offered.

202045 - Geometric Dimensioning and Tolerancing Lab		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 02 Hr./Week	**01** Practical : 01	Term Work : 25 Marks

Prerequisite Courses

Systems in Mechanical Engineering, Project Based Learning - I, Workshop Practise, Engineering Graphics

Course Objectives

1. To understand requirements of industrial drawings
2. To read, understand and explain basic Geometric Dimensioning & Tolerancing concepts
3. To apply various geometric and dimension tolerances based on type of fit
4. To include surface roughness symbols based on manufacturing process
5. To measure and verify position tolerances with applied material conditions
6. To understand requirements for manufacturing and assembly

Course Outcomes

On completion of the course, learner will be able to

CO1. SELECT appropriate IS and ASME standards for drawing
CO2. READ & ANALYSE variety of industrial drawings
CO3. APPLY geometric and dimensional tolerance, surface finish symbols in drawing
CO4. EVALUATE dimensional tolerance based on type of fit, etc.
CO5. SELECT an appropriate manufacturing process using DFM, DFA, etc.

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work Journal

Total 9 Practical Assignments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Industrial Visit Report and Group Assignment.

Practical *(Assignment # 1 to 6 & 10 are compulsory; Select any Two from Assignment # 7 to 9)*
The student shall complete the following Practical in laboratory. Learner will demonstrate skills to communicate drawings as per industry standards:

1. Study of drawing sheet layout, Principles of Drawing and various IS Standards & Conventions in Machine Drawing, Dimensioning practices - Terminology & Basic Rules, Styles, Conventions [02 Hr.]
2. GD&T -
   (a) Terminology, Maximum and Minimum Material conditions, Features, Rules for GD&T, Datum Control [02 Hr.]
   (b) Adding GD&T to a Design, Form Tolerances [02 Hr.]
   (c) Orientation Tolerances, Profile Tolerances [02 Hr.]
   (d) Location Tolerances, Run out Tolerances [02 Hr.]
3. Surface finish, Welding symbols [02 Hr.]
4. Study and reading of Industrial Drawings to understand standard industrial practices viz. Dimensioning, GD&T, Surface finish, welding symbols, etc. [04 Hr.]
   (a) Machine Drawing, (b) Production Drawing, (c) Part Drawing,
   (d) Assembly Drawing - (i) Assembly Drawing for Design, (ii) Assembly Drawing for Instruction Manuals, (iii) Exploded Assembly Drawing, (iv) Schematic Assembly Drawing, (v) Patent Drawing, etc.
5. Calculation of Tolerances based on Type of Fits in Assembly [02 Hr.]
6. Tolerance Stacks-Up with suitable examples [02 Hr.]
7. Design for Manufacturing (DFM) with suitable examples [02 Hr.]
8. Design for Assembly and Dis-assembly with suitable examples [02 Hr.]
9. Design for Safety with suitable examples [02 Hr.]
10. Industrial visit / Case study

Books & Other Resources
Text Books 1. Standards: ASME Y14.5 – 2018 2. Narayana, K. L., Kannaiah, P., Venkata Reddy, K., (2016), "Machine Drawing", 2nd edition, New Age International Publishers, New Delhi, India, ISBN-13: 978-8122440546 3. Bhatt, N. D. and Panchal, V. M., (2014), "Machine Drawing", Charotar Publishing House Pvt. Ltd, Anand, India, ISBN-13: 978-9385039232
Reference Books 1. Cogorno, G. R., (2020), "Geometric Dimensioning and Tolerancing for Mechanical Design", 3rd edition, McGraw-Hill Education 2. Blokdyk, Gerardus, (2019), "Geometric Dimensioning and Tolerancing: A Complete Guide - 2020 Edition", 5STARCooks 3. Standards: ISO/TR 23605:2018, ISO 1101:2017, SP 46, IS 15054(2001)

202046 - Audit Course - III		
Teaching Scheme	**Credits**	**Examination Scheme**
-	-	-

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

Faculty mentor shall be allotted for individual courses and he/she shall monitor the progress for successful accomplishment of the course. Such monitoring is necessary for ensuring that the concept of self learning is being pursued by the students 'in true letter and spirit'.

- If any course through Swayam/ NPTEL/ virtual platform is selected the minimum duration shall be of 8 weeks.
- However if any of the course duration is less than the desired (8 weeks) the mentor shall ensure that other activities in form of assignments, quizzes, group discussion etc. (allied with the course) for the balance duration should be undertaken.

In addition to credits courses, it is mandatory that there should be an audit course (non-credit course) from second year of Engineering. The student will be awarded grade as AP on successful completion of the audit course. The student may opt for any one of the audit courses in each semester. Such audit courses can help the student to get awareness of different issues which make an impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Students can choose one of the audit courses from the list of courses mentioned. Evaluation of the audit course will be done at institute level.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not considered in the calculation of the performance indices SGPA and CGPA. Evaluation of the audit course will be done at institute level itself.

Selecting an Audit Course

List of Courses to be opted (Any one) under Audit Course III

- Technical English For Engineers
- Entrepreneurship Development
- Developing soft skills and personality
- Design Thinking
- Foreign Language (preferably German/ Japanese)
- Science, Technology and Society

The titles indicated above are subject to change in time to come and such an alteration (if any) should be brought to the notice of the BoS.

Using NPTEL Platform: (preferable)

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Students can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.
- After clearing the examination successfully; student will be awarded with a certificate.

Assessment of an Audit Course

- The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary.
- During the course students will be submitting the online assignments. A copy of the same can be submitted as a part of term work for the corresponding Audit course.
- On the satisfactory submission of assignments, the institute can mark as "Present" and the student will be awarded the grade AP on the marksheet.

207002 - Engineering Mathematics - III

Teaching Scheme	Credits	Examination Scheme
Theory : 03 Hr./Week Tutorial : 01Hr/Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Term Work : 25 Marks

Prerequisite Courses

Differential & Integral calculus, Differential equations of first order & first degree, Fourier series, Collection, classification and representation of data and Vector algebra.

Course Objectives

1. To make the students familiarize with concepts and techniques in Ordinary & Partial differential equations, Laplace transform & Fourier transform, Statistical methods, Probability theory and Vector calculus.
2. The aim is to equip them with the techniques to understand advanced level mathematics and its applications that would enhance analytical thinking power, useful in their disciplines.

Course Outcomes

On completion of the course, learner will be able to

CO1. SOLVE higher order linear differential equations and its applications to model and analyze mass spring systems.

CO2. APPLY Integral transform techniques such as Laplace transform and Fourier transform to solve differential equations involved in vibration theory, heat transfer and related mechanical engineering applications.

CO3. APPLY Statistical methods like correlation, regression in analyzing and interpreting experimental data applicable to reliability engineering and probability theory in testing and quality control.

CO4. PERFORM Vector differentiation & integration, analyze the vector fields and APPLY to fluid flow problems.

CO5. SOLVE Partial differential equations such as wave equation, one and two dimensional heat flow equations.

Course Contents

Unit I — Linear Differential Equations (LDE) and Applications — [08 Hr.]

LDE of nth order with constant coefficients, Complementary Function, Particular Integral, General method, Short methods, Method of variation of parameters, Cauchy's and Legendre's DE, Simultaneous and Symmetric simultaneous DE. Modelling of Mass-spring systems, Free &Forced damped and undamped systems.

Unit II — Transforms — [08 Hr.]

Laplace Transform **(LT):** LT of standard functions, properties and theorems, Inverse LT, Application of LT to solve LDE.

Fourier Transform **(FT):** Fourier integral theorem, Fourier transform, Fourier sine & cosine transforms, Inverse Fourier Transforms.

Unit III — Statistics — [07 Hr.]

Measures of central tendency, Measures of dispersion, Coefficient of variation, Moments, Skewness and Kurtosis, Curve fitting: fitting of straight line, parabola and related curves, Correlation and Regression, Reliability of Regression Estimates.

Unit IV — Probability and Probability Distributions — [07 Hr.]

Probability, Theorems on Probability, Bayes Theorem, Random variables, Mathematical Expectation, Probability distributions: Binomial, Poisson, Normal, Test of Hypothesis: Chi-Square test, t-test.

UnitV — Vector Calculus — [08 Hr.]

Vector differentiation, Gradient, Divergence and Curl, Directional derivative, Solenoidal & Irrotational fields, Vector identities. Line, Surface and Volume integrals, Green's Lemma, Gauss's Divergence theorem and Stoke's theorem.

Unit VI	Applications of Partial Differential Equations (PDE)	[08 Hr.]
Basic concepts, modelling of Vibrating String, Solution of Wave equation, One and two dimensional Heat flow equations, Method of separation of variables, use of Fourier series. Solution of Heat equation by Fourier transforms.		

Books & Other Resources

Text Books

1. B.V. Ramana, “Higher Engineering Mathematics”, Tata McGraw-Hill
2. B. S. Grewal, “Higher Engineering Mathematics”, Khanna Publication, Delhi

Reference Books

1. Erwin Kreyszig, “Advanced Engineering Mathematics’, 10e, by Wiley India.
2. M. D. Greenberg, “Advanced Engineering Mathematics”, 2e, by Pearson Education.
3. Peter V. O'Neil , “Advanced Engineering Mathematics”, 7e, by Cengage Learning
4. S. L. Ross, “Differential Equations”, 3e by Wiley India.
5. Sheldon M. Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, 5e, by Elsevier Academic Press

Guidelines for Tutorial and term Work

1. Tutorial shall be engaged in four batches (batch size of 20 students maximum) per division.
2. Term work shall be based on continuous assessment of six assignments (one per each unit) and performance in internal tests.The student shall complete the following activity as a Term Work Journal.

202047 - Kinematics of Machinery		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Oral : 25 Marks

Prerequisite Courses

Systems in Mechanical Engineering, Engineering Mathematics - I and II, Engineering Physics, Engineering Mechanics, Geometric Modeling & Drafting

Course Objectives

1. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications.
2. To develop the competency to analyze the velocity and acceleration in mechanisms using analytical and graphical approach.
3. To develop the skill to propose and synthesize the mechanisms using graphical and analytical technique.
4. To develop the competency to understand & apply the principles of gear theory to design various applications.
5. To develop the competency to design a cam profile for various follower motions.

Course Outcomes

On completion of the course, learner will be able to

CO1. APPLY kinematic analysis to simple mechanisms

CO2. ANALYZE velocity and acceleration in mechanisms by vector and graphical method

CO3. SYNTHESIZE a four bar mechanism with analytical and graphical methods

CO4. APPLY fundamentals of gear theory as a prerequisite for gear design

CO5. CONSTRUCT cam profile for given follower motion

Course Contents

Unit I — Fundamentals of Mechanism — [07 Hr.]

Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom, Mobility of Mechanism, Inversion, Grashoff's law, Four-Bar Chain and its Inversions, Slider crank Chain and its Inversions, Double slider crank Chain and its Conversions, Mechanisms with Higher pairs, Equivalent Linkages and its Cases - Sliding Pairs in Place of Turning Pairs, Spring in Place of Turning Pairs, Cam Pair in Place of Turning Pairs

Unit II — Kinematic Analysis of Mechanisms: Analytical Method — [07 Hr.]

Analytical methods for displacement, velocity and acceleration analysis of slider crank Mechanism, Velocity and acceleration analysis of Four-Bar and Slider crank mechanisms using Vector and Complex Algebra Methods. Computer-aided Kinematic Analysis of Mechanism like Slider crank and Four-Bar mechanism, Analysis of Single and Double Hook's joint

Unit III — Kinematic Analysis of Mechanisms: Graphical Method — [08 Hr.]

Displacement, velocity and acceleration analysis mechanisms by Relative Velocity Method (Mechanisms up to 6 Links), Instantaneous Centre of Velocity, Kennedy's Theorem, Angular Velocity ratio Theorem, Analysis of mechanism by ICR method (Mechanisms up to 6 Links), Coriolis component of Acceleration (Theoretical treatment only)

Unit IV — Synthesis of Mechanisms — [07 Hr.]

Steps in Synthesis: Type synthesis, Number Synthesis, Dimensional synthesis, Tasks of Kinematic synthesis - Path, function and motion generation (Body guidance), Precision Positions, Chebychev spacing, Mechanical and structural errors

Graphical Synthesis: Inversion and relative pole method for three position synthesis of Four-Bar and Single Slider Crank Mechanisms

Analytical Synthesis: Three position synthesis of Four-Bar mechanism using Freudenstein's equation, Blotch synthesis

Unit V **Kinematics of Gears** **[08 Hr.]**

Gear: Classification

Spur Gear: Terminology, law of gearing, Involute and cycloidal tooth profile, path of contact, arc of contact, sliding velocity, Interference and undercutting, Minimum number of teeth to avoid interference, Force Analysis (theoretical treatment only)

Helical and Spiral Gears: Terminology, Geometrical Relationships, virtual number of teeth for helical gears

Bevel Gear & Worm and Worm Wheel: Terminology, Geometrical Relationships

Gear Train: Types, Analysis of Epicyclic gear Trains, Holding torque - simple, compound and Epicyclic gear Trains, Torque on Sun and Planetary gear Train, compound Epicyclic gear Train

Unit VI **Mechanisms in Automation Systems** **[08 Hr.]**

Cams & Followers: Introduction, Classification of Followers and Cams, Terminology of Cam Displacement diagram for the Motion of follower as Uniform velocity, Simple Harmonic Motion (SHM), Uniform Acceleration and Retardation Motion (UARM), Cycloid motion, Cam Profile construction for Knife-edge Follower and Roller Follower, Cam jump Phenomenon

Automation: Introductions, Types of Automation

Method of Work Part Transport: Continuous transfer, Intermittent or Synchronous Transfer, Asynchronous transfer, Different type of transfer mechanisms - Linear transfer mechanisms and Rotary transfer mechanisms

Automated Assembly-Line: Types, Assembly line balancing Buffer Storages, Automated assembly line for car manufacturing, Artificial intelligence in automation

Books & Other Resources

Text Books

1. S. S. Rattan, “Theory of Machines”, Third Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi.
2. Bevan T, “Theory of Machines”, Third Edition, Longman Publication
3. G. Ambekar, “Mechanism and Machine Theory”, PHI
4. J. J. Uicker, G. R. Pennock, J. E. Shigley, “Theory of Machines and Mechanisms”, Fifth Edition, International Student Edition, Oxford

Reference Books

1. Paul E. Sandin, “Robot Mechanisms and Mechanical Devices Illustrated”, Tata McGraw Hill Publication
2. Stephen J. Derby, “Design of Automatic Machinery”, 2005, Marcel Dekker, New York
3. Neil Sclater, “Mechanisms and Mechanical Devices Sourcebook”, Fifth Edition, Tata McGraw Hill Publication
4. Ghosh Malik, “Theory of Mechanism and Machines”, East-West Pvt. Ltd.
5. Hannah and Stephans, “Mechanics of Machines”, Edward Arnolde Publication
6. R. L. Norton, “Kinematics and Dynamics of Machinery”, First Edition, McGraw Hill Education (India) P Ltd. New Delhi
7. Sadhu Singh, “Theory of Machines”, Pearson
8. Dr. V. P. Singh, “Theory of Machine”, Dhanpatrai and Sons
9. C. S. Sharma & Kamlesh Purohit, “Theory of Machine and Mechanism”, PHI
10. M.P. Groover, “Automation, production systems and computer-integrated manufacturing”, Prentice-Hall of India Pvt. Ltd, New Delhi

Web References

1. https://nptel.ac.in/courses/112104121/ (NPTEL1, Kinematics of Machines, Prof. Ashok K Mallik, IIT Kanpur)
2. https://nptel.ac.in/courses/112/106/112106270/ (NPTEL2, Theory of Mechanism, Prof. Sujatha Srinivasan, IIT Madras)
3. https://nptel.ac.in/courses/112/105/112105268/ (NPTEL3, Kinematics of Mechanisms and Machines, Prof. Anirvan DasGupta, IIT Kharagpur)

4. https://nptel.ac.in/courses/112/105/112105236/ (NPTEL4, Mechanism and Robot Kinematics, Prof.Anirvan DasGupta, IIT Kharagpur)
5. http://www.cdeep.iitb.ac.in/webpage_data/nptel/Mechanical/Robotics Course/Course_home_lect1.html (NPTEL5, Introduction to Robotics and Automation, IIT Bombay)

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work

Total 10 experiments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Assignments using Drawing Aids, Assignments using Software & Programming Languages, Assignments using Virtual Laboratory and Detailed Industrial Visit Report.

Practical *(Experiment # 1 is compulsory and Select any Two from Experiment # 2 to 4)*

1. To make a model of any mechanism by using waste material by the group of 4 to 6 students and to give a presentation using PPTs.
2. Speed and torque analysis of epicyclic gear train to determine holding torque.
3. To study and verify cam jump phenomenon.
4. To study manufacturing of gear using gear generation with rack as a cutter and to generate an involute profile.

Assignments using Drawing Aids *(Experiment #1 to 3 and 6 are compulsory and Select any One from Experiment #4-5)*

Do following graphical assignments on Half Imperial drawing sheet:

1. Identify mechanisms in real life and Analyze for types and number of links, pairs, obtain degrees of freedom. Submit the sheet and working video of the mechanism.
2. To solve two problems on velocity and acceleration analysis using relative velocity and acceleration method.
3. To solve two problems on velocity analysis using the ICR method.
4. To draw conjugate profile for any general type of gear tooth.
5. To study various types of gearboxes.
6. To draw cam profile for any two problems with combination of various follower motion with radial and off-set cam.

Assignments using Software *(Any Three Assignments - Minimum one computer programming based and Minimum one based on use of software)*

Do following assignments by using Software or by using Coding/Programming Languages:

1. To design a simple Planer Mechanism by using any software (Geogebra, SAM, Working Model, any 3D Modelling Software, etc.)
2. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for Kinematic Analysis of Slider Crank Mechanism using Analytical Method
3. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for Kinematic Analysis of Hooke's joint Mechanism using Analytical Method
4. To generate a Cam Profile using any Modelling Software (Mech Analyser, any 3D Modelling Software)
5. To synthesize the Four-Bar and Slider Crank Mechanism (Geogebra, SAM, any 2D/3D Modelling Software)
6. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for the Synthesis of Mechanism using Chebychevs spacing, Freudensteins equation and function generation

Assignments using Virtual Laboratory *(minimum Two experiments)*

Please visit the links given below for exploring experiments on Kinematics of Machinery using Virtual Laboratory. Write a Brief Reports of using Virtual Laboratory to perform following assignment:

1. Mechanics-of-Machines Lab (All Experiments), http://mm-nitk.vlabs.ac.in/index.html
2. Mechanisms and Robotics - Oldham Coupling Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html
3. Mechanisms and Robotics - Quick Return Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html

4. Mechanisms and Robotics - CAM Follower Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html

Industrial Visits

A Compulsory industrial visit must be arranged to industries/ establishments consisting automation and mechanization during semester to provide awareness and understanding of the course.

The Industrial Visit must be preferably to

- Manufacturing industries with Assembly-line Automation
- Sugar factory
- Bottle filling plants

Student must submit properly documented Detailed Industrial Visit Report in his/her own words.

Assignments on Content beyond syllabus

Following assignments can be attempted:

1. Forward and Inverse Kinematics of 2R/2P/RP/PR Manipulators using Software (Geogebra, RoboAnalyser, Vlab, etc.)
2. Kinematic Analysis of 6 DOF Industrial Robot using Software (RoboAnalyzer, Vlab, etc.)

202048 - Applied Thermodynamics		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hr./Week Practical : 02 Hr./Week	**04** Theory : 03 Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Oral : 25 Marks

Prerequisite Courses

Engineering Thermodynamics, Systems in Mechanical Engineering, Engineering Mathematics - I, Engineering Mathematics - II

Course Objectives

1. To determine COP of refrigeration cycle and study Psychrometric properties and processes.
2. To study working of engine, Actual, Fuel-Air and Air standard cycle and its Performance.
3. To understand Combustion in SI and CI engines and factors affecting performance parameters
4. To study emission from IC Engines and its controlling method, various emission norms.
5. To estimate performance parameters by conducting a test on I. C. Engines.
6. To determine performance parameters of Positive displacement compressor.

Course Outcomes

On completion of the course, learner will be able to

CO1. DETERMINE COP of refrigeration system and ANALYZE psychrometric processes.
CO2. DISCUSS basics of engine terminology,air standard, fuel air and actual cycles.
CO3. IDENTIFY factors affecting the combustion performance of SI and CI engines.
CO4. DETERMINE performance parameters of IC Engines and emission control.
CO5. EXPLAIN working of various IC Engine systems and use of alternative fuels.
CO6. CALCULATE performance of single and multi stage reciprocating compressors and DISCUSS rotary positive displacement compressors

Course Contents

Unit I — Basics of Refrigeration and Psychrometry — [07 Hr.]

Refrigeration: Reversed Carnot Cycle, unit of refrigeration, Simple Vapour Compression Cycle (VCC), Refrigerating Effect, Compressor Power & COP. Simple Vapor Absorption Cycle (VAC), Comparison between VCC & VAC.

Psychrometry: Introduction, Psychrometry and Psychrometric Properties, Basic Terminologies & Psychrometric Relations, Psychrometric Processes, Psychrometric Chart.

Unit II — Introduction to Internal Combustion (IC) Engine — [06 Hr.]

IC Engine: Components and Construction details, Terminology, Classification, Applications, Intake and exhaust system, Valves actuating mechanisms, Valve timing diagram.

Fuel, Air and Actual Cycle: Air-standard cycles, fuel air cycles, and actual cycles, Effects of variables on performance, various losses, and Comparison of Air standard with Fuel and Actual cycle.

Unit III — SI and CI Engines — [09 Hr.]

SI Engines: Theory of Carburetion and Types of Carburetor, Working of Simple Carburetor, Electronic Fuel Injection System, Combustion stages in SI engines, Abnormal Combustion, Theory of Detonation and Parameters affecting detonations, Rating of fuels in SI engines, Combustion Chambers used in SI Engine.

CI Engines: Fuel Injection system, Construction and Working of Fuel Pump, Fuel Injector and Various types of Nozzle, Combustion stages in CI engines, Theory of knocking and Parameters affecting knocking, Rating of fuels in CI engines, Combustion Chambers used in CI Engines.

Unit IV — IC Engine Testing and Emission — [09 Hr.]

Engine Testing: Engine Testing Procedure, Measurement of indicated power, Brake power, fuel consumption, Air Consumption, Measurement of friction power by Willan's Line Method and Morse Test, calculation of mean effective pressure, various efficiencies, specific fuel consumption, heat balance sheet of IC Engines and performance Characteristic curves.

Emission & Control: Introduction to Indian Driving Cycle (IDC), European Driving Cycle (EDC), SI and CI Engines Emission and controlling methods, Methods to measure emission such as (Non Dispersive Infrared Red (NDIR), Flame Ionization Detector (FID), Chemiluminescent Analyzer, Smoke meter), Euro Norms and Bharat Stage Norms.

Unit V **Engine Systems and Alternative Fuels** **[07 Hr.]**

Cooling system: Air Cooling, Liquid cooling, **Lubrication system**: Objectives of lubrication system, properties of lubricant, Methods of lubrication system, **Ignition system**: battery coil ignition system, magneto ignition system, Electronics Ignition (CDI, TCI), Maximum Brake Torque (MBT) & spark advance. Supercharging and Turbo-charging.

Alternative Fuels: Bio-diesel, Ethanol, LPG, CNG and Hydrogen.

Unit VI **Compressor** **[07 Hr.]**

Reciprocating Compressor: Applications of compressed air, single stage compressor (without clearance and with clearance volume), volumetric efficiency, isothermal efficiency, effect of clearance volume, free air delivery (FAD), actual indicator diagram for air compressor, Multi staging of compressor, optimum intermediate pressure, intercooler, after cooler, Capacity control of compressors.

Rotary Compressors: Roots blower, Vane type, Screw compressor and Scroll compressor.

Books & Other Resources

Text Books

1. Arora C. P., “Refrigeration and Air Conditioning”, Tata McGraw-Hill
2. V. Ganesan, “Internal Combustion Engines”, Tata McGraw-Hill
3. M. L. Mathur and R.P. Sharma, “A course in Internal combustion engines”, Dhanpat Rai & Co.
4. H.N. Gupta, “Fundamentals of Internal Combustion Engines”, PHI Learning Pvt. Ltd.

Reference Books

1. Dossat Ray J, “Principles of refrigeration, S.I. version”, Willey Eastern Ltd, 2000
2. Heywood, “Internal Combustion Engine Fundamentals”, Tata McGraw-Hill
3. Domkundwar & Domkundwar, “Internal Combustion Engine”, Dhanpat Rai & Co.
4. R. Yadav, “Internal Combustion Engine”, Central Book Depot, Ahmedabad.
5. S.Domkundwar,C.P. Kothandaraman,A.Domkundwar,“Thermal Engineering”,DhanpatRai & Co.

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work

Total 10 of the following list must be performed. During Oral, the Student shall be evaluated based on the completion of Practical, Assignments, Presentations and Detailed Industrial Visit Report.

Practical *(Minimum 6 Practical must be performed)*

1. Trial on Vapour Compression System
2. Trial on Vapour Absorption System
3. Trial on Air-Conditioning Test Rig.
4. Morse Test on Petrol engine.
5. Trial on Diesel engine.
6. Trial on Petrol engine.
7. Trial on variable compression ratio engine.
8. Trial on Positive Displacement Air Compressor.
9. Demonstration on Exhaust Gas Analyser and Smoke meter.

Survey *(Minimum one)*

1. Practical Survey of various fuel supply systems.
2. Practical Survey of supercharged and turbocharged engines.

Activity: *Presentation based*

Compulsory study of following topics must be done by students during semester to gain awareness and further understanding of the course and a presentation of the same should be included in the TW:

1. **Engines**:(any one) Homogeneous charge compression ignition (HCCI)/ Stratified charge

engine/Variable valve timing (VVT)/Variable geometry turbocharger (VGT), etc.

2. **Automotive Field**: (any one) Hydrogen CNG vehicles/Adaptive cruise control system/On-board diagnostic system (OBD) / Electric Battery classification/Fuel Cell vehicle/Rear driving emission (RDE) system

Industrial Visit

A Compulsory industrial visit must be arranged to automobile manufacturing or servicing.

Students must submit properly documented Detailed Industrial Visit Report in his/her own words.

<table>
<tr><th colspan="3">202049 - Fluid Mechanics</th></tr>
<tr><th>Teaching Scheme</th><th>Credits</th><th>Examination Scheme</th></tr>
<tr><td>Theory : 03 Hr./Week
Practical : 02 Hr./Week</td><td>04
Theory : 03
Practical : 01</td><td>In-Semester : 30 Marks
End-Semester : 70 Marks
Oral : 25 Marks</td></tr>
</table>

Prerequisite Courses

Engineering Mathematics - I, Engineering Mathematics - II, Engineering Mechanics, Engineering Physics

Course Objectives

1. To understand basic properties of fluids.
2. To learn fluid statics and dynamics
3. To study basics of flow visualization
4. To understand Bernoulli's theorem and its applications.
5. To understand losses in flow, drag and lift forces
6. To learn to establish relation between flow parameters.

Course Outcomes

On completion of the course, learner will be able to

CO1. DETERMINE various properties of fluid

CO2. APPLY the laws of fluid statics and concepts of buoyancy

CO3. IDENTIFY types of fluid flow and terms associated in fluid kinematics

CO4. APPLY principles of fluid dynamics to laminar flow

CO5. ESTIMATE friction and minor losses in internal flows and DETERMINE boundary layer formation over an external surface

CO6. CONSTRUCT mathematical correlation considering dimensionless parameters, also ABLE to predict the performance of prototype using model laws

Course Contents

Unit I — Properties of Fluid — [06 Hr.]

Definition of fluid, concept of continuum, density, specific weight, specific gravity, viscosity, viscosity laws, types of fluid and rheology, measurement of viscosity, application based numerical on viscosity-flow through pipe, lubrication, bearing, brake fluids, parallel plates, rotating shafts etc., vapor pressure surface tension, capillarity, compressibility

Unit II — Fluid Statics — [07 Hr.]

Laws of fluid statics: forces acting on fluid element, pascal's law, hydrostatics law, hydraulic ram Pressure measurement: pressure scale, piezometer, barometer, manometer - simple, inclined, differential, micro manometer, inverted

Forces acting on surfaces immersed in fluid: total pressure and center of pressure on submerged plane surfaces, curved surface submerged in liquid including numerical on dam gate

Buoyancy: flotation, stability of bodies

Unit III — Fluid Kinematics — [08 Hr.]

Flow description methods, types of flows, velocity and acceleration fields, continuity equation in 1D & 3D flow, flow visualization (path line, stream line and streak line), stream tube, angularity, vorticity, stream function and velocity potential function, flow net

Unit IV — Fluid Dynamics — [10 Hr.]

Euler's equation of motion differential form and Navier Stokes equation, Euler's equation of motion along streamline, Bernoulli's theorem and modified Bernoulli's theorem, stagnation pressure, HGL, TEL

Flow measurement: venturimeter, orifice meter, pitot tubes, static pitot tube, introduction to coriolis flow meter, introduction to orifices, notches & weirs

Laminar flow: Entrance region theory, velocity and shear Stress distribution for laminar flow through pipe, fixed parallel plates and Couette flow, velocity profile of turbulent flow

Unit V **Internal & External Flow** **[09 Hr.]**

Internal Flow: Losses - major & minor losses, hydro dynamically smooth and rough boundaries, Moody's chart, compounding of pipes & equivalent pipe, siphons, transmission of power

External Flow: Boundary layer formation over a flat plate, boundary layer thickness, displacement thickness, momentum thickness and energy thickness, boundary layer separation and methods to control separation, drag and lift concepts, types of drag, drag & lift coefficient, aerofoil, bluff body, streamline body

Unit VI **Dimensional Analysis & Similitude** **[08 Hr.]**

Dimensional Analysis: Introduction, system of dimensions, Dimensional homogeneity, Buckingham-Pi Theorem, repeating variables, dimensionless numbers and their physical significance

Similitude & Model Testing: Model & prototype, similarity, scaling parameters , model laws, objectives , importance and application of model studies.

Books & Other Resources

Text Books

1. Sukumar Pati, "Fluid Mechanics and Hydraulics Machines", TATA McGraw Hill.
2. Munson, Young and Okiishi, "Fundamentals of Fluid Mechanics", Wiley India
3. Potter Wiggert, "Fluid Mechanics", Cengage Learning
4. Fox, Pichard, "Introduction to Fluid Mechanics", McDonald- Wiley
5. Modi P. N. and Seth S. M, "Hydraulics and Fluid Mechanics",Standard Book House.
6. Cengel & Cimbla, "Fluid Mechanics",TATA McGraw-Hill
7. F. M. White, "Fluid Mechanics", TATA McGraw-Hill
8. R. K. Bansal, "Fluid Mechanics & Hydraulic Machines", Laxmi Publication

Reference Books

1. Kundu, Cohen, Dowling, "Fluid Mechanics", Elsevier India
2. Chaim Gutfinger David Pnueli, "Fluid Mechanics" Cambridge University press.
3. Edward Shaughnessy, Ira Katz James Schaffer, "Introduction to Fluid Mechanics",Oxford University Press

Web References

1. https://nptel.ac.in/courses/112/105/112105171/
2. https://nptel.ac.in/courses/112/104/112104118/
3. https://nptel.ac.in/courses/112/105/112105269/
4. http://www.efluids.com/efluids/books/efluids_books.htm
5. http://web.mit.edu/hml/ncfmf.html
6. http://www.efluids.com/efluids/pages/edu_tools.htm
7. https://spoken-tutorial.org/tutorial-search/?search_foss=OpenFOAM&search_language=

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work

Total 10 experiments from the following list must be performed. During Oral, the Student is evaluated based on the completion of Practical, Assignments using Virtual Lab and Detailed Mini project / Industrial Visit Report/ Simulation of fluid flow / Programming using any suitable software.

Practical *(Experiment # 3 & 9 are compulsory; Select any One Simulation of Experiments from Experiment # 4 & 6; Perform any Eight experiments)*

1. Determination of pressure using manometers (minimum two)
2. Determination of fluid viscosity and its variation with temperature.
3. Determination of Metacentric height of floating object.
4. Determination of Reynolds number and flow visualization of laminar and turbulent flow using Reynolds apparatus.
5. Draw flow net using electrical analogy apparatus to calculate discharge for rectangular / enlargement / contraction channel.
6. Verification of modified Bernoulli's equation.
7. Calibration of Orifice meter/ Venturimeter/Notch.
8. Determination of minor/major losses through metal/non-metal pipes.

9. Mini project/Industrial visit/Simulation of fluid flow/Programming using any suitable software

Assignments using Virtual Laboratory *(Any Two Virtual Lab experiments from experiment # 1,2,5,7,8 mentioned above)*

Please visit the links given below for exploring and performing experiments on Fluid Mechanics using Virtual Laboratory. Write brief Reports using Virtual Laboratories:

1. https://eerc03-iiith.vlabs.ac.in/
2. http://fm-nitk.vlabs.ac.in/

202050 - Manufacturing Processes		
Teaching Scheme	**Credits**	**Examination Scheme**
Theory : 03 Hr./Week	**03** Theory : 03	In-Semester : 30 Marks End-Semester : 70 Marks

Prerequisite Courses

Material Science and Metallurgy, Engineering Physics, Systems in Mechanical Enginering

Course Objectives

1. Describe various sand and permanent mould casting methods, procedure and mould design aspects.
2. Understand basics of metal forming processes, equipment and tooling.
3. Understand sheet metal forming operations and die design procedure.
4. Classify, describe and configure the principles of various welding techniques.
5. Understand plastic processing techniques.
6. To know about composites, its fabrication processes.

Course Outcomes

On completion of the course, learner will be able to

CO1. SELECT appropriate moulding, core making and melting practice and estimate pouring time, solidification rate and DESIGN riser size and location for sand casting process

CO2. UNDERSTAND mechanism of metal forming techniques and CALCULATE load required for flat rolling

CO3. DEMONSTRATE press working operations and APPLY the basic principles to DESIGN dies and tools for forming and shearing operations

CO4. CLASSIFY and EXPLAIN different welding processes and EVALUATE welding characteristics

CO5. DIFFERENTIATE thermoplastics and thermosetting and EXPLAIN polymer processing techniques

CO6. UNDERSTAND the principle of manufacturing of fibre-reinforce composites and metal matrix composites

Course Contents

Unit I — Casting Processes — [07 Hr.]

Introduction to casting processes, Patterns: Pattern materials, types of pattern, allowances pattern design, Moulding sand, Properties of moulding sands, Core making, Melting practices and furnaces, Pouring and Gating system design, Numerical estimation to find mold filling time, Riser design and placement, Principles of cooling and solidification of casting, Directional and Progressive solidification Estimation of solidification rate, Cleaning and Finishing of casting, Defects and remedies, Principle and equipments of Permanent mould casting, Investment casting, Centrifugal casting, Continuous casting

Unit II — Metal Forming Processes — [08 Hr.]

Plastic deformation. Stress-strain diagram for different types of material, Hot and Cold working, Factors affecting plastic deformation, Yield criteria, Concept of flow stress, Forming Limit diagram

Rolling Process: Rolling terminology, Friction in rolling, Calculation of rolling load

Forging: Open and closed die forging, Forging operations

Extrusion: Types, Process parameter

Wire and Tube Drawing: Wire and tube drawing process, Die profile

Friction and lubrication in metal forming, Forming defects, causes and remedies for all forming processes

Unit III — Sheet Metal Forming — [07 Hr.]

Types of sheet metal operations, Press working equipment and terminology, Types of dies, Clearance analysis, Estimation of cutting forces, Centre of pressure and blank size determination, Design of strip lay-out, Blanking die design, Introduction to Drawing, Bending dies, Methods of reducing forces, Formability and forming limit diagrams

Unit IV **Welding Processes** **[08 Hr.]**

Classification of joining processes, Welding terminology and types of joints

Arc Welding Processes: Principles and equipments of Single carbon arc welding, FCAW, TIG, MIG, SAW

Resistance Welding: Spot, Seam and Projection weld process, Heat balance in resistance welding

Gas Welding and Cutting, Soldering, brazing and braze welding

Welding Metallurgy and Heat Affected Zone, Weld inspection, Defects in various joints and their remedies

Unit V **Processing of polymers** **[07 Hr.]**

Thermoplastics and Thermosetting, Processing of polymers, Thermoforming, Extrusion

Moulding: Compression moulding, Transfer moulding, Blow moulding, Rotation moulding, Injection moulding - Process and equipment

Extrusion of Plastic: Type of extruder, extrusion of film, pipe, Cable and Sheet – Principle

Pressure forming and Vacuum forming

Unit VI **Manufacturing of Composites** **[08 Hr.]**

Introduction to composites, Composite properties, Matrices, Fiber reinforcement

Composite Manufacturing Processes: Hand lay-up Process, Spray lay-up, Filament winding process, Resin transfer moulding, Pultrusion, and Compression moulding process, Vacuum impregnation process, Processing of metal matrix composites, Fabrication of ceramic matrix composites, Carbon-carbon composites, Polymer matrix and nano-composites

Books & Other Resources

Text Books

1. P. N. Rao, “Manufacturing Technology Vol. I & II” , Tata McGraw Hill Publishers
2. P. C. Sharma, “Production Engineering”, Khanna Publishers

Reference Books

1. R. K. Jain, “Production Technology”, Khanna Publishers
2. K. C. Chawala, “Composite Materials”, Springer, ISBN 978-0387743646, ISBN 978-0387743653
3. Brent Strong, “Fundamentals of Composites Manufacturing: Materials, Methods”, SME Book series

202051 - Machine Shop

Teaching Scheme	Credits	Examination Scheme
Practical : 02 Hr./Week	**01** Practical : 01	In-Semester : 30 Marks End-Semester : 70 Marks Term Work : 50 Marks

Prerequisite Courses

Workshop Practice

Course Objectives

1. To understand the basic procedures, types of equipment, tooling used for sand casting and metal forming processes through demonstrations and/(or) Industry visits..
2. To understand TIG/ MIG/ Resistance/Gas welding welding techniques.
3. To acquire skills to handle grinding and milling machine and to produce gear by milling.
4. To acquire skills to produce a composite part by manual process.

Course Outcomes

On completion of the course, learner will be able to

CO1. PERFORM welding using TIG/ MIG/ Resistance/Gas welding technique

CO2. MAKE Fibre-reinforced Composites by hand lay-up process or spray lay-up techniques

CO3. PERFORM cylindrical/surface grinding operation and CALCULATE its machining time

CO4. DETERMINE number of indexing movements required and acquire skills to PRODUCE a spur gear on a horizontal milling machine

CO5. PREPARE industry visit report

CO6. UNDERSTAND procedure of plastic processing

Guidelines for Laboratory Conduction

The student shall complete the following activity as a Term Work

Practical *(Select any One Practical from Practical # 1 & 2; Select any Five Practical from Practical # 3 to 8; Perform Total Six Practicals)*

1. To study and observe various stages of casting through demonstration of sand casting process from pattern making, sand mould preparation and melting and pouring of metal.
2. Visit to any foundry/ permanent mould casting industry to demonstrate various stages of casting and make a report on it.
3. A compulsory visit to any one metal forming industry out of: Rolling mill, Forging plant, Wire/Tube drawing unit and prepare a report on it.
4. A demonstration of any one welding technique out of TIG/ MIG/Resistance/Gas welding. A job drawing to be prepared by an individual institute with details of welding process parameters with weld joint design such as edge preparation, type and size of electrode used, welding current, voltage etc.
5. Manufacturing of Fibre-reinforced Composites by hand lay-up process or spray lay-up techniques.
6. Demonstration on any one plastic component like bottle, bottle caps, machine handles etc. by injection moulding process/ by additive manufacturing process.
7. Demonstration on cylindrical grinding/surface grinding operations, measurement of surface roughness produced and estimation of machining time.
8. Demonstration on indexing mechanism. Calculation of index crank and index plate movement by simple/compound/differential indexing and manufacture of spur gear on a milling machine using indexing head.

Instructions for Laboratory Conduction

Please note following instructions regarding Laboratory Conduction:

1. Industrial Visits to be conducted by the Teaching **Faculty** (subject Teacher).
2. Demonstration of Welding machines, Surface/Cylindrical Grinding, Milling machine, Indexing head and calculation of indexing to be taught by a **subject Teacher in Practical slot**.

202052 - Project Based Learning - II		
Teaching Scheme	**Credits**	**Examination Scheme**
Practical : 04 Hr./Week	**02** Practical : 02	Term Work : 50 Marks

Preamble

Currently, engineering education is undergoing significant structural changes worldwide. The rapidly evolving technological landscape forces educators to constantly reassess the content of engineering curricula in the context of emerging fields and with a multidisciplinary focus. In this process, it is necessary to devise, implement and evaluate innovative pedagogical approaches for the incorporation of these novel subjects into the educational programs without compromising the cultivation of the traditional skills. In this context, the educational community is showing rapidly rising interest in project-based learning approaches.

The mainstream engineering education follows traditional classroom teaching, in which the major focus is mainly on the lecture and the student has very little (if any) choice on the learning process. However rapid development in engineering and technology requires adopting a teaching approach that would assist students not only in developing a core set of industry relevant skills, but also enable them to adapt to changes in their professional career.

Course Objectives

1. To emphasize project based learning activities that are long-term, interdisciplinary and student-centric.
2. To inculcate independent and group learning by solving real world problems with the help of available resources.
3. To be able to develop applications based on the fundamentals of mechanical engineering by possibly applying previously acquired knowledge.
4. To get practical experience in all steps in the life cycle of the development of mechanical systems: specification, design, implementation, and testing.
5. To be able to select and utilize appropriate concepts of mechanical engineering to design and analyze selected mechanical system.

Course Outcomes

On completion of the course, learner will be able to

CO1. IDENTIFY the real-world problem (possibly of interdisciplinary nature) through a rigorous literature survey and formulate / set relevant aims and objectives.
CO2. ANALYZE the results and arrive at valid conclusions.
CO3. PROPOSE a suitable solution based on the fundamentals of mechanical engineering by possibly integration of previously acquired knowledge.
CO4. CONTRIBUTE to society through proposed solutions by strictly following professional ethics and safety measures.
CO5. USE of technology in proposed work and demonstrate learning in oral and written form.
CO6. DEVELOP ability to work as an individual and as a team member.

Group Structure

Working in supervisor/mentor –monitored groups. The students plan, manage and complete a task/project/activity which addresses the stated problem.

1. Create groups of 5 (five) to 6 (six) students in each class
2. A supervisor/mentor teacher is assigned to 3-4 groups or one batch

Project Selection

The project can be selected by undertaking a survey of journal papers, patents or field visit (A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific). The problem shall consist of following facets: feasibility of arriving at a solution, analyzing the problem, design and development of the system (hardware or virtual).

There are no commonly shared criteria/ guidelines for what constitutes an acceptable project. Projects vary greatly in the depth of the questions explored, the clarity of the learning goals, the content and structure of the activity undertaken.

Solution to problem-based projects through ***"learning by doing"*** is recommended. The model begins with the identifying of a problem, often growing out of a question or "wondering". This formulated problem then stands as the starting point for learning. A problem can be theoretical, practical, social, technical, symbolic, cultural and/or scientific and grows out of students" wandering within different disciplines and professional environments. As stated in the preamble as the world has adapted and propagated multidisciplinary approach, hence the proposed project activity preferably should not be restricted to only mechanical domain specific projects rather should be Interdisciplinary in nature. However the chosen problem should be integration of other streams of engineering with Mechanical engineering.

Although in a genuine case 100% software/ virtual project topic may be allowed.

Ethical Practices, teamwork and project management:

Use Indian standards or any relevant standards for project manufacturing, respect the time of others, attend the reviews, poster presentation and model exhibitions, strictly follow the deadline of project completion, comply with all legislation requirements that govern workplace health and safety practices.

Effective Documentation

In order to make our engineering graduates capable of preparing effective documentation, it is required for the students to learn the effective writing skills. The PBL final report is expected to consist of the Literature Survey, Problem Statement, Aim and Objectives, System Block Diagram, System Implementation Details, Discussion and Analysis of Results, Conclusion, System Limitations and Future Scope. Many freely available software tools (for instance Mendley (Elsevier), Grammarly) are expected to be used during the preparation of PBL synopsis and final report. It is expected that the PBL guides/mentors shall teach students about utilizing valid sources of information (such as reference papers, books, magazines, etc) related to their PBL topic.

Evaluation & Continuous Assessment

The institution/head shall be committed to ensuring the effective and rigorous implementation of the idea of project based learning. Progress of PBL shall be monitored regularly on a weekly basis. Weekly review of the work shall be necessary. During the process of monitoring and continuous assessment and evaluation the individual and team performance is to be measured. PBL is monitored and continuous assessment is done by supervisor /mentor and authorities. Students must maintain an institutional culture of authentic collaboration, self-motivation, peer-learning and personal responsibility. The institution/department should support students in this regard through guidance/orientation programs and the provision of appropriate resources and services. Supervisor/mentor and Students must actively participate in assessment and evaluation processes.

The effectiveness of the concept PBL lies in rigorous and continuous assessment and evaluation of the student performance. It is recommended that all activities are required to be recorded regularly. A regular assessment of PBL work is required to be maintained at the department in PBL log book by students. It is expected that the PBL log book must include following:

1. Information of students and guide
2. Weekly monitoring by the PBL guide,
3. Assessment sheet for PBL work review by PBL guide and PBL Evaluation Committee (PEC).

The PEC structure shall consist of Head of the department, 1/2 senior faculties of the department and one industry expert (optional). Continuous Assessment Sheet (CAS) is to be maintained by the department.

Recommended parameters for assessment, evaluation and weightage

1. Idea Inception (kind of survey). (10%)
2. Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents). (15%)
3. Attended reviews, poster presentation and model exhibition. (10%)

4. Demonstration (Poster Presentation, Model Exhibition etc). (10%).
5. Awareness /Consideration of - Environment/ Social /Ethics/ Safety measures/Legal aspects. (5%)
6. Outcome (physical model/prototype/ virtual model/ product development/ assembly & disassembly and analysis of standard mechanism or system, design and development of small applications using Arduino, design of control systems, development of various systems/ subsystems of BAJA/SUPRA/Robots/GoKart/ Sunrisers/Hackathon/ application development and similar activities/ System performance and analysis) (40%)
7. Participation in various competitions/ publication/ copyright/ patent) (10%)

Learning Resources

Reference Books / Research Articles

1. John Larmer, John R. Mergendoller, and Suzie Boss, "Setting the Standard for Project Based Learning"
2. John Larmer and Suzie Boss, "Project Based Teaching: How to Create Rigorous and Engaging Learning Experiences"
3. Erin M. Murphy and Ross Cooper, "Hacking Project Based Learning: 10 Easy Steps to PBL and Inquiry"

Web resources

1. https://www.edutopia.org/project-based-learning
2. www.howstuffworks.com
3. https://www.pblworks.org/
4. www.wikipedia.org

202053 - Audit Course - IV		
Teaching Scheme	**Credits**	**Examination Scheme**
-	-	-

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

Faculty mentor shall be allotted for individual courses and he/she shall monitor the progress for successful accomplishment of the course. Such monitoring is necessary for ensuring that the concept of self learning is being pursued by the students 'in true letter and spirit'.

- If any course through Swayam/ NPTEL/ virtual platform is selected the minimum duration shall be of 8 weeks.
- However if any of the course duration is less than the desired (8 weeks) the mentor shall ensure that other activities in form of assignments, quizzes, group discussion etc. (allied with the course) for the balance duration should be undertaken.

In addition to credits courses, it is mandatory that there should be an audit course (non-credit course) from second year of Engineering. The student will be awarded grade as AP on successful completion of the audit course. The student may opt for any one of the audit courses in each semester. Such audit courses can help the student to get awareness of different issues which make an impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Students can choose one of the audit courses from the list of courses mentioned. Evaluation of the audit course will be done at institute level.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not considered in the calculation of the performance indices SGPA and CGPA. Evaluation of the audit course will be done at institute level itself.

Selecting an Audit Course

List of Courses to be opted (Any one) under Audit Course IV

- Language & Mind Emotional Intelligence
- Advanced Foreign Language (preferably German/ Japanese)
- Human Behaviour
- Speaking Effectively
- Business Ethics
- Technical writing/ Research writing

The titles indicated above are subject to change in time to come and such an alteration (if any) should be brought to the notice of the BoS.

Using NPTEL Platform: (preferable)

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Students can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.
- After clearing the examination successfully; student will be awarded with a certificate.

Assessment of an Audit Course

- The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary.
- During the course students will be submitting the online assignments. A copy of the same can be submitted as a part of term work for the corresponding Audit course.
- On the satisfactory submission of assignments, the institute can mark as "Present" and the student will be awarded the grade AP on the mark sheet.

Savitribai Phule Pune University
Faculty of Science & Technology

Curriculum/Syllabus
For
Third Year
Bachelor of Engineering
(Choice Based Credit System)
Mechanical Engineering
(2019 Course)
Board of Studies – Mechanical and Automobile Engineering
(With Effect from Academic Year 2021-22)

Savitribai Phule Pune University

Board of Studies - Automobile and Mechanical Engineering

Undergraduate Program - Mechanical Engineering (2019 pattern)

Course Code	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credit			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
Semester-V														
302041	Numerical & Statistical Methods	3	-	1	30	70	25	-	-	125	3	-	1	4
302042	Heat & Mass Transfer	3	2	-	30	70	-	50	-	150	3	1	-	4
302043	Design of Machine Elements	3	2	-	30	70	-	-	25	125	3	1	-	4
302044	Mechatronics	3	2	-	30	70	-	-	25	125	3	1	-	4
302045	Elective I	3	-	-	30	70	-	-	-	100	3	-	-	3
302046	Digital Manufacturing Laboratory	-	2	-	-	-	50	-	-	50	-	1	-	1
302047	Skill Development	-	2	-	-	-	25	-	-	25	-	1	-	1
302048	Audit course - V$	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**15**	**10**	**1**	**150**	**350**	**100**	**50**	**50**	**700**	**15**	**5**	**1**	**21**
Semester-VI														
302049	Artificial Intelligence &Machine Learning	3	2	-	30	70	-	-	25	125	3	1	-	4
302050	Computer Aided Engineering	3	2	-	30	70	-	50	-	150	3	1	-	4
302051	Design of Transmission Systems	3	2	-	30	70	-	-	25	125	3	1	-	4
302052	Elective II	3	-	-	30	70	-	-	-	100	3	-	-	3
302053	Measurement Laboratory	-	2	-	-	-	50	-	-	50	-	1	-	1
302054	Fluid Power &Control Laboratory	-	2	-	-	-	50	-	-	50	-	1	-	1
302055	Internship/Mini project *	-	4	-	-	-	100	-	-	100	-	4	-	4
302056	Audit course - VI$	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	**12**	**14**	**-**	**120**	**280**	**200**	**50**	**50**	**700**	**12**	**9**	**-**	**21**

Elective-I		**Elective-II**	
302045-A	Advanced Forming & Joining Processes	302052-A	Composite Materials
302045-B	Machining Science & Technology	302052-B	Surface Engineering

Abbreviations: TH: Theory, **PR**: Practical, **TUT**: Tutorial, **ISE**: In-Semester Exam, **ESE**: End-Semester Exam, **TW**: Term Work, **OR**: Oral

Note: Interested students of TE (Automobile Engineering and Mechanical Engineering) can opt for any one of the audit course from the list of audit courses prescribed by BOS (Automobile and Mechanical Engineering)

Instructions:

- Practical/Tutorial must be conducted in FOUR batches per division only.
- Minimum number of Experiments/Assignments in PR/Tutorial shall be carried out **as mentioned in the syllabi** of respective courses.
- Assessment of tutorial work has to be carried out similar to term-work. The Grade cum marks for Tutorial and Term-work shall be awarded on the basis of **continuous evaluation.**
- $Audit course is mandatory but non-credit course. Examination has to be conducted at the end of Semesters for award of grade at institute level. Grade awarded for audit course shall not be calculated for grade point & CGPA.

302041: Numerical and Statistical Methods					
Teaching Scheme		Credits		Examination Scheme	
Theory	3Hrs./Week	Theory	3	In-Semester	30 Marks
Tutorial	1Hr./Week	Tutorial	1	End-Semester	70 Marks
				Term Work	25 Marks

Prerequisites: System of linear equations, Partial differentiation, Statistics, Probability, Problem solving and programming.

Course Objectives:

1. **UNDERSTAND** applications of systems of equations and solve mechanical engineering applications.
2. **APPLY** differential equations to solve the applications in the domain of fluid mechanics, structural, etc.
3. **LEARN** numerical integration techniques for engineering applications.
4. **COMPARE** the system's behavior for the experimental data.
5. **INTERPRET** Statistical measures for quantitative data.
6. **ANALYZE** datasets using probability theory and linear algebra.

Course Outcomes:

On completion of the course the learner will be able to;

CO1: **SOLVE** system of equations using direct and iterative numerical methods.
CO2: **ESTIMATE** solutions for differential equations using numerical techniques.
CO3: **DEVELOP** solution for engineering applications with numerical integration.
CO4: **DESIGN** and **CREATE** a model using a curve fitting and regression analysis.
CO5: **APPLY** statistical Technique for quantitative data analysis.
CO6: **DEMONSTRATE** the data, using the concepts of probability and linear algebra.

Course Contents

Unit 1	Roots of Equation and Simultaneous Equations	07 Hrs.

Roots of Equation: Bracketing method and Newton-Raphson method
Solution of simultaneous equations: Gauss Elimination Method with Partial pivoting, Gauss-Seidel method, Thomas algorithm for Tri-diagonal Matrix.

Unit 2	Numerical Solution of Differential Equations	08 Hrs.

Ordinary Differential Equations [ODE]: Taylor series method, Euler Method, Runge-Kutta 4^{th} order. Simultaneous equations using Runge-Kutta 2^{nd} order method.
Partial Differential Equations [PDE]: Finite difference method, Simple Laplace method, PDE's Parabolic explicit solution, Elliptic explicit solution.

Unit3	Numerical Integration	06 Hrs.

Numerical Integration (1D): Trapezoidal rule, Simpson's $1/3^{rd}$Rule, Simpson's$3/8^{th}$Rule, Gauss Quadrature2-point and 3-point method.
Double Integration: Trapezoidal rule, Simpson's $1/3^{rd}$Rule.

Unit 4	Curve Fitting and Regression Analysis	08 Hrs.

Curve Fitting: Least square technique- first order, power equation, exponential equation and quadratic equation.

Regression Analysis: Linear regression, Nonlinear regression, Multiple regressions, Polynomial regression. Lagrange's interpolation, Numerical interpolation and differentiation using Newton's forward method, inverse interpolation (Lagrange's method only).

Unit 5	Statistics	08 Hrs.

Measures of central tendency: mean, median, mode. Measurement of variability and dispersion: Standard deviation, standard error, variance, range. Measure of shape: skewness, kurtosis

Statistical diagram: scattered diagram, histogram, pie charts, and measure of association between two variables. Correlation: Karl Pearson's Coefficient of correlation and its mathematical properties, Spearman's Rank correlation and its interpretations.

Unit 6	Probability and Linear Algebra	08 Hrs.

Probability: Joint, conditional and marginal probability, Bayes' theorem, independence, theorem of total probability, expectation and variance, random variables. Probability distributions: Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Normal and Chi square.

Linear algebra: Review of matrix operations, vector and vector spaces, linear mapping.

Books and other resources

Text Books:

1. Steven C. Chapra, 'Applied Numerical Methods with MATLAB for Engineers and Scientist', Tata Mc-Graw Hill Publishing Co. Ltd.
2. B. S. Grewal, 'Numerical Methods in Engineering and Science', Khanna Publication.
3. B. S. Grewal, 'Higher Engineering Mathematics', Khanna Publication.

References Books:

1. Erwin Kreyszig, 'Advanced Engineering Mathematics', Wiley India
2. Joe D. Hoffman, 'Numerical Methods for Engineers and Scientists', CRC Press
3. Sheldon M. Ross, 'Introduction to Probability and Statistics for Engineers and Scientists', 5e, by Elsevier Academic Press
4. Deisentoth, Faisal, Ong, 'Mathematics for machine learning', Cambridge University Press.
5. Kandasamy, 'Numerical methods', S Chand.
6. Jason Brownlee, 'Statistical Methods for Machine Learning', Machine learning Mastery.

Web References:

1. http://nptel.ac.in/courses/111101003/
2. http://nptel.ac.in/courses/111105038/
3. http://nptel.ac.in/courses/111107063/
4. http://nptel.ac.in/courses/111105041/
5. http://nptel.ac.in/courses/111104079/
6. https://www.analyticsvidhya.com/

List of Tutorials
Term Work shall consist of: **Group A – (Any three programs using suitable programming language)** 1. Roots of equation 2. Simultaneous equations 3. Ordinary differential equation 4. Partial differential equation 5. Numerical Integration **Group B (Any three programs for simple dataset using suitable programing)** 6. Curve fitting using least square technique 7. Regression analysis 8. Determine statistical measures 9. Probability distribution **Group C (Mandatory)** 10. One program based mini project using mechanical engineering application dataset **Note: Tutorials shall be mandatorily conducted in the computer laboratory.**

302042: Heat and Mass Transfer					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Practical	**50 Marks**

Prerequisites: First and Second Law of Thermodynamics, Fluid properties, Continuity equation, Differential and Integral Calculus, Ordinary differential and Partial Differential Equations, Numerical solution for Differential Equations.

Course Objectives:

1. **IDENTIFY** the laws for different modes of heat transfer.
2. **UNDERSTAND** the properties and economics of thermal insulation and **ANALYZE** heat transfer through fins and thermal systems with lumped heat capacitance.
3. **ANALYZE** the natural and forced convective mode of heat transfer in various geometric configurations.
4. **UNDERSTAND AND REALIZE** various laws with their interrelations and analyze Radiation heat transfer in black and grey bodies/surfaces with or without radiation shields.
5. **UNDERSTAND** the fundamentals and laws of mass transfer and its applications.
6. **ANALYZE** various performance parameters for existing heat exchanger and **DEVELOP** methodologies for designing a heat exchanger under prescribed conditions and for a particular application, with references TEMA standards

Course Outcomes: On completion of the course, learner will be able to

- CO1. **ANALYZE** & **APPLY** the modes of heat transfer equations for one dimensional thermal system.
- CO2. **DESIGN a** thermal system considering fins, thermal insulation and & Transient heat conduction.
- CO3. **EVALUATE** the heat transfer rate in natural and forced convection & validate with experimentation results.
- CO4. **INTERPRET** heat transfer by radiation between objects with simple geometries, for black and grey surfaces.
- CO5. **ABILITY** to analyze the rate of mass transfer using Fick's Law of Diffusion and understands mass diffusion in different coordinate systems.
- CO6. **DESIGN & ANALYSIS** of heat transfer equipments and investigation of its performance.

Course Contents

Unit 1	**Fundamentals of Heat Transfer**	**08 Hrs.**

Basic Concepts: Different Modes and Laws of heat transfer, 3-D heat conduction equation in Cartesian coordinates (with derivation), and its simplified equations, simplified equations in cylindrical and spherical coordinates (simplified equations, no derivation) thermal conductivity,

thermal diffusivity, electrical analogy, Thermal contact Resistance. **Boundary and initial conditions:** Temperature boundary condition, heat flux boundary condition, convection boundary condition, radiation boundary condition. **1-D steady state heat conduction without and with heat generation:** Heat conduction without heat generation in plane wall, composite wall, composite cylinder, composite sphere. Heat conduction with heat generation in Plane wall, Cylinder and Sphere with different boundary conditions.		
Unit 2	**Heat Transfer through Extended Surfaces & Transient Heat Conduction**	**08 Hrs.**
Thermal Insulation – Critical thickness of insulation, Types and properties of insulating materials, Safety considerations in thermal insulation, Economic and cost considerations, Payback period, Numerical on payback period. **Heat transfer through extended surfaces:** Types of fins and its applications, Governing Equation for constant cross sectional area fins, Solution for infinitely long fin (with derivation), adequately long fin with insulated end tip and short fins (no derivation), Fin Efficiency & Effectiveness of fins, estimation of error in Temperature measurement by thermometer. **Transient heat conduction:** Validity and criteria of lumped system analysis, Biot Number, Fourier Number, Time Constant and Response of thermocouple, Use of Heisler Charts for plane wall, cylinder and sphere		
Unit 3	**Convection**	**08 Hrs.**
Principles of Convection: Local and average heat transfer coefficient, Hydrodynamic and Thermal boundary layer for a flat plate and pipe flow. **Forced Convection:** Physical significance of non-dimensional numbers, Empirical correlations for flat plate, pipe flow, and flow across cylinders, spheres, tube banks. **Free Convection:** Physical significance of non-dimensional numbers, Free convection from a vertical, horizontal surface, cylinder and sphere. Mixed Convection **Boiling and Condensation:** Types of boiling, Regimes of pool boiling, Film wise condensation, Drop wise condensation (No Numerical treatment), Critical heat flux.		
Unit 4	**Radiation**	**07 Hrs.**
Thermal Radiation; definition of various terms used in radiation mode; Stefan-Boltzmann law, Kirchhoff's law, Planck's law and Wein's displacement law. Intensity of radiation and solid angle; Lambert's law; Radiation heat exchange between two black surfaces, configuration or view factor. Radiation heat exchange between grey surfaces, Electrical analogy for radiation, Radiation shields, Numerical.		
Unit 5	**Mass Transfer**	**07 Hrs.**
Physical origins, applications of mass transfer, Mixture Composition, Phase diagram, Fick's Law of Diffusion with numerical treatment, Restrictive Conditions, Mass diffusion coefficient, Conservation of Species, The Mass Diffusion equation – Cartesian coordinates deviation, cylindrical coordinates and Spherical coordinates (no derivation), Boundary and initial conditions.		

Unit 6:	Heat Exchangers and Equipment Design	07 Hrs.

Heat Exchangers: Classification and applications of heat exchangers, Heat exchanger analysis – LMTD for parallel and counter flow heat exchangers, Effectiveness– NTU method for parallel and counter flow heat exchangers, cross flow heat exchangers, LMTD correction factor, Heat Pipe, Introduction to electronic cooling - Active and passive methods of augmented heat transfer.
Process Equipment Design: Condenser Design, Introduction to TEMA standards, Design considerations for heat exchangers, Materials of construction and corrosion, Temperature effects, Radiation effects, Economic consideration, Condenser and Heat exchanger design and performance calculations, Design of shell and tube type Heat Exchanger

Books & Other Resources

Text Books:

1. Franck P. Incropera, David P. DeWitt – Fundamentals of Heat and Mass Transfer,
2. Y. A. Cengel and A.J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, Tata McGraw Hill Education Private Limited.
3. S.P. Sukhatme, A Textbook on Heat Transfer, Universities Press.
4. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Science.
5. Joshi's Process Equipment Design, by V.V. Mahajani , S.B. Umarji ,Trinity Press

Reference Books:

1. P.K. Nag, Heat & Mass Transfer, McGraw Hill Education Private Limited.
2. M.M. Rathod, Engineering Heat and Mass Transfer, Third Edition, Laxmi Publications, New Delhi
3. V. M. Domkundwar, Heat Transfer, Dhanpat Rai & Co Ltd.
4. A.F. Mills, Basic Heat and Mass Transfer, Pearson.
5. S. P. Venkatesan, Heat Transfer, Ane Books Pvt. Ltd.
6. Holman, Fundamentals of Heat and Mass Transfer, McGraw – Hill publication.
7. M. Thirumaleshwar, Fundamentals of Heat and Mass Transfer, Pearson Education India.
8. B.K. Dutta, Heat Transfer-Principles and Applications, PHI.
9. C.P. Kothandaraman, S. V. Subramanyam, Heat and Mass Transfer Data Book, New Academic Science.
10. Process heat Transfer, D. Q. Kern, Wiley Publication

NPTEL Links:
E books: Links to be provided

1. https://libgen.is
2. http://libgen.li/item/index.php?md5=314BFA11A24C3C1ACFDED2B5AB88E5E9

Links of NPTEL / related videos

1. https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785
2. https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785
3. https://www.youtube.com/watch?v=J_zqQcncAu4&index=3&list=PLpCr5N2IS7Nmu22MOgDWOr0sSlIpUNUz3
4. https://www.youtube.com/watch?v=SNnd0f3xXlg&list=PLpCr5N2IS7Nmu22MOgDWOr0s

SlIpUNUz3&index=11 5. https://www.youtube.com/watch?v=SNnd0f3xXlg&list=PLpCr5N2IS7Nmu22MOgDWOr0sSlIpUNUz3&index=11 6. https://www.youtube.com/watch?v=lnFjt30goiY&index=18&list=PLpCr5N2IS7Nmu22MOgDWOr0sSlIpUNUz3
Guidelines for Laboratory Conduction
The student shall complete the following activity as a Term Work
Complete **eight** experiments and **two** assignments (Sr. no.10 to 13). 1. Determination of Thermal Conductivity of insulating powder. 2. Determination of Thermal Conductivity of metal rod. 3. Determination of local and average heat transfer coefficient in Natural Convection. 4. Determination of local and average heat transfer coefficient in Forced Convection. 5. Determination of temperature distribution, fin efficiency in Natural / Forced Convection. 6. Determination of Emissivity of a Test surface. 7. Determination of Stefan Boltzmann Constant. 8. Determination of heat transfer, overall heat transfer coefficient and effectiveness of Plate Heat Exchanger. 9. Study of Pool boiling phenomenon and determination of Critical Heat Flux (CHF). 10. Assignment to solve transient heat transfer problem using Heisler and Grober Charts. 11. Design of heat exchanger for any simple application. 12. Industrial visit to heat treatment industry/ heat exchanger manufacturing industry. 13. Demonstration of dropwise and filmwise condensation. 14. Virtual laboratory: study of the performance of heat exchanger /study of variation of Thermal Conductivity. **Link for Virtual Lab: - https://www.vlab.co.in/**

302043: Design of Machine Elements

Teaching Scheme		Credits		Examination Scheme	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Oral	**25 Marks**

Prerequisites: The basics of material elastic behavior, stress, strain, its relationship, failure modes, different theories of failure and its applications. The design cycle, basis of design considerations like strength, rigidity, manufacture, assembly and cost, standards and codes. The preferred sizes and series, tolerances and types of fits. Construction of SMD and BMD. Roots of equations, Interpolation rule.

Course Objectives:

1. **UNDERSTAND** the various design considerations, design procedure and select materials for a specific application
2. **CALCULATE** the stresses in machine components due to various types of loads and failure
3. **ANALYZE** machine components subjected to variable loading for finite and infinite life
4. **DESIGN** various machine components such as shafts, couplings, keys, screws, joints, springs

Course Outcomes:

On completion of the course, learner will be able to

CO1. **DESIGN AND ANALYZE** the cotter and knuckle Joints, levers and components subjected to eccentric loading.

CO2. **DESIGN** shafts, keys and couplings under static loading conditions.

CO3. **ANALYZE** different stresses in power screws and **APPLY** those in the procedure to design screw jack.

CO4. **EVALUATE** dimensions of machine components under fluctuating loads.

CO5.**EVALUATE & INTERPRET** the stress developed on the different type of welded and threaded joints.

CO6.**APPLY** the design and development procedure for different types of springs.

Course Contents

Unit 1	**Design of Simple Machine Elements**	**08 Hrs.**

Factor of safety, Selection of Factor of Safety, Service factor, Design of Cotter joint, Knuckle joint, Design of hand / foot lever, lever for safety valve, bell crank lever, Design of components subjected to eccentric loading.

Unit 2	**Design of Shafts, Keys and Couplings**	**08 Hrs.**

Shaft design on the Strength basis, torsional rigidity basis and lateral rigidity basis, Design of shaft as per A.S.M.E. code. Design of square and rectangular keys, Kennedy key and splines. Design of Flange Coupling and Bushed-Pin Flexible Coupling.

Unit 3	Design of Power Screws	07 Hrs.
Terminology of Power Screw, Torque analysis and Design of power screws with square and trapezoidal threads, Collar friction torque, Self-locking screw, Efficiency of square threaded screw, Efficiency of self-locking screw, Design of screw, nuts and C-Clamp. Design of screw jack, Differential and Compound Screw and Re-circulating Ball Screw (Theoretical treatment only).		
Unit 4	**Design against Fluctuating loads**	**07 Hrs.**
Stress concentration and its factors, Reduction of stress concentration factors, fluctuating stresses, fatigue failures, endurance limit, S-N curve, Notch sensitivity, Endurance limit, Endurance strength modifying factors, Reversed stresses – Design for Finite and Infinite life, Cumulative damage in fatigue failure, Soderberg, Gerber, Goodman Lines, Modified Goodman diagrams, Fatigue design under combined stresses:- (Theoretical treatment only.)		
Unit 5	**Threaded and Welded joints**	**08 Hrs.**
Introduction to threaded joints, Bolts of uniform strength, locking devices, eccentrically loaded bolted joint in shear, Eccentric load perpendicular and parallel to axis of bolt, Eccentric load on circular base. Introduction to welded joints, Strength of butt, parallel and transverse fillet welds, Axially loaded unsymmetrical welded joints, Eccentric load in plane of welds, Welded joints subjected to bending and torsional moments.		
Unit 6	**Design of Springs**	**07 Hrs.**
Types and applications of springs, Stress and deflection equations for helical compression Springs, Springs in series and parallel, Design of helical springs, concentric helical springs, surge in spring, Design of Multi-leaf springs, Nipping of Leaf springs, Shot Peening.		

Books and other resources

Text Books:

1. Bhandari V.B., Design of Machine Elements, Tata McGraw Hill Publication Co. Ltd.
2. Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw Hill Publication Co. Ltd.

References Books:

1. Spotts M.F. and Shoup T.E., Design of Machine Elements, Prentice Hall International.
2. Juvinal R.C., Fundamentals of Machine Components Design, John Wiley and Sons.
3. Black P.H. and O. Eugene Adams, Machine Design, McGraw Hill Book Co. Inc.
4. Willium C. Orthwein, Machine Components Design, West Publishing Co. and Jaico Publications House.
5. Hall A.S., Holowenko A.R. and Laughlin H.G, Theory and Problems of Machine Design, Schaum's Outline Series.
6. C. S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI Learing Pvt. Ltd.
7. D. K. Aggarwal & P. C. Sharma, Machine Design, S.K Kataria and Sons.
8. P. C. Gope, Machine Design: Fundamentals and Applications, PHI Learing Pvt. Ltd.
9. Design Data - P.S.G. College of Technology, Coimbatore.
10. K. Mahadevan, K. Balveera Reddy, Design Data Handbook for Mechanical Engineers, CBS Publishers.

Term Work
The student shall complete the following activity as a Term Work; The term work shall consist of three design projects. The design project shall consist of assembly drawing, with a bill of material and overall dimensions and drawings of individual components. The Project should be assigned to a group of maximum four students. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified for important surfaces. A design report giving all necessary calculations of the design of components should be submitted in a separate file. Design data book shall be referred for selection of materials and standard components for given loading conditions. All three design projects should be carried out using suitable software. Project 1: - Cotter joint/ knuckle joint/turn buckle for a specified application. Project 2: - Bush Pin Flexible Coupling for specified application. Project 3: - Bottle type/toggle jack for vehicles. OR Project 3: - A Design Project to develop and apply the knowledge of Machine Design and drafting software for any mechanical system on the basis of: (1) Idea generation, (2) Creativity, Reliability and safety, (3) Design parts of the system (4) Ergonomic Considerations (5) Use of International standards.
Web References:

UNIT 1: Design of Simple Machine Elements		
Sr. No	**Topic Title**	**NPTEL video Link**
1	Factor of safety, Selection of Factor of Safety, Service factor	https://www.youtube.com/watch?v=ofmbhbVCUqI&list=PL3D4EECEFAA99D9BE&index=3
2	Design of components subjected to eccentric loading.	https://www.youtube.com/watch?v=__py5xbKHGA
UNIT 2: Design of Shafts, Keys and Couplings		
3	Design of shaft as per A.S.M.E. code	https://www.youtube.com/watch?v=SL21aDqgs8Q
4	Design of a C-Clamp. Design of screw jack,	https://youtu.be/PEKfS2Q1WqM https://www.youtube.com/watch?v=PEKfS2Q1WqM&list=PL3D4EECEFAA99D9BE&index=19
5	Differential and Compound Screw and Re-circulating Ball Screw	https://www.youtube.com/watch?v=TPURJnlekeo
UNIT 4: Design against Fluctuating Loads		
6	Cumulative damage in fatigue failure,	https://www.youtube.com/watch?v=WRoPQGE0WdI
7	Soderberg, Gerber, Goodman Lines, Modified Goodman Diagrams	https://www.youtube.com/watch?v=WRoPQGE0WdI
8	Fatigue design under combined stresses	https://www.youtube.com/watch?v=WRoPQGE0WdI

UNIT 5: Threaded and Welded joints		
9	Eccentrically loaded bolted joint in shear, Eccentric load perpendicular and parallel to axis of bolt	https://www.youtube.com/watch?v=__py5xbKHGA https://www.youtube.com/watch?v=YZYcMtkZiDY
10	Eccentric load on circular base	https://www.youtube.com/watch?v=__py5xbKHGA
11	Eccentric load in plane of welds, Welded joints subjected to bending and torsional moments	https://www.youtube.com/watch?v=__py5xbKHGA https://www.youtube.com/watch?v=YZYcMtkZiDY
UNIT 6: Design of Springs		
12	Surge in spring	https://www.youtube.com/watch?v=tTBnW5gAieM
13	Shot Peening.	https://www.youtube.com/watch?v=46quOD7V-cQ
14	Design of Multi-leaf	https://youtu.be/T4IgtIkBnOo

302044: Mechatronics					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Oral	**25 Marks**

Prerequisites: Basics of Electrical components, Binary to Decimal Conversion, Data communication Module, Op amp Circuits, Linear Algebra, Laplace Transformation method, Logic gates.

Course Objectives:

1. **UNDERSTAND** the key elements of mechatronics, principle of sensor and its characteristics.
2. **UNDERSTAND** the concept of signal processing and use of interfacing systems such as ADC, DAC, Digital I/O.
3. **UNDERSTAND** the block diagram representation and concept of transfer function.
4. **UNDERSTAND** the system modeling and analysis in frequency domain.
5. **UNDERSTAND** the system modeling and analysis in time domain, controller modes and its industrial applications..
6. **UTILIZE** the concepts of PLC system and its ladder programming and significance of PLC system in industrial application.

Course Outcomes:

On completion of the course, learner will be able to

CO1. **DEFINE** key elements of mechatronics, principle of sensor and its characteristics.

CO2. **UTILIZE** concept of signal processing and **MAKE** use of interfacing systems such as ADC, DAC, Digital I/O.

CO3. **DETERMINE** the transfer function by using block diagram reduction technique.

CO4. **EVALUATE** Poles and Zero, frequency domain parameter for mathematical modeling for mechanical system.

CO5. **APPLY** the concept of different controller modes to an industrial application.

CO6. **DEVELOP** the ladder programming for industrial application.

Course Contents

Unit 1	**Introduction to Mechatronics, Sensors & Actuators**	**07 Hrs.**

Introduction to Mechatronics and its Applications Measurement Characteristics (Static/Dynamic), **Sensors:** Types of sensors; Motion Sensors – Encoder (Absolute & incremental), Lidar, Eddy Current, Proximity (Optical, Inductive, Capacitive), MEMS Accelerometer;

Temperature sensor –Pyrometer, Infrared Thermometer; Force / Pressure Sensors – Strain gauges, Piezoelectric sensor; Flow sensors – Electromagnetic, Ultrasonic, Hot-wire anemometer; Color sensor – RGB type; Biosensors – Enzyme, ECG, EMG

Actuators: Servo motor; Hydraulic and Pneumatic (must be restricted to classification and working of one type of linear and rotary actuator); linear electrical actuators Selection of Sensor & Actuator

<table>
<tr><td>Unit 2</td><td>Data Acquisition and Signal Communication</td><td>08 Hrs.</td></tr>
<tr><td colspan="3">Signal Communication: Serial, Parallel; Synchronous, Asynchronous
Introduction to DAQ, Types, Components of a Data Acquisition System (Sensor, Signal conditioning, processing, controlling and storage/display/action)
Data Acquisition: Signal collection, Signal conditioning – Isolation& Filtering, Amplification, Sampling, Aliasing, Sample and hold circuit, Quantization, Analog-to-digital converters (4 bit Successive Approximation type ADC), Digital-to-Analog converters (4 bit R2R type DAC), Data storage Applications: DAQ in Household ,Digital Pressure Gauge, Digital Flow measurement, DVB Digital Video Broadcast, AM/FM</td></tr>
<tr><td>Unit 3</td><td>Control systems & transfer function based modelling</td><td>07 Hrs.</td></tr>
<tr><td colspan="3">Introduction to control systems, need, Types- Open and Closed loop, Concept of Transfer Function, Block Diagram & Reduction principles and problems; Applications (Household, Automotive, Industrial shop floor)
Transfer Function based modeling of Mechanical, Thermal and Fluid system; Concept of Poles & Zeros; Pole zero plot, Stability Analysis using Routh Hurwitz Criterion (Numerical Approach)</td></tr>
<tr><td>Unit 4</td><td>Time and Frequency Domain Analysis</td><td>08 Hrs.</td></tr>
<tr><td colspan="3">Time Domain Analysis – Unit step Response analysis via Transient response specifications (Percentage overshoot, Rise time, Delay time, Steady state error etc.)
Frequency Domain Analysis – Frequency Domain Parameters - Natural Frequency, Damping Frequency and Damping Factor; Mapping of Pole Zero plot with damping factor, natural frequency and unit step response ; Introduction to Bode Plot, Gain Margin, Phase Margin</td></tr>
<tr><td>Unit 5</td><td>Controllers</td><td>07 Hrs.</td></tr>
<tr><td colspan="3">Introduction to controllers, Need for Control, Proportional (P), Integral (I) and Derivative (D) control actions; PI, PD and PID control systems in parallel form; (Numerical approach), Feed forward anticipatory control
Manual tuning of PID control, Ziegler–Nichols method
Applications: Electro–Hydraulic/Pneumatic Control, Automotive Control</td></tr>
<tr><td>Unit 6</td><td>Programmable Logic Controller (PLC)</td><td>08 Hrs.</td></tr>
<tr><td colspan="3">Introduction to PLC; Architecture of PLC; Selection of PLC; Ladder Logic programming for different types of logic gates; Latching; Timers, Counters; PLC control of Hydraulics / Pneumatics / Mechatronics systems involving timing and counting operations.</td></tr>
<tr><td colspan="3" align="center">Books and other resources</td></tr>
</table>

Text Books:

1. William Bolton, Mechatronics: Electronics Control Systems in Mechanical and Electrical Engineering, 6th Ed, 2019
2. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication, 2008

References Books:

1. Alciatore and Histand, Introduction to Mechatronics and Measurement Systems, 5th Ed, 2019
2. Bishop (Editor),Mechatronics – An Introduction CRC 2006
3. Mahalik, Mechatronics – Principles, concepts and applications, Tata Mc-Graw Hill publication, New Delhi
4. C.D.Johnson, Process Control Instrumentation Technology, Prentice Hall,New Delhi
5. Bolton, Programmable Logic Controller, 4th Ed, Newnes, 2006

Web References:

1. https://www.elprocus.com/what-is-a-biosensor-types-of-biosensors-and-applications/
2. https://www.elprocus.com/color-sensor-working-and-applications/
3. https://www.youtube.com/watch?v=kbjCGGTXqUo&ab_channel=Controlengineering
4. https://youtu.be/clTA0pONnMs?list=PLHMDN3JFtE5wEz95H2XuzRaafK3fUsaki
5. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L-12(SS)%20(IA&C)%20((EE)NPTEL).pdf
6. https://nptel.ac.in/content/storage2/courses/112104158/lecture5.pdf

Term Work

The Term work shall consist of completion of Practical, Self-learning Study Assignments and Presentations. Oral examination shall be based on the Term work undertaken during the semester.

Practical (**Any one** experiments out of experiment no **1 to 3** from the following list whereas experiment no. **4 to 10** are mandatory).

1. Experiment on measurement of temperature using suitable sensor.
2. Experiment on measurement of load using suitable sensor.
3. Experiment on measurement of displacement using suitable sensor.
4. Development of a data acquisition / mechatronics system using low cost open source hardware and software.
5. Experiment on interfacing of suitable sensor and actuator with DAQ.
6. Modeling and analysis of mechanical system and its verification using suitable simulation software.
7. PID control of Mechanical System using suitable simulation software and experimental verification (verification only if experimental setup is available).
8. Ladder Logic Simulation of suitable application.
9. Demonstration of PLC controlled electro hydraulic / elector pneumatic circuit.
10. Industrial visit to understand integration and application of Mechatronics.

Assignments:

1. Application of Sensors and Actuators in Health Science and Selection of Suitable Sensor and Actuator.
2. Block Diagram Representation of Feedback Control System and determination of Closed Loop Transfer Function.

302045-A: Advanced Forming & Joining Processes					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisite Courses: Manufacturing Processes, Engineering Materials and Metallurgy, Machine shop

Course Objectives:

1. **UNDERSTAND** advances in sheet metal forming operations
2. **UNDERSTAND** the advanced special metal forming processes.
3. **UNDERSTAND** weld metallurgy and weld characterization techniques.
4. **UNDERSTAND** and describe various advanced solid state welding processes.
5. **CLASSIFY AND DESCRIBE** various advanced welding processes.
6. **KNOW** about sustainable manufacturing and its role in manufacturing industry

Course Outcomes:

On completion of the course, learner will be able to

- CO1. **ANALYSE** the effect of friction in metal forming deep drawing and IDENTIFICATION of surface defects and their remedies in deep drawing operations
- CO2. **ASSESS** the parameters for special forming operation and SELECT appropriate special forming operation for particular applications
- CO3. **ANALYSE** the effect of HAZ on microstructure and mechanical properties of materials
- CO4. **CLASSIFY** various solid state welding process and **SELECT** suitable welding processes for particular applications
- CO5. **CLASSIFY** various advanced welding process and **SELECT** suitable welding processes for particular applications.
- CO6. **INTERPRET** the principles of sustainable manufacturing and its role in manufacturing industry.

Course Contents

Unit 1	**Mechanics of Sheet Metal Forming**	**08 Hrs.**

Theory of plasticity – yield criteria-work of plastic deformation- Sheet Metal Forming-Formability studies-conventional processes, Effect of friction in forming operation, Experimental techniques of evaluation of friction in metal forming, deep drawing, analysis (Numerical), surface defects identification and remedies, introduction to Forming simulation, Challenges in Forming.

Unit 2	**Special Forming Processes**	**08 Hrs.**

Special Forming Processes: HVF, HERF (Explosive Forming) techniques- super plastic forming techniques-Hydro forming-Stretch forming, Laser beam forming-principles and process parameters-Advantages, limitations and applications of different forming processes. Orbital forging-Isothermal-Hot and cold isostatic pressing-High speed extrusion, Water hammer forming, Incremental Sheet forming, Magnetic Pulse forming, Metal Spinning, Electro Hydraulic Forming, Micro forming.

Unit 3	**Weld Metallurgy**	**07 Hrs.**
Weld Metallurgy: Weld thermal cycles and their effects, effects of pre and post weld heat treatments, concept of HAZ, concept of weldability and its assessment. Welding of dissimilar materials, Weld characterization, Weld decay and weld sensitization, Introduction to ASME, ASWE, IS Welding Standards, (welding skill levels).		
Unit 4	**Solid State Welding Processes**	**07 Hrs.**
Solid State Welding Processes: Cold pressure welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction stir welding, Forge welding, Roll welding and Hot pressure welding processes - features, advantages, limitations and applications, Advances in adhesive bonding, cladding.		
Unit 5	**Advanced Welding Processes**	**08 Hrs.**
Advanced Welding Processes: Electrogas, electroslag welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding - principle, working and applications, Cold Metal Transfer - concepts, processes and applications, Underwater welding, Welding automation in aerospace, nuclear and surface transport vehicles, Robotic Welding, Plasma Arc Welding, Plasma Transferred Arc Welding.		
Unit 6	**Sustainable Manufacturing**	**07 Hrs.**
Sustainable Manufacturing: Introduction to sustainability and drivers for sustainable development and sustainable manufacturing, fundamentals of sustainable manufacturing, various tools, factors of sustainability, Principles of Life Cycle Assessment (Goal, Scope and Life Cycle Inventory), Approaches, Role in Industry 4.0, Green Manufacturing, Environment protection norms, ISO 14000, recycling techniques, safety norms in forming and welding, socio-economic aspects, case study on waste recycling, material recycling, etc.		
Books and other resources		
Text Books: 1. Sindo Kou, “Welding Metallurgy”, Wiley Publications Second Edition 2. Dr. V. D. Kodgire and S. V. Kodgire, “Material Science & Metallurgy For Engineers”, Everest Publication 3. William D. Callister, “Materials Science and Engineering an Introduction”, Jr, John Wiley & Sons, Inc. 4. O.P. Khanna, " Welding Technology", Dhanpat Rai & Sons Publications Edition 2015 5. Dr. R. S. Parmar,"Welding Processes and Technology", Khanna Publications Edition 2017 6. J. Paulo Davim, " Sustainable Manufacturing", Wiley Publications Edition 2010		
References Books: 1. Z. Marciniak, J.L.Duncan, "Mechanics of Sheet Metal Forming", Butterworth Heinemann-2002. 2. Dr. Sadhu Singh, "Theory of Plasticity and Metal Forming Processes", Khanna Publishers Edition 2008 3. O.P. Khanna, " Engineering Metallurgy", Dhanpat Rai & Sons Publications 4. Ali Hasan - Islam Nawaz, "Advanced Welding Technology", SCITECH Publications India Pvt. Ltd. Edition 2018 5. Dr. K. S. Yadav, "Advanced Welding Technology"', Rajsons Publications Pvt. Ltd. 6. Tool and Manufacturing Engineers' Handbook: Forming V by Charles Wick Publisher		

: Society of Manufacturing Engineers; 4th edition (1 Aug. 1996)

7. Dornfeld and David, "Green Manufacturing" - Fundamentals and Applications, DOI 10.1007/978.1.4419.6016.0_2, Springer Science +Business Media, New York 2013.
8. R. Ganesh Narayanan, Jay S Gunasekera,"Sustainable Material Forming and Joining", by CRC Press 2020.

Web References:

1. NPTEL Course on "Forming" by Dr. R. Chandramouli, IIT Madras
2. NPTEL Course on "Welding Engineering" by Dr. D. K. Dwivedi, IIT Roorkee
3. NPTEL Course on "Advances in welding and joining technologies" by Prof. SwarupBag IIT Guwahati.
4. NPTEL Course on "Welding Metallurgy" by Prof. Pradeep K. Jha, IIT Roorkee
5. NPTEL Course on "Sustainability through Green Manufacturing System – An Applied Approach" by Prof. Deepu Philip IIT Kanpur and Dr. Amardeep Singh Oberaoi, NIT Jalandar.

302045-B:Machining Science &Technology					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Mechanics, Gear terminology, Material properties, Degree of freedom.

Course Objectives:

1. **KNOW** about fundamentals of metal cutting process, tool wear and tool life.
2. **IMPART** the knowledge of machining phenomenon like milling, gear and thread manufacturing, grinding, super finishing, etc.
3. **UNDERSTAND** the basic concepts, importance and functions of Jigs, Fixtures.
4. **PREPARE** list of operations, tools, set of manufacturing instructions and selection of quality assurance method.
5. **GENERATE** CNC program for appropriate machining processes like turning and milling.

Course Outcomes:

On completion of the course, learner will be able to

- CO1. **DEFINE** metal cutting principles and mechanics of metal cutting and tool life.
- CO2. **DESCRIBE** features of gear and thread manufacturing processes.
- CO3. **SELECT** appropriate grinding wheel and demonstrate the various surface finishing processes.
- CO4. **SELECT** appropriate jigs/fixtures and to draw the process plan for a given component.
- CO5. **SELECT & EVALUATE** various parameters of process planning.
- CO6. **GENERATE** CNC program for Turning / Milling processes and generate tool path using CAM software.

Course Contents

Unit 1	**Mechanics of Metal Cutting**	**08 Hrs.**

Introduction to metal cutting, Elements of machining process, Geometry of single-point cutting tool, Orthogonal and Oblique cutting processes,

Chip formation, Types of chips, Chip thickness ratio, Process parameters and their effect on machining, chip breakers,

Merchant's Circle of forces analysis – forces and energy calculations, power consumed – MRR-Effect of Cutting variables on forces,

Concepts of Machinability- Factors affecting machinability, Machinability Index, Tool Life, Tool life equation of Taylor, Tool wear and its types, Factors affecting on tool life.

Unit 2	**Gear and Thread Manufacturing**	**07 Hrs.**

Introduction, Materials of gears, Methods of gear manufacturing-casting, forging, forming etc, milling of gears (indexing methods and numerical), Helical gear cutting, Gear Shaping and Gear hobbling, Gear inspection.

Thread Manufacturing: Various methods of thread manufacturing**,** thread rolling, die threading & tapping, Thread milling, Thread grinding etc.

Unit 3	Grinding & Surface finishing	08 Hrs.

Types and Operations of grinding machines, Grinding wheel– Shapes, Designation and selection, Abrasives & classification, Bond & bonding, Grit, Grade & Structure of wheels, Types of grinding wheels, mounting of grinding wheels, Glazing and loading of wheels, Dressing and truing of wheels, Balancing of wheels, Diamond wheels.

Super-finishing processes – Introduction to Honing, Lapping, Buffing and Burnishing. (Construction, working and controlling parameters)

Unit 4	Jigs and Fixtures	08 Hrs.

Significance and purpose of jigs and fixtures and their functions in the manufacturing processes, Concept of degree of freedom, 3-2-1 principle of location. General guidelines to design jigs and fixtures, advantages of jigs and fixtures.

Jigs- Definition, Elements of jig with the types, Location guidelines, Principles of clamping, Principles of guiding, Channel jig, Template jig, Plate jig, Angle plate jig, Turn over jig, Box jig, Latch type jig.

Fixtures: Definition. Elements of fixtures, Location guidelines, Principles of clamping, Principles of setting element, turning fixture, welding fixture, Milling fixture, Assembly and Inspection fixtures.

Unit 5	Process Planning	06 Hrs.

Introduction- methods of process planning, drawing interpretation, material evaluation, steps in process selection, production equipment and tooling selection, process parameters calculation for various production processes, Selection of jigs and fixtures, selection of quality assurance methods, documents for process planning, Economics of process planning, case studies.

Unit 6	CNC Programming	08 Hrs.

CNC Programming-CNC part programming adaptable to suitable controller. Steps in developing CNC part program. CNC part programming for Lathe Machine – Threading & Grooving cycle (Canned cycle). CNC part programming for Milling Machine - Linear & circular interpolation, milling cutter, tool length compensation & cutter radius compensation. Pocketing, contouring & drilling, subroutine and Do loop using canned cycle.

Books and other resources

Text Books:

1. A Text Book of Production Technology, P. C. Sharma, S.Chand Publications
2. A Text Book of Manufacturing Technology, R. K. Rajput, Laxmi Publications (p) LTD
3. A Text book of Manufacturing Technology, Metal Cutting and Machine Tools, P. N. Rao, Vol. 2, 2nd edition, Tata McGraw Hill Publishing Co. Ltd, New Delhi, 2002
4. Elements of Workshop Technology, Vol-II, S. K. HajraChaudhary, Media Promoters &Publications Pvt Ltd.
5. S. K. Sinha, CNC Programming using Fanuc Custom Macro B, McGraw-Hill Professional

References Books:

1. Theory of Metal Cutting, M. C. Shaw, 1st Edition, Oxford and I.B.H. publishing, 1994
2. Jigs & Fixtures, P.H. Joshi, Third edition, McGraw Hill, 2017
3. Production Technology Manufacturing Systems VOL-I & II, R. K. Jain, Khanna Publishers
4. Production Technology –HMT, Tata McGraw Hill publication
5. An Expert Process Planning System, Chang, T. C., Addison Wesley Longman, 1990

6. Process Planning- Design/Manufacture Interface, Scallan P, Butterworth-Heinemann, 2003
7. CNC Machines, B. S. Pabla, M. Adithan, New Age International, 2018
8. Manufacturing Science, Amitabh Ghosh and AshokKumar Mallik, Affiliated East-West Press, 2010

Web References:

1. https://nptel.ac.in/content/storage2/courses/108105063/pdf/L-
2. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-32.pdf
3. https://nptel.ac.in/content/storage2/courses/112105127/pdf/LM-34.pdf
4. https://nptel.ac.in/courses/112/107/112107143/

302046: Digital Manufacturing Laboratory					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**2 Hrs./Week**	**Practical**	**1**	**Term Work**	**50 Marks**

Prerequisites: Construction and operating of conventional machine tools, principles of machining and forming processes, cutting tool and machining parameters, programming languages like C, Python etc., basics of 3D printing.

Course Objectives:

1. **ACQUIRE** skills to handle conventional machines and CNC machine for manufacturing of a component.
2. **PREPARE** manual part program for given component as per ISO standards.
3. **ACCUSTOM** skills of Additive manufacturing technology.
4. **APPRECIATE** the influence of cutting tool parameters on the performance.
5. **APPLY** Digital Manufacturing tools for process simulation of manufacturing processes.
6. **SELECT** appropriate type of jigs and fixtures for a given component

Course Outcomes:

On completion of the course, learner will be able to

CO1.**DEVELOP** a component using conventional machines, CNC machines and Additive Manufacturing Techniques.

CO2.**ANALYZE** cutting tool parameters for machining given job.

CO3.**DEMONSTRATE** simulation of manufacturing process using Digital Manufacturing Tools.

CO4.**SELECT** and **DESIGN** jigs and Fixtures for a given component.

CO5.**DEMONESTRATE** different parameters for CNC retrofitting and reconditioning.

Guidelines for Laboratory Conduction

The learner shall complete the following activity as a Term Work;

1. Demonstration of cutting tool geometry and nomenclature of the tools used in conventional and CNC machines.
2. Machining of a mechanical component using conventional machines such as lathe, drilling, milling, grinding and any additional machine tool or processes as per requirement. Manufacturing drawing with appropriate geometrical and dimensional tolerances, detailed process planning to be included.
3. Preparing manual CNC part program using G Codes and M Codes as per ISO (DIN 66025) and RS274 standards for CNC lathe/mill machine.
4. Machining of mechanical component using CNC machine (Lathe/Mill/HMC/VMC). Manufacturing drawing with appropriate geometrical and dimensional tolerances, detailed process planning to be included.
5. Demonstration of Additive Manufacturing technology (from modelling to printing) (To be performed Batch-wise)
6. Demonstration of the usage of Digital Manufacturing tools for process simulation of manufacturing processes like casting, forging, sheet metal, plastic processing (free / open source software)

7. Demonstration of various types of jigs and fixtures, and a case study on design and use of Jigs & Fixture for any given component.
8. Preparing Online Calculator/Catalogue for selection of cutting parameters by using programming languages like C, Python etc.
9. Study on CNC retrofitting and reconditioning
10. Visit to an Industry which uses advanced manufacturing processes

Please note following instructions regarding Laboratory Conduction:

1. Sr. No. 1 to 7are mandatory and any 2 from Sr. No. 8 to 10.
2. Practical are to be performed under the guidance of concerned faculty member.
3. Journal should consist of Job Drawing, Process Sheet and Program, appropriate write-up and shall be part of term-work submission.

302047: Skill Development					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**2 Hrs./Week**	**Practical**	**1**	**TW**	**25 Marks**

Prerequisites: Students should have knowledge of Construction and working of IC engine / compressor / gear box / centrifugal pump/tail stock. Working principles of any type of mechanism / power plants. Working of electric and hydraulic systems of 4 wheeler vehicle. Working of machine tools, engine and transmission of different automotive and home appliances. Advanced manufacturing processes. Solid mechanics and design of machine elements.

Course Objectives:

1. **INTRODUCE** the skills required in an industry such as design, development, assembly & disassembly.
2. **DEVELOP** the skills required for fault diagnose of engine and transmission of different automotive and various home appliances.
3. **ESTABLISH** the skills required for maintenance of any machine tool.
4. **CREATE** awareness about industrial environment.

Course Outcomes:

On completion of the course, learner will be able to

CO1.**APPLY**& **DEMONSTRATE** procedure of assembly & disassembly of various machines.
CO2.**DESIGN & DEVELOP** a working/model of machine parts or any new product.
CO3.**EVALUATE** fault with diagnosis on the machines, machine tools and home appliances.
CO4.**IDENTIFY** & **DEMONSTRATE** the various activities performed in an industry such as maintenance, design of components, material selection.

Course Contents

1. Assembly and Disassembly of any of the following mechanical systems/ subsystems: bicycle (geared), e-Bikes, e-Motor Cycles, Drones, Flying devices, gear box, IC engines, centrifugal pump etc.
2. Assembly- Disassembly/ Fault diagnosis of home appliances such as mixer, grinder, washing machine, fan, ovens, gas geyser, chopping machine, kneading machine, exercise machines, etc.
3. Development and demonstration of working/animation model of any mechanism.
4. Design a circuit of electric and hydraulic system of4 wheelers and its verification.

   OR

   Circuit design /PCB design using software for control of BLDC electric motors used in e-Vehicles.
5. Undertake total preventive maintenance for any machine tool or mechanical system.
6. Visit to an industry for awareness about preventive maintenance.
7. Use of ergonomic principles for the design of hand tools, control in automobile dashboards, human operated mobile devices.

8. Use of alternative materials in the construction of daily activity machine and tool components
9. Interpretation of Drawings; Exercises in identifying the type of production, extracting important functional dimensions, checking the number of parts in an assembly. Checking and listing missing dimensions.
10. Exercises in -preparation of detailed production drawings as per BIS standard of simple machine parts having relevant notes and indications (limits/tolerances, surface finish, the process of production, relevant tools, materials, measuring instruments).

The documentation activity as a part of the Term work shall not be restricted to merely generation of 2D/3D CAD Drawings with dimensions (as applicable), Exploded View, Flowchart of Maintenance Work etc. but can be beyond.

Skill Development Documentation Diary must be maintained by every student.

302048: Audit Course V		
Teaching Scheme	**Credits**	**Examination Scheme**
	Non-Credit	

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

Faculty mentor shall be allotted for individual courses and he/she shall monitor the progress for successful accomplishment of the course. Such monitoring is necessary for ensuring that the concept of self-learning is being pursued by the students 'in true letter and spirit'.

- If any course through Swayam/ NPTEL/ virtual platform is selected the minimum duration shall be of 8 weeks.
- However if any of the course duration is less than the desired (8 weeks) the mentor shall ensure that other activities in form of assignments, quizzes, group discussion etc. (allied with the course) for the balance duration should be undertaken.

In addition to credits courses, it is mandatory that there should be an audit course (non-credit course) from third year of Engineering. The student will be awarded grade as AP on successful completion of the audit course. The student may opt for any one of the audit courses in each semester. Such audit courses can help the student to get awareness of different issues which make an impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Students can choose one of the audit courses from the list of courses mentioned. Evaluation of the audit course will be done at institute level.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not considered in the calculation of the performance indices SGPA and CGPA. Evaluation of the audit course will be done at institute level itself.

Selecting an Audit Course

List of Courses to be opted (Any one) under Audit Course V

- Entrepreneurship and IP strategy
- Engineering Economics
- Mangment of Inventory Systems

The titles indicated above are subject to change in time to come and such an alteration (if any) should be brought to the notice of the BOS.

Using NPTEL Platform: (preferable)

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Students can select any one of the courses mentioned above and has to register for the

corresponding online course available on the NPTEL platform as an Audit course. • Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal. • After clearing the examination successfully; student will be awarded with a certificate.
Assessment of an Audit Course
• The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary. • During the course students will be submitting the online assignments. A copy of the same can be submitted as a part of term work for the corresponding Audit course. • On the satisfactory submission of assignments, the institute can mark as "Present" and the student will be awarded the grade AP on the mark-sheet.

302049: Artificial Intelligence & Machine Learning					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Oral	**25 Marks**

Prerequisites: Linear Algebra, Probability, Statistics, Logical Reasoning.

Course Objectives:

1. **ACQUAINT** with fundamentals of artificial intelligence and machine learning.
2. **LEARN** feature extraction and selection techniques for processing data set.
3. **UNDERSTAND** basic algorithms used in classification and regression problems.
4. **OUTLINE** steps involved in development of machine learning model.
5. **FAMILIARIZE** with concepts of reinforced and deep learning.
6. **IMPLEMENT AND ANALYZE** machine learning model in mechanical engineering problems.

Course Outcomes:

On completion of the course, learner will be able to

CO1. **DEMONSTRATE** fundamentals of artificial intelligence and machine learning.
CO2. **APPLY** feature extraction and selection techniques.
CO3. **APPLY** machine learning algorithms for classification and regression problems.
CO4. **DEVISE AND DEVELOP** a machine learning model using various steps.
CO5. **EXPLAIN** concepts of reinforced and deep learning.
CO6. **SIMULATE** machine learning model in mechanical engineering problems.

Course Contents

Unit 1	**Introduction to AI & ML**	**06 Hrs.**

History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, Introduction to Machine Learning. **Basics:** Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation.

Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical.

Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning.

Unit 2	**Feature Extraction and Selection**	**08 Hrs.**

Feature extraction: Statistical features, Principal Component Analysis.

Feature selection: Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering.

Unit 3	**Classification & Regression**	**08 Hrs.**

Classification: Decision tree, Random forest, Naive Bayes, Support vector machine.

Regression: Logistic Regression, Support Vector Regression. **Regression trees:** Decision tree, random forest, K-Means, K-Nearest Neighbor (KNN). Applications of classification and regression algorithms in Mechanical Engineering.

Unit 4	Development of ML Model	07 Hrs.
Problem identification: classification, clustering, regression, ranking. Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions.		
Unit 5	**Reinforced and Deep Learning**	**08 Hrs.**
Characteristics of reinforced learning; Algorithms: Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning; Models: Markov Decision Process, Q Learning. Characteristics of Deep Learning, Artificial Neural Network, Convolution Neural Network. Application of Reinforced and Deep Learning in Mechanical Engineering.		
Unit 6	**Applications**	**08 Hrs.**
Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms.		

Books and other resources

Text Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, “Artificial Intelligence – Building Intelligent Systems”, PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), “Artificial Intelligence: A Modern Approach,” Third edition, Pearson, 2003.

References Books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Web References:

1. http://nptel.ac.in/courses/111101003/
2. https://nptel.ac.in/courses/106/106/106106202/
3. https://nptel.ac.in/courses/112/103/112103280/
4. https://www.analyticsvidhya.com/

Term Work
List of Experiments: 1. To study supervised/unsupervised/Reinforcement learning approach. 2. To acquire, visualize and analyze the data set (from time-domain/ frequency-domain/ etc.) . 3. To extract features from given data set and establish training data. 4. To select relevant features using suitable technique. OR 5. To use PCA for dimensionality reduction. 6. To classify features/To develop classification model and evaluate its performance (any one classifier). 7. To develop regression model and evaluate its performance (any one algorithm). 8. Markov process for modelling manufacturing processes. OR 9. Reinforced Learning for optimizing engineering designs / Robot Guidance and Navigation. 10. GA for optimization of multi-dimensional function / path planning in robotics. OR 11. NN for parameter and model identification / tuning of Control Algorithms. **Note:** • Students need to apply the computational algorithms using suitable software / programming language. • Experiment 1, 2, 3, 6 & 7 are compulsory. Experiment 2 to 7 to be taken on same data set

302050: Computer Aided Engineering					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Practical	**50 Marks**

Prerequisite Courses: Solid Mechanics, Numerical and Statistical Methods, Engineering Mathematics, Manufacturing Processes, Fluid Mechanics, Heat and Mass Transfer.

Course Objectives:

1. **UNDERSTAND** the basic concepts of Computer Aided Engineering (CAE) and **CHARACTERISTICS** of various elements required for analysis.
2. **NURTURE** students about the discretization process and criteria for quality mesh.
3. **UNDERSTAND** the approaches of Finite Element Method (FEM) and to find displacement and stresses over the body.
4. **DEVELOP** the knowledge and skills needed to effectively evaluate the results using Finite Element Analysis (FEA).
5. **APPLY** computational technique to solve complex solid mechanics problems and its loading states.
6. **STUDY** the applications of CAE in the various domains of the Mechanical Engineering.

Course Outcomes:

On completion of the course, learner will be able to

CO1: **DEFINE** the use of CAE tools and **DESCRIBE** the significance of shape functions in finite element formulations.

CO2: **APPLY** the various meshing techniques for better evaluation of approximate results.

CO3: **APPLY** material properties and boundary condition to SOLVE 1-D and 2-D element stiffness matrices to obtain nodal or elemental solution.

CO4: **ANALYZE** and **APPLY** various numerical methods for different types of analysis.

CO5: **EVALUATE** and **SOLVE** non-linear and dynamic analysis problems by analyzing the results obtained from analytical and computational method.

CO6: **GENERATE** the results in the form of contour plot by the USE of CAE tools.

Course Contents

Unit 1	**Elemental Properties**	**07 Hrs.**

Introduction to Computer Aided Engineering (CAE), Use of CAE in Product development, Discretization methods – Finite Element Method (FEM), Finite Difference Method (FDM) and Finite Volume Method (FVM), CAE Tools- Pre-processor, Solver and Post-Processor.

Element Shapes – 1D, 2D and 3D elements, Nodal Unknowns and field variables, Coordinate Systems, Shape Functions- linear, quadratic and cubic, Convergence Requirements of Shape Functions, Derivation of Polynomial Shape Functions using coordinate systems for Bar, Beam, Triangular, and rectangular elements.

Unit 2	**Meshing Techniques**	**06 Hrs.**
Discretization of a Structure, 1D, 2D and 3D element Meshing, Element selection criteria, Refining Mesh, Effect of mesh density in critical region, Use of Symmetry. Element Quality Criterion:-Jacobian, Aspect ratio, Warpage, Minimum and Maximum angles, Average element size, Minimum Length, skewness, Tetra Collapse etc., Higher Order Element vs Mesh Refinement, Geometry Associate Mesh, Mesh quality, Bolted and welded joints representation, Mesh independent test.		
Unit 3	**1D Finite Element Analysis**	**08 Hrs.**
Consistent Unit System, Introduction to approaches used in Finite Element Analysis (FEA) such as direct approach and energy approach **Bar and Truss Element** - Element stiffness matrix, Assembling stiffness Equation, Load vector, stress and reaction forces calculations. **Temperature effect on Bar Element-** Calculation due to uniform temperature change, Stress and reaction forces calculations.		
Unit 4	**2D Finite Element Analysis**	**08 Hrs.**
Plane Stress-Strain, axi-symmetric problems in 2D elasticity. **Constant Strain Triangle (CST) -** Element Stiffness matrix, Assembling stiffness equation, Load vector, Stress and reaction forces calculations. **Post Processing Techniques** – Check and validate accuracy of results, Average and Un-average stresses, and special tricks for Post Processing. Interpretation of results and design modifications, CAE reports.		
Unit 5	**Non-Linear and Dynamic Analysis**	**08 Hrs.**
Non-Linear Analysis: Introduction to Nonlinear Problems, Comparison of Linear and Nonlinear analysis, Types of Nonlinearities, Stress-strain measures for Nonlinear analysis, Analysis of Geometric, Material Nonlinearity, Solution Techniques for Nonlinear analysis, Newton Raphson Method, Essential steps in Nonlinear analysis. **Dynamic Analysis:** Introduction to Dynamic Analysis, Comparison of Static and Dynamic analysis, Time domain and frequency domain, Types of loading, Simple Harmonic motion, Free vibration, Boundary conditions of free vibration, Solution.		
Unit 6	**Applications of Computer Aided Engineering**	**08 Hrs.**
Computational Fluid Dynamics (CFD): Introduction, Three dimensions of Fluid Dynamics, Equilibrium Equation for a fluid, Conservation form of Fluid flow equation, Integral form of the Conservation Laws. **Injection moulding of Plastics:** Simplification of Mould Geometry for FEA, Material Model for Mould FEA, Boundary Conditions for Mould FEA, Loading of Mould in FEA, Results Analysis. **Simulation for Manufacturing Processes like Casting and Sheet Metal Applications:** Introduction and workflow of Casting Simulation Software and Sheet Metal Applications. **Durability Analysis:** Durability, Reliability and Fatigue**,** FEA bases fatigue analysis viz: Stress-Life approach (S-N method) and Strain-Life approach (E-N method). **Crash Analysis:** Introduction, Explicit time integration schemes, implicit integration schemes. **Noise Vibration and Harshness (NVH) Analysis:** NVH Concepts, Terminology, FEA for structural Dynamics, FEA for Acoustics.		

Books and other resources
Text Books: 1. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune, 1^{st} Edition, 2008. 2. S. S. Bhavikatti, Finite Element Analysis, New Age International Publishers, Third Edition, 2015. 3. Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 2002. 4. G Lakshmi Narasaiah, Finite Element Analysis, BS Publications / BSP Books, 2nd edition, 2020. 5. J. N. Reddy, An Introduction to the Finite Element Method, Mcgraw Hill Series in Mechanical, 2005. 6. P. Seshu, Text book of Finite Element Analysis, PHI Learning Private Limited, New Delhi, 10^{th} Printing, 2012.
References Books: 1. K. J. Bathe, Finite Element Procedure, Prentice-Hall of India (P) Ltd., New Delhi, 1996. 2. Cook R. D., Finite Element Modeling for Stress Analysis, John Wiley and Sons Inc, 1995. 3. G.R. Liu S. S. Quek, The Finite Element Method- A Practical Course, Butterworth Heinemann, 2013. 4. Fagan M. J., Finite Element Analysis Theory and Practice, Harlow Pearson/Prentice Hall, 2012. 5. S. Moaveni, Finite element analysis, theory and application with Ansys, Pearson, Third Edition, 2011. 6. David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill, 2017. 7. Mukhopadhyay M and Sheikh A. H., Matrix and Finite Element Analyses of Structures, Ane Books Pvt. Ltd., 2009 8. Daryl L. Logan, A First Course in the Finite Element Method, Fourth Edition, Thomson Canada Limited, 2007. 9. O.C. Zienkiewicz, The Finite Element Method: Its Basis and Fundamentals, Sixth Edition, Elsevier Butterworth-Heinemann, 2005.
Web References: • **https://nptel.ac.in/courses/112/104/112104116/-**for Basics of Finite Element Analysis by Prof.Nachiketa Tiwari, IIT Kanpur • **https://nptel.ac.in/courses/112/106/112106130/**for Advanced Finite Element Analysis by Dr. R. Krishnakumar, Department of Mechanical Engineering, IIT Madras • **https://nptel.ac.in/courses/112/103/112103299/**for Finite Element Analysis for Welding Analysis by Prof. Swarup Bag, Department of Mechanical Engineering, IIT Guwahati. • **https://sites.ualberta.ca/~wmoussa/AnsysTutorial/** for ANSYS Tutorials

Term Work
The student shall complete the following activity as a Practical using any commercial FEA software or open-source software's 1. 1D Bar Element – Structural Linear Analysis 2. Truss Analysis using 1D Element 3. Plate/Shell Element – Structural Linear and Non-Linear Analysis 4. Beam Element – Non-Linear Buckling Analysis 5. Thermal Analysis – Static/Transient Analysis 6. Coupled Analysis- (Structural + Thermal) 7. Analysis of Machine Component using 3D Elements 8. Non-Linear Analysis of Assembly using Contact Elements 9. Modal Analysis – Spring -Mass system, simply supported/Cantilever beam, etc. 10. Presentation on advanced applications of FEA, NVH, CFD, Crash, Fatigue, Manufacturing, etc. **Note:** • The lab report shall consist of completion of Practical's and Presentations. • Practical examination shall be based on the practical undertaken during the semester.

302051: Design of Transmission Systems					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Oral	**25 Marks**

Prerequisites: Classification of Gears, Gear Terminology, Terminology of Helical gear, Virtual number of teeth. Classification, selection and application of Belt, chain and rope drives.

Course Objectives:

1. **APPLY** fundamentals for the design and/or selection of elements in transmission systems.
2. **UNDERSTAND** the philosophy that real engineering design problems are open-ended and challenging.
3. **DEMONSTRATE** design skills for the problems in real life industrial applications.
4. **DEVELOP** an attitude of team work, critical thinking, communication, planning and scheduling through design projects.
5. **PERCEIVE** about safety, ethical, legal, and other societal constraints in execution of their design projects.
6. **BUILD** a holistic design approach to find out pragmatic solutions to realistic domestic and industrial problems

Course Outcomes:

On completion of the course, learner will be able to

CO1.**APPLY** the principle of Spur & Helical gear design for industrial application and PREPARE a manufacturing drawing with the concepts of GD&T.

CO2.**EXPLAIN** and **DESIGN** Bevel & Worm gear considering design parameters as per design standards.

CO3.**SELECT&DESIGN** Rolling and Sliding Contact Bearings from manufacturer's catalogue for a typical application considering suitable design parameters.

CO4.**DEFINE** and **DESIGN** various types of Clutches, Brakes, used in automobile.

CO5.**APPLY** various concept to **DESIGN** Machine Tool Gear box, for different applications

CO6.**ELABORATE** various modes of operation, degree of hybridization and allied terms associated with hybrid electric vehicles.

Course Contents

Unit 1	**Spur and Helical Gears**	**07 Hrs.**

Introduction to gears: Material selection for gears, Modes of gear tooth failure, Gear Lubrication Methods.

Spur Gears: Number of teeth and face width, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation.

AGMA (American Gear Manufacturing Association) approach of Gear design (Only mathematical relations, no numerical)

Helical Gears: Force analysis of Helical Gear, Beam Strength of Helical Gear, Wear strength and estimation of effective load based on Velocity factor (Barth factor) and Buckingham's equation. (No numerical on force analysis of helical)		
Unit 2	**Bevel and Worm Gear**	**08 Hrs.**
Bevel Gears: Types of Bevel gears, Terminology, Virtual number of teeth, and force analysis of Straight Bevel Gear. Design of Straight Bevel Gear based on Beam Strength, Wear strength and estimation of effective load based on Velocity factor (Barth factor) and Buckingham's equation. (Simple numerical to be taken no design calculations) **Worm Gears:** Worm and worm gear terminology and proportions of worm and worm gears, Force analysis of worm gear drives, Friction in Worm gears, efficiency of worm gears, Worm and worm gear material, Strength and wear ratings of worm gears (Bending stress factor, speed factor, surface stress factor, zone factor) IS 1443-1974, Thermal consideration in worm gear drive. *(Simple numerical to be taken no design calculations)*		
Unit 3	**Sliding and Rolling Contact Bearing**	**07 Hrs.**
Sliding contact bearing (Theoretical treatment only): Introduction to sliding contact bearing, classification, Reynolds's equation (2D), Petroff's equations, Sommerfeld number, Parameters of bearing design. **Rolling Contact Bearings**: Types of rolling contact Bearings and its selection, Static and dynamic load carrying capacities, Stribeck's Equation, Equivalent bearing load, Load-life relationship, Selection of bearing life, Selection of rolling contact bearings from manufacturer's catalogue, Design for cyclic loads, Types of failure in rolling contact bearings - causes and remedies. (Simple Numerical treatment)		
Unit 4	**Design of Clutches and Brakes**	**07 Hrs.**
Clutches: Introduction, Types of clutches, Material, Positive clutches, friction clutches, single plate, multiple plate, Cone clutch, and centrifugal clutches, Application of friction clutches automotive and industrial machinery sector. (Only Theoretical Treatment) **Brakes**: Introduction, Types of brakes, Material, Design of band brake, external and internal shoe breaks internal expanding shoe brakes, design of disc brakes. Application of brakes in automotive and industrial machinery sector. (Only Theoretical Treatment)		
Unit 5	**Design of M/C Tool Gear Box**	**08 Hrs.**
Introduction to Machine Tool Gearboxes, classification, basic considerations in design of drives and its Applications, Determination of variable speed range, Graphical representation of speed and structure diagram, Ray diagram, selection of optimum ray diagram, Kinematic /Gearing Diagram, Deviation diagram, Difference between numbers of teeth of successive gears in a change gear box. *(Note: Full design problem to be restricted up to 2 Stages only & No design problem on deviation diagram*)		
Unit 6	**Transmission system in Hybrid Electric Vehicle**	**08 Hrs.**
Introduction, Types of Hybrid Electric Vehicles: Basic Classification, Basic Modes of Operation, Other Derivatives, Degree of Hybridization. Power Split Devices (PSD): Simple and EM compound PSD, HEV Component Characteristics: The IC Engine, Electric Machines, Battery, HEV Performance Analysis: Series HEV, Parallel HEV, HEV Component Sizing: General Considerations, Sizing for Performance, Optimum Sizing, Power Management: Control Potential, Control.		

Books and other resources

Text Books:

1. Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw Hill Publication Co. ltd.
2. Spotts M.F. and Shoup T.E., Design of Machine Elements, Prentice Hall International.
3. Bhandari V.B, Design of Machine Elements, Tata McGraw Hill Publication Co. Ltd.
4. Juvinal R.C, Fundamentals of Machine Components Design, John Wiley and Sons.

References Books:

1. Design Data - P.S.G. College of Technology, Coimbatore.
2. Vehicle Powertrain Systems by Behrooz Mashadi, David Crolla. A John Wiley & Sons, Ltd
3. Automobiles–Power trains and Automobiles–Dynamics by Crolla, David, A John Wiley &Sons, Ltd
4. Automotive Engineering Powertrain, Chassis System and Vehicle Body by David A Crolla, Elsevier B H New York, London, Oxford.
5. lack P.H. and O. Eugene Adams, Machine Design, McGraw Hill Book Co. Inc.
6. Willium C. Orthwein, Machine Components Design, West Publishing Co. and Jaico Publications House.
7. P. Kannaiah, Design of Transmission systems‖, SCIETCH Publications Pvt Ltd.
8. C.S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI Learning Pvt. Ltd.
9. D.K. Aggarwal& P.C. Sharma, Machine Design, S.K Kataria and Sons.
10. P. C. Gope, Machine Design: Fundamentals and Applications, PHI Learning Pvt. Ltd.
11. Bhandari, V. B. Machine Design data book, Tata McGraw Hill Publication Co. Ltd.
12. K. Mahadevan, K. Balveera Reddy, Design Data Handbook for Mechanical Engineers, CBS Publishers.

Web References:

1. https://www.youtube.com/watch?v=b42_IO87X4s
2. https://www.youtube.com/watch?v=vTZ4Gah3wfo
3. https://www.youtube.com/watch?v=ER6LC7ONCD8
4. https://www.youtube.com/watch?v=nMsB6Soz4Hc
5. https://www.youtube.com/watch?v=WOTDbCPukoM
6. https://www.youtube.com/watch?v=fMNQglkUfhs
7. https://freevideolectures.com/course/2363/design-of-machine-elements

Term Work
Student shall complete the following activity as a Term Work; The Submission shall consist of completion of Two Design projects and study Assignments. Oral examination shall be based on the practical undertaken during the semester. **Design Project 1 (Any one)** 1. Design of gearbox for wind mill application or sluice gate. (Use AGMA approach) 2. Design of gearbox for building Elevator. (Use AGMA approach) 3. Design of gearbox for Hoist. (Use AGMA approach) 4. Design of gearbox for Worm gear box for Sugar Industry. (Use AGMA approach) 5. Design of clutch system for automobile 6. Design of brake system for automobile **Design Project 2** Projects shall be in the form of design of mechanical systems on multi speed spindle gear box including design of belt and pulley, Prime mover selection etc. The design project shall consist of two full imperial (A1) size sheets involving assembly drawing with a part list and overall dimensions and drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified for important surfaces. A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. Design data book shall be used wherever necessary to achieve selection of standard components. **Assignment: Any Two (PPT Presentation and Report)** 1. Application orientated Numerical on HEV 2. Lubricating oils: Properties, additives, selection of lubricating oils 3. Properties & selection of sliding bearing materials 4. Application of belt, rope and chain drives and its selection method for Industry 5. Transmission system of HEV

302052-A: Composite Materials					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Engineering Materials, Metallurgy, Manufacturing Process, Basic Design aspects.

Course Objectives:

1. **DESCRIBE** what are composite materials and their differences with respect to conventional materials.
2. **COMPREHEND** the challenges associated with Polymer Matrix composites.
3. **UNDERSTAND** the requirement of Metal Matrix Composites
4. **RECOGNIZE** design and properties aspect of composites
5. **UNDERSTAND** the testing, inspection and standard in Composites
6. **ORIENT** to the specific Application of Composites

Course Outcomes:

On completion of the course, learner will be able to

CO1. **DEFINE & COMPARE** composites with traditional materials.

CO2. **IDENTIFY & ESTIMATE** different parameters of the Polymer Matrix Composite

CO3. **CATEGORISE** and **APPLY** Metal Matrix Process from possessions landscape.

CO4. **DETERMINE** volume/weight fraction and strength of Composites.

CO5. **SELECT** appropriate testing and inspection method for composite materials.

CO6. **SELECT** composites materials for various applications.

Course Contents

Unit 1	**Introduction to Composites**	**07 Hrs.**

Definitions, Need of Composites, Classification of Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Natural Composites, Carbon Fiber composites, Properties of composites in comparison with standard materials. Advantages and Disadvantages. Natural Composites, Hybrid materials and their difference with Composite materials, Applications.

Unit 2	**Polymer Matrix Composite**	**08 Hrs.**

Polymer resins – thermosetting resins, thermoplastic resins – reinforcement fibers – roving's – woven fabrics – non woven random mats – various types of fibers. PMC processes – hand layup processes – spray up processes – compression moulding – reinforced reaction injection moulding – resin transfer moulding – Pultrusion – Filament winding – Injection moulding. Fiber reinforced plastics (FRP), Glass Fiber Reinforced Plastics (GFRP). Laminated Composites.

Unit 3	**Metal Matrix Composite**	**07 Hrs.**

Characteristics and types of MMC, advantages and limitations of MMC, Reinforcements – particles – fibers. Effect of reinforcement – volume fraction – rule of mixtures. Processing of MMC – powder metallurgy process – diffusion bonding – stir casting – squeeze casting, a spray process, Liquid infiltration In-situ reactions-Interface-measurement of interface properties.

Unit 4	Mechanics of Composite Materials	08 Hrs.
Geometrical aspects – volume and weight fraction (Numerical). Large particle composites and the rule of mixtures for elastic constants, failure, fatigue, and long-term strength, methods of optimum design of materials and structures, Micromechanics of a Lamina, Unidirectional continuous fiber, discontinuous fibers, short fiber systems, woven reinforcements –Mechanical Testing: Determination of stiffness and strengths of unidirectional composites; tension, compression, flexure and shear (Numerical).		
Unit 5	**Testing, Inspection & Standards in Composites**	**07 Hrs.**
Test Environments, Mechanical Test (Tensile, compression, shear & Fatigue) Bond Strength / Ply Adhesion ASTM F904, Testing Techniques for Composite Double Cantilever Beam, End Notch Flexure, Inter laminar Share Strength, Materials Nondestructive Inspection (NDI) of Composites, Thermographic testing of composites. ASTM & ISO standards for composites materials.		
Unit 6	**Application of Composite Materials**	**08 Hrs.**
Applications of Composites material for Aerospace and Transportation application, viz LCA/LCH, Automobile Industry -lightweight, cost-effective, multi-material technology, compatibility with automation systems and rapid processing. Energy Applications-Ecofriendly Prime movers, Infrastructure and Building Applications, Maine Applications- Boats and Ships, Ecofriendly storage Tanks Sports Industry-Protective Equipment's.		

Books and other resources

Text Books:

1. Chawla K.K., Composite materials Science and Engineering, Springer – Springer New York-2016
2. Daniel Gay- Composite Materials- Design and Applications, CRC Press, 2014
3. Autar Kaw- Mechanics of Composite Materials, Taylor and Francis, Second Edition- 2006
4. Robert M Jones-Mechanics of Composite Material, CRC Press, 2018
5. Madhujit Mukhopadhyay - Mechanics of Composite Materials and Structure, University Pres, 2004
6. S.C. Sharma -Composite Materials, Narosa Publishing House—2000

References Books:

1. A Bent Strong- Fundamentals of Composites Manufacturing-Materials, Methods and Applications, Society of Manufacturing Engineers, 2008
2. Clyne T.W. and Withers P.J-Introduction to Metal Matrix Composites, Cambridge University Press, 1995
3. Agarwal B. D. and Broutmen L. J-Analysis and performance of Fiber Composites, Wiley Publicaions-Fourth Edition, 2017
4. M. W. Hyer, Scott R. White- Stress Analysis of Fiber-reinforced Composite Materials, DEStech Publications, Inc., 2009
5. Carl T. Herakovich- Mechanics of Fibrous Composites, Wiley Publicaions, 1998
6. Erich Fitzer, Lalit M. Manocha - Carbon Reinforcements and Carbon /carbon Composites, Springer-Verlag, 1998
7. Murray Schwartz, Mel M. Schwartz- Composite Materials Handbook, McGraw-Hill, 1992
8. Composite Materials Handbook, SAE International, 2017

Web References:

1. Introduction of Composite - https://nptel.ac.in/courses/112/104/112104229/
2. Advanced Composite - https://nptel.ac.in/courses/112/104/112104249/
3. Polymer Process - https://nptel.ac.in/courses/113/105/113105077/
4. Manufacturing of composite - https://nptel.ac.in/courses/112/104/112104221/
5. Processing of Polymer composite - https://nptel.ac.in/courses/112/107/112107221/
6. Composite materials - https://nptel.ac.in/courses/101/106/101106038/
7. Mechanics of laminated of composite - https://nptel.ac.in/courses/112/104/112104161/
8. Composite Materials and Structure - https://nptel.ac.in/courses/101/104/101104010/

302052-B: Surface Engineering					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Basic Chemistry, Engineering Materials & Basic Metallurgy concepts

Course Objectives:

1. **DEVELOP** fundamental understanding and role of materials to allow surface selection for mechanical contact surfaces
2. **UNDERSTAND** surface modification and coating method to enhance surface performance
3. **RECOGNIZE** method for testing surface properties

Course Outcomes:

On completion of the course, learner will be able to-

CO1. **DEFINE** the basic's principle & mechanism of surface degradation.

CO2. **ANALYSE & SELECT** correct corrosion prevention techniques for a different service condition.

CO3. **DEMONSTRATE** the role of surface engineering of materials to modify/improve the surface properties.

CO4. **SELECT** the suitable surface heat treatments to improve the surface properties.

CO5. **APPLY** the surface modification technique to modify surface properties.

CO6. **ANALYSE & EVALUTE** various surface coating defects using various testing/characterization method.

Course Contents

Unit 1	Introduction to Surface Engineering and Surface Degradation	08 Hrs.

Introduction to engineering components, surface dependent properties and failures, importance and scope of surface engineering; surface and surface energy; Structure and type of interfaces, surface and related equations; Surface engineering: classification, definition, scope and general principles.
Adhesive wear, Abrasive wear, Erosion wear, Polishing wear; Corrosion: definition; Various Forms of Corrosion; Corrosion Triangle, Pilling and Bedworth rule, Formation and growth of films, Concept of Electrode Potential, Concept of Polarization, Electrochemical and galvanic series of metals.

Unit 2	Corrosion Testing and Prevention methods	07 Hrs.

Corrosion Testing –Introduction of Corrosion Testing by Physical (only weight loss & salt spray method) and Electrochemical Methods such as ASTM standard methods only G-5&A262-A.
Corrosion Prevention methods –Metallurgical and Environmental aspects of corrosion, Inhibitors, Internal & External coating, Cathodic & Anodic protection, use of special alloys, Improvement in design/ changes in design to control corrosion.

Unit 3	Surface Treatment Methods	08 Hrs.

Diffusion: Principles of diffusion, Fick‟s law, diffusion in solids, Diffusion in liquids; Surface hardening: Carburizing, Carburizing atmosphere and Heat treatment after Case Hardening, Depth of carburization, Case depth measurement, ASTM E1077-01 Depth of carburization, ASTM standard

G105, G95, Bainite control in case, Drip Feed Carburizing, dimensional changes during case hardening; Nitriding, Carbonitriding, Tufftriding, Nitrocarburising, Plasma Nitriding; Induction Hardening, Flame Hardening, Laser Hardening, Selection of steels for these treatments and their applications.		
Unit 4	**Advance Surface Modification Techniques**	**07 Hrs.**
Surface modification processes: ion beam surface treatment; sol-gel coating technology; laser surface alloying. Coating for corrosion resistance: conversion coatings; compound coatings - diamond-like nanocomposites, nitrides, silicides, and carbides. Coating for wear resistance: carbon nitride thin films; sputter deposited nanostructured ceramic coatings; dielectric coatings of Si-C alloy films. Electroless coating.		
Unit 5	**Surface Coating Techniques**	**07 Hrs.**
Introduction; importance of coating; types of coating: metal, inorganic, and organic. Processes of metal coatings: electrodeposition; flame spraying; Cold spray coating; cladding; hot dipping; vapor deposition. Processes of inorganic coatings: spraying; diffusion coating; chemical conversion. Processes of organic coatings: surface preparation; priming coat; top coats, Antidust coating, Hardfacing; Coatings for high temperature, Coatings for aerospace and aircrafts.		
Unit 6	**Surface Evaluation and Characterizations**	**08 Hrs.**
Coating Defects & remedies: Crawling, cratering & related defects; Flooding, wrinkling, Bubbling and Pin-holing, Overspray and Dry Spray, Blushing, foaming, blistering, checking and cracking, blooming, chalking, embrittlement, orange peel, yellowing etc. Measurement of coating thickness; porosity and adhesion of surface coating; measurement of residual stress and stability; Surface microscopy and topography by scanning probe microscopy; spectroscopic analysis of modified surfaces; Surface roughness, Atomic force microscopy.		

Books and other resources

Text Books:

1. K.G. Budinski, Surface Engineering for Wear Resistances, Prentice Hall, Englewood Cliffs, 1988.
2. M. Ohring, The Materials Science of Thin Films, Academic Press Inc, 2005.
3. Peter Martin, " Introduction to Surface Engineering and Functionally Engineered Materials", John Willey
4. M. G. Fontana - Corrosion Engineering, 3rd Edition, TATA Mc Graw Hill, 2008.
5. J. R. Davis-Surface Engineering for Corrosion and Wear Resistance, ASM International, 2001
6. R. W. Revie & H.H. Uhlig - Corrosion and Corrosion Control, An Introduction to Corrosion Science & Engineering, 4th Edition, Wiley Inter science , 2008.

References Books:

1. Mircea K. Bologa, "Surface Engineering and Applied Electrochemistry", Springer.
2. Devis, J.R.," Surface Engineering for Corrosion & Wear Resistance", 2001 Maney Publicsing
3. D.R. Jones - Principals and Prevention of Corrosion, 2nd International Edition, Prentice Hall International Singapore, 1995.
4. L. L. Shreir- Corrosion Volume I & II, Butterworths, London, 1994.
5. ASM Handbook Volume 5: Surface Engineering, ASM International, USA, 1994.

Web References:

1. Aqueous Corrosion and Its Control - Course (nptel.ac.in): By Dr. V. S. Raja
2. Corrosion Failures and Analysis - Course (nptel.ac.in):By Dr. KallolMandol
3. Surface Engineering of Nanomaterials - Course (nptel.ac.in): By Prof. Kaushik Pal
4. Fundamentals of Surface Engineering: Mechanisms, Processes and Characterizations - Course (nptel.ac.in)by Prof. D.K. Dwivedi

302053: Measurement Laboratory					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**2 Hrs./Week**	**Practical**	**1**	**Term Work**	**50 Marks**

Prerequisites: Basics of Linear measurements and working principles of Electrical and Electronics devices.

Course Objectives:

1. **DEVELOP** necessary skills for calibration and testing of instruments
2. **APPLY** fundamentals of measuring methods by collecting data ,analysis and interpretation
3. **APPLY** knowledge of Designing limiting gauges
4. **APPLY** knowledge of Electronic/Electrical measuring instruments

Course Outcomes:

On completion of the course, learner will be able to-

CO1. **EVALUATE** causes of errors in Vernier calipers, micrometers by performing experiments in standard metrological conditions, noting deviations at actual and by plotting cause and effect diagram, to reduce uncertainty in measurement.

CO2. **ANALYZE** strain measurement parameters by taking modulus of elasticity in consideration to acknowledge its usage in failure detection and force variations.

CO3. **EXAMINE** surface Textures, surface finish using equipment's like Talysurf and analyze surface finish requirements of metrological equipment's like gauges, jaws of vernier calipers, micrometers, magnifying glasses of height gauge and more, to optimize surface finish accuracy requirements and cost of measurement.

CO4. **MEASURE** the dimensional accuracy using Comparator and limit gauges and appraise their usage in actual measurement or comparison with standards set to reduce measurement lead time.

CO5. **PERFORM** Testing of Flow rate, speed and temperature measurements and their effect on performance in machines and mechanisms like hydraulic or pneumatic trainers, lathe machine etc. to increase repeatability and reproducibility.

CO6. **COMPILE** the information of opportunities of entrepreneurships/business in various sectors of metrology like calibrations, testing, coordinate and laser metrology etc in an industry visit report.

Term Work

The student shall complete the following activity as a Term Work

1. Fundamentals of measurements and Calibration process by using Dead weight Tester/Strain Gauges/Pressure Gauge.
2. Linear and angular Measurement: Demonstration and calculations using Vernier Caliper, Screw gauge, Dial gauge, height gauge, Bevel protector etc. and plotting cause and effect diagram for their errors in measurement with the help of OER software's or software's like Minitab or in excel sheet.
3. Limit Gauges: Concepts, uses and applications of Go –No Go Gauges, Taylor's principle and Design of gauges (Numerical and student activity)
4. Surface roughness measurement of a given sample using surface tester. Students should also

plot of flow chart of its usage.

5. Determination of geometry and dimensions of given composite object / single point tool, by using Optical Projector / Tool makers' Microscope and differentiate between its usefulness in real life.
6. Verification of dimensions and geometry of given components using Electric/Mechanical/Optical/Pneumatic comparator in context of manufacturing.
7. Determination of modulus of elasticity of a mild steel specimen using strain gauges and its improvement to reduce cost of measurement.
8. Calibration of Thermocouple for temperature measurement / Experimentation by using Gear Tooth Vernier Caliper
9. Speed Measurement and calibration of photo and magnetic speed pickups for the measurement of speed by using Stroboscope.
10. Calibration for Flowrate measurement by using Anemometers, Ultrasonic flow meters and plotting of Risk Priority Number (RPN) of any of the used equipments.
11. Determination of geometry of a given sample by using Coordinate Measuring Machine as per NPL standard and also acknowledge requirements of ISO 10360-5:2020 in CMM measurement.
12. Applications of Open Education Resources like Scilab in measurement / Students should develop any online calculator/app for calculations/numerical analysis relevant to metrology.

Important Note:

1. Relevant theory to be taught during practical hours
2. Sr. No. 1, 2, 3 and 12 are mandatory and any 4 from Sr. No. 4 to 11.
3. Practical's are to be performed under the guidance of concerned faculty member.

Industry Visit to provide exposure to students (Anyone to be covered to fulfil CO6 essentially)

- Demonstration of CMM with the help of software and its futuristic improvements as per Industry 4.0 requirements.
- Design of Go –No Go gauges and Senor applications with modernization as per IOT and Industry 4.0
- Calibration Process as per NABL accreditation norms
- Laser Metrology and its relevant setup functions to be carried out by engineers along with safety precautions to reduce measurement lead time and uncertainty.
- Temperature Measurements of Furnaces, Boilers etc with its cost analysis
- Flow Measurements of Air, Fluids to reduce measurement lead time

Text Books:

1. Jain R.K., Engineering Metrology, Khanna Publication.
2. D.S.Kumar, Mechanical Measurements and Control Metropolitan Book Co.Pvt.Ltd.
3. I.C.Gupta, Engineering Metrology, Dhanpath Rai.
4. Bewoor A. K. and Kulkarni V. A., Metrology and Measurements, McGraw hill Publication.

Reference Books:

1. Narayana K.L., Engineering Metrology.
2. Galyer J.F &Shotbolt C.R., Metrology for engineers
3. Judge A.W., Engineering Precision Measurements, Chapman and Hall
4. Francis T. Farago, Mark A. Curtis, Handbook of dimensional measurement

5. ASTME, Handbook of Industrial Metrology, Prentice Hall of India Ltd.
6. Connie Dotson, Fundamentals of Dimensional Metrology, ThamsonPubln. 4th Edition.

Online Education resources: viz. NPTEL web site:

1. nptel.ac.in/courses/112106179
2. www.nptelvideos.in/2012/12/mechanical-measurements-and-metrology.html
3. https://nptel.ac.in/courses/112/107/112107242/
4. freevideolectures.com › Mechanical › IIT Madras
5. https://nptel.ac.in/courses/112/106/112106139/

302054: Fluid Power & Control Laboratory					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**2 Hrs./Week**	**Practical**	**1**	**Term Work**	**50 Marks**

Prerequisites: Hydraulic fluids, Relay logic and Ladder Logic/PLC programming

Course Objectives:

1. **UNDERSTAND** working principles of control devices and accessories.
2. **SELECT** different components from manufactures' catalogues.
3. **DEMONSTRATE** the capabilities to simulate and design fluid power systems.
4. **UNDERTAKE** digitalization of fluid power system.

Course Outcomes:

On completion of the course, learner will be able to

CO1.**DEFINE** working principle of components used in hydraulic and pneumatic systems.

CO2.**IDENTIFY & EXPLAIN** various applications of hydraulic and pneumatic systems.

CO3.**SELECT** an appropriate component required for hydraulic and pneumatic systems using manufactures' catalogues.

CO4.**SIMULATE & ANALYSE** various hydraulic and pneumatic systems for industrial/mobile applications.

CO5.**DESIGN** a hydraulic and pneumatic system for the industrial applications.

CO6.**DESIGN & DEMONESTRATE** various IoT, PLC based controlling system using hydraulics and pneumatics.

Practical

The student shall complete the following Practical in laboratory

1. Study of fluid power control systems
   a. Fluid Power Engineering Fundamentals
      - Fluid power basics (governing laws used in fluid power systems)
      - Discuss fluid power transmission and explain basic methods of transmission of power
      - Advantages and disadvantages of fluid power systems
      - Explain role of fluid power engineering in today's industrial automation
      - Clarify the aims of automation
   b. Components of Fluid Power System
      - Components of hydraulic system
      - Components of pneumatic systems
      - Draw symbols of hydraulic and pneumatic components
2. Study and trial on actuators
   a. Study of actuators used in hydraulics and pneumatics
      - Introduction
      - Types of actuators
        - Linear actuators
        - Rotary actuators
        - Limited rotary actuators
   b. Test on linear /rotary actuator. Calculate force/speed/rpm/torque as per case.

3. A) Study and trial on Gear/Vane/Piston pump

a. Study of hydraulic pumps.
  - Introduction and classification
  - Advantages of positive displacement pumps
  - Types of pumps
    - External and internal gear pump
    - Vane pumps
    - Piston pumps
      - Axial pumps
      - Radial piston pumps

b. Trial Gear/Vane/Piston pump.

OR

B) Study and testing of pressure control valve.

a. Circuits with pressure control valve i.e. pressure reducing/counterbalance/brake valve/Sequencing circuit

b. Test on pressure relief valve

4. Study and design of compressed air generation and distribution system

a. Reservoir
b. Driers
c. Types of Regulators
d. Filters
e. Lubricators
f. FRL
g. Loop piping system
h. Assignment on calculation (manual/excel sheet/simulation tool) of pressure loss in piping system

5. Study of control valves

a. Introduction
b. Types of control valves
  - Directional control valves
  - Pressure control valves
  - Flow control valves
  - Cartridge valves
  - Proportional control valves/Electro-hydraulics/proportional valves
  - Demonstration of cut-section/transparent/dismantling of any one valve

c. Regenerative circuit
d. Speed control circuits
e. Transverse and feed circuit.

6. Study of accessory used in hydraulic systems

a. Reservoirs
b. Accumulators: weight loaded, spring loaded, gas loaded.
c. Intensifier
d. Fluid conductors/pipes; pipe fittings
e. Demonstration of electro hydraulic circuit/accumulator/intensifier

7. Following experiments to be done on pneumatic trainer

a. Automatic reciprocating circuit
b. Speed control circuit/Flow control valve
c. Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve
d. Electro pneumatic circuits

8.	a) Simulation of hydraulic and pneumatic circuits: Design of any two industrial hydraulics and two pneumatic circuits using manufacturers' catalogue and analysis using any open source/free/commercial software or application. OR b) Design of industrial hydraulic and pneumatic circuits, selection of components using the manufacturer's catalogue and analysis using any open source/free/commercial software or application.
9.	A) Industrial visit. (Automotive workshop, small or medium scale /automation industry) B) Trouble shooting of fluid power system.
10.	Study and implementation of IoT based system to operate electro-pneumatic/hydraulic circuit from a remote location. i.e. Demonstration of one cycle of operation of cylinder extension by actuation of solenoid and then retraction by deactivation of the solenoid through proximity sensor. OR Demonstration of counting and stopping a cycle once the number of the cycle's are completed (using PLC) OR any other application of relay ladder logic or PLC. (Equipments required for implementation include Smart Phone, Node MCU, Relay 5 volt to 24 volt and account on cloud.)

Assessment of Term Work

The student shall complete the above mentioned activities and prepare a Term Work Journal;

Important Note:

Term Work of the Student shall be evaluated based on the completion of Practical, Industrial Visit Report and Group Assignment. Continuous evaluation by the faculty shall be done for the award of the Credit associated with the course.

No practical examination shall be conducted for the award of the credit

Books and other resources

Text Books:

1. Esposito A, Fluid Power with application, Prentice Hall
2. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill
4. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication

References Books:

1. Pipenger J.J, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
4. ISO - 1219, Fluid Systems and components, Graphic Symbols
5. Standard manufacturing catalogues
6. Fundamentals of Pneumatics, Vol I, II and III. FESTO
7. Fundamentals of fluid power control, John Watton Cambridge University press 2012
8. Introduction to Fluid power, Thomson Prentcie Hall 2004
9. Hydraulic Control Systems Herbert E. Merritt John Wiley and Sons, Inc

Web References:

URL links:

1. https://nptel.ac.in/courses/112/106/112106175/
2. http://ndl.iitkgp.ac.in/document/QXBqK1czOUpyM3FlamVjTmREMWFEUFdEb25sZ01FZVRtZmhWNXlobUZ0MFJ0Zk1kU1dSYmEwK1RSZG1FMUNDNQ
   Fluid Power Control: Web-Course Module-01 Module-02 Module-03 Module-04

Links of Video Lectures:

1. https://nptel.ac.in/courses/112/106/112106300/
2. https://www.digimat.in/nptel/courses/video/112105047/L01.html

Recommended on line courses: https://nptel.ac.in/course.html

302055: Internship/Mini project				
Teaching Scheme**		**Credits**	**Examination Scheme**	
		04	**TW**	**100 Marks**

Prerequisites: Knowledge of design, manufacturing processes, modeling, and mechanical systems

Course Objectives:

Internship provides an excellent opportunity to learner to see understand the conceptual aspects learned in classes and deployed into the practical world. Industry/on project experience provides much more professional experience as value addition to classroom teaching.

1. To encourage and provide opportunities for students to get professional/personal experience through internships.
2. To learn and understand real life/industrial situations.
3. To get familiar with various tools and technologies used in industries and their applications.
4. To nurture professional and societal ethics.
5. To create awareness of social, economic and administrative considerations in the working environment of industry organizations.

Course Outcomes:

On completion of the course, learners should be able to

CO1. **DEMONSTRATE** professional competence through industry internship.

CO2. **APPLY** knowledge gained through internships to complete academic activities in a professional manner.

CO3. **CHOOSE** appropriate technology and tools to solve given problem.

CO4. **DEMONSTRATE** abilities of a responsible professional and use ethical practices in day to day life.

CO5. **DEVELOP** network and social circle, and **DEVELOPING** relationships with industry people.

CO6. **ANALYZE** various career opportunities and **DECIDE** career goals.

****Guidelines:**

Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices and culture. Internship is structured, short-term, supervised training often focused around particular tasks or projects with defined time scales.

Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations.

Engineering internships are intended to provide students with an opportunity to apply conceptual knowledge from academics to the realities of the field work/training. The following guidelines are proposed to give academic credit for the internship undergone as a part of the Third Year Engineering curriculum.

Duration:
Internship is to be completed after semester 5 and before commencement of semester 6 of at least 4 to 6 weeks; and it is to be assessed and evaluated in semester 6.
Internship work Identification:
Student may choose to undergo Internship at Industry/Govt. Organizations/NGO/MSME/Rural Internship/ Innovation/IPR/Entrepreneurship. Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO's/Government organizations/Micro/Small/ Medium enterprises to make themselves ready for the industry. Students must get Internship proposals sanctioned from college authority well in advance. Internship work identification process should be initiated in the Vth semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their Vth semester examination and before academic schedule of semester VI. Student can take internship work in the form of the following but not limited to: 1. Working for consultancy/ research project, 2. Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute / 3. Learning at Departmental Lab/Tinkering Lab/ Institutional workshop, 4. Development of new product/ Business Plan/ registration of start-up, 5. Industry / Government Organization Internship, 6. Internship through Internshala, 7. In-house product development, intercollegiate, inter department research internship under research lab/group, micro/small/medium enterprise/online internship, 8. Research internship under professors, IISC, IIT's, Research organizations, 9. NGOs or Social Internships, rural internship, 10. Participate in open source development.
Internship Diary/ Internship Workbook:
Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered and suggestions given, if any. The training diary/workbook should be signed every day by the supervisor. Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.
Internship Work Evaluation:
Every student is required to prepare and maintain documentary proofs of the activities done by him as internship diary or as workbook. The evaluation of these activities will be done by Program Head/Cell In-charge/ Project Head/ faculty mentor or Industry Supervisor based on- Overall compilation of internship activities, sub-activities, the level of achievement expected, evidence needed to assign the points and the duration for certain activities. Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External – a supervisor from place of internship.

Recommended evaluation parameters-Post Internship Internal Evaluation -50 Marks + Internship Diary/Workbook and Internship Report - 50 Marks
Evaluation through Seminar Presentation/Viva-Voce at the Institute
The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria: • Depth of knowledge and skills • Communication & Presentation Skills • Team Work and Creativity • Planning & Organizational skills • Adaptability • Analytical Skills • Attitude & Behavior at work • Societal Understanding • Ethics • Regularity and punctuality • Attendance record • Diary/Workbook • Student's Feedback from External Internship Supervisor
After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. Internship Diary/workbook may be evaluated on the basis of the following criteria: • Proper and timely documented entries • Adequacy & quality of information recorded • Data recorded • Thought process and recording techniques used • Organization of the information The report shall be presented covering following recommended fields but limited to, • Title/Cover Page • Internship completion certificate • Internship Place Details- Company background-organization and activities/Scope and object of the study / Supervisor details • Index/Table of Contents • Introduction • Title/Problem statement/objectives • Motivation/Scope and rationale of the study • Methodological details • Results / Analysis /inferences and conclusion • Suggestions / Recommendations for improvement to industry, if any • Attendance Record • Acknowledgement • List of reference (Library books, magazines and other sources)

Feedback from internship supervisor(External and Internal)
Post internship, faculty coordinator should collect feedback about student with recommended parameters include as- Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Team work, Leadership… **Reference:** 1. https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf 2. https://internship.aicte-india.org/
IMPORTANT NOTE: **The student shall be encouraged to undertake the industrial internships however the Industry may provide opportunity to a limited few amongst the students available. In such scenario it becomes the moral responsibility of the faculty to create opportunity for such group of students (similar to the ones in Industry) by assigning them some real life problem as a part of the mini project and encouraging/mentoring them to attempt viable solutions. Hence the provision of Mini project is being done to accommodate such students and expose them with the Industrial practices in house. The students can be encouraged to consider analysis of the global patents available as a mini project,**

Mini project					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**4 Hrs./Week**	**Practical**	**4**	**Term work**	100

Course Objectives:

Students shall UNDERTAKE and EXECUTE a Mini Project through a group of students to

1. **UNDERSTAND** the "Product Development Cycle", through Mini Project.
2. **PLAN** for various activities of the project and distribute the work amongst team members.
3. **LEARN** budget planning for the project.
4. **INCULCATE** mechanical/interdisciplinary implementation skills.
5. **DEVELOP** students' abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project.
6. **UNDERSTAND** the importance of document design by compiling Technical Report on the Mini Project work carried out.

Course Outcomes:

On completion of the course, learner will be able to

CO1. **EXPLAIN** plan and execute a Mini Project with team.
CO2. **IMPLEMENT** hardware/software/analytical/numerical techniques, etc.
CO3. **DEVELOP** a technical report based on the Mini project.
CO4. **DELIVER** technical seminar based on the Mini Project work carried out.

Course Contents

Maximum Group Size: Minimum 2 and maximum 4 students can form a group for the mini project.

Project Type: (The selected mini project must be based on any of the following)

1. Development of a prototype mechanical system/product.
2. Investigate performance of mechanical systems using experimental method

3. Parametric analysis of components/systems/devices using suitable software **4.** Investigation of optimum process/material for product development using market survey. **5.** Solution for society/industry problems
The Assessment Scheme will be: *a.* **Continuous Assessment 50 marks** *(based on regular interaction, circuit development)* b. **End Semester 50 marks** *(based on poster presentation, demonstration / Seminar)*
Project domain may be from the following, but not limited to: 1.Thermal Systems 2. Robotics Mechanisms/design systems 3. Production/advance manufacturing 4. Materials: Composite/Nano 5. Automation and Control Systems 6. Mechatronic Systems 7. Agriculture system. 8. Smart systems using AI-ML
A project report with following contents shall be prepared: 1. Title 2. Objectives 3. Relevance and significance 4. Methodology 5. Analysis-Simulation/experimentation/survey/testing etc. 6. Result and Discussion 7. Conclusion

302056: Audit Course VI		
Teaching Scheme	**Credits**	**Examination Scheme**
	Non-Credit	

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

Faculty mentor shall be allotted for individual courses and he/she shall monitor the progress for successful accomplishment of the course. Such monitoring is necessary for ensuring that the concept of self-learning is being pursued by the students 'in true letter and spirit'.

- If any course through Swayam/ NPTEL/ virtual platform is selected the minimum duration shall be of 8 weeks.
- However if any of the course duration is less than the desired (8 weeks) the mentor shall ensure that other activities in form of assignments, quizzes, group discussion etc. (allied with the course) for the balance duration should be undertaken.

In addition to credits courses, it is mandatory that there should be an audit course (non-credit course) from third year of Engineering. The student will be awarded grade as AP on successful completion of the audit course. The student may opt for any one of the audit courses in each semester. Such audit courses can help the student to get awareness of different issues which make an impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Students can choose one of the audit courses from the list of courses mentioned. Evaluation of the audit course will be done at institute level.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not considered in the calculation of the performance indices SGPA and CGPA. Evaluation of the audit course will be done at institute level itself.

Selecting an Audit Course

List of Courses to be opted (Any one) under Audit Course VI

- Business and Sustainable Development
- Management Information System
- International Business

The titles indicated above are subject to change in time to come and such an alteration (if any) should be brought to the notice of the BOS.

Using NPTEL Platform: (preferable)

NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in

- Students can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course.
- Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal.
- After clearing the examination successfully; student will be awarded with a certificate.

Assessment of an Audit Course
• The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary. • During the course students will be submitting the online assignments. A copy of the same can be submitted as a part of term work for the corresponding Audit course. • On the satisfactory submission of assignments, the institute can mark as “Present” and the student will be awarded the grade AP on the mark-sheet.

Savitribai Phule Pune University
Faculty of Science & Technology

Curriculum/Syllabus

For

Fourth Year

Bachelor of Engineering

(Choice Based Credit System)

Mechanical Engineering

(2019 Course)

Board of Studies – Mechanical and Automobile Engineering

(With Effect from Academic Year 2022-23)

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

Course Code	Course Name	Teaching Scheme (Hrs./week)			Examination Scheme and Marks						Credit			
		TH	PR	TUT	ISE	ESE	TW	PR	OR	TOTAL	TH	PR	TUT	TOTAL
Semester-VII														
402041	Heating Ventilation Air-Conditioning and Refrigeration	3	2	-	30	70	-	-	25	125	3	1	-	4
402042	Dynamics of Machinery	3	2	-	30	70	-	-	25	125	3	1	-	4
402043	Turbomachinery*	2	2	-	-	50	25	-	25	100	2	1	-	3
402044	Elective – III	3	-	-	30	70	-	-	-	100	3	-	-	3
402045	Elective - IV	3	-	-	30	70	-	-	-	100	3	-	-	3
402046	Data Analytics Laboratory	-	2	-	-	-	50	-	-	50	-	1	-	1
402047	Project (Stage - I)	-	4	-	-	-	50	-	50	100	-	2	-	2
402054	Audit Course VII$	-	-	-	-	-	-	-	-	-	-	NC		
	Total	**14**	**12**	**-**	**120**	**330**	**125**	**-**	**125**	**700**	**14**	**6**	**-**	**20**
Semester-VIII														
402048	Computer Integrated Manufacturing	3	2	-	30	70	25	-	25	150	3	1	-	4
402049	Energy Engineering	3	2	-	30	70	25	-	25	150	3	1	-	4
402050	Elective - V	3	-	-	30	70	-	-	-	100	3	-	-	3
402051	Elective - VI	3	-	-	30	70	-	-	-	100	3	-	-	3
402052	Mechanical Systems Analysis Laboratory	-	2	-	-	-	25	-	25	50	-	1	-	1
402053	Project (Stage - II)	-	10	-	-	-	100	-	50	150	-	5	-	5
402055	Audit Course VIII$	-	-	-	-	-	-	-	-	-	NC			
		12	**16**	**-**	**120**	**280**	**175**	**-**	**125**	**700**	**12**	**8**	**-**	**20**

Elective-III		Elective-V	
402044A	Automobile Design	402050A	Quality and Reliability Engineering
402044B	Design of Heat Transfer Equipments	402050B	Energy Audit and Management
402044C	Modern Machining Processes	402050C	Manufacturing Systems and Simulation
402044D	Industrial Engineering	402050D	Engineering Economics and Financial Management
402044E	Internet of Things	402050E	Organizational Informatics
402044F	Computational Fluid Dynamics	402050F	Computational Multi Body Dynamics
Elective-IV		**Elective-VI**	
402045A	Product Design and Development	402051A	Process Equipment Design
402045B	Experimental Methods in Thermal Engineering	402051B	Renewable Energy Technologies
402045C	Additive Manufacturing	402051C	Automation and Robotics
402045D	Operations Research	402051D	Industrial Psychology and Organizational Behavior
402045E	Augmented Reality and Virtual Reality	402051E	Electrical and Hybrid Vehicle

Audit Courses			
402054A	Yoga Practices	**402054B**	Stress Management
402055A	Managing Innovation	**402055B**	Operations Management

Abbreviations: TH: Theory, **PR**: Practical, **TUT**: Tutorial, **ISE**: In-Semester Exam, **ESE**: End-Semester Exam, **TW**: Term Work, **OR**: Oral

- Student can select any elective subjects from the list given as per his/her choice. However, it is advised to select the subjects from within a group identified for specialization.

Instructions:

- Practical/Tutorial must be conducted in **FOUR batches per division** only.
- Minimum number of Experiments/Assignments in PR/Tutorial shall be carried out **as mentioned in the syllabi** of respective courses.
- Assessment of tutorial work has to be carried out similar to term-work. The Grade cum marks for Tutorial and Term-work shall be awarded on the basis of **continuous evaluation.**
- End semester examination shall be of 2 hrs. for the ***** Marked Turbomachinery Course.
- $^{\$}$Audit course is mandatory but non-credit course. Examination has to be conducted at the end of Semesters for award of grade at institute level. Grade awarded for audit course shall not be calculated for grade point & CGPA.

Program Outcomes (POs)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability attitude and behavior that students acquire through the program.

The POs essentially indicate what the students can do from subject-wise knowledge acquired by them during the program. As such, POs define the professional profile of an engineering graduate.

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. **Design/Development of Solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems:

   a. that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline as against problems given at the end of chapters in a typical text book that can be solved using simple engineering theories and techniques;

   b. that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions;

   c. that require consideration of appropriate constraints / requirements not explicitly given in the problem statement such as cost, power requirement, durability, product life, etc.;

   d. which need to be defined (modelled) within appropriate mathematical framework; and

   e. that often require use of modern computational concepts and tools, for example, in the design of an antenna or a DSP filter.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an

understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402041: Heating, Ventilation, Air Conditioning and Refrigeration					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Oral	**25 Marks**

Prerequisites: Thermodynamics, Applied Thermodynamics, Fluid Mechanics, Heat and Mass Transfer.

Course Objectives:

1. To understand and compare different refrigerants with respect to properties, applications and Environmental issues and Air refrigeration systems.
2. To understand Multistage compression cycles and multistage evaporator systems.
3. To understand various components, operating and safety controls employed in Refrigeration and Air Conditioning systems and advanced refrigeration systems.
4. To understand the basic air conditioning processes on psychometric charts, human comfort and to provide the knowledge of indoor and outdoor air quality requirements.
5. To study the ventilation and infiltration in air conditioning and duct design for various comfort conditions and industrial air conditioning systems.
6. To understand advanced A/C systems and heat pump.

Course Outcomes:

On completion of the course the learner will be able to;

CO1.**ANALYSE** different air-craft refrigeration systems and **EXPLAIN** the properties, applications and environmental issues of different refrigerants.

CO2.**ANALYSE** multi pressure refrigeration system used for refrigeration applications.

CO3.**DISCUSS** types of compressors, condensers, evaporators and expansion valves along with regulatory and safety controls and **DESCRIBE** Transcritical and ejector refrigeration systems.

CO4.**ESTIMATE** cooling load for air conditioning systems used with concern of design conditions and indoor quality of air.

CO5.**DESIGN** air distribution system along with consideration of ventilation and infiltration.

CO6.**EXPLAIN** the working of types of desiccants, evaporative, thermal storage, radiant cooling, clean room and heat pump systems.

Course Contents

Unit 1	**Gas Cycle Refrigeration and Refrigerants**

Gas Cycle Refrigeration: Application to air-craft refrigeration, Simple system, Bootstrap, Regenerative, reduced ambient system, Concept of Dry Air Rated Temperature (DART)

Refrigerants: Introduction, Definition and requirement, Classification of refrigerants, Designation of refrigerants, Desirable properties of Refrigerants-Thermodynamic, Chemical and Physical.

Properties of ideal refrigerant. Environmental issues like ODP, GWP & LCCP. Selection of environment friendly refrigerants, Alternative refrigerants, Secondary refrigerants, Anti-freeze solutions, Zeotropes and Azeotropes, Refrigerant recovery, reclaims, recycle and recharge.	
Unit 2	**Multi Pressure Systems**
Multistage or Compound Systems: Need of multi staging, Two stage compression with flash gas removal, flash intercooler and complete multistage compression system. **Multi Evaporator Systems:** Single compressor-individual expansion valve, Single compressor-multiple expansion valve, Individual compressor-multiple expansion valve, Individual compressor with compound compression and flash inter cooling. (Limited to two evaporators). Ammonia-CO_2 cascade cycle. (Only theoretical approach).	
Unit 3	**Practical aspects of Vapor Compression and Advanced Refrigeration Systems**
Major components of refrigeration cycle: Types of compressors, Characteristics of reciprocating and centrifugal compressors, Types of evaporators, Types of condensers and Types of expansion valves. **Safety Controls:** LP/HP cut-off, Low temperature control, Frost control, Motor overload control, Oil pressure failure control. Capacity controls for different compressors. **Advanced Refrigeration System:** Transcritical cycle and their types, Simple ejector refrigeration system (analysis and numerical)	
Unit 4	**Applied Psychrometry**
Psychrometric Chart, Psychrometric processes using BPF, ADP, SHF, RSHF, GSHF, ESHF, ERSHF and adiabatic mixing of two air streams. Heat load estimation: - Air conditioning, heating & cooling load calculations. **Envelop Load estimation:** Concept of sol-air temperature, Time lag & Decrement method and ETD or CLTD methods. **Thermal Comfort:** Basic parameters, Thermodynamics of human body, Thermal comfort and Comfort charts, Factors affecting thermal comforts. **Indoor Air Quality (IAQ):** Indoor air contaminants, Basic strategies to improve indoor air quality. **Outdoor Design Conditions:** Outdoor air requirements for occupants, Use of outdoor weather data in design, Outdoor weather characteristics and their influence.	
Unit 5	**Ventilation, Infiltration & Air Distribution systems (Ducts)**
Ventilation and infiltration: Natural ventilation, Mechanical ventilation. **Duct Design:** Definition of duct and types of ducts, Economic factors influencing duct layout, Materials for ducts and its specification, Flow through duct, Pressure in ducts, Friction loss in ducts, Friction chart for circular ducts, Equivalent diameter of a circular duct for rectangular sections, Methods of duct designs. (Numerical treatment on duct design). **Air Distribution System:** Factors considered in air distribution system, (simple numerical). Types of air distribution devices. Fan coil unit, Fan laws, Types of fans used in air conditioning applications, Types of supply air outlets, Selection and location of outlets, Filters, Diffusers, Grillers, and Dampers.	

Unit 6	Advanced Air Conditioning Systems

Advanced AC Systems: Working of summer, winter and year-round AC systems, all air system, all water system, air water system, variable refrigerant flow and variable air volume systems, unitary and central air conditioning.

Desiccant-Based Air Conditioning Systems: Introduction, Sorbents & Desiccants, Dehumidification, Liquid spray tower, Solid packed tower, Rotary desiccant dehumidifiers, Hybrid cycles, Solid desiccant Air-Conditioning (Theoretical treatment).

Evaporative Cooling Air Conditioning Systems, Thermal storage Air Conditioning systems, clean room Air Conditioning systems, Radiant cooling. (No numerical), Heat pumps and its different circuits.

Books and other resources

Text Books:

1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill
2. Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd, 1983
3. Arora and Domkundwar, Refrigeration & Air Conditioning, Dhanpatrai & Company, New Delhi
4. Khurmi R.S. and Gupta J.K., Refrigeration and Air conditioning, Eurasia Publishing House Pvt.Ltd, New Delhi,1994.
5. Ballaney P.L., Refrigeration and Air conditioning, Khanna Publishers, New Delhi, 1992.
6. S.N.Sapali , Refrigeration and Air conditioning ,Eastern Economy Edition.
7. Arora R.C., Refrigeration and Air Conditioning, PHI, India.

References Books:

1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000.
2. Stockers W.F and Jones J.W., Refrigeration and Air conditioning, McGraw Hill International editions 1982.
3. Aanatnarayan, Basics of refrigeration and Air Conditioning, Tata McGraw Hill Publications.
4. Roger Legg, Air Conditioning System Design, Commissioning and Maintenance.
5. ASHRAE Handbook (HVAC Equipments) & ISHRAE handbook.
6. Shan Wang, Handbook of Refrigeration and Air Conditioning, McGrawHill Publications.
7. Wilbert Stocker, Industrial Refrigeration, McGrawHill Publications.
8. ASHRAE, Air Conditioning System Design Manual, IInd edition, ASHRAE.

Term Work

The student shall complete the following activity as a Term Work (Any eight experiments, No. 8 or 9 is compulsory):

1. Trial on Ice Plant.
2. Performance Simulation of Central Air-conditioning plant.
3. Trial on Air-conditioning system.
4. Performance analysis of Cooling tower.
5. Building heat load simulation using suitable software.
6. Design of cold storage with process layout.
7. Analysis of Vapor Compression Cycle using suitable software.
8. Visit to Refrigeration or cold storage Plant
9. Visit to Air Conditioning Plant.
10. Trial on heat pump/ejector/cascade/desiccant/evaporative systems.

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402042: Dynamics of Machinery					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Oral	**25 Marks**

Pre-requisites: Strength of Materials, Engineering Mechanics, Kinematics of Machinery, Engineering Mathematics and Numerical Methods

Course Objectives:

1. To conversant with balancing problems of machines.
2. To understand mechanisms for system control – Gyroscope.
3. To understand fundamentals of free and forced vibrations.
4. To develop competency in understanding of vibration in Industry.
5. To develop analytical competency in solving vibration problems.
6. To understand the various techniques of measurement and control of vibration and noise.

Course Outcomes:

On completion of the course, students will be able to -

CO1. **APPLY** balancing technique for static and dynamic balancing of multi cylinder inline and radial engines.

CO2. **ANALYZE** the gyroscopic couple or effect for stabilization of Ship, Airplane and Four wheeler vehicles.

CO3. **ESTIMATE** natural frequency for single DOF un-damped & damped free vibratory systems.

CO4. **DETERMINE** response to forced vibrations due to harmonic excitation, base excitation and excitation due to unbalance forces.

CO5. **ESTIMATE** natural frequencies, mode shapes for 2 DOF un-damped free longitudinal and torsional vibratory systems.

CO6. **DESCRIBE** noise and vibration measuring instruments for industrial / real life applications along with suitable method for noise and vibration control.

Unit 1	**Balancing**

Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, balancing in multi-cylinder in-line engines, direct and reverse cranks method -radial and V engines. Introduction to Balancing machines – Types, Classification and Methods

<table>
<tr><td>Unit 2</td><td>Gyroscope</td></tr>
<tr><td colspan="2">Introduction, Precessional angular motion, Gyroscopic couple, Effect of gyroscopic couple on an airplane, Effect of gyroscopic couple on a naval ship during steering, pitching and rolling, Stability of a Four Wheel drive moving in a curved path (Theoretical treatment only), Stability of a two wheel vehicle taking a turn (Theoretical treatment only), Effect of gyroscopic couple on a disc fixed rigidly at a certain angle to a rotating shaft.</td></tr>
<tr><td>Unit 3</td><td>Single Degree of Freedom Systems – Free Vibration</td></tr>
<tr><td colspan="2">Fundamentals of Vibration: Elements of a vibratory system, vector representation of S.H.M., degrees of freedom, Introduction to Physical and Mathematical modeling of vibratory systems: Bicycle, Motor bike and Quarter Car. types of vibration, equivalent stiffness and damping, formulation of differential equation of motion (Newton, D'Alembert and energy method)
Un-damped free vibrations: Natural frequency for longitudinal, transverse and torsional vibratory systems. (Numerical on only longitudinal and transverse systems.)
Damped free vibrations: Different types of damping, Viscous damping – over damped, critically damped and under damped systems, initial conditions, logarithmic decrement, Dry friction or coulomb damping - frequency and rate of decay of oscillations.(Numerical only on Logarithmic decrement)</td></tr>
<tr><td>Unit 4</td><td>Single Degree of Freedom Systems - Forced Vibrations</td></tr>
<tr><td colspan="2">Forced vibrations of longitudinal and torsional systems, Frequency Response to harmonic excitation (Numerical on only longitudinal systems), excitation due to rotating and reciprocating unbalance, base excitation, magnification factor, Force and Motion transmissibility
Quality Factor. Half power bandwidth method, Critical speed of shaft having single rotor of undamped systems. (Theoretical treatment only)</td></tr>
<tr><td>Unit 5</td><td>Two Degree of Freedom Systems – Un-damped Vibrations</td></tr>
<tr><td colspan="2">Free vibration of spring coupled systems – longitudinal and torsional, torsionally equivalent shafts, natural frequency and mode shapes, Eigen value and Eigen vector by Matrix method (Numerical only on longitudinal systems and Matrix Method)
Combined rectilinear and angular motion, Vibrations of Geared systems (Theoretical treatment only)</td></tr>
<tr><td>Unit 6</td><td>Measurement and Control of Vibrations, Introduction to Noise</td></tr>
<tr><td colspan="2">A) Measurement: Vibration Measuring Instruments, Accelerometers, Impact hammer, Vibration shakers, Vibration Analyzer, Vibration based condition monitoring, Analysis of Vibration Spectrum, Standards related to measurement of vibration.

B) Control: Vibration control methods - passive, semi active and active vibration control, control of excitation at the source, control of natural frequency, Vibration isolators, Tuned Dynamic Vibration Absorbers.

C) Noise: Fundamentals of noise, Sound concepts, Decibel Level, Logarithmic addition, subtraction and averaging, sound intensity, noise measurement, Noise control at the Source, along the path and at the receiver, Reverberation chamber, Anechoic Chamber, Noise standards. (Unit VI – Only theoretical treatment)</td></tr>
</table>

Books

Textbook:

1. S. S. Rao, Mechanical Vibrations, Pearson Education Inc. New Delhi.
2. G. K. Grover, Mechanical Vibrations, New Chand and Bros.,Roorkee
3. Wiiliam J Palm III, Mechanical Vibration, Wiley India Pvt. Ltd, New Delhi
4. Uicker J. John, Jr, Pennock Gordon R, Shigley Joseph E., Theory of Machines and Mechanisms, International Version, OXFORD University Press, New Delhi.
5. M L Munjal, Noise and Vibration Control, Cambridge University Press India
6. S. S. Rattan, Theory of Machines, Third Edition, McGraw Hill Education (India) Pvt. Ltd. New Delhi.

References:

1. Weaver, Vibration Problems in Engineering, 5th Edition Wiley India Pvt. Ltd, New Delhi.
2. Bell, L. H. and Bell, D. H., Industrial Noise Control – Fundamentals and Applications‖, Marcel Dekker
3. Alok Sinha, Vibration of Mechanical System, Cambridge university Press, India
4. Debabrata Nag, Mechanical Vibrations, Wiley India Pvt. Ltd, New Delhi.
5. Kelly S. G., Mechanical Vibrations, Schaums outlines, Tata McGraw Hill Publishing Co. Ltd.
6. Meirovitch, L., Elements of Mechanical Vibrations‖, McGraw Hill.
7. Ver, Noise and Vibration Control Engineering, Wiley India Pvt. Ltd, New Delhi.
8. Bies, D. and Hansen, C., Engineering Noise Control - Theory and Practice, Taylor and Francis.
9. Shrikant Bhave, Mechanical Vibrations Theory and Practice, Pearson, New Delhi

Term Work

A] Compulsory Experiments (Sr. No. 1 to 6)

1. Balancing of wheel / rotor on computerized balancing machine OR Experimental verification of dynamic balancing of rotating masses.
2. To determine the natural frequency of damped vibration of single degree freedom system and to find it‘s damping coefficient.
3. To obtain frequency response curves of single degree freedom system of vibration for different amount of damping.
4. To verify natural frequency of torsional vibration of two rotor system and position of node.
5. To measure vibration of healthy and faulty beam using FFT analyzer in time and/ or frequency domain and further classify the condition.
6. To measure noise of any healthy and faulty machine element and represent it into time and/or frequency domain and further predict the condition in future.

B] Any Two Experiments from the following:

1. To determine critical speed of shaft with single rotor.
2. Experimental verification of principle of dynamic vibration absorber.
3. Experiment on shock absorbers and to plot its characteristic curve.
4. To determine the effect of active gyroscopic couple on a spinning disc and verify the gyroscopic effect.
5. Industrial visit based on Conditioning Monitoring and Fault Diagnosis.

C] List of Compulsory Assignment:

1. Simulation (using suitable software) of free response of SDOF damped system to demonstrate different damping conditions by solving differential equation numerically.

OR

2. Simulation (using suitable software) of total response of SDOF damped system to harmonic excitation by solving differential equation numerically.

OR

1. 3. A case study based on conditioning monitoring and fault diagnosis using machine learning.

402043: Turbomachinery					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**2 Hrs./week**	**Theory**	**2**	**In-Semester**	**-**
Practical	**2 Hrs./week**	**Term Work**	**1**	**End-Semester***	**50 marks**
				Term Work	**25 marks**
End semester examination shall be of 2 hrs.				**Oral**	**25 marks**

Prerequisites: Fluid Mechanics, Thermodynamics, Heat Transfer, Engineering Mathematics

Course Objectives:

1. To provide the knowledge of basic principles, governing equations and applications of Turbomachines.
2. To provide the students with opportunities to apply basic thermos-fluid dynamics flow equations to Turbomachines.
3. To explain construction and working principles of Turbomachines.
4. To evaluate the performance characteristics of Turbomachines.

Course Outcomes:

On completion of the course the learner will be able to;

CO1: **VALIDATE** impulse moment principle using flat, inclined and curved surfaces and **INVESTIGATE** performance characteristics of hydraulic turbines.

CO2: **DETERMINE** performance parameters of impulse and reaction steam turbine along with discussion of nozzles, governing mechanism & losses.

CO3: **MEASURE** performance parameters of single & multistage centrifugal pumps along with discussion of cavitation and selection.

CO4: **EXPLAIN** performance parameters of centrifugal compressor along with discussion of theoretical aspects of axial compressor.

Course Contents

Unit 1	**Impact of Jet and Hydraulic Turbines**

Introduction and Impact of Jet: Introduction to Turbomachines (Hydraulic & Thermal), Classification of Turbo machines, Applications of Turbomachines. Impulse momentum principle and its application to fixed and moving flat, inclined, and curved plate/vanes. Velocity triangles and their analysis, work done equations, vane efficiency (No numerical)

Hydraulic Turbines:

Introduction to Hydro power plant, Classification of Hydraulic Turbines, Concept of Impulse and Reaction Turbines. Construction, Principle of Working, design aspects, velocity diagrams and its analysis of Pelton wheel, Francis, and Kaplan turbines, Degree of reaction, Draft tube: types and efficiencies, governing of hydraulic turbines, Cavitation in turbines.

Unit 2	**Steam Turbines**

Steam Nozzle: Equations for velocity and mass flow rate (No derivation, no numerical)
Steam Turbines: Construction and working of Impulse and Reaction steam turbine, velocity diagram, work done efficiencies, Multi-staging, compounding, Degree of reaction, losses in steam turbine, governing of steam turbines

Unit 3	**Centrifugal Pumps**

Introduction & classification of rotodynamic Pumps, Main Components of Centrifugal Pump, Construction and Working of Centrifugal Pump, Types of heads, Velocitytriangles and their analysis, Effect of outlet blade angle, Work done and Efficiency, Series and parallel operation of pumps, Priming of pumps, specific speed

Unit 4	**Rotary Compressors**

Centrifugal Compressors: Classification of Centrifugal Compressor, construction and working, velocity diagram, flow process on T-S Diagram, Euler's work, actual work input, various losses in Centrifugal Compressor

Axial flow compressors: Construction and working, stage velocity triangle and it's analysis, enthalpy entropy diagram, stage losses and various efficiencies of axial flow compressors, [No numerical]

Books and other resources

Text Books:

1. Fluid mechanics and hydraulic machines, Dr. R.K. Bansal, Laxmi Publication
2. Hydraulics & Fluid Mechanics and Machinery, Modi P N & Seth S N, Standard Book House
3. Turbines, Compressors & Fans, S.M. Yahya, Tata-McGraw Hill
4. Turbomachines, B. U. Pai, Wiley India
5. Steam and Gas Turbines and Power Plant Engineering, R. Yadav, Central Publication house

Web References:

https://nptel.ac.in/courses/112105206
https://nptel.ac.in/courses/112105182
https://nptel.ac.in/courses/112104117

Guidelines for Laboratory Conduction

- Term work shall consist of eleven experiments.
- Experiment No1,3,8,10,11 and 12 are compulsory.
- From remaining experiments (2,4,5,6,7 and 9) any five experiments are to be performed.
- Data from any one trial performed should be analyzed by using suitable software.

Term Work
The student shall complete the following activity as a Term Work: 1. Study of Impulse momentum principle and its application to fixed flat, moving, inclined, and curved plates/vanes. 2. Verification of Impulse Momentum Principle. 3. Study of Unit quantities, Specific speed and performance characteristics of hydraulic turbines. 4. Study and Trial on Impulse water Turbine and plotting the main and operating characteristics 5. Study and Trial on any one hydraulic Reaction Turbine and plotting the main and operatingcharacteristics. 6. Study and Trial on Convergent-Divergent Air/Steam nozzle 7. Study and Trial on steam Turbine and plotting the operating characteristics. 8. Study of Cavitation, NPSH, Thoma's cavitation factor, maximum suction lift. 9. Study and Trial on Centrifugal Pump and plotting the operating characteristics. 10. Study of Surging, stalling and choking phenomenon in compressors, performancecharacteristics of Centrifugal and Axial flow Compressors. 11. Visit to hydro/steam power plant and report to be submitted. 12. Visit to Pumping Station and report to be submitted. **OR** 12. Design of Pumping system installation using Manufacturers catalogue, specific to housing or industrial application.

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402044A: Automobile Design					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30**
				End-Semester	**70**

Prerequisites: Engineering Mathematics-I and II, Systems in Mechanical Engineering, Engineering Mechanics, Theory of Machines, Automobile Engineering, Design of Machine Elements

Course Objectives:

1. To help the students to acquire in-depth knowledge of design of Different engine components and engine subsystems.
2. To make students to understand the different chassis components selection and design.
3. To enable the students with the knowledge of Vehicle Packaging and System Integration and NVH.

Course Outcomes:

On completion of the course the learner will be able to;

CO1: **COMPREHEND** the steps involved in the design process of Principal Engine Components.

CO2: **GAIN** the knowledge and design of Engine Sub-Systems.

CO3: **COMPUTE** the critical dimensions of chassis components involved in the Steering System and Differential and final drive of a vehicle.

CO4: **SELECT** the tyres and wheels required for automobile vehicle and design the various types automotive brakes.

CO5: **UNDERSTAND** the design concepts of Automotive Suspension system

CO6: **POSSES** the knowledge of Vehicle Packaging and System Integration, NVH.

Course Contents

Unit 1	**Principal Engine Components**

Design of cylinder and cylinder head, construction of cylinder liners, design of piston and piston-pins, piston rings, design of connecting rod. Design of crank-shaft and crank-pin, (Theoretical treatment only). Material for I. C. engine components.

Unit 2	**Engine Subsystems**

Design of cooling system - radiator, water pump and fan, Computation of air cooling system, Design of fuel system, Governor, Intake and exhaust system, Selection of lubricant, lubricating system, pump and filters.

Unit 3	**Steering System and Differential**

Mechanical Steering Gears, Power Steering Drives, Basic Principles of the Steering Process, Steering Kinematics, Steering Mechanism Design- Geometry for Correct Steering, Linkages, Basic Wheel

Alignment.
Design of propeller shaft. Design details of final drive gearing. Design of Bevel Gears in deferential, Design details of full floating, semi-floating and three quarter floating rear shafts.(Theoretical treatment only)

Unit 4	Wheels, Tyres and Automotive Brakes

Wheels and Tyres: Introduction, wheel tyre assemblies, wheels, rims, Wheel fixing, Tyres, Constructional details, Tread Design, Noise, Aspect Ratio, Tread Design consideration, Run Flat Tyres, Materials, Retreading and Manufacturing, Factors affecting tyre life.

Automotive Brakes: Mechanical Brakes, Hydraulic brakes, Servo brakes, Air brakes, ABS, Brake Lining, Brake efficiency, Stopping Distance, Theory of Internal Shoe Brake, banking of vehicles, Banking of vehicle on curved path. Numerical.

Unit 5	Automotive Suspension system

Springs - Types of Suspension Springs, Shock Absorbers, Independent Suspension system, Double wishbone suspensions, McPherson struts and strut dampers, Rear axle trailing-arm suspension, Semi-trailing-arm rear axles, Multi-link suspension, Air Suspension, Hydro-elastic suspensions, Rear Suspension (Dead Axle), Active Suspension, Suspension control systems,
Design of helical springs, Design of leaf springs, Numerical.

Unit 6	Vehicle Packaging and System Integration

Vehicle Packaging and System Integration: Introduction to Automotive Ergonomics, Vehicle Packaging background, Vehicle packaging organization, packaging engineering and ergonomics, Principles used in vehicle packaging, Vehicle packaging procedure, Mechanical packaging, Occupant packaging, driver package development steps and calculations, entry and exit considerations, driver field of view.

Engineering Anthropometry and Biomechanics: Engineering Anthropometry and Biomechanics, Use of Anthropometry in Designing Vehicles, Applications of Biomechanics in Vehicle Design

Books

Text Books:

1. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", 2013, Society of Automobile Engineers Inc., ISBN: 978-1560911999
2. Engine Design – Giles J. G., Lliffe Book Ltd.
3. Engine Design – Crouse, Tata McGraw Publication, Delhi.
4. Design of Automotive Engine – A. Kolchin and V. Demidov
5. Automobile Engineering: Vol.1- Dr. Kirpal Singh, Standard Publishers Distributors.
6. A Textbook of Machine Design, R.S. Khurmi J.K. Gupta, Eurasia Publishing House.
7. Design of Machine Elements - V. B. Bhandari Tata McGraw-Hill, 2007
8. Automotive Product Development- A Systems Engineering Implementation- Vivek D. Bhise, CRC PressTaylor & Francis Group, ISBN-13: 978-1-4987-0681-0

References Books:

1. Chassis Handbook, Bernd Heißing | Metin Ersoy (Eds.) Vieweg+Teubner Verlag |Springer Fachmedien Wiesbaden GmbH 2011

2. The Motor Vehicle, T.K.Garrette, Steeds, Newton, Butterworth Heinemann.
3. The Automotive Chassis, Vol. 1: Components Design , Giancarlo Genta • Lorenzo Morello, ISBN: 978-1-4020-8673-1 e-ISBN: 978-1-4020-8675-5, 2009 Springer Science+Business Media B.V.
4. Ergonomics in the Automotive Design Process, Vivek D. Bhise, CRC Press, Taylor & Francis Group, ISBN-13: 978-1-4398-4211-9

Web References:

1. https://archive.nptel.ac.in/courses/107/106/107106088/
2. https://nptel.ac.in/courses/107103084

402044B: Design of Heat Transfer Equipments					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Thermodynamics, Heat Transfer

Course Objectives:

1. Understand the basic concept and design methodology of heat exchangers.
2. Identify the design requirements for different types of heat exchangers
3. Define the important heat-exchanger design parameters
4. Perform sizing of a given type of heat exchanger for a specific application.
5. Make use of basic knowledge of fluid mechanics, heat transfer, and material properties in both performance and design calculations.

Course Outcomes:

On completion of the course the learner will be able to;

CO1: **EXPLAIN** the design aspect of heat exchanger considering fouling factor for Heat Transfer Applications

CO2: **SELECT** and **DESIGN** the double tube heat exchangers for process industry

CO3: **DESIGN** the Shell & Tube Heat Exchangers for specified conditions

CO4: **DESIGN** the condensers and evaporators for refrigeration applications

CO5: **DESIGN the** compact heat exchangers

CO6: **ANALYSE** the performance of counter and cross flow cooling tower.

Course Contents

Unit 1	**Fundamentals of Heat Exchanger Design**

Introduction: Introduction, classification of heat exchangers and their applications, different standards used for heat exchanger

Basics of heat exchanger design: Basic design equation, LMTD for parallel flow and counter flow arrangement, correction factor for LMTD for cross flow and multi –pass heat exchangers, Effectiveness - NTU method for heat exchanger design/analysis

Fouling of Heat Exchanger: Introduction, causes of fouling, types of fouling, effect of fouling, fouling factor, overall heat transfer coefficient with fouling, fouling factors for various process and services, methods to reduce fouling, cleaning process of fouled heat exchanger

Unit 2	**Double Pipe Heat Exchanger**
Constructional features, Applications, Thermal and Hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop, Rating and sizing problem. Correlations for tube side pressure drop and heat transfer coefficients. Pressure drop and heat transfer coefficient correlations for shell side flow, different methods to enhance the heat transfer coefficient (Theoretical Treatment only)	
Unit 3	**Shell & Tube Heat Exchangers**
Tube layouts for exchangers, Baffled heat exchangers, Calculation of shell and tube heat exchangers, Shell side film coefficients, Shell side equivalent diameter (Kerns method, Bell-Delaware method), The temperature difference in a 1-2 heat exchanger. Shell side pressure drop, Tube side pressure drop, Analysis and performance of 1-2 heat exchanger and design of shell & tube heat exchangers.	
Unit 4	**Condensers and evaporators for Refrigeration systems**
Design considerations of heat exchangers for refrigeration and air conditioning applications, thermal design of heat exchanger used for refrigeration applications, air cooled condenser, Design considerations of Evaporative condensers. **Evaporator**: Evaporator for refrigeration and air-conditioning, thermal analysis of evaporator, standards for evaporators and condensers,	
Unit 5	**Design of compact heat exchangers**
Classification of compact heat exchangers, Plate heat exchangers (Numerical treatment), plate fin heat exchanger, tube fin heat exchanger (Numerical treatment), coiled tube heat exchangers (Numerical treatment), mini and micro channel heat exchangers, factors affecting on design of heat exchanger, Thermal analysis in compact heat exchanger.	
Unit 6	**Direct Contact Heat Exchanger**
Cooling towers, relation between wet bulb & dew point temperatures, Classification of cooling towers, Cooling tower internals and the roll of fills, Heat Balance, Analysis of cooling tower requirements, Deign of counter flow, cooling towers, Determination of the number of diffusion units.	
Books and other resources	
Text Books: 1. Fundamentals of Heat Exchanger Design by Ramesh K Shah, Wiley Publication 2. Compact Heat Exchangers by Kays, V.A. and London, A.L., McGraw Hill 3. Process Heat transfer by Donald Q Kern, McGraw Hill	

References Books:

1. Heat Exchanger Design Handbook by Kuppan, T, Macel Dekker, CRC Press
2. Heat Exchanger Selection, Rating and Thermal Design by Sadik, Kakac, CRC Press

Web References:

1. https://www.pdfdrive.com/heat-exchanger-design-handbook-e56045839.html
2. https://www.pdfdrive.com/heat-exchangers-book-e25375475.html
3. https://www.pdfdrive.com/heat-exchangers-selection-rating-and-thermal-design-third-edition-e186214274.html
4. https://www.pdfdrive.com/compact-heat-exchangers-selection-application-design-and-evaluation-e186388889.html

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402044C - Modern Machining Processes					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisite
Engineering Materials and Metallurgy, Manufacturing Processes

Course Objectives

1. To understand the different modern machining process.
2. To evaluate the process parameters of modern machining processes.
3. To able to select the process for application.
4. To apply the knowledge of different modern machining for manufacturing.

Course Outcomes
On completion of the course, learner will be able to

CO1. **UNDERSTAND** and **ANALYZE** the mechanism, process parameters of mechanical assisted modern machining processes.
CO2. **UNDERSTAND** the mechanism, construction and working of laser, plasma and electron beam assisted machining.
CO3. **CLASSIFY** and **ANALYZE** the mechanism, process parameters of the chemical and electrochemical machining.
CO4. **RELATE** and **ANALYZE** the mechanism and select process parameters Electrical Discharge Machining for an application.
CO5. **ILLUSTRATE** the application of micromachining processes.
CO6. **SUGGEST** appropriate nanomachining process for the specific application.

Course Contents

Unit 1	**Mechanically Assisted Modern Machining Process**

Introduction to modern manufacturing processes, Need and classification of modern manufacturing methods.

Introduction to advanced Mechanical Energy Process machining processes and their classification, - Abrasive Jet Machining (AJM), Abrasive Water Jet Machining (AWJM), Ultra Sonic Machining (USM), Water Jet Machining (WJC) -Principle, Working, process parameters, Effect of process parameters on Material removal rate, tool wear, surface finish, Advantages, Limitations & applications, economics of machining.

Unit 2	Energy Assisted Modern Fabrication Process
Introduction to Energy Process machining processes, Principle, applications, classifications and selection, process parameters, concept of energy level, Heat Affected Zone and economics of the process in Laser beam machining (LBM) Laser Optics, Plasma arc machining (PAM), Electron Beam Machining (EBM), Focused Ion beam (FIB).	
Unit 3	**Electro-chemical Machining Process**
Electro chemical machining (ECM): Introduction, Working Principle, equipment, process parameters, material removal rates, surface integrity, type of electrolyte, Advantages, limitations & applications of ECM, economics of machining. Electrochemical Grinding (ECG), Electro stream Drilling (ESD), Photochemical machining (PCM) Chemical machining (ChM).	
Unit 4	**Electro-thermal Machining Process**
Electric discharge machining (EDM): Introduction, Working Principle, EDM-Spark Circuits, selection of tool electrodes and dielectric fluids, process parameters, material removal rates, surface integrity, Heat Affected zone, Advantages, limitations & applications of EDM, Wire Electric Discharge Machining (W-EDM), Electric Discharge Grinding (EDG), Electric Discharge Diamond Grinding (EDDG), economics of machining. Electrochemical discharge machining (ECDM)	
Unit 5	**Micro And Precision Manufacturing Process**
Micro machining processes that include working principle, material removal mechanism, effect of process parameters, materials processed, applications - Diamond turn machining, micro turning, Micro drilling, micro engraving, micro milling, Micro electro discharge machining, Case study on each process. economics of machining.	
Unit 6	**Nano-Machining And Nano Finishing Techniques**
Fundamental of micro and nano technology, Effect of material aspects, concepts of micro and Nano systems and Microsystems Products, Microsystems and Microelectronics, Micro and Nano fabrication-wet and dry etching, photolithography-LIGA process, Application of Microsystems, Case study on MEMS. Magnetic Abrasives Finishing (MAF), Abrasive Flow Finishing (AFF) Magnetorheological Finishing (MRF), Rotational - Magnetorheological Abrasive Flow Finishing (R-MRAFF).	

Books & Other Resources

Text Books

1. V. K. Jain "Advanced Machining Processes" Allied Publishers Pvt. Ltd., New Delhi, 2007.
2. Pandey P.C. and Shan H.S. "Modern Machining Processes" Tata McGraw-Hill.
3. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001.
4. M. P Groover., "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", 6th edition, Wiley 2015.

Reference Books

1. V. K. Jain, "Micro manufacturing Processes", CRC Press.
2. R. Balasubramaniam, RamaGopal V. Sarepaka, Sathyan Subbiah, "Diamond Turn Machining:

Theory and Practice", CRC Press.
3. MEMS Material and Process Handbook, Reference proceedings, Reza Ghodssi, Pinyen Lin, Springer.
4. Hassan El-Hofy, "Advanced Machining Processes", McGraw Hill Publications.
5. Julian W. Gardner, "Microsensors MEMS and smart devices", Wiley.
6. Mc Geough, "Advanced Methods of Machining", Chapman and Hall, London, 1998.
7. A. Ghosh and A. K. Mallik, Manufacturing Science, East-West Press, New Delhi, 2006.

Web References

1. https://nptel.ac.in/courses/112/103/112103202
2. https://nptel.ac.in/courses/112/104/112104028
3. https://nptel.ac.in/courses/112/105/112105212

402044D: Industrial Engineering					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Tutorial		**Tutorial**		**End-Semester**	**70 Marks**

Prerequisites: Basic concepts of Mathematics and Mechanical Engineering, Industrial Orientation, Quality Control, Human Psychology, Basic Finance, Passion for Continual Improvement.

Course Objectives:

1. To introduce the concepts, principles, and framework of Industrial Engineering and Productivity enhancement approaches.
2. To familiarize the students with different time study and work measurement techniques for productivity improvement.
3. To introduce various aspects of facility design.
4. To acquaint the students with various components and functions of Production Planning and Control.
5. To acquaint the student about inventory management and approaches to control.
6. To acquire the students with concepts of ergonomics, value engineering and job evaluation.

Course Outcomes

Learner will be able to:

CO1. **EVALUATE** the productivity and **IMPLEMENT** various productivity improvement techniques.
CO2. **APPLY** work study techniques and **UNDERSTANDS** its importance for better productivity.
CO3. **DEMONSTRATE** the ability to **SELECT** plant location, appropriate layout and material handling equipment.
CO4. **USE** of Production planning and control tools for effective planning, scheduling and managing the shop floor control.
CO5. **PLAN** inventory requirements and **EXERCISE** effective control on manufacturing requirements.
CO6. **APPLY** Ergonomics and legislations for human comfort at work place and **UNDERSTANDS** the role of value engineering in improving productivity.

Course Contents

Unit 1	**Introduction to Industrial Engineering and Productivity**

Introduction to Industrial Engineering, Historical background and scope, Contribution of Taylor, Gilbreth, Gantt, Maynard, Ford, Deming and Ohno. Importance of Industrial engineering. Introduction to Work system design

Productivity: Definition of productivity, Measures of Productivity, Total Productivity Model, Need for Productivity Evaluation, Productivity measurement models, Productivity improvement approaches, Principles, Productivity Improvement techniques – Technology based, Material based, Employee based, Product based techniques. (Numerical on productivity measurement)

Unit 2	**Work Study**

Method Study: Introduction and objectives, Areas of application of work study in industry, Selection and Basic procedure. Recording techniques, Operations Process Chart, Flow Process Chart (Man, Machine & Material) Multiple Activity Chart, Two Handed process chart, Flow Diagram, String Diagram and Travel Chart, Cycle and chronocycle graphs, SIMO chart, Therbligs, Micro motion and macro-motion study: Principles of motion economy, Normal work areas and work place design.

Work Measurement: Techniques, time study, steps, work sampling, Determination of time standards. Observed time, basic time, normal time, rating factors, allowances, standard time, and standard time determination. (Numerical)

Introduction to PMTS, MTM, and MOST

Unit 3	**Production Facility Design**

Plant Location: Introduction, Factors affecting location decisions, Multi-facility location

Plant Layout: Principles of Plant layout and Types, factors affecting layout, methods, factors governing flow pattern, travel chart for flow analysis, analytical tools of plant layout, layout of manufacturing shop floor, repair shop, services sectors, and process plant. Layout planning, Quantitative methods of Plant layout and relationship diagrams. Dynamic plant layout

Material Handling: Objectives and benefits of Material handling, Relationship between layout and Material handling, Equipment selection

Unit 4	**Production Planning and Control**

Types and methods of Production, and their Characteristics, functions and objectives of Production Planning and Control, Steps: Process planning, Loading, Scheduling, Dispatching and Expediting with illustrative examples, Capacity Planning, Aggregate production planning and Master production scheduling. Introduction to a line of balance, assembly line balancing, and progress control

Forecasting Techniques: Causal and time series models, Moving average, Exponential smoothing, Trend and Seasonality. (Numerical)

Unit 5	**Inventory and Inventory Control**

Materials: Profit Centre: Role of materials management techniques in material productivity improvement, cost reduction and value improvement.

Purchase Management: Purchase management, incoming material control. Acceptance sampling and inspection. Vendor rating system.

Inventory: Functions, Costs, Classifications, Deterministic inventory models and Quantity discount

Inventory Control: EOQ (Numericals), concepts, type of Inventory models-deterministic and probabilistic, Selective inventory control, Fundamental of Material Requirement Planning (MRP-I), Manufacturing Resource Planning (MRP-II), Enterprise Resource Planning (ERP), Just-in-Time system (JIT) and Supply Chain Management (SCM)

Unit 6	Ergonomics, Value Engineering and Job Evaluation

Ergonomics: Introduction to ergonomics and human factors Engineering - physiological basis of human performance, basic anatomy of human body and its functional systems; principles of ergonomics, design of display and controls in relation to information processing by human being, Introduction to Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA)

Value Engineering: VE concepts, Principles, Methodologies and standards, methods of functional analysis.

Job Evaluation and Wage Plan: Objective, Methods of job evaluation, job evaluation procedure, merit rating (Performance appraisal), method of merit rating, wage and wage incentive plans, Performance appraisal, concept of KRA (Key Result Areas), Introduction to industrial legislation.

Books and other resources

Text Books:

1. O. P. Khanna, Industrial engineering and management, Dhanpat Rai publication
2. M Mahajan, Industrial Engineering and Production Management, Dhanpat Rai and Co.
3. Martend Telsang, Industrial Engineering, S. Chand Publication.
4. Banga and Sharma, Industrial Organization& Engineering Economics, Khanna publication.

References Books:

1. Askin, Design and Analysis of Lean Production System, Wiley, India
2. Introduction to Work Study by ILO, ISBN 978-81-204-1718-2, Oxford & IBH Publishing Company, New Delhi, Second Indian Adaptation, 2008.
3. H. B. Maynard, K Jell, Maynard's Industrial Engineering Hand Book, McGraw Hill Education.
4. Zandin K.B., Most Work Measurement Systems, ISBN 0824709535, CRCPress,2002
5. Martin Murry, SAP ERP: Functionality and Technical Configuration, SAP Press.
6. Barnes, Motion and time Study design and Measurement of Work, Wiley India
7. Sumanth, D.J, "Productivity Engineering and Management", TMH, New Delhi, 1990.
8. Edosomwan, J.A, "Organizational Transformation and Process re- Engineering", British Cataloging in publications, 1996.
9. Prem Vrat, Sardana, G.D. and Sahay, B.S, "Productivity Management - A systems approach", Narosa Publications, New Delhi, 1998.
10. Francis, R.L., and White, J.A, "Facilities layout and Location", Prentice Hall of India, 2002.
11. James A. Tompkins, John A. White, "Facilities Planning", Wiley, 2013
12. Richard L. Francis, Leon F Mc Ginnes and John A. White, "Facility Layout and Location-

An Analytical Approach", PHI, 1993
13. G. K. Agarawal, "Plant Layout and Material Handling", Jain Brothers, 2007

Web References:

1. https://archive.nptel.ac.in/courses/112/107/112107143/#
2. https://nptel.ac.in/courses/112107249
3. https://onlinecourses.nptel.ac.in/noc22_me04/preview
4. https://nptel.ac.in/courses/112107292
5. https://nptel.ac.in/courses/112107142

402044E: Internet of Things					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Systems in Mechanical Engineering**,** Programming and Problem Solving, Basic Electronics Engineering, Solid Mechanics, Solid Modeling and Drafting, Electrical and Electronics Engineering, Mechatronics, Measurement Laboratory, Fluid Power & Control Laboratory

Course Objectives:

1. Introduction to IoT, Overview of IoT Building Blocks
2. Build small applications in IoT for Mechanical Engineering Applications using Sensors, Actuators, Microcontrollers and Cloud
3. Learn commonly used IoT Simulation Hardware platforms
4. Understand different Communication Technologies used in IoT
5. Development of application level protocol and Security of IoT Ecosystem
6. Understand IoT applications in different domains

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **EXPLAIN** the Applications/Devices, Protocols and Communication Models of IoT

CO2. **DEMONSTARTE** small Mechanical Engineering IoT oriented applications using Sensors, Actuators, Microcontrollers and Cloud

CO3. **SELECT** commonly used IoT Simulation Hardware platforms

CO4. **APPLICATION** of Interfacing and Communication Technologies for IoT

CO5. **ILLUSTRATE** IoT Application Development and Security of IoT Ecosystem

CO6. **EVALUATE** Present and Future Domain specific Applications of IoT Ecosystem

Course Contents

Unit 1	**Introduction to the Internet of Things (IoT)**

Overview, History, Definition and Characteristics, Connectivity Terminologies, Building blocks, Types of technologies used in IoT System, Baseline Technologies (Machine-to-Machine (M_2M) communications, Cyber-Physical-Systems (CPS)), IoT Vs M_2M, IoT enabled Technologies, IoT Levels and Templates, Design Methodology, The Physical Design Vs Logical Design of IoT, Functional blocks of IoT and Communication Models/Technologies, Development Tools used in IoT, IoT Architecture and Protocols, Various Platforms for IoT, Real time Examples of IoT, Challenges in IoT, The process flow of an IoT application, Evolution of Connected Devices,

<table>
<tr><td colspan="2">Applications of IoT, IoT Enablers, Overview of Governance, Privacy and Security Issues.</td></tr>
<tr><td>Unit 2</td><td>Sensors, Actuators and Microcontrollers</td></tr>
<tr><td colspan="2">Measuring physical and virtual quantities in digital world, Overview of Sensors working, Analog Vs Digital Sensors, Wired Vs Wireless Sensors, Types of Sensors, Types of Converters

Types of Transducers and Actuator, Controlling Hardware, Types of Controller, Role of microcontroller as gateway to interfacing sensors and actuators, Microcontroller Vs Microprocessor, Type of microcontrollers in embedded System</td></tr>
<tr><td>Unit 3</td><td>IoT Simulation Environment Hardware platforms and Endpoint Interfacing</td></tr>
<tr><td colspan="2">IoT supported Hardware platforms: Introduction to IoT Simulation Environment and Devices (Raspberry Pi, Espressif Processors, Arduino), Architecture, Setup, IDE, Installation, Interfaces (serial, SPI, I_2C), Programming with focus on interfacing for reading input from pins, connecting external gadgets/sensors/actuators, Controlling and Displaying Output, Libraries, Basics of Embedded C programming

Interfacing: Interfacing Input, Intermediate, Output and Display Sensors, Converters, Actuators, Controlling Hardware, Controllers and Network Devices,

IoT Architecture: Building architecture and Open source architecture (OIC), Main design principles and needed capabilities, An IoT architecture outline, Standards Considerations</td></tr>
<tr><td>Unit 4</td><td>Interfacing and Communication for Building IoT Applications</td></tr>
<tr><td colspan="2">Communication: Overview and Working of Controlled Systems, Connectivity models - TCP/IP Vs OSI model, IoT Communication Models, IoT Communication APIs, Serial Vs Parallel Communication, Wires Vs Wireless Communication, their Technologies and Hardware

IoT Communication Protocols: Protocol Standardization for IoT, Role of M_2M in IoT, M_2M Value Chains, IoT Value Chains, M_2M and WSN Protocols (SCADA and RFID)

Physical Servers and Cloud Platforms: Web server, Posting sensor(s) data to web server, Introduction to Cloud Storage models and Communication APIs Webserver, API Virtualization concepts and Cloud Architecture, Advantages and limitations of Cloud computing, IoT Cloud platforms, Cloud services</td></tr>
<tr><td>Unit 5</td><td>IoT Application Development and Security of IoT Ecosystem</td></tr>
<tr><td colspan="2">Application Protocols: MQTT, REST/HTTP, SQL Back-end Application Designing (Designing with Apache, MySQL, HTML, CSS), Non SQL Back-end Application Designing (MongoDB Object Type Database, jQuery for UI Designing), JSON lib for data processing

Security: Need of security in IoT, Security & Privacy during development, Privacy for IoT</td></tr>
</table>

enabled devices, IoT security for consumer devices, Security levels, protecting IoT devices, Security, Privacy and Trust in IoT-Data-Platforms

Unit 6	**Present and Future Domain specific Applications of IoT Ecosystem**

IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, Business, Manufacturing, Smart Homes/Home automation, Surveillance applications, Connected Vehicles, Agriculture, Healthcare, Activity Monitoring, Retail, Logistics, Security, Health and Lifestyle, Legal challenges, IoT in Environmental Protection Modern Day IoT Applications, Smart Grid, Smart Cities - Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities

Future: Future IoT ecosystem, Need of powerful core for building secure algorithms, Examples for new trends (AI, ML penetration to IoT)

Books and other resources

Text Books:

1. Bahga, A. and Madisetti, V., (2015), “Internet of Things - A Hands-on Approach,” Universities Press, ISBN: 9788173719547
2. Hajjaj, S S H. and Gsangaya, K. R., (2022), “The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers,” CRC Press, ISBN: 9781032110950
3. Raj, P. and Raman, A. C., (2017), “The Internet of Things: Enabling Technologies, Platforms, and Use Cases,” Auerbach Publications/CRC Press, ISBN: 9781498761284
4. Adrian McEwen, A. and Cassimally, H., (2013), “Designing the Internet of Things,” John Wiley and Sons, ISBN:
5. Veneri, G., Capasso, A., (2018), “Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0,” Packt Publishing, ISBN: 9781789537222
6. Hersent, O, Boswarthick, D., Elloumi, O., (2012), “The Internet of Things: Key Applications and Protocols”, Wiley, ISBN: 9781119994350
7. Uckelmann, D., Harrison, M., Michahelles, F., (2011), “Architecting the Internet of Things,” Springer, ISBN: 9781119994350

References Books:

1. daCosta, F., (2013), “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, Apress Publications, ISBN: 9781430257417
2. Waher, P., (2015), “Learning Internet of Things,” Packt Publishing, ISBN: 9781783553532
3. Ovidiu, V. and Friess, P., (2014), “Internet of Things - From Research and Innovation to Market Deployment,” River Publishers, ISBN: 9788793102941, https://www.riverpublishers.com/pdf/ebook/RP_E9788793102958.pdf
4. Ida, N., (2020), “Sensors, Actuators and Their Interfaces,” SciTech Publishers, ISBN: 9781785618352
5. Pfister, C., (2011), “Getting Started with the Internet of Things,” O’Reilly Media, ISBN:

9781449393571
6. Wallace, S., Richardson, M., Wolfram Donat, W., (2021), "Getting Started With Raspberry Pi: Getting to Know the Inexpensive ARM-Powered Linux Computer," Make Community, LLC, ISBN: 9781680456998
7. Elangovan, U., (2019), "Smart Automation to Smart Manufacturing: Industrial Internet of Things," Momentum Press, ISBN: 9781949449266
8. Jha, S., Tariq, U., Joshi, G. P., Solanki, V. K., (2022), "Industrial Internet of Things: Technologies, Design, and Applications," CRC Press, ISBN: 9780367607777
9. Schwartz, M., (2016), "Internet of Things with Arduino Cookbook," Packt Publishing, ISBN: 9781785286582
10. Kurniawan, A., (2019), "Internet of Things Projects with ESP32: Build exiting and powerful IoT projects using the all-new Expresif ESP32," Packt Publishing, ISBN: 9781789956870

Web References:

1. https://nptel.ac.in/courses/106105166
2. https://www.udemy.com/internet-of-things-iot-for-beginners-getting-started/
3. http://playground.arduino.cc/Projects/Ideas
4. http://www.megunolink.com/articles/arduino-garage-door-opener
5. http://www.willward1.com/arduino-wifi-tutorial
6. http://www.toptechboy.com/arduino-lessons
7. https://www.eprolabs.com
8. http://www.makeuseof.com/tag/pi-overdose-heres-5-raspberry-pi-alternatives

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402044F: Computational Fluid Dynamics					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Mathematics, Physics, Systems in Mechanical Engineering, Engineering Thermodynamics, Applied Thermodynamics, Fluid Mechanics, Numerical & Statistical Methods, Heat & Mass Transfer, Computer Aided Engineering

Course Objectives:

1. Model fluid / heat transfer problems, apply fundamental conservation principles and Identify Discretization methods
2. Formulate a model the for conduction and advection problems
3. Formulate a model the for Convection-Diffusion problems
4. Understand the External/Internal flow simulation
5. Recognize the Scales of turbulence and Understand the formulation methods
6. Understand the Fluid-Structure Interaction Problems and their applications

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **DISTINGUISH** and **ANALYSE** the governing equations of fluid mechanics and heat transfer in various formulations

CO2. **ANALYZE** and **MODEL** the conduction and advection problems

CO3. **ANALYZE** and **MODEL** the Convection-Diffusion problems

CO4. **IDENTIFY** and **EVALUATE** the External/Internal flow and its simulation

CO5. **DISTINGUISH** and **COMPARE** concepts of stability and turbulence.

CO6. **USE** and **APPLY** a CFD tool for effectively solving practical Fluid-Structure Interaction problems

Course Contents

Unit 1	**Introduction to Computational Fluid Dynamics**

Introduction to Computational Fluid Dynamics, CFD as a research and design tool, Applications in various branches of Engineering, Derivation and physical interpretation of governing equations (conservation of mass, momentum and energy) in differential form, Concept of substantial derivative, divergence and curl of velocity, Mathematical behavior of Governing Equations and boundary conditions, Discretization methods for the CFD (FDM, FVM, FEM, Hybrid Methods), Intro to Meshless Methods, Meshed Vs Meshless Methods

Unit 2 | **Conduction and Advection**

Conduction: Solution of two dimensional steady and unsteady heat conduction equation using finite volume method (Implicit and Explicit) with Dirichlet, Neumann, Robbin boundary conditions, Stability Criteria

Advection: Solution of two dimensional steady and unsteady heat advection equation using finite volume method (Implicit and Explicit) with Dirichlet BC, Stability Criteria, Introduction to first order upwind, CD, second order upwind and QUICK convection schemes

Unit 3 | **Convection-Diffusion**

Solution of two dimensional steady and unsteady heat convection-diffusion equation for slug flow using finite volume method (Implicit and Explicit), Stability Criteria, 1-D transient convection-diffusion system, Peclet Number

Unit 4 | **Introduction to External/Internal flow simulation**

Solution of Navier-Stoke' equation for incompressible flow using SIMPLE algorithms for lid driven cavity flow problem, Introduction to external flow simulation – Flow over circular Cylinder and Aerfoils.

Unit 5 | **Turbulent Flow Modeling**

Introduction to turbulence, Scales of turbulence, Reynolds Averaged Navier-Stokes (RANS) equation, One equation model (Derivation) and two equation model, Introduction to Direct Numerical Simulation (DNS), Large Eddy Simulation (LES)

Unit 6 | **Introduction to Fluid-Structure Interaction**

Types of Fluid-Solid Couplings, Applications, Mechanical Forces and Equilibrium, Rigid Body Motions, Balance Laws in Lagrangian and Eulerian Form, Lagrangian Solid System, Eulerian Fluid System, Kinematics of Eulerian and Lagrangian Modeling, Continuum Mechanics of Moving Domains, Coupled Fluid-Structure Equations, Application of Arbitrary Lagrangian Eulerian (ALE) Formulation

Books and other resources

Text Books:

1. Ghoshdastidar, P. S. (2017), "Computational Fluid Dynamics and Heat Transfer," Cengage learning, ISBN: 9788131533079
2. Atul Sharma, A., (2016), "Introduction to Computational Fluid Dynamics: Development, Application and Analysis," Wiley, ISBN: 9781119002994
3. Versteeg, H. K., Malalasekhara, W., (2007), "An Introduction to Computational Fluid Dynamics: The Finite Volume Method," PHI, ISBN: 9780131274983
4. Muralidharan, K., Sundarajan , T., (2009), "Computational Fluid Flow and Heat Transfer," Narosa Pub, ISBN: 9788173195228
5. Rao, J.S., (2017), "Simulation Based Engineering in Fluid Flow Design," Springer, ISBN: 9783319463810
6. Anderson, Jr., D. A. A (2017), "Computational Fluid Dynamics - the Basics with

Applications," , McGraw Hill Education, ISBN: 9781259025969

7. Jaiman, R. K. and Joshi, V., (2022), "Computational Mechanics of Fluid-Structure Interaction: Computational Methods for Coupled Fluid-Structure Analysis," Springer, ISBN: 9789811653544

References Books:

1. Thompson, J. F., Soni, B. K., Weatherill, N. P., (1998), "Handbook of Grid Generation," CRC Press, ISBN: 9780849326875
2. Ferziger, J. H., Perić, M., Street, R. L., (2019), "Computational Methods for Fluid Dynamics,"Springer, ISBN: 9783319996912
3. Pletcher, R.H., Tannehill, J.C., Anderson, D.A., (2012), "Computational Fluid Mechanics and Heat Transfer," CRC Press, ISBN: 9781591690375
4. Patankar, S. V., (2017), "Numerical Heat Transfer and Fluid Flow," CRC Press, ISBN: 9781138564695
5. Chung, T. J., (2014), "Computational Fluid Dynamics," Cambridge University Press, ISBN: 9781107425255
6. Tu, J., Yeoh, G-H. and Liu, C., (2018), "Computational Fluid Dynamics: A practical approach," Butterworth-Heinemann, ISBN: 9780081011270
7. Date, A. W., (2005), "Introduction to Computational Fluid Dynamics," Cambridge University Press, ISBN: 9780521685337
8. Schlichting, H., Gersten, K., (2016), "Boundary-Layer Theory," Springer, ISBN: 9783662529171
9. Tennekes, H. and Lumley, J. L., (2018), "A First Course in Turbulence," The MIT Press, ISBN: 9780262536301
10. Wilcox, D.C., (1998), "Turbulence Modeling for CFD," DCW Industries, ISBN: 9780963605153
11. Paidoussis M. P., Price, S. and de Langre, E., (2011), "Fluid-Structure Interactions: Cross-Flow-Induced Instabilities," Cambridge University Press, ISBN: 9780521119429
12. Bungartz, H-J. and Schäfer, M., (2006), "Fluid-Structure Interaction: Modelling, Simulation, Optimization," Springer, ISBN: 9783540345954

Web References:

1. Singh, K. M., (2019), "Computational Fluid Dynamics," IIT Roorkee, https://nptel.ac.in/courses/112107080
2. Ramakrishna, M., (2019), "Introduction to CFD," IIT Madras, https://archive.nptel.ac.in/courses/101/106/101106045/
3. Roy, A., (2019), "Introduction to CFD," IIT Kharagpur, https://archive.nptel.ac.in/courses/101/105/101105085/
4. Chakraborty, S., (2020), "Computational Fluid Dynamics," IIT Kharagpur, https://archive.nptel.ac.in/courses/112/105/112105254/
5. Chandrasekaran, S., (2019), "Advanced Marine Structures," IIT Madras, https://nptel.ac.in/courses/114106037

402045A: Product Design and Development					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Pre requisites: Basic Engineering Science - Physics, Chemistry, Material Science, Engineering Metallurgy, Manufacturing processes Etc.

Course Objectives:

To explain student's significance of

1. Product design and Product development
2. Market Survey & Product Specification Finalization
3. Concept Inception, Verification and selection
4. Concept Exploration & Development
5. Design Verification and Validation
6. Robust Design and Development

Course Outcomes:

On completion of the course the learner will be able to;

- CO1. **UNDERSTAND** Product design and Product development processes
- CO2. **UNDERSTAND** Processes, tools and techniques for Market Survey & Product Specification Finalization
- CO3. **UNDERSTAND** Processes, tools and techniques for Concept Inception, Verification and selection
- CO4. **UNDERSTAND** Processes, tools and techniques for Concept Exploration & Development
- CO5. **UNDERSTAND** Processes, tools and techniques for Design Verification and Validation
- CO6. **UNDERSTAND** Processes, tools and techniques for Robust Design and Development

Course Contents

Unit 1	**Introduction to Product Design and Development**

Topics- Product design and Development definition, Objectives of Product design and development, Engineering Design Process, Engineering Development Process (Gateway System), Product Design Vs Product Development, Features of successful product design and development, Essential Factors for product design, The challenges of product development, ASIMOW Model/Morphology of product design, Who design and develops product-Concurrent engineering approach/CFT Approach, Reasons for new product failure, Product Life Cycle

Unit 2	**Market Survey & Product Specification Finalization**
Topics- Product definition, Types of products, Customer Population and Market segmentation- Types of customers and Needs, Customer need Models- Introduction to Kano Model, Triz Method/Altshuller Matrix, Design Thinking, etc. Types of Design information and the Various Sources of information, Product planning and its Phases, Mission statement and Technical Questioning, Technology forecasting and S-curve, Tools for gathering Customer needs, QFD and House of quality	
Unit 3	**Concept Inception, Verification and selection**
Topics- Idea generation and Idea generation approaches-Triz Method, Benchmarking, Brainstorming, Alternate thinking, Reverse Engineering etc, Product Policy of an organization, Selection of Profitable Concept- SWOT Analysis, Concept Selection Process, Pugh's Concept selection process, Concept Analysis- Marketing aspect, Product characteristics (Functional/ Operational/Durability/Aesthetic/Ergonomic Aspects), Economic analysis, Production aspect, functional Modelling and decomposition- Functional analysis system technique, Subtract and operate procedure	
Unit 4	**Concept Exploration & Development**
Topics-Solid Modelling of part and assembly, Product architecture, Digital product design of part and assembly with respect to Engineering drawing definition, Classification of engineering drawing, Elements of production drawing, Bill of material, Types of dimensions, Arrangement of dimensions, Principles of dimensioning, Limits, Fits and Tolerances, Geometric Tolerances, Datum System, Design for Assembly, Design for manufacturing, Design for processes, Product design Steps, Introduction of Ergonomics in product design, Design Review/Part Print Analysis	
Unit 5	**Design Verification and Validation**
Topics-FEA-CFD-MBD-FSI, Simulation driven design, Additive manufacturing, Policy and Homologation certification by National and International agencies, Introduction to Break Even analysis and Production capacity planning, Make VS buy Decision, Business case Preparation, Facility tooling and gauges design and Development- Vendor Development, Letter of Intent, Purchase order, Product costing, Product Testing and Validation, Introduction to Production part approval process tools (PPAP)	

Unit 6	Robust Design and Development

Tools and Techniques for Robust design and Development- Advance Product Quality Planning, Design Failure Mode Effect Analysis, Value Analysis and Value Engineering, Product Life cycle management and Product data Management etc.

Case studies on-

1. Teamcenter application in Product design and Development
2. DFMEA (Minimum Three parts)
3. Process Flow Chart (Minimum Three Parts)
4. Part Print analysis (Minimum Three Parts)

Text Books:

1. K. Chitale; R.C. Gupta, Product Design and Manufacturing, Prentice Hall India.
2. Dieter George E., Engineering Design McGraw Hill Pub. Company, 2000.
3. How Products are made by Jocqueline L. Longe
4. Creating Innovative products Using Total Design by Don Clausing and Ron Andrade
5. Metrics and Case Studies For Evaluating engineering designs by Jay Alan Moody
6. Understanding Engineering Design by Richard Birmingham
7. Designing for quality by Robert H. Lochner
8. New Product development by Barclay Z. Dann P. Holroyd
9. Developing an Ergonomics Processes by Alison Heller

References Books:

1. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education Inc.
2. Grieves, Michael, Product Lifecycle Management McGraw Hill
3. Bralla, James G., Handbook of Product Design for Manufacturing, McGraw Hill Pub.

2\. 4. Karl Ulrich, product design and development, TMH.

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402045B: Experimental Methods in Thermal Engineering					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Basics of Physics. Fundamentals of Thermodynamics, Fluid Mechanics & Heat transfer.

Course Objectives:

1. To introduce the theory and experimentation in thermal engineering - Problem solving approaches, types of engineering experiments, computer simulation and physical experimentation.
2. To enhance the knowledge of various measuring instruments, techniques and importance of error and uncertainty analysis.
3. To give the exposure to measurement of pressure, flow velocity, measurement of temperature, optical methods of measurement.

Course Outcomes:

On completion of the course the learner will be able to;

- CO1. **IDENTIFY** the suitable instrument for measuring parameters as per performance characteristics
- CO2. **ANALYZE** experimental data by using different statistical techniques and estimate error
- CO3. **DISTINGUISH** different methods of temperature measurements and thermal radiation
- CO4. **CLASSIFY** various pressure measurement instruments and their comparison
- CO5. **EXPLAIN** different flow measurement methods and flow visualization techniques
- CO6. **APPLY** knowledge of modern engineering experimentation, including calibration, data acquisition, analysis and interpretation using different AI and ML techniques

Course Contents

Unit 1	**Measuring instruments**

Basics of measuring instruments: Fundamental elements of a measuring instrument, Calibration, System response, Importance of measurement and experimentation, Selection of measuring system

Characteristics of instruments: Elements of Measuring Instruments Performance characteristics - Static & Dynamic characteristics, Response of general form of instrument, Random and transient input, Instrument loading under static and dynamic condition, Transducer and sensor used for thermal systems

Unit 2	Design of Experiments
Analysis of Experimental Data: Analysis of experimental data, Causes and type of experimental errors, data reduction techniques, statistical analysis of experimental data, Statistical distributions, probability distributions and curve fitting, Regression analysis, Co-relations **Uncertainty Analysis:** Nomenclature, Precision Vs Accuracy, Errors in measurement, Sampling. **(Numerical on Uncertainty analysis)** **Design of Experiments:** Factorial Design, Taguchi Method, Response Surface Design **(Case studies of experimental work)**	
Unit 3	**Temperature, Heat flux and Radiation measurements**
Temperature and Heat flux measurement: Overview of thermometry, Thermoelectric temperature measurement, Hg-in-glass thermometer, RTD (Resistance Temperature Detector), thermistor, thermocouple, thermopile, liquid-crystal thermography, optical pyrometer. Themo well, Issues in Heat flux measurements. Thermos profile of heat exchanger. Non-contact type temperature Measurements **Thermal radiation measurements:** Detection of thermal radiation, Radiation Thermometry, Measurement of emissivity, Reflectivity and transmissivity measurements, Solar radiation measurements.	
Unit 4	**Pressure measurements**
Different pressure measurement instruments and their comparison, Types of Sensors used in Pressure Measurement, Manometers, bourdon tube pressure gauge, diaphragm gauge, bellow gauge, McLeod gauge, Pirani gauge and ionization gauge. Transient response of pressure transducers. Pressure measurements in combustions. Applications of Pressure measurements. **(Numerical on Pressure measurements)**	
Unit 5	**Flow measurements and Visualization techniques**
Flow measurements: Introduction to Flow Measurement, Positive displacement flow meters, Flow obstruction methods, Magnetic flow meters, LDA (Laser Doppler Anemometry), Other methods. Applications of flow measurements. **Flow visualization techniques**: Shadowgraph, Schlieren and interferometer. Other methods. Ultrasonic flow measurement. Flow measurements techniques used to validate CFD results. Micro channel flow measurement. Velocity measurement based on thermal effect.	
Unit 6	**DAS and AIML**
Data Acquisition System (DAS) and Signal analysis: General Data Acquisition System, Signal conditioning, storage, Data transmission, - A/D & D/A conversion - Data storage and Display **AI & ML (Artificial Intelligence & Machine Learning) Applications:** Introduction to AI / ML.	

Approaches of AI/ ML. Predication of Measurement Parameter using ML Approaches such as Regression/ Classification. Finding Statistical Parameter such as ANOVA (Analysis of Variance), Correlation.
Books and other resources
Text Books: 1. Holman, J.P., “Experimental methods for engineers”, Tata McGraw hill 7th Edition, 2007 2. E.O. Doebelin, Measurement systems, Application and Design, 5 th edition, Tata McGraw-Hill, 2008 3. Beckwith & Buck : Mechanical Measurements 4. Willard, Mertt, Dean,Settle : Instrumental Methods of analysis
References Books: 1. Morris A.S, “Principles of Measurements and Instrumentation”, 3 Edition, Butterworth-Heinemann, . 2. Prebrashensky V., “Measurement and Instrumentation in Heat Engineering”, Vol.1, MIR Publishers, . 3. T.G. Beckwith, J.H. Lienhard V, R. D. Marngoni, Mechanical Measurements, 5 th edition, Pearson Education, 2010 4. D.C. Montgomery, Design and Analysis of Experiments, John Wiley, New York. 5. Introduction to Machine learning, Nils J.Nilsson 6. Introduction to Machine Learning with Python A guide for data scientists, Andreas, C. Muller & Sarah Guido, O'Reilly

402045C: Additive Manufacturing

Teaching Scheme		Credits		Examination Scheme	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisite: Manufacturing processes, Engineering metallurgy, Solid mechanics

Course Objectives

1. To know the principle, methods, possibilities and limitations as well as environmental hazards of Additive Manufacturing technologies.
2. To get familiar with the characteristics of the different materials used in Additive Manufacturing technologies
3. To explore the potential of additive manufacturing technologies in real life applications.

Course Outcomes

On completion of the course, learner will be able to

CO1. **USE** and **CLASSIFY** the fundamentals of Additive Manufacturing Technologies for engineering applications.

CO2. **IDENTIFY** and **CATEGORIZE** the methodology to manufacture the products using light-based photo-curing, LASER based technologies and **STUDY** their applications, benefits.

CO3. **IDENTIFY** and **CATEGORIZE** the methodology to manufacture the products using extrusion-based deposition, inkjet-based technologies and **STUDY** their applications, benefits.

CO4. **SYNTHESIZE, RECOMMEND** and **DESIGN** the suitable material and process for fabrication and build behavior of verities of product.

CO5. **DESIGN** and **CONSTRUCT** the AM equipment's for appropriate applications and the input CAD model.

CO6. **DEVELOP** the knowledge of additive manufacturing for various real-life applications.

Course Contents

Unit 1 **Introduction to Additive Manufacturing**

Introduction to AM, Historical Development, Additive v/s Conventional Manufacturing, Role of AM in Product development cycle, Rapid prototyping, Relevance of AM in Industry 4.0, Current industry and manufacturing trends driving AM, AM Process-Chain, Reverse engineering, Advantages, Types of materials, Classification of AM Processes (Process-based, material form based, application-based - direct and indirect processes and Micro- and Nano-additive processes), Process Planning for Additive Manufacturing

Unit 2	Light and LASER based Techniques
Introduction, Process and mechanism, Materials, Process Physics, Parameters, Benefits, Drawbacks, Limitations and Applications of **Light-Based Photo-curing**: Stereolithography (SLA), Digital Light Processing (DLP), Direct Laser Writing (DLW), Continuous Liquid Interface Production (CLIP) **Laser-Based Melting**: Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Selective Laser Melting (SLM), Electron-Beam Melting (EBM), Laser Blown Powder, Laser Wire Deposition, Laser Engineered Net Shaping (LENS), 3D Laser Cladding	
Unit 3	**Extrusion and energy based Techniques**
Introduction, Process and mechanism, Materials, Process Physics, Parameters, Benefits, Drawbacks, Limitations and Applications of **Extrusion-Based Deposition**: Fused Deposition Modeling (FDM), Fused Filament Fabrication (FFF), Direct Ink Writing (DIW), Robocasting, Bio-printing **Inkjet(droplet)-Based Deposition and Fusion**: Multi-jet Modeling (MJM), Polyjet Printing, Nanoparticle Jetting, Binder Jetting, Multi-Jet Fusion, Color-jet Printing (CJP), Energy Deposition Techniques: Plasma/TIG/MIG/Arc Deposition, Electron Beam-based DED, Direct Metal Deposition (DMD)	
Unit 4	**Materials and Design for AM**
Introduction, Materials: Metals, Polymers, Ceramics & Bio-ceramics, Composites, Hierarchical Materials, Biomimetic Materials, Shape-Memory Alloys, 4D Printing & Bio-active materials, Material selection, **AM Material Specific Process Parameters**: Processes, Heat or Chemical Treatments, Phase Transformations, Process Selection for various applications, DfAM: Process specific strategies, Rules and Recommendations, **Quality considerations and Post-Processing techniques**: Requirements and Techniques, Support Removal, Sanding, Acetone treatment, Polishing, Heat treatments, Hot isostatic pressing, Materials science, Surface enhancement Techniques and its Material Science Analysis of AM's error sources	
Unit 5	**Hardware and Software for AM**
Construction of Basic AM Machines: Equipment Layout and sub-system Design, Construction, Working, Equipment Topology/Layout Frame Designs, 3D Printer Design Considerations (Filament, Frame, Build Platform, Extruder Design, Nozzles, Print Bed, Heated build/Base Plate, Heater, Dispenser, Optical system, Cooling system, Gas Recirculation System, Laser controller, Gas Filtration, Inert Gas Cooling system, Powder Handling System, Loading/unloading System, Moving Parts and end stops, Sensors, Actuators, Motors and Control Electronics, Power supply, Machine Tool Peripheral), Raw Material Manipulation **Software and Controller**: Types of In-fill, Types of slicing, Software Integration (with Process, Slicing, etc), Control system (PLC and safety PLC, micro control/ Microcontroller, Micro-processor control), CAD Software and Controller Interfacing, CURA Software, Relevant G/M Codes, Standard firmware (Merlin Software, etc), In-process Monitoring, Calibration	

Unit 6	Case Studies, Application and Special Topics

Case Studies and Application of AM: 3D printing in prominent industries (Aerospace, Electronics, Defense, Automotive, Construction, Architectural, Machine-Tools), Other industrial applications (Health-Care, Personalized Surgery, Bio-medical Applications, Assistive Devices, Food-Processing, Food & Consumer Applications, Art, Fashion, Jewelry, Toys & Other Applications, etc)
Special Topics: 4D/5D Printing, Bio-printing, Bio-materials, scaffolds and tissue and Organ Engineering, Mass Customization and Future trends.

Books & Other Resources

Text Books

1. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015 2.
2. Amit Bandyopadhyay, Susmita Bose, "Additive manufacturing", CRC Press, Taylor & Francis Group, 2016 3.
3. Ian Gibson, David W. Rosen, Brent Stucker "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer, 2010

Reference Books

1. L. Lu, J. Y. H. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Springer, 2001
2. Andreas Gebhardt and Jan-Steffen Hötter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing" Hanser Publishers, Munich, 2016.
3. Ben Redwood, FilemonSchöffer& Brian Garret, "The 3D Printing Handbook: Technologies, design and applications", 3D Hubs B.V. 2017
4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004
5. Andreas Gebhardt, "Understanding Additive", Hanser Publishers, Munich, 2011
6. Ben Redwood, Filemon Schöffer & Brian Garret, "The 3D Printing Handbook – Technologies, Design and Applications" Part One:3D Printing Technologies and Materials, 3D Hubs, 2017
7. Chee Kai, Kah Fai, Chu Sing, 'Rapid Prototyping: Principles and Applications", 2nd Ed., 2003
8. D. T. Pham and S.S. Dimov, "Rapid Manufacturing" Springer, 2001
9. Rupinder Singh J. Paulo Davim, "Additive Manufacturing - Applications and Innovations" CRC Press Taylor& Francis Group, 2019
10. . I. Gibson, D. W. Rosen, B. Stucker, "Additive Manufacturing Technologies" Springer, 2010
11. L. Jyothish Kumar, Pulak M. Pandey, David Ian Wimpenny, "3D Printing and Additive Manufacturing Technologies" Springer, 2019

Web References

1. NPTEL Course on Fundamentals of Additive Manufacturing Technologies by Prof. SajanKapil, IIT Guwahati, https://onlinecourses.nptel.ac.in/noc21_me115/preview
2. Introduction to Additive Manufacturing, https://www.youtube.com/watch?v=LCQoi10cG To NPTEL IIT Kanpur, "Rapid Manufacturing", Dt. Janakarajan Ramkumar Prof. Amandeep Singh, https://onlinecourses.nptel.ac.in/noc20_me50/preview

402045D: Operations Research					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Engineering Mathematics, Theory of Probability, Statistics, Basic Industrial Functions and Business Environment.

Course Objectives:

1. To familiarize the students with the use of practice oriented mathematical applications for optimization functions in an organization.
2. To familiarize the students with various tools of optimization, probability, statistics and simulation, as applicable in particular scenarios in industry for better management of various resources.

Course Outcomes

On completion of the course, learner will be able to

- CO1. **EVALUATE** various situations of Games theory and Decision techniques and **APPLY** them to solve them in real life for decision making.
- CO2. **SELECT** appropriate model for queuing situations and sequencing situations and **FIND** the optimal solutions using models for different situations.
- CO3. **FORMULATE** various management problems and **SOLVE** them using Linear programming using graphical method and simplex method.
- CO4. **FORMULATE** variety of problems such as transportation, assignment, travelling salesman and **SOLVE** these problems using linear programming approach.
- CO5. **PLAN** optimum project schedule for network models arising from a wide range of applications and for replacement situations find the optimal solutions using appropriate models for the situation.
- CO6. **APPLY** concepts of simulation and Dynamic programming

Course Contents

Unit 1	**Introduction to OR, Theory of Games and Decision Analysis**

Introduction to OR: Origin of Operations Research, Definition, Evolution and Classification of Quantitative methods, Operations Research Techniques and Methodology, Advantages and Limitations, Scope and Applications of OR

Theory of Games: Introduction, Classification of Games**,** Two-person Zero Sum Games, Solution of 2 x 2 Game with no Saddle Point, Dominance in Games, Subgame Method to Solve (2 x n or m x 2) Mixed Strategy Games, Graphical Method to Solve (2 x n or m x 2)

Games **Decision Analysis:** Introduction, Decision Under Certainty, Decision Under Risk, Decision Under Uncertainty (Maximin, Minimax, Maximax, Minimin Criterions, Hurwicz Criterion, Laplace Criterion, Savage or MiniMax Regret Criterion), Decision Tree.	
Unit 2	**Queuing Theory and Sequencing Model**
Queuing Theory: Introduction, Elements of Queuing, Characteristics of Waiting Lines, Service discipline, Service Mechanism, Terminology and Kendall's Notation of Queuing system, Single Channel systems M/M/1: FCFS/∞/ ∞ and M/M/1: FCFS/N/ ∞ **Sequencing Models:** Solution of Sequencing Problem - Processing of n Jobs Through Two Machines, Processing of n Jobs Through Three Machines, Processing of Two Jobs Through m Machines, Processing of n Jobs Through m Machines	
Unit 3	**Linear Programming**
Introduction, Formulation of LPP, LPP by Graphical Method, Solution of LPP by Simplex Method, Big M Method and Two-phase method (Limited to 2 variables only), Conversion of Primal to Dual problems	
Unit 4	**Transportation and Assignment Model**
Transportation Model: Introduction, Formulation of Transportation problem, Methods to Find Basic Feasible Solution (Vogel's Approximation Method (VAM), Least Cost Method (LCM), North West Corner Rule (NWCR)), Unbalanced Transportation Problem, Degeneracy in Transportation Problem (Theoretical treatment only), Optimality Test- Modified Distributed Method **Assignment Model:** Introduction, Mathematical Formulation of Assignment Problem Difference between Transportation and Assignment problem Assignment Problem, Hungarian Method, Balanced and Unbalanced Assignment problem, Maximization in Assignment Problems, Travelling Salesman Problem (Mathematical Formulation and Numerical)	
Unit 5	**Project Management**
Network Models: Fulkerson's Rule, Concept and Types of Floats, CPM and PERT, Crashing Analysis and Resource Scheduling **Replacement Analysis:** Replacement of Items that Deteriorate, Replacement of Items that Fail Suddenly	
Unit 6	**Simulation and Dynamic Programming**
Simulation: Introduction, Simulation Definition, Types of Simulation, Steps of Simulation, Advantages and Disadvantage of simulation, Stochastic Simulation and Random numbers, Monte Carlo simulation, Random number Generation **Dynamic Programming:** Introduction, Dynamic Programming Model, Applications of Dynamic Programming Model to Shortest Route problems, Bellman Optimality Principle, Resource Allocation problem by Dynamic Programming	

Books and other resources

Text Books:

1. Prem Kumar Gupta, D. S. Hira, Problems in Operations Research: Principles and Solutions, S. Chand, 1991
2. J. K. Sharma, Operations Research: Theory and Application, Laxmi pub. India, 2010.
3. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut, 2015.
4. L.C.Jhamb, Quantative Techniques Vol. I &II, Everest Publication, 2007.
5. Manohar Mahajan, Operation Research, Dhanpatrai Publication, 2006.
6. V. K. Kapoor, Operations Research: Quantitative Techniques for Management, Sultan Chand Publications, 2013.

References:

1. Hillier F.S., and Lieberman G.J., Operations Research, Eight Edition, Mc. Tata McGraw Hill, India, 2011.
2. Ravindran, ―Engineering optimization Methods and Applications‖, 2nd edition, Wiley, India
3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Second Edition, Mc. WSE Willey,
4. Operations Research - An introduction, Hamdy A Taha, Pearson Education, 2010

Web References:

1. https://nptel.ac.in/courses/110106062
2. https://nptel.ac.in/courses/111107128
3. https://www.digimat.in/nptel/courses/video/110106062/L01.html
4. https://archive.nptel.ac.in/courses/112/106/112106134/

402045E: Augmented Reality and Virtual Reality

Teaching Scheme		Credits		Examination Scheme	
Theory	3 Hrs./Week	Theory	3	In-Semester	30 Marks
				End-Semester	70 Marks

Prerequisites: Mathematics, Physics, Programming and Problem Solving, Engineering Graphics, Solid Modeling and Drafting, Numerical & Statistical Methods, Mechatronics, Artificial Intelligence &Machine Learning, Computer Aided Engineering

Course Objectives:

1. Learn the fundamental Computer Vision, Computer Graphics and Human-Computer interaction Techniques related to VR/AR
2. Review the Geometric Modeling Techniques
3. Review the Virtual Environment
4. Discuss and Examine VR/AR Technologies
5. Use of various types of Hardware and Software in Virtual Reality systems
6. Simulate and Apply Virtual/Augmented Reality to varieties of Applications

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **UNDERSTAND** fundamental Computer Vision, Computer Graphics and Human-Computer Interaction Techniques related to VR/AR

CO2. **UNDERSTAND** Geometric Modeling Techniques

CO3. **UNDERSTAND** the Virtual Environment

CO4. **ANALYZE** and **EVALUATE** VR/AR Technologies

CO5. **APPLY** various types of Hardware and Software in Virtual Reality systems

CO6. **DESIGN** and **FORMULATE** Virtual/Augmented Reality Applications

Course Contents

Unit 1	Introduction to Virtual Reality (VR)

Virtual Reality and Virtual Environment, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark

Unit 2	Computer Graphics and Geometric Modelling

The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, Color theory, Conversion From 2D to 3D, 3D space curves, 3D boundary representation, Simple 3D modelling, 3D clipping, Illumination models, Reflection models, Shading algorithms, Geometrical Transformations: Introduction, Frames of reference,

Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection	
Unit 3	**Virtual Environment**
Input/Output Devices: Input (Tracker, Sensor, Digital Gloves, Movement Capture, Video-based Input, 3D Menus & 3D Scanner, etc.), Output (Visual/Auditory/Haptic Devices) **Generic VR system:** Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems, Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system **Physical Simulation:** Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft	
Unit 4	**Augmented Reality (AR)**
Taxonomy, Technology and Features of Augmented Reality, AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, Enhancing interactivity in AR Environments, Evaluating ARsystems	
Unit 5	**Development Tools and Frameworks**
Human factors: Introduction, the eye, the ear, the somatic senses **Hardware:** Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems **Software:** Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML	
Unit 6	**AR / VR Applications**
Introduction, Engineering, Entertainment, Science, Training, Game Development	
Books and other resources	

Text Books:

1. Coiffet, P., Burdea, G. C., (2003), “Virtual Reality Technology,” Wiley-IEEE Press, ISBN: 9780471360896
2. Schmalstieg, D., Höllerer, T., (2016), “Augmented Reality: Principles & Practice,” Pearson, ISBN: 9789332578494
3. Norman, K., Kirakowski, J., (2018), “Wiley Handbook of Human Computer Interaction,” Wiley-Blackwell, ISBN: 9781118976135
4. LaViola Jr., J. J., Kruijff, E., McMahan, R. P., Bowman, D. A., Poupyrev, I., (2017), “3D User Interfaces: Theory and Practice,” Pearson, ISBN: 9780134034324
5. Fowler, A., (2019), “Beginning iOS AR Game Development: Developing Augmented Reality Apps with Unity and C#,” Apress, ISBN: 9781484246672
6. Hassanien, A. E., Gupta, D., Khanna, A., Slowik, A., (2022), “Virtual and Augmented Reality for Automobile Industry: Innovation Vision and Applications,” Springer, ISBN: 9783030941017

References Books:

1. Craig, A. B., (2013), "Understanding Augmented Reality, Concepts and Applications," Morgan Kaufmann, ISBN: 9780240824086
2. Craig, A. B., Sherman, W. R., Will, J. D., (2009), "Developing Virtual Reality Applications, Foundations of Effective Design," Morgan Kaufmann, ISBN: 9780123749437
3. John Vince, J., (2002), "Virtual Reality Systems, "Pearson, ISBN: 9788131708446
4. Anand, R., "Augmented and Virtual Reality," Khanna Publishing House
5. Kim, G. J., (2005), "Designing Virtual Systems: The Structured Approach", ISBN: 9781852339586
6. Bimber, O., Raskar, R., (2005), "Spatial Augmented Reality: Merging Real and Virtual Worlds," CRC Press, ISBN: 9781568812304
7. O'Connell, K., (2019), "Designing for Mixed Reality: Blending Data, AR, and the Physical World," O'Reilly, ISBN: 9789352138371
8. Sanni Siltanen, S., (2012), "Theory and applications of marker-based augmented reality," Julkaisija –Utgivare Publisher, ISBN: 9789513874490

Web References:

1. Manivannan, M., (2018), "Virtual Reality Engineering," IIT Madras, https://nptel.ac.in/courses/121106013
2. Misra, S., (2019), "Industry 4.0: Augmented Reality and Virtual Reality," IIT Kharagpur, https://www.youtube.com/watch?v=zLMgdYI82IE
3. Dube, A., (2020), "Augmented Reality - Fundamentals and Development," NPTEL Special Lecture Series, https://www.youtube.com/watch?v=MGuSTAqlZ9Q
4. http://cambum.net/course-2.htm

402046: Data Analytics Laboratory					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**2 Hrs.**	**Practical**	**1**	**Term Work**	**50**

Prerequisites: Engineering Mathematics**,** Artificial Intelligence & Machine Learning, Numerical and Statistical Methods, Fundamental of Mechanical Engineering

Course Objectives:

1. To explore the fundamental concepts of data analytics.
2. To understand the various search methods and visualization techniques.
3. To apply various machine learning techniques for data analysis.

Course Outcomes:

On completion of the course, the learner will be able to

CO1: **UNDERSTAND** the basics of data analytics using concepts of statistics and probability.

CO2: **APPLY** various inferential statistical analysis techniques to describe data sets and withdraw useful conclusions from acquired data set.

CO3: **EXPLORE** the data analytics techniques using various tools

CO4: **APPLY** data science concept and methods to solve problems in real world context

CO5: **SELECT** advanced techniques to conduct thorough and insightful analysis and interpret the results

Course Contents

Preamble:

The motivation behind the data analytics lab for mechanical engineers is to make them competent to learn data-driven decision-making involving predictive, prescriptive, descriptive, and diagnostic analytics. Data analytics offers a new paradigm of bottom-up versus top-down modelling and solving supported by the traditional physics-based approach. An engineer involved in traditional modelling (e.g., developing a finite analysis or a reliability model) looks at the problem of interest and in essence, fits in the model he/she was trained to use. An engineer equipped with data science knowledge gathers historical data and uses data-mining tools to build the model of interest. If needed, he/she can further optimize this data-driven model with tools such as evolutionary computation algorithms.

Possible approaches:

Predictive Analytics:

Predictive analytics involves the use of mathematical methods and tools such as machine learning, data mining, statistical analysis, and predictive models. It is used to:

- Identify anomalies in the process, which help in preventive maintenance.
- Estimate the demand for product, raw material etc.: based on historical data and current

scenario.

- Forecast possible outcomes based on data obtained from the process.

Prescriptive Analytics:
Prescriptive analytics is used to identify ways in which an industrial process can be improved. While predictive analytics tells when could a component/asset fails, prescriptive analytics tells what action you need to take to avoid the failure. So, you can use the results obtained from prescriptive analysis to plan the maintenance schedule, review your supplier, etc. Prescriptive analytics also helps you manage complex problems in the production process using relevant information.

Descriptive Analytics:
The core purpose of descriptive analytics is to describe the problem by diagnosing the symptoms. This analytics method also helps discover the trends and patterns based on historical data. The results of a descriptive analytics are usually shown in the form of charts and graphs. These data visualization tools make it easy for all the stakeholders, even those who are non-technical to understand the problems in the manufacturing process.

Diagnostic Analytics:
Diagnostic analytics is also referred to as root cause analysis. While descriptive analytics can tell what happened based on historical data, diagnostic analytics tells you why it happened. Data mining, data discover, correlation, and down and drill through methods are used in diagnostic analytics. Diagnostic analytics can be used to identify cause for equipment malfunction or reason for the drop in the product quality.

TERM WORK:

A] Experiments (Any 6)

Sr. No.	Data Domain	Objective	Methodology	Data type
1	Thermal / Heat Transfer / HVAC / Fluid Mechanics / Fluid Power	Predictive / Prescriptive / Descriptive / Diagnostic (but not limited to)	Statistical / mathematical /numerical/computational/intelligent (but not limited to)	Numeric or image based or data in any suitable form
2	Solid Mechanics / Design			
3	Machining / Manufacturing			
4	Automation & Robotics			
5	Maintenance / Reliability / Condition Monitoring			
6	Quality Control			
7	Materials and Metallurgy			
8	Energy Conservation and Management			
9	Industrial Engineering, Estimation, and Costing			
10	Automotive technology			

B] List of Assignments (Any Three)
The survey of methods used for data analysis in the data domain mentioned above **(Any Three)** and discussion on any case studies.

Guidelines for selection of data domain, source, size, etc.:

- The data domain must be selected from various fields of mechanical engineering such as (but not limited to) thermal, heat power, design, manufacturing, automotive, HVAC, condition monitoring, process industry, solid and fluid mechanics, quality, materials and metallurgy, automation & robotics, energy conservation and management, ERP, Industrial engineering, estimation, and costing, etc.

- The volume of data should be considerably larger size in view of extracting meaningful insights, such as hidden patterns, unknown correlations, trends, and customer preferences through tools such as machine learning, deep learning, reinforcement learning, etc. Though the data size cannot be bluntly defined or there is no threshold, however, the data gathered from small trials/experimentation to analyse the input-output relationship should not be considered such as a trial on an external gear pump for studying its characteristics considering limited range of parameters for few trials. The appropriate data size must be selected as per the relevant data domain to yield a reliable model. For example, in the case of vibration-based condition monitoring based on numeric data, the size of data gathered depends on the sampling frequency of data acquisition and ranges from 5 kHz to 20 kHz or even more than that as per the data domain. Same for image data, the minimum number of images with appropriate resolution should be selected w.r.t data domain to yield a robust model.
- The data collected through real-time experiments is preferred however in case of no resources/facility available, data collected through simulation, survey, etc. can also be considered. The benchmark datasets made available by standard technical/academic/research/commercial/professional societies and organizations are also allowed.
- The standard instrumentation is preferred for performing experiments and data collection; however, the use of open-source hardware for building in-house low-cost data acquisition systems is also recommended.
- The choice of programming language and software depends on the data domain and the provision of the methodology used for its processing. Any standard programming language and data analytics software can be used.
- The approach mentioned above (but not limited to) should be considered while defining the problem and objectives, selecting the data domain, and deciding the methodology. The methodology can be statistical, mathematical, numerical, computational, or intelligent.

Books and Other Resources

Text Books:

1. Brunton, S. L., & Kutz, J. N. (2022). Data-driven science and engineering: Machine learning, dynamical systems, and control. Cambridge University Press.
2. Dunn, P. F., & Davis, M. P. (2017). Measurement and data analysis for engineering and science. CRC press.
3. Roy, S. S., Samui, P., Deo, R., & Ntalampiras, S. (Eds.). (2018). Big data in engineering applications (Vol. 44). Berlin/Heidelberg, Germany: Springer.
4. Middleton, J. A. (2021). Experimental Statistics and Data Analysis for Mechanical and

Aerospace Engineers. Chapman and Hall/CRC.
5. Brandt, S. (1970). Statistical and computational methods in data analysis.
6. Robinson, E. L. (2017). Data analysis for scientists and engineers. In Data Analysis for Scientists and Engineers. Princeton University Press.
7. Araghinejad, S. (2013). Data-driven modeling: using MATLAB® in water resources and environmental engineering (Vol. 67). Springer Science & Business Media.
8. Niu, G. (2017). Data-driven technology for engineering systems health management. Beijing, China: Springer.

References Books:

1. Zsolt Nagy, "Artificial Intelligence and Machine Learning Fundamentals", Packt Publishing, 2018, ISBN: 978-1-78980-165-1
2. Hastie, Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman. The elements of statistical learning: data mining, inference, and prediction. Vol. 2. New York: springer, 2009.
3. Zaki, Mohammed J., Wagner Meira Jr, and Wagner Meira. Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press, 2014.
4. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.

Assessment of Term Work

The student shall complete the above mentioned activities and prepare a Term Work in the form of Journal.

Important Note:

Term Work of the Student shall be evaluated based on the completion of experiments, group assignments and case studies. Continuous evaluation by the faculty shall be done for the award of the credit associated with the course.

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402047: Project (Stage I)					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**4 Hrs./Week**	**Practical**	**2**	**Term Work**	**50 Marks**
				Oral	**50 Marks**

Prerequisites: Project Based Learning, Internship/Mini Project, Laboratory works, Skill Development, Audit Courses, Industrial Visits

Course Objectives:

1. To provide an opportunity of designing and building complete system or subsystems based on areas where the student likes to acquire specialized skills.

2. To obtain hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills.

3. To embed the skill in a group of students to work independently on a topic/ problem/ experimentation selected by them and encourage them to think independently on their own to bring out the conclusion under the given circumstances of the curriculum period in the budget provided with the guidance of the faculty.

4. To encourage creative thinking processes to help them to get confidence by planning and carrying out the work plan of the project and to successfully complete the same, through observations, discussions and decision making process.

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **IMPLEMENT** systems approach.
CO2. **CONCEPTUALIZE** a novel idea / technique into a product.
CO3. **THINK** in terms of a multi-disciplinary environment.
CO4. **TAKE ON** the challenges of teamwork, and **DOCUMENT** all aspects of design work.
CO5. **UNDERSTAND** the management techniques of implementing a project.
CO6. **DEMONSTRATE** the final product for Functionality, Designability, and Manufacturability.

Course Contents

Project work in the seventh semester is an integral part of the Term Work. The project work shall be based on the knowledge acquired by the student during the graduation and preferably it should meet and contribute towards the needs of the society.

1. Fabrication of product/testing setup of an experimentation unit/small equipment, in a group.
2. Experimental verification of principles used in Mechanical Engineering Applications

3. Projects having valid database, algorithm, and output reports, preferably software based.
4. Study projects are strictly **not** allowed.

Project Lab

1. There has to be a **Project Lab** in the department.

a. It consists of necessary tools required to do a project.
b. Previous projects and their components.
c. Common measuring instruments.
d. Previous years' project reports.
e. Project related books and Publications.
f. Proper linkage with central workshop and various laboratories.
g. Safety measures.

2. All the project activities must be handled with a digital platform which is developed in the department according to the policies laid down by the institution. Respective authority levels to be created to maintain the transparency and confidentiality of the process. (ERP)

Books and other resources

Web References:

1. SWAYAM-NPTEL Course.
2. MOOCs' Courses.

Guidelines for Project Execution

At the end of the VIth Semester

1. A group of 3-4 students shall be formed according to their suitability.
2. Department faculty will float prospective Project Titles through Project Coordinator.
3. Department will take care of a list of titles at least two times of the groups.
4. Students will interact with guides for scope and outline of the project.
5. Maximum of two groups will be given to a guide.
6. Guide and Project groups will be finalized at the end of sixth semester so that project work can be started at the start of Seventh semester.

During the VIIth Semester

1. Project work is expected to be done in the Project Lab.
2. Projects must be executed in association with industrial experts/facilities.
3. Progress of project work is monitored regularly on weekly project slots/project day.
4. Regular interval presentations are to be arranged to review and assess the work.
5. Project work is monitored and continuous assessment is done by guide and authorities.

Term Work

- The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
- Recommended performance measure parameters may Include-Problem definition and scope of the project, Literature Survey, Appropriate Engineering approach used, Exhaustive and

Rational Requirement Analysis.

- Comprehensive Implementation - Design, modeling, documentation, Usability, Optimization considerations (Time, Resources, Costing), Thorough Testing, Project Presentation and Demonstration (ease of use and usability), Social and environment aspects.
- The term work under project submitted by students shall include work Diary;

Work Diary to be maintained by a group and countersigned by the guide (weekly). The contents of work diary shall reflect the efforts taken by project group for;

a. Searching suitable project work

b. Brief report preferably on journals/research or conference papers/books or literature surveyed to select and bring up the project.

c. Brief report of feasibility studies carried to implement the conclusion.

d. Rough Sketches/ Design Calculations

e. Synopsis

- The group should submit the synopsis in the following form.
  - i. Title of Project
  - ii. Names of Students
  - iii. Name of Guide
  - iv. Relevance
  - v. Present Theory and Practices
  - vi. Proposed work
  - vii. Expenditure
  - viii. References
- The synopsis shall be signed by each student in the group, approved by the guide (along with external guide in case of sponsored projects) and endorsed by the Head of the Department.
- Presentation: The group has to make a presentation in front of the faculty of department at the end of semester.

Examination Scheme

- During university examination Internal examiner (preferably the guide) and External examiners jointly, evaluate the project work.
- During the process of monitoring and continuous assessment & evaluation the individual and team performance is to be measured.
- The project term work shall be evaluated on the basis of reviews. In first semester two reviews are to be taken and evaluated for total 50 marks (25 marks each)
- Review 1 and 2 will be based on synopsis submission (team members, Title of the Project Work, Abstract, Problem Definition, work done earlier, Objectives of the Project, Methodology of the Project, Application / Significance of the Project, Duration of the Project, Individual Role of the Student, References, sponsored etc.)
- The final presentation shall be taken in front of external examiner and to be evaluated for 50 marks

  20 marks for presentation (Oral, Written)

  30 marks for quality of the project work

Project Report
• Stage I report shall be in the booklet form • Plagiarism check is must, and certificate shall be attached in the report
References: • References format MUST BE STANDARD – ASME, SAE or IEEE

402054: Audit Course VII					
Teaching Scheme		**Credits**	**Examination Scheme**	
		Non- Credit		

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

Faculty mentor shall be allotted for individual courses and he/she shall monitor the progress for successful accomplishment of the course. Such monitoring is necessary for ensuring that the concept of self-learning is being pursued by the students 'in true letter and spirit'

- If any of the following listed course is selected through Swayam/ NPTEL/ virtual platform, the minimum duration shall be of 8 weeks.
- However if any of the course duration is less than the desired (8 weeks) the mentor shall ensure that other activities in form of assignments, quizzes, group discussion etc. (allied with the course) for the balance duration should be undertaken.
- Students can join any online platform or can participate any online/offline workshop to complete the Audit course with prior-permission of mentor.

In addition to credits courses, it is mandatory that there should be an audit course (non-credit course) from Final year of Engineering. The student will be awarded grade as AP on successful completion of the audit course. The student may opt for any one of the audit courses in each semester. Such audit courses can help the student to get awareness of different issues which make an impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Students can choose one of the audit courses from the list of courses mentioned. Evaluation of the audit course will be done at institute level. The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not considered in the calculation of the performance indices SGPA and CGPA. Evaluation of the audit course will be done at institute level itself

List of Courses to be opted (Any one) under Audit Course
A. Yoga Practices **B.** Stress Management Note:-The title indicated above are subject to change in time to come and such an alteration (if any) should be brought to the notice of the BoS.
Using NPTEL Platform: (preferable)
NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in • Students can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course. • Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal. • After clearing the examination successfully; student will be awarded with a certificate.
Assessment of an Audit Course
• The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary • During the course students will be submitting the online assignments/report/course completion certificate etc. A copy of the same can be submitted as a part of term work for the corresponding Audit course. • On the satisfactory submission of assignments/report/course completion certificate etc., the institute can mark as "Present" and the student will be awarded the grade AP on the mark-sheet.

402048: Computer Integrated Manufacturing

Teaching Scheme		Credits		Examination Scheme	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Term Work	**25 Marks**
				Oral	**25 Marks**

Prerequisites: knowledge of earlier studied subjects like Solid Modeling and Drafting, Computer Aided Engineering, Industrial Engineering

Course Objectives:

1. **Understand and realize** need of CIM and factory automation.
2. **Learn** to integrate hardware and software elements for CIM.
3. **Generate and Integrate** CNC program for appropriate manufacturing techniques.
4. **Learn** to integrate processes planning, quality and MRP with computers.
5. **Know** about flexible, cellular manufacturing and group technology.
6. **Understand** IOT, Industry-4.0 and cloud base manufacturing.

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **EXPLAIN** CIM and factory automation.
CO2. **UNDERSTAND** the integration of hardware and software elements for CIM
CO3. **APPLY** CNC program for appropriate manufacturing techniques.
CO4. **ANALYZE** processes planning, quality and MRP integrated with computers.
CO5. **INTERPRET** flexible, cellular manufacturing and group technology.
CO6. **ANALYZE** the effect of IOT, Industry-4.0 and cloud base manufacturing.

Course Contents

Unit 1	Introduction to CIM

Need of CIM, Introduction, Evolution of CIM,CIM Hardware and software, Role of CIM System, Definition of CIM, automation and types of automation, Reasons for automation, Types of Production, Functions in Manufacturing, CIM wheel, Computerized element of CIM, Advantages of CIM

Unit 2	Data Integration

CAD-CAM Integration, Product development through CIM, Design Activities in a networked

environment, Networking in a manufacturing company, hardware elements of networking, CIM Database, Database requirements of CIM, Database management, Database Models, EDM, Product Data Management (PDM), Product life cycle Management(PLM)	
Unit 3	**Computer Aided Manufacturing (CAM)**
Introduction to Computer Aided Manufacturing (CAM), Coordinate system, working principal of CNC Lathe, Turning Centers, Milling Machine, Machining Centers. Steps in developing CNC part program, Tool and geometric compensations, CNC Lathe and Mill part programming, Canned cycles, subroutine and Do loop, CIM Integrable Machines	
Unit 4	**Computer Aided Process Planning and Quality Control**
Process Planning: Computer Aided Process Planning (CAPP), Benefits of CAPP, Logical steps in Computer Aided Process Planning, Approaches to CAPP, Material Requirement Planning, Capacity Planning, Manufacturing Resource Planning (MRP) - Input, working, outputs and benefits, Concept of dependent demand, structure of MRP system, planning & implementation issues, MRP-II & Enterprise Resource Planning (ERP), Computer Aided Production Scheduling, Control Systems: Shop Floor Control, Inventory Control, Computer Aided Inspection and Quality Control, Manufacturing Execution System(MES)	
Unit 5	**FMS & Cellular Manufacturing**
Introduction Flexible Manufacturing Systems, FMS components, Material handling and storage system, applications, benefits, computer control systems, types of FMS Layout, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture. Group Technology(GT), Part Families – Parts Classification and coding, Simple Problems in Opitz Part Coding system – Production flow Analysis, Cellular Manufacturing – Composite part concept – Machine cell design and layout, Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method, Arranging Machines in a GT cell – Hollier Method – Simple Problems	
Unit 6	**Future Smart Factories**
Industry 4.0: Functions, Applications and Benefits. Components of Industry 4.0, Introduction to Industry 5.0, Internet of Things (IoT): IoT applications in manufacturing, Big-Data and Cloud Computing for IoT, IoT for smart manufacturing, influence of IoT on predictive maintenance, Supply-Chain Optimization, Supply-Chain & logistics, Internet of Things and M_2M Communication Technologies **Digital Manufacturing w.r.t. Industry 4.0**: Industrial Automation, Cyber-Physical Manufacturing Systems, Digital Twin Driven Smart Manufacturing, Digital Manufacturing, Assembly and Automation Systems, Scheduling and Cloud Manufacturing, Knowledge Management, Digital Supply Chains, Reconfigurable Manufacturing Systems, Web based Application in Manufacturing	
Books and other resources	
Text Books: 1. Automation, Production system & Computer Integrated manufacturing, M. P. Groover Person	

India, 2007 2nd edition.

2. Principles of Computer Integrated Manufacturing, S. Kant Vajpayee, Prentice Hall India

References Books:

1. Chang, T.C. and Wysk, R.A., 1997. Computer-aided manufacturing. Prentice Hall PTR.
2. Xu, X., 2009. Integrating Advanced Computer-Aided Design, Manufacturing, and Numerical Control. Information Science Reference.
3. Weatherall, A., 2013. Computer integrated manufacturing: from fundamentals to implementation. Butterworth-Heinemann.
4. Nanua Singh, Systems Approach to Computer Integrated Design and Manufacturing, John Wiley Publications.
5. Harrington J, Computer Integrated Manufacturing Krieger Publications 1979.
6. Zeid, CAD/CAM, Tata McGraw Hill.
7. Jha, N.K. "Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.

NPTEL Link:

1. https://youtube.com/playlist?list=PLFW6lRTa1g808_CfYhZKdv2eXplAQiAwS
2. https://nptel.ac.in/courses/112104289
3. https://onlinecourses.nptel.ac.in/noc22_me10/preview
4. https://archive.nptel.ac.in/courses/112/104/112104289/
5. https://archive.nptel.ac.in/noc/courses/noc20/SEM1/noc20-me44/

Link for Virtual Lab: - http://vlabs.iitkgp.ac.in/cim/#

Guidelines for Laboratory Conduction

1. Practical/Tutorial must be conducted in FOUR batches per division only.
2. Minimum 08 numbers of Experiments/Assignments shall be completed.
3. Experiments shall be conducted following 'Case Based Methodology'
4. Open source software, simulation tools may be used wherever required.

Term Work

The student shall complete the following activity as a Term Work:

1. Modelling of Mechanical Component using any 3D CAD software, Preparing CNC part program using any CAM software, and execute it on CNC Turning.
2. Modelling of Mechanical Component using any 3D CAD software, Preparing CNC part program using any CAM software, and execute it on CNC Milling.
3. Generate Bill of Material (BOM) from Assembly and other data using CAD Software.
4. Prepare Computer Aided Process Plan for selected part using variant type of CAPP Software.
5. Use MRP (Material Resource Planning) Software for CIM and Assembly.
6. Generate Part Family Code for a machine components using OPITZ Method
7. Study FMS system from Video clip and identify various elements of FMS and its controlling by computer.
8. Modeling and Simulation of Computer Integrated Manufacturing System. (VLab IIT, Kharagpur OR comparable sources)
9. Machine vision based quality control. (VLab IIT, Kharagpur OR comparable sources)
10. Remote Monitoring and Operation of a Computer Integrated Manufacturing System. (VLab IIT, Kharagpur OR comparable sources)

402049: Energy Engineering					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Practical	**2 Hrs./Week**	**Practical**	**1**	**End-Semester**	**70 Marks**
				Term Work	**25 Marks**
				Oral	**25 Marks**

Prerequisites: Thermodynamics, Applied Thermodynamics, Heat Transfer, Turbo machines

Course Objectives:

1. To study the energy scenario, the components of thermal energy based plant, improved Rankine cycle
2. To understand details of steam condensing plant, cooling tower system, analysis of condenser, the environmental impacts and methods to reduce various pollution from energy systems
3. To study layout, component details of diesel engine power plant, hydel and nuclear energy systems
4. To understand components; layout of gas and improved power cycles
5. To learn basic principles of energy management, storage and economics of power generation
6. To study the working principle , construction of renewable energy systems

Course Outcomes:

On completion of the course the learner will be able to;

CO1: **EXPLAIN** the power generation scenario, the layout components of thermal power plant and **ANALYZE** the improved Rankine cycle.

CO2: **ANALYZE** the performance of steam condensers, cooling tower system; RECOGNIZE an environmental impact of energy systems and methods to control the same.

CO3: **EXPLAIN** the layout, component details of diesel engine plant, hydel and nuclear energy systems.

CO4: **ANALYZE** gas and improved power cycles.

CO5: **EXPLAIN** the fundamentals of renewable energy systems.

CO6: **EXPLAIN** basic principles of energy management, storage and economics of power generation.

Course Contents

Unit 1	**Energy Scenario and Thermal Energy based Power Plants**

Energy Scenario: global and Indian energy scenario, role of Government and Private organizations, energy crisis, energy security, energy policy, India’s low carbon transition.

Thermal Energy Based Plant: layout of modern thermal energy based plant with different circuits, site selection, classification of coal, coal benefication, selection of coal for thermal power plant, slurry type fuels, in-plant handling of coal, pulverized fuel handling systems, FBC systems, high pressure boilers, improved Rankine cycle: Rankine cycle with only reheating and only regeneration (Numerical Treatment) **,** energy conservation in boilers

Unit 2	Steam Condensers, Cooling Towers and Environmental Impact of Energy System

Steam condensers: need, elements of steam condensing plant, classification, Dalton’s law of partial pressure, condenser efficiency, vacuum efficiency, cooling water requirements (Numerical Treatment), air leakage and its effects on condenser performance, air pumps (Numerical Treatment for Air Pump capacity), steam condenser market.

Cooling Towers: need, classification of condenser water cooling systems, classification of cooling pond and cooling towers. environmental effects of cooling towers, next generation cooling towers

Environmental impact of energy system: different pollutants from energy plants, methods to control pollutants: types of scrubbers; ash handling system; dust collections; ESP, carbon credits and footprints, water treatment in thermal energy based plant

Unit 3	Diesel, Hydel, Nuclear Energy systems

Diesel engine power plant: general layout; different systems of DEPP, plant layout of high/medium /low capacity DEPP, performance operating characteristics based on heat rate, advantages; disadvantages; applications; methods of energy conservation

Hydel energy: basics of hydrology, hydrograph, flow duration curve, mass curve (Numerical Treatment), hydel power plant (HPP)- site selection, classification of HPP (Based on head, nature of load, water quantity), criteria for turbine selection, components of HPP- dams; spillways; surge tank and forebay, advantages and disadvantages of HPP.

Nuclear energy: nuclear fission/fusion, elements of NPP, types of nuclear reactor (PWR, BWR, CANDU, LMCR, GCR, Fast Breeder) nuclear fuels, moderators, coolants, control rod and shielding, nuclear waste disposal, nuclear power development programme of India**.**

Unit 4	Gas and Improved Power cycle

Gas turbine power plant: components, general layout of GTPP, open & closed cycle gas turbine plant, Brayton cycle analysis for thermal efficiency, work ratio, maximum & optimum pressure ratio, methods to improve thermal efficiency of GTPP: only inter-cooling; only reheating & only regeneration cycle (numerical treatment),

Improved cycle based Power Plant: gas and steam combined cycle plant, Cogeneration, introduction to tri-generation, steam power plants with process heating (Numerical Treatment), Integrated Gasification Combined Cycle (IGCC) plant, Kalina (Cheng) Cycle.

Unit 5	Energy Management, Storage and Economics of Power Generation

Energy management and storage: energy management with storage systems, energy demand estimation, energy pricing, thermal energy storage methods.

Power plant instrumentation: layout of electrical equipment, switch gear, circuit breaker, protective devices, measurement of high voltage, current and power.

Economics of power generation: cost of electrical energy, fixed and operating cost [methods to determine depreciation cost] (numerical treatment), load curves, performance and operation characteristics of power plants, load division, all terminologies related to fluctuating load plant, tariff (numerical treatment), analysis of energy bill

Unit 6	Renewable Energy Systems

Solar thermal and photovoltaic energy: solar thermal plant based on flat plate collector;
solar photovoltaic systems, applications, economics and technical feasibility.
Wind Energy: wind availability, basic components of wind mills, performance operating characteristics, wind solar hybrid power plants, Cost economics and viability of wind farm.
Geothermal Energy: typical geothermal field, superheated steam system, flash type, binary cycle plant**,** economics of geothermal energy.
Tidal Energy: components, single basin, double basin systems
Ocean Thermal Energy: working principle, Claude /Anderson /hybrid cycle
Wave Energy: dolphin type wave machines
MHD Power Generation: working principle, open/ close cycle MHD generator
Fuel cell: main components, working Principle
Biomass Energy: biomass gasifier
Hydrogen Energy: principle of hydrogen production, hydrogen storage, applications.

Books and other resources

Text Books:

1. Domkundwar & Arora, Power Plant Engineering, Dhanpat Rai & Sons, New Delhi
2. Domkundwar & Domkundwar- Solar Energy and Non Conventional Sources of Energy, Dhanpat Rai& Sons, New Delhi.
3. R.K.Rajput, Power Plant Engineering, Laxmi Publications New Delhi

References Books:

1. E.I.Wakil, Power Plant Engineering, McGraw Hill Publications New Delhi
2. P.K.Nag, Power Plant Engineering, McGraw Hill Publications New Delhi.
3. R.Yadav , Steam and Gas Turbines ,Central Publishing House, Allahabad.
4. G.D.Rai, Non-Conventional Energy Sources, Khanna Publishers, Delhi
5. S.P.Sukhatme, Solar Energy,Tata McGraw-Hill Publications, New Delhi
6. G R Nagpal, Power Plant Engineering , Khanna Publication

Web References:

1. https://nptel.ac.in/courses/112107291

2. https://nptel.ac.in/courses/112103277
3. https://nptel.ac.in/courses/103103206
4. https://nptel.ac.in/courses/115103123
5. https://cea.nic.in/?lang=en

Term Work

The student shall complete the following activity as a Term Work:

1. Trial on Steam Power Plant to determine
   a) Plant Efficiency, Rankine Efficiency Vs Load
   b) Specific Steam consumption Vs Load
   c) Rate of Energy Input Vs Load
   d) Heat Rate and Incremental heat Rate Vs Load
2. Trial on Diesel Power Plant to determine
   a) Plant Efficiency Vs Load
   b) Total fuel consumption Vs Load
   c) Rate of Energy Input Vs Load
   d) Heat Rate and Incremental heat Rate Vs Load
3. Analysis of HT/LT electricity bill and recommendations for energy saving opportunities.
4. Case study on different control systems in thermal power plant .
   (Review of control principles, Combustion control, pulveriser control, control of air flow, Furnace pressure and feed water, steam temperature control, turbine control, Safety provisions / Interlocks)
5. Design and component selection for solar photovoltaic power plant with net metering.
6. Estimation of annual energy from wind data and component selection for wind mill.
7. Case study on cogeneration in Sugar mill/Paper mill/Cement kiln.
8. Design and performance analysis of steam surface condenser for steam thermal power plant.
9. Design and performance analysis of cooling tower system for steam thermal power plant.
10. Case study on biomass gasification and analysis of properties of syngas.
11. Case study on production of bio-diesel and evaluation of its properties and its use in diesel engine based power plant.
12. Design and performance analysis of Thermal energy storage system.
13. Case study on energy management in conventional/ renewable energy power plant
14. Visit to Thermal Energy Based plant /Co-generation Power plant.
15. Visit to GTPP/Combined Cycle/renewable energy plants.

IMP Notes for Term Work:

1. Eight experiments from No.1 to 15 from above list should be conducted.
2. Experiment No, 1and 2 are compulsory.
3. Any six experiments can be performed 3 to 15.

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402050A: Quality & Reliability Engineering					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Engineering Mathematics, Probability, Statistics

Course Objectives:

1. To analyze and apply Quality & Reliability Tools to solve real-life problems.
2. To plot control charts and calculate process capability.
3. To ascertain System reliability for sustainable product design.
4. To find out FMEA and understand reliability centered Maintenance.

Course Outcomes:

On completion of the course the learner will be able to:

CO1. **UNDERSTAND** basic concepts of quality and **RELATE** various quality tools

CO2. **DEVELOP** analytical competencies to **SOLVE** problems on control charts and process capability.

CO3. **UNDERSTAND** fundamental concepts of reliability**.**

CO4. **EVALUATE** system reliability.

CO5. **IDENTIFY** various failure modes and **CREATE** fault tree diagram.

CO6. **UNDERSTAND** the concept of reliability centered maintenance and **APPLY** reliability tests methods.

Course Contents

Unit 1	**Introduction to Quality and Quality Tools**

Precision and accuracy, Quality dimensions, Statements, Cost of quality & value of quality, Deming‟s cycles & 14 Points, Juran Trilogy approach, Seven Quality Tools, Introduction to N Seven Tools, Quality Circle, 5S, Kaizen, Poka yoke, Kanban, JIT, QMS (ISO 9000, TS16949, ISO14000). Criteria for Quality Award (National & International)

Unit 2	**Statistical quality control**

Statistical quality control: Statistical concept, Frequency diagram, Concept of variance analysis, Control, Chart for Variable (X & R Chart) & Attribute (P & C Chart), Process capability (Indices: cp, cpk, ppk), Statistical Process Control and six sigma. Acceptance Sampling: Sampling Inspection, OC Curve and its characteristics, sampling methods, Sampling Plans, calculation of sample size, AOQ, Probability of acceptance

Unit 3	**Fundamental concepts of Reliability**

Reliability definitions, failure, failure density, failure Rate, hazard rate, Mean Time to Failure (MTTF),

Mean Time Between Failure (MTBF), pdf, cdf, safety and reliability, life characteristic phases, modes of failure, areas of reliability, quality and reliability assurance rules, importance of reliability, Uncertainty analysis, Probability theory and probability distributions	
Unit 4	**System Reliability & Allocation Techniques**
Series, parallel, mixed configuration, k- out of n structure, analysis of complex systems, conditional probability method, cut set and tie set method, Redundancy & Types, Reliability allocation or apportionment, reliability apportionment techniques - equal apportionment, AGREE, ARINC, reliability predictions from predicted unreliability, minimum effort method	
Unit 5	**Reliability in Design & Development**
Reliability techniques- Failure mode, effects analysis (FMEA), Failure mode, effects and criticality analysis (FMECA)-Case Studies, RPN, Basic symbols, Ishikawa diagram for failure representation, Fault Tree construction and analysis - case studies, minimal cut & tie set methods	
Unit 6	**Reliability Testing and Management**
Objectives & types of maintenance, Maintainability, factors affecting maintainability, system down time, availability - inherent, achieved and operational availability, Reliability Centered Maintenance, Stress strength interaction, Introduction to reliability testing, Testing for Reliability and Durability- Accelerated Life Testing and Highly Accelerated Life Testing (HALT)	

Books and other resources

Text Books:

1. L. S. Srinath, Reliability Engineering, EWP , 4th Edition 2011
2. E. Balgurusamy, Reliability Engineering, McGraw Hill Education 2002
3. S. S. Rao, Reliability Based Design, Mc Graw Hill Inc. 1992

References Books:

1. E. E. Lewis, Introduction to Reliability Engineering, John Wiley and Sons.
2. Alessandro Birolini, Reliability Engineering Theory and Practice, Springer.
3. B. S. Dhillon, Maintainability, Maintenance and Reliability for Engineers, CRC press.
4. K. C. Kapoor and L. R. Lubersome, Reliability in Engineering Design Willey Publication.
5. Basu S.K, Bhaduri , Terotechnology and Reliability Engineering, Asian Books Publication.

402050B: Energy Audit and Management					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30**
				End-Semester	**70**

Prerequisites: Engineering Thermodynamics, Applied Thermodynamics, Heat and Mass Transfer, HVAC, Turbomachines

Course Objectives:

1. To impart basic knowledge to the students about current energy scenarios, energy conservation, energy audit and energy management.
2. To inculcate the systematic knowledge and skill in assessing the energy efficiency, energy auditing and energy management.
3. To carry out an energy audit of Institute/Industry/Organisation

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **EXPLAIN** the energy need and role of energy management
CO2. **CARRY OUT** an energy audit of the Institute/Industry/Organization
CO3. **ASSESS** the ENCON opportunities using energy economics
CO4. **ANALYSE** the energy conservation performance of Thermal Utilities
CO5. **ANALYSE** the energy conservation performance of Electrical Utilities
CO6. **EXPLAIN** the energy performance improvement by Cogeneration and WHR method

Course Contents

Unit 1 — Energy Scenario and Management

Energy needs of a growing economy, Current and long-term energy scenario - India and World, Concept of energy conservation and energy efficiency, Energy and environment, Need of Renewable energy, Principles of Energy management, Energy policy, Energy action planning, Energy security and reliability, Energy sector reforms.

Unit 2 — Energy Audit

Need of Energy Audit, Types of energy audit, Energy audit methodology, Energy audit instruments, Analysis and recommendations of energy audit, Benchmarking, Energy audit reporting, Introduction to software and simulation for energy auditing, Current Energy Conservation Act and Electricity Act and its features.

Unit 3 — Energy Economics

Costing of Utilities (Numerical): Determination of the cost of steam, fuels, compressed air and electricity

Financial Analysis Techniques (Numerical): Simple payback, Time value of money, Net Present Value (NPV), Return on Investment (ROI), Internal Rate of Return (IRR), Risk and Sensitivity analysis, Energy performance contracts and role of ESCOs.

Unit 4	**Evaluation of Thermal Utilities**

Energy performance opportunities and assessment of Boilers and Furnaces (Numerical on direct method), Heat exchangers, Cooling towers, DG sets, Fans & blowers, Pumps, Compressors, Compressed air systems and HVAC systems. Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.

Unit 5	**Evaluation of Electrical Utilities**

Electricity billing, Electrical load management and maximum demand control, penalties, Power factor improvement and benefits, Selection and location of capacitors. Distribution and transformer losses, Harmonics.

Electrical motors: Types, Efficiency, Selection, Speed control, Energy efficient motors

Lamp types and their features, recommended illumination levels, Lighting system performance assessment and efficiency improvement (Numerical), Electricity saving techniques.

Unit 6	**Cogeneration and Waste Heat Recovery**

Cogeneration: Need, applications, advantages, classification, Introduction to Trigeneration

Waste Heat Recovery: Classification, Application, Concept of Pinch analysis, Potential of WHR in Industries, Commercial WHR devices, saving potential, CDM projects and carbon credit calculations.

Case Studies: Energy Audit of Institute/MSMEs/Organization, Guidelines for Energy Manager and Energy Auditor examination conducted by BEE.

Books and other resources

Text Books:

1. Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV.

References Books:

1. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, “Guide to Energy Management”, Seventh Edition, The Fairmont Press Inc., 2012.
2. Craig B. Smith, “Energy Management Principles”, Pergamon Press, 2015.
3. Hamies, “Energy Auditing and Conservation; Methods, Measurements, Management and Case Study”, Hemisphere Publishers, Washington, 1980.
4. Albert Thumann P.E. CEM, William J. Younger CEM, “Handbook of Energy Audit”, The Fairmont Press Inc., 7th Edition.
5. Wayne C. Turner, “Energy Management Handbook”, The Fairmont Press Inc., , Georgia.
6. Abbi Y. A., Jain Shashank, “Handbook on Energy Audit and Environment management”,

TERI, Press, New Delhi, 2006.
7. Anthony L Kohan, “Boiler Operator’s Guide”, Fourth Edition, McGraw Hill
8. Robert L. Loftness, “Energy Hand Book”, Second edition, Von Nostrand Reinhold Company
9. G. G. Rajan, “Optimizing Energy Efficiencies in Industry”, Tata McGraw Hill, 2001
10. Amlan Chakrabarti, “Energy Engineering and Management”, Prentice Hall, India 2011

Web References:

1. www.npcindia.gov.in
2. http://www.bee-india.nic.in
3. www.aipnpc.org (for entire course material along with case studies)
4. https://beeindia.gov.in/sites/default/files/EC%20Guidelines-Final.pdf

402050C: Manufacturing System and Simulation					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Understanding of manufacturing and business processes, industrial engineering principles and concepts.

Course Objective:

1. To help mechanical engineers understand broadly the functioning of manufacturing systems.
2. To describe the role of facilities and support systems.
3. To enable students understand various types of simulations used in manufacturing environment.
4. To acquaint with the methodology of manufacturing simulation using computer software and the repercussions of changes & variability therein, over time.
5. To showcase the areas of simulation applications in manufacturing and allied field.

Course Outcomes

On completion of the course the learner will be able to;

CO1. **UNDERSTAND** the concepts of manufacturing system, characteristics, type, etc.

CO2. **UNDERSTAND** the concepts of Facilities, manufacturing planning & control and Support System.

CO3. **UNDERSTAND** the concepts of manufacturing towards solving productivity related problems.

CO4. **DEVELOP** a virtual model to solve industrial engineering related issues such as capacity. utilization, line balancing.

CO5. **BUILDING** tools to view and control simulations and their results.

CO6. **PLAN** the data representation & Evaluate the results of the simulation.

Course Contents

Unit 1	**Manufacturing System**

Preamble: Industrial Revolutions, Smart manufacturing, Challenges, Digitalization, Manufacturing System, Simulation, Data Analysis & Predictive decision-making, Types and classification of production systems and their characteristics, Introduction to manufacturing systems (manual, worker-machine and automated), Components & classifications, principles of manufacturing systems

Characteristics, requirements and operation of Manufacturing Systems: Custom manufacturing system, Intermittent manufacturing system, Continuous manufacturing system, Flexible manufacturing system, Mass customization, Assembly systems: Manual assembly systems,

Automated assembly systems, Hybrid assembly systems, and Reconfigurable manufacturing systems, Laws of Manufacturing, Manufacturing Systems as a Foundations of World-Class Practices, Performance measures of manufacturing systems and approaches to enhance the performance	
Unit 2	**Facilities and Manufacturing Support System**
Overview, characteristics, principles and requirements of following facilities and manufacturing support systems: **Facilities**: Material Handling Equipment, Quality control approaches, Computer systems to control manufacturing operations, Factory and Plant Layout, Group Technology (GT) & Cellular Layout, Robotics **Manufacturing Planning**: Process Planning, Production Planning, Master Scheduling, Material requirement planning and capacity planning **Manufacturing Control**: Shop floor control, Inventory control, Quality Control and Maintenance strategies **Business Functions**: Business functions and Sequence of information processing activities.	
Unit 3	**Manufacturing Simulation: Introduction**
History of simulation, basic simulation concept, purpose, appropriateness and considerations, advantages and disadvantages of simulation, areas of application, Overview of types of simulations [Discrete event simulation (DES), System dynamics (SD), Agent-based modeling (ABM), Intelligent simulation using artificial intelligence (AI) techniques, Petri net, Monte Carlo simulation (MCS), Virtual simulation], Steps in simulation study, simulation as a decision making tool	
Unit 4	**Discrete Event Simulation: Introduction**
Problem Formulation: Formulating problem statement, Tools for Developing the Problem Statement, Orientation Process, simulation project objectives, evaluation of simulation project **System Definition**: Discrete versus Continuous, Components and Events to Model, Manufacturing System Processes and Events **Input Data Collection and Analysis**: Sources for input data, collecting input data, deterministic vs. probabilistic input data, discrete vs. continuous input data, random numbers, variables, common input data distributions, analyzing input data	
Unit 5	**Discrete Event Simulation: Model Translation, Validation and Analysis**
Simulation Program Selection: Overview of various simulation software like AutoMod, ProModel, Arena, WITNESS Horizon, Quest, SIMFACTORY, FlexSim etc. Case study on translation to showcase model box, elements, building the model, attributing the data, queuing, material handling and conveyors, etc., output data)	

Verification, and Validation: Verification of Simulation Models, Calibration and Validation of Models, Face Validity, Validation of Model Assumptions, Validating Input-Output Transformations (Using Historical Input Data, Using a Turing Test), Design of Simulation Experiments, What if analysis, Sensitivity Analysis, Predictive decision-making

Interpretation of Outputs: Measures of Performance and their estimation, Analysis of terminating and non-terminating systems

Unit 6	Discrete Event Simulation: Applications and Case Studies

Applications: Assembly line balancing (Design and balancing of assembly lines), Capacity planning (Uncertainty due to changing capacity levels, increasing the current resources, improving current operations to increase capacity), Cellular manufacturing (Comparing planning and scheduling in CM, comparing alternative cell formation), Just-in-time (Design of Kanban systems), Scheduling (rules, capacity, layout, analysis of bottlenecks, performance measurement), Production planning and inventory control (Safety stock, batch size, bottlenecks, forecasting, and scheduling rules), Resource allocation (Allocating equipment to improve process flows, raw materials to plants, resource selection), Scheduling (Throughput, reliability of delivery, job sequencing, production scheduling, minimize idle time, demand, order release), Robotics, PLCs, Material Handling Equipments (Electronic Monorail System, Power & Free Conveyors, AGVs,)

Case Studies: 1-2 detailed case studies on above applications

Books and other resources

Text Books:

1. Obi S. C., Introduction to manufacturing systems, Author House, 2013.
2. Banks J. and Carson J.S., Nelson B.L., "Discrete event system simulation", 4th Edition, Pearson., United Kingdom, 2005.
3. Christopher A. Chung, Simulation Modeling Handbook: A Practical Approach, CRC Press, 2004
4. Al-Aomar, R., Williams, E. J., & Ulgen, O. M. (2015). Process simulation using witness. John Wiley & Sons.

References Books:

1. Peiter Mosterman, Discrete-Event Modeling and Simulation: A Practitioner's Approach, Taylor & Francis Group, 2009
2. David Elizandro and Hamdy Taha , Performance Evaluation of Industrial Systems: Discrete Event Simulation in Using Excel/VBA, Second Edition, CRC Press, 2012
3. Evon M. O. Abu-Taieh, Asim Abdel Rahman El Sheikh, Handbook of Research on Discrete Event Simulation Environments: Technologies and Applications, Information science reference, 2010
4. Steffen Bangsow (Ed.), Use Cases of Discrete Event Simulation: Appliance and Research, Springer 2012
5. Byoung Kyu Choi, Donghun Kang, Modeling And Simulation Of Discrete-Event, Systems, John Wiley & Sons, Inc, 2013

6. Ernst G. Ulrich, Vishwani D. Agrawal, Jack H. Arabian, Concurrent And Comparative Discrete Event Simulation, Springer Science+Business Media, 1992
7. Lawrence Leemis, Steve Park, Discrete-Event Simulation: A First Course, Prantice Hall, 2004
8. Theodore T. Allen, Introduction to Discrete Event Simulation and Agent-based Modeling, Springer.

Web References:

1. https://archive.nptel.ac.in/courses/110/106/110106044/
2. https://archive.nptel.ac.in/courses/112/107/112107220/
3. https://www.youtube.com/user/WitnessSimulation/videos
4. https://vimeo.com/lanner
5. https://www.lanner.com/en-gb/insights/customer-stories/
6. https://onlinecourses.nptel.ac.in/noc19_me45/preview

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402050D: Engineering Economics and Financial Management

Teaching Scheme		Credits		Examination Scheme	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
Tutorial		**Tutorial**		**End-Semester**	**70 Marks**

Prerequisites: Understanding of economics & Finance in organizational functions and zeal to learn the subject

Course Objectives:

1. To introduce the concepts of economics & finance in industry.
2. To understand cost analysis and pricing
3. To acquire knowledge on basic financial management aspects and develop the skills to analyze financial statements
4. To understand the budgetary process and control.
5. To understand the international business process and associated financial facets
6. To introduce the entrepreneurial financial aspects.

Course Outcomes

On completion of the course, students will be able to -

CO1. **UNDERSTAND** the business environment, concepts of economics and demand-supply scenario.

CO2. **APPLY** the concepts of costing and pricing to evaluate the pricing of mechanical components.

CO3. **UNDERSTAND** accounting systems and analyze financial statements using ratio analysis

CO4. **SELECT** and **PREPARE** the appropriate type of budget and understand the controlling aspects of budget.

CO5. **UNDERSTAND** the international business and trade system functioning

CO6. **DEMONSTRATE** understanding of financing decisions of new ventures and performance

Course Contents

Unit 1	Introduction to Business and Economics

Business: Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance

Economics: Significance of Economics, Micro and Macro Economic Concepts, Various terms and

<table>
<tr><td colspan="2">Concepts, Importance of National Income, Inflation, Money Supply in Inflation, Factors of Production, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics

Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition

Demand and Supply: Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting. Determinants of Supply, Supply Function & Law of Supply. Utility and Laws of returns</td></tr>
<tr><td>Unit 2</td><td>Costs and Cost Accounting</td></tr>
<tr><td colspan="2">Costs: Standard cost, estimated cost, First cost, Fixed cost, Variable cost, Incremental cost, Differential cost, Sunk and marginal cost, Cost curves, Breakeven point and breakeven chart, Limitations of breakeven chart, Interpretation of breakeven chart, margin of safety, Angle of incidence and multi product break even analysis, Cost Output Decision and Estimation of Cost, Zero Based Costing and numerical

Cost Accounting: Objectives of cost accounting, elements of cost: material cost, labor cost, and expenses, allocation of overheads by different methods, Costing based on direct and indirect costs, Overheads apportionment and absorption, Different Models of Depreciation. Numerical on costing

Pricing: Contribution, P/V-ratio, profit-volume ratio or relationship, Types of Pricing, Pricing policies, Pricing methods, Product Life Cycle based Pricing, Price fixation, depreciation and methods of calculating depreciation</td></tr>
<tr><td>Unit 3</td><td>Financial Accounting</td></tr>
<tr><td colspan="2">Accounting, Cost accounting & Management accounting, Various types of business entities, Accounting principles, postulates & meaning of accounting standards, Accounting cycle, Capital and revenue, Revenue, Expenses, Gains & Losses, Types of accounts & their rules, Journal Entries Create ledger, Preparation of Trial Balance, Finalizations, Preparation of Trading & Profit & Loss account, Understanding of Assets & Liabilities

Balance sheet and related concepts - Profit & Loss Statement and related concepts, Financial Ratio Analysis, Cash flow analysis, Funds flow analysis, Comparative financial statements, Analysis & Interpretation of financial statements, Concept of Ratio Analysis, Preparation of Balance sheet (numerical)

Investments: Risks and return evaluation of investment decision, Average rate of return, Payback Period, Net Present Value, Internal rate of return</td></tr>
<tr><td>Unit 4</td><td>Budget and Budgetary Control</td></tr>
<tr><td colspan="2">Budgeting and Budgetary Control: Concept of budget, Types and classification of budgets,</td></tr>
</table>

Advantages and limitations, Methods of budgeting **Budgetary Control:** objectives, merits and limitations, Budget administration. Functional budgets. Fixed and flexible budgets, Installation of Budgetary Control System, Zero base budgeting, Taxes and Financial Planning, Impact of Taxation and Inflation on Financial Management	
Unit 5	**International Business and Finance**
Concept of globalization, factors influencing globalization, concept of international business and motives, international trade, institutional framework in international business, the significance of foreign trade policy, export-import procedures Definition and function of money, Qualities of a good money, classification of money, value of money, index numbers, appreciation and depreciation of money, Gresham's Law and its limitations, Theory of exchange, barter, stock exchange, Speculation Taxation and Insurance Balance of Trade and Balance of Payments, Barriers to Trade, Benefits of Trade/Comparative Advantage, Foreign Currency Markets/Exchange Rates, Monetary, Fiscal and Exchange rate policies, Economic Development	
Unit 6	**Entrepreneurial Finance**
Sources of Funds for Entrepreneurs and Start Ups: Entrepreneurial Finance Vs. Corporate Finance; Traditional Sources of Funds, Early-Stage Sources of Funds- Incubators, Accelerators, Crowd Funding, Business Angels, Mezzanine Funds, Venture Capitals, Private Equity, LBO, Funding Process - Deal Sourcing, Deal Negotiation, Deal Agreement, Term Sheet **Investment Decisions for Start Ups:** Time Value of Money, Types of Investment Decisions, Capital Budgeting Process - Investment Evaluation, Risk Analysis in Capital Budgeting - Risk Adjusted Discount Rate, Certainty Equivalent, Decision Tree, Sensitivity Analysis, Scenario Analysis **Valuation and Measurement of Financial Performance**: Pre Money and Post Money Valuation, Factors Influencing Valuation, Valuation Methods, Dilution and Valuation of Equity, Metrics used for Performance Evaluation, Harvesting-Exit Strategies	
Books and other resources	
Text Books: 1. Hay, Donald A. and Derek J. Morris. Industrial Economics and Organization: Theory and Evidence, 2nd Edition (Oxford: Oxford University Press), 1991. 2. Lall, Sanjaya. Competitiveness, Technology and Skills (Cheltenham: Edward Elgar), 2001. 4. Scherer, F. M. and D. Ross. Industrial Market Structure and Economic Performance, 3rd Edition (Houghton: Mifflin), 1990. 3. Financial Accounting", Dr. Kaustubh Sontakke [Himalaya Publishing House] 4. Chandra, Prasanna (2004). Financial Management: Theory and Practice. New Delhi: TATA McGraw Hill	
References Books: 1. Accounting Theory & Practice Prof Jawahar Lal [Himalaya Publishing House]	

2. Brearley, Richard A. and Myers, Stewart C. (1988). “Principles of Corporate Finance”, New Delhi: McGraw-Hil
3. Engineering Economics, Tara Chand, Nem Chand and Brothers, Roorkee
4. Engineering Economy, Thuesen, G. J. and Fabrycky, W. J., Prentice Hall of India Pvt. Ltd.
5. Mechanical Estimating and Costing, T. R. Banga and S. C. Sharma, Khanna Publishers, Delhi
6. Industrial Organization and Engineering Economics, T. R. Banga and S. C. Sharma, Khanna Publishers, New Delhi
7. Mechanical Estimating and Costing, D. Kannappan et al., Tata McGraw Hill Publishing Company Ltd., New Delhi
8. A Text Book of Mechanical Estimating and Costing, O. P. Khanna, Dhanpat Rai Publications Pvt. Ltd., New Delhi
9. Industrial Engineering and Management, O. P. Khanna, Dhanpat Rai and Sons, New Delhi
10. Financial Management, I. M. Pandey, Vikas Publishing House Pvt. Ltd., New Delhi
11. Engineering Economics, James L. Riggs, David D. Bedworth and Sabah U. Randhawa, Tata McGrawHill Publishing Co. Ltd., New Delhi
12. Engineering Economy, Paul DeGarmo, Macmillan International Inc., New York
13. Entrepreneurial Finance-The Art and Science of Growing Ventures, Edited by Alemany L. and Andreoli, J.J, 2018, Cambridge University Press.
14. Rogers, S and Makonnen, R, Entrepreneurial Finance: Finance and Business Strategies for the Serious Entrepreneur, 4th Ed., Mc Graw Hill Education, 2020

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_ma44/
2. https://onlinecourses.nptel.ac.in/noc22_hs72/
3. https://onlinecourses.nptel.ac.in/noc22_mg63/
4. https://onlinecourses.nptel.ac.in/noc22_mg108/
5. https://onlinecourses.nptel.ac.in/noc22_hs113/
6. https://onlinecourses.nptel.ac.in/noc22_ma44/

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402050E: Organizational Informatics					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Understanding of design, manufacturing and business processes, industrial engineering principles and concepts and information technology. Manual processes of data / information generation, handling and interpretation / usage.

Course Objectives:

1. To provide a comprehensive grounding in many facets of Organizational Information systems.
2. To describe the role of information technology at various levels of organization.
3. To introduce integrated and co-ordinate network of components required for information system.
4. To enable students understand the Product Data Management (PDM) and Product Lifecycle Management (PLM) spanning product development and beyond.
5. To acquaint with information needs and ERP for manufacturing activities.
6. To introduce manufacturing execution system.
7. To describe the information requirements for successful integration of business activities.

Course Outcomes

Learner will be able to:

CO1. Demonstrate an understanding of the scope, purpose and value of information systems in an organization.

CO2. Understand the constituents of the information system.

CO3. Demonstrate the Understanding of the management of product data and features of various PLM aspects.

CO4. Relate the basic concepts of manufacturing system and the ERP functionalities in context of information usage.

CO5. Understand the manufacturing execution system and it's applications in functional areas.

CO6. Outline the role of the information system in various types of business and allied emerging technologies.

Course Contents

Unit 1	Information Systems in the Enterprise

Types of information: operational, tactical, strategic and statutory, Pyramid Diagram, management structure, requirements of information at different levels of management and various functions, Information Quality

The Need for Information Systems: Digital Convergence and the changing Business Environment,

Information and Knowledge Economy, Contemporary Approach to IS and Management Challenges, Information requirements for Industry 5.0 **Information Systems in the Enterprise**: Types of Information Systems in the Organization-Transaction Processing System (TPS), Decision Support System (DSS), Management Information System (MIS) and Executive Support System (ESS). Functional Perspective of IS; Enterprise Systems; Strategic uses of Information Systems; Economic, Organizational and Behavioral Impacts; IT Impact on Decision Making; Leveraging Technology in the Value Chain; MIS and Core Competencies; Strategic Information Systems (SIS)	
Unit 2	**Components of Information System**
Introduction to technical and non-technical components of Information System Hardware, Software and IT Infrastructure: Evolution of IT Infrastructure; Digital Storage; IT Infrastructure Components; Current Trends in Hardware Platforms; Enterprise Software; Groupware **Databases and Data Warehouses**: Traditional vs Database approach; Database Models, Introduction to Relational Model, and Object Oriented Model; Relational Operations SQL, Data Modelling; Databases on the Web, Data Warehousing, Advances in Database Technology, Network fundamentals, LAN hardware, Ethernet LANs, Token Ring LAN	
Unit 3	**Product Data and Product Lifecycle Management System**
Product Data Management: Product Data, Product Data Management, Basic Functions of a PDM System, Product Data issues - Access, applications, Archiving, Availability, Change, and Confidentiality. Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow **Product Life-cycle Management system**: system architecture, Information models and product structure, Information model, the product information data model, the product model, functioning of the system. Reasons for the deployment of PLM systems. Introduction, modules and features of various PLM software like Arena, TeamCenter, Windchill, Oracle, SAP, Aras etc.	
Unit 4	**Manufacturing Information System**
The Evolution from MRP to MRP II to ERP, ERP: Principle, ERP framework, Business Blue Print, Business Engineering V/S Business Process Reengineering (BPR), Introduction to various ERP software like SAP, People soft, Baan and Oracle, Comparison, ERP Modules, their Features and applications, Customization and ERP Implementation, Manufacturing Information Systems in lean manufacturing and industry 5.0 environments, Manufacturing Database Integration.	
Unit 5	**Manufacturing Execution System**
Concept, functional hierarchy model, generic activity model of manufacturing operations management, various modules like detailed production scheduling, product definition management and production execution management, Historians, diverse reporting and tracking & tracing, plant dashboard, workflow management, interfaces, integration with ERP, and Plant modules, Advantages	

per Functional Area, MES implementation	
Unit 6	**Business Information System**
Electronic Commerce and the Digital Organization: Cross functional Enterprise Information System, Internet based Business Models. B2B, EDI and B2C Models; Role of Intranets/Extranet, Web Enabled Business Management, Strategic Enterprise Systems - Information requirement and systems for SCM, CRM, SRM **Emerging Technologies in IS**: Cloud Computing, Artificial intelligence systems; Knowledge based expert system (KBES), Knowledge Management System **Management of Information System**: Implementation Processes, Maintenance, Evaluation and Security of Information System, Protection of Information System	

Books and other resources

Text Books:

1. Kenneth C. Laudon & Jane P. Laudon. "Management Information Systems". Pearson Publishing
2. W. S. Jawadekar, Management Information Systems, Tata McGraw Hill, 2002
3. Robert Schultheis and Mary Summer, Management Information Systems –The Managers View, TataMcGraw Hill, 2008.
4. Goyal D.P., Management Information Systems –A Managers Perspective, Macmillan Publishers.
5. David L Olson: Managerial Issues of Enterprise Resource Planning Systems, McGraw Hill, International Edition-2009.
6. Rainer, Turban, Potter: Introduction to Information Systems, WILEY-India, 2009.
7. Vaman, ERP in Practice, TMH, 2009
8. Sartori, L.G., "Manufacturing Information Systems", Addison-Wesley Publishing Company
9. Date, C.J.,"An Introduction to Database Systems" Addison Wesley", 8th Edn,. 2003
10. Orlicky, G., "Material Requirements Planning", McGraw-Hill, 1994.
11. Kerr, R., "Knowledge based Manufacturing Management", Addison-Wesley
12. Franjo, C., "Manufacturing Information & Data Systems Analysis, Design & Practice", Butterworth-Heinemann, 2002.
13. Weiming S, "Information Technology for Balanced Manufacturing Systems", Springer, 2006.

References Books:

1. Gupta Uma G., Management Information Systems –A Managers Perspective, Galgotia Publications.
2. Gordon Davis, Management Information System: Conceptual Foundations, Structure and Development, Tata McGraw Hill, 2000.
3. Haag, Cummings and Mc Cubbrey, Management Information Systems for the Information Age, McGraw Hill, 2005.
4. Turban, McLean and Wetherbe, Information Technology for Management –Transforming Organizations in the Digital Economy, John Wiley, 2007.

5. Raymond McLeod and Jr. George P. Schell, Management Information Systems, Pearson Education, 2007.
6. James O Brien, Management Information Systems – Managing Information Technology in the Ebusiness enterprise, Tata McGraw Hill, 2002.
7. Avgerou, C., Ciborro, C., & Land, F. (2004). The social study of information and communication technology: Innovation, actors, and contexts. London: Oxford University Press.
8. Kallinikos, J. (2011). Governing through technology: Information artefacts and social practice. New York: Palgrave Macmillan.
9. Luff, P., Hindamarsh, J., & Heath, C. (2000). Workplace studies: Recovering work practice and informing system design. London: Cambridge University Press.
10. Alex Leon and Mathew Leon: "Data Base Management Systems", Vikas Publishing House, New Delhi.
11. Mahadeo Jaiswal, Monika Mital: "Management Information System", Oxford University Press, New Delhi, 2008.
12. Murthy C.S.V.: "Management Information System", Himalaya Publications, New Delhi, 2008.
13. Panneerselvam R.: "Database Management System", PHI Private Limited, New Delhi, 2008.
14. Philip J, Pratt, Joseph J. Adamski: "Database Management Systems", Cengage Learning, New Delhi, 2009.
15. Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006.
16. Antti Saaksvuori, Anselmi Immonen, Product Life Cycle Management - Springer, 1st Edition
17. Stark, John. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer-Verlag, 2004
18. Alexis Leon: ERP (Demystified), 5/E, Tata McGraw-Hill, 2009.
19. C. S. V. Murthy: Management Information System, Himalaya, 2009
20. James A. Obrein: Management Information Systems, TMH, 2009

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1. https://onlinecourses.nptel.ac.in/noc20_mg60/preview
2. https://nptel.ac.in/courses/106105195
3. https://nptel.ac.in/courses/110105148
4. https://onlinecourses.nptel.ac.in/noc19_mg54/preview
5. https://nptel.ac.in/courses/110106146
6. https://www.youtube.com/watch?v=NzyhYxUCjlg

402050F: Computational Multi Body Dynamics					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Mathematics, Physics, Systems in Mechanical Engineering, Solid Modeling and Drafting, Kinematics of Machinery, Numerical & Statistical Methods, Computer Aided Engineering, Design of Transmission Systems, Dynamics of Machinery

Course Objectives:

1. Study basic terminology and concepts used in Multibody Dynamics
2. Understand the types of joints, its kinematics and relevant transformations
3. Understand the formulation methods and Formulate problems using Principals of Dynamics
4. Analyze the kinematics and dynamics of rigid Planar inter-connected bodies
5. Analyze the kinematics of rigid spatial inter-connected bodies
6. Analyze the kinematics and dynamics of rigid spatial inter-connected bodies and Recognize the applications of Multibody Dynamics with applications to machine and structural dynamics

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **APPLY** the basic terminology and concepts used in Multibody Dynamics to solve varieties of motion related applications

CO2. **IDENTIFY and EVALUATE** the types of joints, its kinematics and relevant transformations

CO3. **DISTINGUISH and COMPARE** the formulation methods

CO4. **DERIVE** equations of motion and **EVALUATE** the kinematics and dynamics of rigid Planar inter-connected bodies

CO5. **DERIVE** equations of motion and **EVALUATE** the kinematics of rigid Spatial inter-connected bodies

CO6. **APPLY** MBD tool effectively and **SIMULATE** it to solve and validate practical Multibody Dynamics problems and its solutions

Course Contents

Unit 1	**Introduction to Computational Multi Body Dynamics**

Introduction: Single Body Dynamics Vs Multi Body Dynamics, Machine-Design Approach Vs Control-System Approach, Basic Building Blocks (Bodies, Constraints or Joints, Forces, Motions, Sensors, Controllers, Reference Frames, Contacts, etc.)

Kinematics: Angular velocity, matrix representation of angular velocity, simple angular velocity, Differentiation in two reference frames, angular acceleration, velocity and acceleration equations, two points fixed on a rigid body, point moving on a rigid body	
Unit 2	**Joints and Kinematics**
Types of joints (planar and spatial joints), Vector formulation of Constraint equations, Jacobian, Computation of Kinematics, Transformations (body-fixed and space-fixed rotations), Velocity Transformations	
Unit 3	**Basic Principles of Dynamics**
D'Alembert's Principle, Equilibrium and Virtual work, Virtual displacements, generalized forces, workless constraints, Lagrange's equation, Non-holonomic constraints, Lagrange's form of D'Alembert's principle - Jourdain - Kane Method, Generalized Inertia, Mass matrix **Newton-Euler Equations**: Constraint equations, augmented formulation, Lagrange multipliers, embedding technique and amalgamated formulation **Principle of virtual work and Lagrange's Equation**: Kinetic energy, potential energy function, generalized forces on a rigid body, derivation of equations of motion using Lagrange's method	
Unit 4	**Planar Multi Body Dynamics Motion Simulation**
Planar Kinematic Analysis: Joint constraints (Revolute, prismatic, gear and cam pairs, etc), Motion/Force Constraints, The automatic assembly of the systems of equations for position, velocity and acceleration analysis, Iterative solution of systems of non-linear equations, **Dynamics of Planar Systems:** Dynamics of Planar systems, Geometry of masses, computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element, Simple applications of Forward and Inverse Dynamic Analysis	
Unit 5	**Kinematic Analysis of Spatial Systems**
Kinematics of Rigid bodies in Space: Reference frames for the location of a body in space, Euler angles and Euler parameters. Screw motion in space, Velocity, Acceleration and Angular Velocity, Relationship between the Angular Velocity Vector and the time derivatives of Euler parameters, Articulated Rigid Body Dynamics **Dynamic Analysis of Spatial Systems:** Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, spherical, screw, etc). Equations of motion of constrained spatial systems	
Unit 6	**Spatial Multi Body Dynamics Motion Simulation and its Applications**
Computation of spatial generalized forces for external forces. Computation of reaction forces from Lagrange's multipliers, Recursive Inverse Dynamics Survey of Existing Kinematic and Multibody dynamics Simulation software, Varieties of Applications	

Books and other resources
Text Books: 1. Nikravesh, P.E., (2019), "Planar multibody dynamics: formulation, programming with MATLAB®, and applications," CRC Press, ISBN: 9781138096127 2. Shabana, A.A., (2020), "Dynamics of Multobody Systems," Cambridge University Press, ISBN: 9781108485647 3. Rao, J.S., (2011), "Kinematics of Machinery Through HyperWorks," Springer, ISBN: 9789400711556 4. Haug, E.J., (1988), "Computer-Aided Kinematics and Dynamics of Mechanical Systems, Volume-I, Basic Methods," Prentice Hall, ISBN: 9780205116690 5. Haug, E.J., (2021), "Computer-Aided Kinematics and Dynamics of Mechanical Systems, Volume-II, Modern Methods," www.researchgate.net
References Books: 1. Wittenburg, J., (2012), "Dynamics of Systems of Rigid Bodies," Vieweg+Teubner Verlag, ISBN: 9783322909435 2. Roberson, R.E., Schwertassek, R., (2012), "Dynamics of Multibody Systems," Springer, ISBN: 9783642864667 3. Huston, R.L., (1990), "Multibody Dynamics," Butterworth-Heinemann, ISBN: 9780409900415 4. Schielen, W., (1990), "Multibody Systems Handbook," Springer, ISBN: 9783540519461 5. Rampalli, R., Ferrarotti, G. and Hoffmann, M., (2012), "Why Do Multi-Body System Simulation?," NAFEMS, ISBN: 9781874376545 6. Greenwood, D.T., (1987), "Principles of Dynamics," Pearson, ISBN: 9780137099818 7. Moon, F. C., (2008), "Applied Dynamics with Applications to Multibody and Mechatronic Systems," Wiley-VCH, ISBN: 9783527407514 8. Kane, T.R, Levinson, D.A., (1985), "Dynamics: Theory and Applications," McGraw-Hill, ISBN: 9780070378469 9. de Jalon, J.C., Bayo, E., (2011), "Kinematic and Dynamic Simulation of Multibody Systems," Springer, ISBN: 9781461276012 10.Jazar, R. N., (2011), "Advanced Dynamics: Rigid Body, Multibody, and Aerospace Applications," John Wiley & Sons, ISBN: 9780470398357 11.Nandihal, P., Mohan, A., and Saha, S.K., (2021), "Dynamics of Rigid-Flexible Robots and Multibody Systems," Springer, ISBN: 9789811627972 12.Shah, S., Saha, S.K., and Dutt, J.K., (2012), Dynamics of Tree-type Robotic Systems, Springer, ISBN: 9789400750050
Web References: • https://www.youtube.com/channel/UCN3-GeDjFM4A3muyhsS9mpQ

402051A: Process Equipment Design					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Design of Machine Elements

Course Objectives:

1. Understand the process flow diagrams (PFD) and design codes
2. Understand the content of piping and instrument diagrams (P&ID)
3. Understand the design of Cylindrical and Spherical Vessels and Thick Walled High Pressure Vessels
4. To enable students to apply the requirements of the relevant industry standards to the mechanical design of equipment's used in the process industry and above ground atmospheric storage

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **INTERPRET** the different parameters involved in design of process Equipments.
CO2. **ANALYZE** thin and thick walled cylinder
CO3. **DESIGN** cylindrical vessel, spherical vessel, tall vessels and thick walled high pressure vessels
CO4. **DESIGN** different process Equipments and select pump, compressor etc. and auxiliary services
CO5. **EVALUATE** Process parameters and their correlation
CO6. **APPLY** the concepts of process equipment design for specific applications

Course Contents

Unit 1	**Process Design**

Basic concepts in process design, block diagrams for flow of processes, material flow balance. Design pressures -–temperatures, design stresses, factory of safety, minimum shell thickness and corrosion allowance, weld joints efficiency, design loading, stress concentration and thermal stresses, failure criteria, optimization technique such as Lagrange's multiplier and golden section method, cost and profitability estimation. Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA.API-650, BS-1500 & 1515

Unit 2	**Piping design**

Process Piping Design: Thin and thick walled cylinder analysis, pre stressing, Piping codes for design, construction and inspection, Piping flow diagrams and pipe work symbols, design of layout of water, steam and compressed air pipes work, Types of couplings

Unit 3	**Thin and Thick Vessels**

Design of Cylindrical and Spherical Vessels: Types and classes of vessels, types design of end closers, local stresses due to discontinuity or change of shape of vessel, vessel opening compensation, design of standard and non-standard flanges, design of vessels and pipes under external pressure, design of supports for process vessels

Design of Tall Vessels: Determination of equivalent stress under combined loadings including seismic and wind loads application of it to vertical equipment like distillation column

Design of Thick Walled High Pressure Vessels: Thick walled cylinder analysis, pre stressing of thick cylinders, Design by various theories of failure, construction of these vessels with high strength steel and other special methods.

Unit 4	**Process Equipment Design**

Process Equipment Design: Storage vessels, reaction vessels, agitation and mixers, heat exchangers, filters and driers, centrifuges. Code practices, selection and specification procedures used in design. Selection of pumps, compressors, electrical equipment's and auxiliary services, safety, etc., pipe fitting, linings and flanged connections. Types of valves used on pipe line. Fabrication of pipe lines, expansion joints and pipe supports

Unit 5	**Process Control**

Process Control: Processes, Process parameters and their correlations, Fundamentals of process measurements and control modern control devices and other controls of major unit operation and processes.

Unit 6	**Execution and Application of specific process Equipment Design**

Execution: Planning, manufacture, inspection and erection of process equipment like pressure vessels, chimneys, ducting, heat exchangers, pulverizing equipment, etc. protective coatings, lining of Vessels

Application of specific process Equipment Design: Fuel pumping stations, fire extinguishers, HVAC, fume extraction systems with IOT and AI

Books and other resources

Text Books:

1. Process Equipment Design : By Dr. M.V. Joshi, Mc-Millan.
2. Process Equipment Design : By Browell and Young, John Wiley.
3. Plant Design and Economics : Max and TimasulausKalus – McGraw Hill.
4. Industrial Instrumentation servicing Hand Book : Cannel Grady, McGraw Hill.

References Books:

1. Handbook of Instrumentation and Control : Kellen Heward, McGraw Hill
2. Chemical Engineering Handbook: Perry John, McGraw Hill.
3. Chemical Equipment Design: B.C. Bhattacharya.
4. Industrial Pipe Work: D.N.W. Kentish, McGraw Hill.
5. Chemical Engineering: J.M. Coulson, Richardson, Sinnott Vol. VII, Maxwell, McMillan.
6. Pressure Vessel Design Hand Book: H. Bedna.
7. Dryden’s outlines of Chemical Technology for the 2: By Roa M. Gopala, Sitting M., East West Press Pvt. Ltd., New Delhi.
8. Applied Process Design for Chemical and Petrochemical, Vol. I, II and III: By E.E. Ludwig, Gulf Publication Co., Houston.
9. Chemical Process Control: An Introduction to Theory and Practice: By Stephanopoulos G., Prentice Hall of India, New Delhi.
10. Chemical Process Equipment Selection and Design: By Stanley M.Walas, Butterworth-Heinemann Series in Chemical Engineering.
11. Process System Analysis and Control: By D.R. Coughanowr, McGraw Hill, New York.
12. Engineering Optimization: Theory and Practice: By Rao S.S., New Age Publishing Co., New Delhi.
13. Optimization of Chemical Processes: By Edgar T.F., Himmelblau D.M., McGraw Hill Book Co., New York.
14. Control Devices, Vol. I and II : Liptak
15. Analysis, synthesis and design of Chemical Processes : Richard Turton, Richard C. Bailie, Wallace B. Whiting, Josheph A. Shaewitz, Prentice Hall Int. Series in Physical and Chemical Science.

Savitribai Phule Pune University

Board of Studies - Mechanical and Automobile Engineering

Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402051B: Renewable Energy Technologies					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30**
				End-Semester	**70**

Prerequisites: Systems in mechanical engineering, Applied Thermodynamics, Fluid mechanics, Heat transfer and Energy Engineering

Course Objectives:

1. To understand fundamentals, needs and scopes of renewable energy technologies.
2. To design and applications of solar thermal conversion systems.
3. To explain constructions, working and design of solar photovoltaic system used for domestic applications.
4. To design a wind energy system.
5. To study Wind farm and Solar Photovoltaic grid-connected Systems.
6. To describe biomass energy conversion systems.

Course Outcomes:

On completion of the course the learner will be able to;

1. **DESCRIBE** fundaments, needs and scopes of renewable energy systems.
2. **EXPLAIN** performance aspects of flat and concentric solar collectors along with applications.
3. **DESIGN** solar photovoltaic system for residential applications.
4. **DESIGN AND ANALYSIS** of wind energy conversion system.
5. **APPLY** Installation practices of Wind and Solar Photovoltaic Systems for grid connection.
6. **DETERMINE** performance parameters of bio-energy conversion systems.

Course Content

Unit 1	**Introduction to Renewable Energy Technologies**

Scenario of Renewable Energy Generation: Energy (and power) policies in the country, Energy supply and renewable energy programme during different plan periods. Renewable energy use and target in India, JNNSM policies and initiatives

Solar Energy Fundamentals: Solar Radiation and Measurement, Solar constant, Solar angles, day length, angle of incidence on tilted surface, Extra-terrestrial characteristic, Effect of earth atmosphere, Measurement and estimation on horizontal and tilted surfaces (numerical treatment on Solar angles and Measurements), Analysis of Indian solar radiation data and applications, Basics of solar cell, Forming the PN junction solar cells, Photo conversion efficiency, Theoretical limits

Wind Energy Fundamentals: Wind speed, Wind direction, Data measurement and analysis, Variation of wind speed with height and time, Wind potential assessment (numerical treatment), and

wind resources worldwide and in India, wind energy forecast	
Unit 2	**Solar Thermal Systems and Applications**
Solar thermal collectors: Flat plate collectors, Thermal analysis, Heat capacity effect, Testing methods, Evacuated tube collectors (ETC) analysis, its design and application, Numerical on flat plate collectors. **Solar Concentrating Collectors:** types- line and point concentrator, tracking systems, theory of Concentrating collectors, parabolic trough collector, parabolic dish collector, Central receiver systems, concentrated Fresnel linear receiver (CFLR). **Solar thermal Applications:** Solar energy thermal storage, heating and cooling of buildings, solar pumping, solar cooker, solar still, solar drier, solar refrigeration and air conditioning, solar pond, heliostat, solar furnaces, Solar thermal power generation.	
Unit 3	**Solar Photovoltaic Systems**
Solar Cells and Modules: Classification of Solar cells, First generation: Single crystalline, Poly crystalline, Second Generation: Thin film, Cd-Te, CIGS, Third Generation: Polymer based, DSSC, Perovskites, Hybrid, Quantum Dots, Multi Junction Tandem cells, Inorganic and Hybrid cells, Different losses and mitigation, Factors Affecting Electricity Generated by a Solar cell, types of modules, PV panel and array, solar cell equation, Fill factor and maximum power, Shading and hot-spot formation. **Power Conditioning Equipment**: Inverters, Regulators, Other Devices, System Analysis-Design Procedure, Design Constraints, selection of components, calculation of life cycle costing, payback time and Levelized Energy Cost (LEC) (Numerical treatment on- Designing solar PV system to find power consumption, Size the PV panel, Inverter and battery size, Solar charge controller size and costing for domestic applications only) Recent PV market trends, Benchmark cost of different PV components	
Unit 4	**Wind Energy Systems**
Components of wind turbines, Types of wind turbines- Horizontal axis and Vertical axis **Aerodynamics of wind turbines**: Aerofoil sections and lift and drag coefficients, relative wind velocity, Power extraction from the wind energy, Wind power generation curve, Maximum power and Betz coefficient, Power Coefficient of a wind turbine (C_p), Axial thrust and torque developed by the turbine, Design tip speed ratio and solidity **Design parameters:** Rotor axis rotation: Horizontal or Vertical, Rotor position - upwind and downwind of tower, Rotor Speed - constant or variable, Type of hub: rigid, teetering, hinged blades or gimballed, Number of blades, Tower Structure, Materials used for wind turbine components, calculation of life cycle costing, payback time and Levelized Energy Cost (LEC). Performance	

evaluation of Wind energy system. Note: Numerical on aerodynamics, design parameters and payback estimation.	
Unit 5	**Design of grid connected Wind and Solar Photovoltaic Systems**
Wind Farm: Off-shore and on-shore wind farms, Small wind turbines special considerations and designs, testing, noise issues, Site selection and turbine spacing, rotor selection, ICT based monitoring and control of wind farms, Annual Energy Output (AEO) with numerical treatment, optimal placement of wind turbine in a wind farm, Wind power farm: installation operation and maintenance **Design of Wind Energy Conversion Systems:** Power control**:** stall, variable pitch, controllable aerodynamic surfaces and yaw control. Yaw Control: driven yaw, free yaw or fixed yaw **Design of Solar PV systems**: Site selection for solar photovoltaic plants, choice of module and their techno-economical characteristics, Series and parallel combination of PV array installation and output calculation with numerical treatment**,** off grid, on-grid, standalone system, grid interface. Enhancing array performance: cooling, concentrator, Solar PV tracking, effect of dust on PV and remedies, Installation of electrical and electronic components: array combiner box, inverter, Distribution boxes, safety devices, Maintenance procedure of solar photovoltaic plants, DPR preparation for roof-top and MW scale solar plants	
Unit 6	**Bio Energy Systems**
Bio-mass: Biomass types, Characteristics (Ultimate analysis, Proximate analysis, Calorific value, Physical Properties, Thermodynamic properties, Feedstock Handling Characteristic, Thermo-gravimetric analysis), Biomass estimation, Biomass formulation (Numerical Treatment). **Bio-fuel**: Introduction to bio-fuels, feedstocks for bio-fuel production, bio-diesel, bio-hydrogen, concept of bio-refinery **Thermo-chemical conversion**: Pyrolysis, Liquefaction and Gasification, Gasifier and types. Gas production, environmental effects, Producer gas utilization, Biomass integrated gasification/combined cycles systems (Numerical Treatment). **Bio-chemical Conversion:** Biodegradation, Aerobic Digestion, Anaerobic digestion; Biogas digester types and biogas utilization	
Books and other resources	
Text Books: 1. S P Sukhatme and J P Nayak, Solar Energy: Principles of Thermal Collection and Storage, McGraw-Hill Education, 2017 2. G. N. Tiwari, Solar Energy: Fundamentals, Design, Modelling and Applications, Alpha Science, 2002	

3. Rabindra Satpathy, Venkateswarlu Pamuru, Solar PV power: Design, manufacturing and applications from sand to sand to systems.
4. B. H. Khan, Non-Conventional Energy Sources, Second Edition. Tata Mc-Graw Hill.
5. J. F. Manwell, J. G. McGowan and A. L. Rogers., Wind Energy Explained- Theory, Design and Application. John Wiley and Sons Ltd.
6. G. D. Rai, Energy Sources, Khanna Publications.
7. John R. Balfour, Introduction To Photovoltaic System Design (The Art and Science of Photovoltaics), Jones and Bartlett Publishers,
8. Michel C. Allard, Bioenergy Systems, Biological Sources and Environmental Impact, Nova Science Publishers, Inc.; UK ed. edition 2013.
9. Prabir Basu, Biomass Gasification, Pyrolysis and Torrefaction, Academic Press, Elsevier, 2013.
10. Meisam Tabatabaei, Biogas: Fundamentals, Process, and Operation (Biofuel and Biorefinery Technologies, Springer; 2018.

References Books:

1. G. N. Tiwari, Arvind Tiwari, Handbook of Solar Energy: Theory, Analysis and Applications, Springer, 27-Jun-2016 - Technology & Engineering.
2. S. Yang, H.A. El-Enshasy, N. Thongchul (Eds.), Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals and Polymers, Wiley, 2013.
3. Handbook of Renewable Energy Springer; 1st ed. 2017.
4. Richard Jemmett, Methane Production Guide - How to Make Biogas. Three simple anaerobic digesters for home construction: Generate your own renewable energy from waste, RW Jemmett; 3rd edition (13 February 2011).
5. Wim Soetaert, Biofuels, Wiley, 2011.

Web Courses:

1. https://nptel.ac.in/courses/103103206
2. https://nptel.ac.in/courses/103103207
3. https://nptel.ac.in/courses/108108078
4. https://nptel.ac.in/courses/102104057

Web References:

India_2020_Energy_Policy
https://iea.blob.core.windows.net/assets/2571ae38-c895-430e-8b62-bc19019c6807/India_2020_Energy_Policy_Review.pdf
Cost Analysis Of Energy Savings
Link: https://egyankosh.ac.in/bitstream/123456789/47587/1/Unit-3.pdf
National Electricity Plan
https://powermin.gov.in/en/content/national-electricity-plan-0
Report : https://powermin.gov.in/sites/default/files/uploads/NEP-Trans1.pdf
Economic & Financial Evaluation of Renewable Energy Projects
https://pdf.usaid.gov/pdf_docs/PNADB613.pdf
https://energypedia.info/wiki/The_Economics_of_Renewable_Energy
Analyzing The Falling Solar And Wind Tariffs: Evidence From India
https://www.adb.org/sites/default/files/publication/566266/adbi-wp1078.pdf
Mapping India's Energy Subsidies 2020
https://www.iisd.org/system/files/publications/india-energy-transition-2020.pdf
Jawaharlal Nehru National Solar Mission policies and initiatives:
Presentation: https://iitj.ac.in/CSP/material/JNNSM-Final.pdf
Report: https://mnre.gov.in/img/documents/uploads/file_f-1608040317211.pdf
Benchmark costs for Grid-connected Rooftop Solar PV systems:

https://www.yellowhaze.in/mnre-solar-benchmark-cost-2021-22/
Benchmark costs for Grid-connected Rooftop Solar Photo-voltaic systems for the financial year 2021-22
https://mnre.gov.in/img/documents/uploads/file_f-1629353920466.pdf
Installation & Maintenance of Solar Panel
https://rdso.indianrailways.gov.in/works/uploads/File/Handbook%20on%20Installation%20&%20maintenance%20of%20Solar%20Panel(1).pdf

402051C: Automation and Robotics					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Mathematics, Systems in Mechanical Engineering, Programming and Problem Solving, Basic Electronics Engineering, Engineering Mechanics, Solid Modeling and Drafting, Electrical and Electronics Engineering, Kinematics of Machinery, Mechatronics, Design of Transmission Systems

Course Objectives:

1. Introduce the need of Industrial Automation
2. Learn various types of Robots and the functional elements of Robotics
3. Identify and Judge application specific selection of Robot Drive Systems
4. Recognize various types End-effectors and Sensors used in Robotic Automation
5. Study the basic Mathematical Modeling Techniques of Robot
6. Understand the basics of Robot Programming and Robotic Applications

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **UNDERSTAND** the basic concepts of Automation
CO2. **UNDERSTAND** the basic concepts of Robotics
CO3. **IDENTIFY** and **EVALUATE** appropriate Drive for Robotic Applications
CO4. **COMPARE** and **SELECT** End-effectors and Sensors as per Application
CO5. **DEVELOPE** the Mathematical Modeling Approaches of Robot
CO6. **EVALUATE** the fundamentals of robot programming and **CLASSIFY** the Applications

Course Contents

Unit 1	**Introduction to Automation**

Introduction: Automation in Production systems, Automated Manufacturing Systems, Reasons for Automation, Automation Principles and Strategies, USA (Use, Simplify & Automate) Principle, Automation Migration Principle, Types of Automation, Classification by Function/ Transfer Method, Automation using Hydraulic/Pneumatic Systems, Electrical/Electronic Systems and Automated Assembly Systems - Selection criteria, components, applications

Automated Assembly Systems: Types and Configurations, Part Feeding Devices, Part Orientation Devices, Part Conveying Devices, Feed tracks, Escapements and Part placing mechanism, Parts Delivery at workstations, Single-station and Multi-station Assembly Machines

<table>
<tr><td>Unit 2</td><td>Fundamentals of Robot Technology</td></tr>
<tr><td colspan="2">Introduction: History, Definitions specified by Agencies, Classification and Applications, Laws of robotics, Specifications of robots, Flexible automation Vs. Robotics technology, Safety measures in robotics, Role of Robots in Automation

Robot Anatomy and configurations: Cartesian, Cylindrical, Polar, Articulated, SCARA, Pendulum Arm, Multiple Joint Arm, Parallel Manipulator, Work Envelope/Volume, Degree of Freedom associated with Robot Arm & Wrist, Joints & Joint Notification Scheme, Precision of Movement</td></tr>
<tr><td>Unit 3</td><td>Robot Drive Systems</td></tr>
<tr><td colspan="2">Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives - D.C. Servo Motors, Stepper Motors, A.C. Servo Motors, BLDC - Salient Features, Applications and Comparison of all these Drives, Micro actuators, Selection of drive, Power and Motion Transmission Systems for Robot, Motion Conversion, Determination of Power of motor, Types of Gearbox - Planetary, Harmonic, Cycloidal Gearbox and Gear Ratio, Variable Speed Arrangements</td></tr>
<tr><td>Unit 4</td><td>End-effectors & Sensors in Automation</td></tr>
<tr><td colspan="2">End-effectors/Grippers/Tooling: Introduction, Types, Classification, Construction, Working, Selection and Design Considerations of End-Effectors/Grippers/Tooling Interface used in various Robotic Applications, Active and Passive Compliance

Sensors/Transducers: Introduction, Types, Classification, Construction, Working, Selection and Design Considerations of Transducers, Sensors, Resolvers, Encoders, Switches, Position/Range/Touch/Force/Torque/Safety Sensors and Transduces, Machine Vision System used in various Robotic Applications</td></tr>
<tr><td>Unit 5</td><td>Mathematical Modeling of Serial and Parallel Robots</td></tr>
<tr><td colspan="2">Kinematics: General Mathematical Preliminaries on Vectors & Matrices, Link Equations and relationships, Direct Kinematics, Coordinate and Vector Transformation using matrices, Rotation matrix, Inverse Transformations, Composite Rotation matrix, Homogenous Transformations, Robotic Manipulator Joint Coordinate System, Inverse Kinematics of two joints/link manipulator, DH Parameters, Jacobian Transformation in Robotic Manipulation, Static Analysis

Dynamics: Direct Dynamics, Mass/Inertia and their Positions of links, Lagrangian/Eularian/Newtonian Approaches for formulation of equations of motion of planar two link/joint manipulator</td></tr>
<tr><td>Unit 6</td><td>Performance and Applications of Robots</td></tr>
<tr><td colspan="2">Robot Performance and Economics: Introduction to Robotic Programming, Types of Robot Programming, Motion Programming, Simulation and Off-line Programming, Programming Examples such as Palletizing, Loading, Unloading, Material Handling, etc., Robot Economics, Functional Safety in Robotic Applications, Social Aspects of Robotics, Industry 4.0

Robots in Manufacturing Applications: Robot-based Manufacturing System, Robot Cell Design</td></tr>
</table>

Considerations and Selection of Robot

Robots in Non-manufacturing Applications: Field And Service Robotics, Mobile Robots, Wheeled, Legged, Tracked, Hybrid Terrestrial Mobile Robots, Unmanned Aerial Vehicle (UAV), Autonomous Underwater Vehicles (AUV), Humanoids, Robotic Assistive Technologies for Rehabilitation of Humans

Books and other resources

Text Books:

1. Groover, M. P., (2016), "Automation, Production Systems, and Computer-integrated Manufacturing," Pearson Education, ISBN: 9789332572492
2. Derby, S. J., (2004), "Design of Automatic Machinery," CRC Press, ISBN: 9780824753696
3. Deb, S. R., Deb, S., (2017), "Robotics Technology and Flexible Automation," McGraw Hill Education, ISBN: 9780070077911
4. Sandler, B. Z., (1999), "Robotics: Designing the Mechanisms for Automated Machinery," Academic Press/Prentice Hall, ISBN: 9780137816002
5. Tsai, L. W., (1999), "Robot Analysis: The Mechanics of Serial and Parallel Manipulators," Wiley-Interscience, ISBN: 9780471325932
6. Nagarajan, R., (2016), "Introduction to Industrial Robotics," Pearson Education India, ISBN: 9789332544802
7. Gupta, A. K., Arora, S. K., Westcott, J. R., (2016), "Industrial Automation and Robotics: An Introduction," Mercury Learning & Information, ISBN: 9781938549304

References Books:

1. Niku, S. B., (2020), "Introduction to Robotics, Analysis, Control, Applications," Wiley, ISBN: 9781119527626
2. Groover, M. P., Weiss, M., Nagel, R. N., Odrey, N. G., R.,Dutta, A., (2017), "Industrial Robotics - Technology ,Programming and Applications," McGraw Hill Education, ISBN: 9781259006210
3. Ray Asfahl, C., (1992), "Robots and Manufacturing Automation," Wiley, ISBN: 9780471553915
4. Koren, Y., (1985), "Robotics for Engineers," McGraw-Hill, ISBN: 9780070353992
5. Saha, S. K., (2017), "Introduction to Robotics" McGraw-Hill Education, ISBN: 9789332902800
6. Mittle, R., Nagrath, I., (2017), "Robotics and Control," McGraw Hill Education, ISBN: 9780070482937
7. Craig, J., (2021), Introduction to Robotics: Mechanics and Control, Pearson, ISBN: 9781292164939
8. Mike Wilson, M., (2014), "Implementation of Robot Systems: An introduction to robotics, automation, and successful systems integration in manufacturing," Butterworth-Heinemann, ISBN: 9780124047334
9. Spong, M. W., Hutchinson, S., Vidyasagar, M., (2020), "Robot Modeling and Control," Wiley, ISBN: 9781119523994
10. Siegwart, R., Nourbakhsh, I. R., Scaramuzza, D., (2011), "Introduction to Autonomous

Mobile Robots," The MIT Press, ISBN: 9780262015356
Web References: • Pratihar, D. K., (2019), "Robotics,: IIT Kharagpur, https://onlinecourses.nptel.ac.in/noc19_me74/preview • Asokan, T., Ravindran, B., Vasudevan, K., (2020), "Introduction to Robotics," IIT Madras, https://onlinecourses.nptel.ac.in/noc20_de11/preview • www.roboanalyzer.com

402051D: Industrial Psychology and Organizational Behavior					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Understanding psychology as natural science, Infancy and Preschool Years, Diversity and Social Interaction, zeal to contribute for individual, group, social and national development.

Course Objectives:

1. To develop an understanding of the nature, functioning and design of organization as social collectivities.
2. To orient the students to the application of principles of psychology in an industrial and organizational workplace
3. To demonstrate the understanding of job requirement and related fatigue, boredom and ways to handle it.
4. To develop the insights into performance management and understanding related improvement strategies.
5. To have an understanding of human behavior in groups and develop knowledge and skills in leadership, power, communication, negotiation and conflict management.
6. To develop the acumen to understand the organizational culture, change management and organizational development.

Course Outcomes

On completion of the course the learner will be able to;

CO1. **DEMONSTRATE** fundamental knowledge about need and scope of industrial - organizational psychology and behavior.

CO2. **ANALYZE** the job requirement, have understanding of fatigue, boredom and improve the job satisfaction.

CO3. **UNDERSTAND** the approaches to enhance the performance.

CO4. **KNOWLEDGE** of theories of organizational behavior, learning and social-system.

CO5. **UNDERSTAND** the mechanism of group behavior, various aspects of team, leadership and conflict management.

CO6. **EVALUATE** the organizational culture, manage the change and understands organizational development approaches.

Course Content

Unit 1	Industrial Psychology: Introduction

Introduction to Industrial Psychology, Brief History of Industrial Psychology, Nature, Scope and Problems, psychology as a science and areas of applications, Individual differences and their

<table>
<tr><td colspan="2">evaluation, Role of heredity and environment, study of behavior and stimulus to response behavior, Types of individual differences, Scientific management and it’s limitations

Hawthorne Studies: Introduction, Hawthorne Studies, Implication of Hawthorne Studies, Criticisms of Hawthorne Studies, Relevance of Industrial psychology in era of Industry 5.0</td></tr>
<tr><td>Unit 2</td><td>Job Analysis and Industrial Fatigue</td></tr>
<tr><td colspan="2">Job Analysis and Evaluation, Employee Selection, Performance Evaluation, training and development

Industrial Fatigue: Introduction, Concept and Meaning, Types of Industrial Fatigue, Causes of Fatigue, Contents, Fatigue Symptoms, Industrial Studies on Fatigue, Causes and Remedies of Industrial Fatigue, Effects of Industrial Fatigue

Industrial Boredom: Introduction, Concept and Meaning, Causes and Remedies of Boredom, Effects of Boredom, Reducing Boredom</td></tr>
<tr><td>Unit 3</td><td>Performance Management</td></tr>
<tr><td colspan="2">Performance Management: Introduction, Concept and Meaning, Objectives of Performance Management, Process of Performance Management, Approaches to Performance Development, Methods of Performance Management

Relevance of Leadership and supervision, Recruitment, Time and Stress Management, Occupational Health and Safety. Implication of Motivation Theories in Workplace, Factors Influencing Job Satisfaction, Reducing Dissatisfaction</td></tr>
<tr><td>Unit 4</td><td>Organizational Behavior: Introduction</td></tr>
<tr><td colspan="2">Concept of organization & organizational behavior, Organizational structure, factors affecting behavior in organizations, Theories of Organization - Classic Organizational Theory, Human Relations Theory, Contingency Theories, Models and Approaches of Organizational Behavior.

Ethics and ethical behavior in organizations, Learning: meaning and definition, process and theories of learning, Understanding a social-system, Organizational Behavior in an Engineering Sector Organization</td></tr>
<tr><td>Unit 5</td><td>Group Behavior and Interpersonal Relationships</td></tr>
<tr><td colspan="2">Group Behavior: Groups: Concept and Classification, Stages of Group Development, Group Structure, Roles and Norms, Premise and Issues. Group Decision-Making: Group vs Individual, Groupthink and Groups Shift, Group Decision Making Techniques and Process

Team work: meaning, concept, types, creating, an effective team

Leadership: Functions and approaches; trait, behavioral and contingency models; characteristics of successful leaders; role of power in leadership

Interpersonal Relationships: Understanding Self and Others, Developing Interpersonal</td></tr>
</table>

Relationships, Transactional Analysis, Johari Window

Conflict Management: Concept, Causes, Types, Stages, Effects, Management of Conflicts

Unit 6	Organizational Culture, Change Management and Organizational Development

Organizational Culture: Concept, Dominant Culture, Strong vs Weak Cultures, Creating and Sustaining Culture, Employees Learning of the Culture, Creating a Customer-Responsive Culture.

Organizational Changes: Concept and Forces for Change, Managing Planned Changes, Resistance to Change, Approaches to Manage Organizational Change, Organizational Development, Culture-Boundedness of Managing the Change.

Organizational theory and development:
Organizational Theory: Classical organizational THEORY, Humanistic Theory, Open-System Theory
Organizational development: Need, models of Organizational change, Organizational development interventions

Books and other resources

Text Books:

1. Vikram Bisen and Priya, Indistrial Psychology, New Age Publication, 2010.
2. Michael Aamodt, Organizational/ Industrial Psychology, Wadsworth Cengage Learning, 2010
3. Robbins, S.P. Organizational Behaviour. Prenctice-Hall, latest edition.
4. Spector, P.E. Industrial and Organizational Psychology: Research and Practice. International Student Version. Latest Edition. Wiley.
5. Davis K. & Newstrom J.W., Human Behaviour at work, Mcgraw Hill International, 1985
6. Stephen P. Robbin & Seema Sanghi, Organizational behavior, Pearson, 2011
7. L.M. Prasad, Organizational behavior, S Chand & sons

References Books:

1. Blum M.L. Naylor J.C., Horper & Row, Industrial Psychology, CBS Publisher
2. Luthans Fred, Organizational Behaviour, McGraw Hill International.
3. Morgan C.t., King R.A.,John Rweisz & John Schoples, Introduction to Psychology, McHraw Hill, 1966
4. Schermerhorn J.R.Jr., Hunt J.G &Osborn R.N., Managing, Organizational Behaviour, John Willy
5. Arnold J., Robinson, Iran, T. and Cooper, Cary L, Work Psychology, Macmillan IndiaLtd.
6. Muchincky (2009). Psychology applied to work. New Delhi: Cengage.
7. Griffin, Ricky W: Organizational Behaviour, Houghton Mifflin co., Boston.
8. Ivancevich; John and Micheeol T. Matheson, Organizational Behaviour and Management, Tata McGraw-Hill, New Delhi.
9. Newstrom, John W. and Keith Davis: Organizational Behavior: Human Behavior at Work, Tata McGraw-Hill, New Delhi.
10. Steers Richard m. and J. Stewart black: Organizational Behavior, Hrper Collins college

Publishers, New York.

11. Sukla, Madhukar: Understanding Organizations: Organization Theory and Practice in India, Prentice Hall, New Delhi.

Web References:

1. http://nptel.ac.in/cour ses/110105034/1
2. http://nptel.ac.in/cour ses/110105034/6
3. http://nptel.ac.in/cour ses/110105034/12
4. http://nptel.ac.in/cour ses/110105034/8
5. http://nptel.ac.in/cour ses/110105034/14
6. http://nptel.ac.in/course s/110105034/23
7. http://nptel.ac.in/course s/110105034/26
8. http://nptel.ac.in/course s/110105034/27
9. http://nptel.ac.in/cour ses/110105034/34
10. http://nptel.ac.in/cour ses/110105034/2
11. http://nptel.ac.in/cour ses/110105034/40

402051E: Electric and Hybrid Vehicle					
Teaching Scheme		**Credits**		**Examination Scheme**	
Theory	**3 Hrs./Week**	**Theory**	**3**	**In-Semester**	**30 Marks**
				End-Semester	**70 Marks**

Prerequisites: Mathematics, Physics, Chemistry, Systems in Mechanical Engineering, Basic Electrical Engineering, Electrical and Electronics Engineering, Kinematics of Machinery, Computer Aided Engineering, Design of Transmission Systems

Course Objectives:

1. Introduce the concepts of electric vehicle and allied technologies
2. Learn the concept and types of hybrid electric vehicle
3. Identify and Judge application specific selection of Prime Movers, Energy Storage and Controllers required for e-vehicles
4. Recognize the e-Vehicle Configurations and Understand the Mechanics of vehicle movement
5. Design and Select the body frame with relevant suspension system and Testing of e-Vehicle as per Regulation/Licensing/Approval Organizations
6. Understand the Battery Charging techniques and management

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **UNDERSTAND** the basics related to e-vehicle
CO2. **CLASSIFY** the different hybrid vehicles
CO3. **IDENTIFY** and **EVALUATE** the Prime Movers, Energy Storage and Controllers
CO4. **DISCOVER** and **CATAGORIZE** the Electric Vehicle Configuration with respect to Propulsion, Power distribution and Drive-Train Topologies
CO5. **DEVELOP** body frame with appropriate suspension system and **TESTING** of for e-Vehicles
CO6. **CLASSIFY** and **EVALUATE** Battery Charging techniques and management

Course Contents

Unit 1	**Introduction to Electric and Hybrid Vehicle**

History and evolution of Electric Vehicles, Comparison of Electric with Internal Combustion Engine Vehicles, Limitations of IC Engine Vehicles (ICEV), Exhaust Emission and Global warming, Environmental importance of Hybrid and Electric Vehicles, Overview of EV Challenges, Classification, Overview of EV Technologies, Advantages and Disadvantages, Economic and Environmental impacts of using Electrical Vehicles, Emerging Technologies for Electric Vehicle Drives, Case Studies of Two-Wheeler, Three-Wheeler, and Four-Wheeler Electric Vehicles,

<table>
<tr><td colspan="2">Brief introduction to Autonomous and self-driving Vehicles</td></tr>
<tr><td>Unit 2</td><td>Hybrid Electric Vehicle</td></tr>
<tr><td colspan="2">Classification of HEV: Architecture, Construction, Working, Advantages and Limitations of Conventional and Gridable HEV, Classification of Conventional HEV, Types of Gridable HEV, Tractive force, Power and Energy requirements for standard drive cycles of HEV

Hybrid Electric Drive-Trains: Basic concept of Hybrid Traction, introduction to various hybrid Drive-Train Topologies, Power flow Control in Hybrid Drive-Train Topologies, Fuel Efficiency Analysis

Control Strategy: Supervisory Control, Selection of Modes</td></tr>
<tr><td>Unit 3</td><td>Prime Movers, Energy Storage and Controllers</td></tr>
<tr><td colspan="2">Brief introduction to Motors: Classification, Construction, Working, Control, Design criteria, Application and Design Examples, Selection of Motor, Structural Configuration of Motor Layout, Motor Safety and Maintenance, Motor Torque and Power Rating

Brief introduction to Energy Storage Systems: Classification - Types and Packs, Construction, Working, Comparison and Selection, Principle of Operation, Units of Battery/Fuel Cell Energy Storage, Battery Performance Parameters Estimation, Battery/Cell Modeling, Traction Batteries and their Capacity Calculation and Power Rating for standard drive cycles, Lifetime and Sizing Considerations, Power and Efficiency, Characteristic Curves, Battery Cooling/Thermal Control and Protection, Battery Safety and Maintenance, Auxiliary battery, Hybridization of energy storage devices, Ultra capacitor and Ultra flywheel

Controllers: Configuration based on power electronics, Torque/Speed Coupling, Speed and Torque Controllers, BCU, MCU, Speed Control for Constant Torque/Power Operation of all electric motors, Control Methods</td></tr>
<tr><td>Unit 4</td><td>Electric Vehicle Configuration and Mechanics of Vehicle Movement</td></tr>
<tr><td colspan="2">Electric Vehicle Configuration with respect to Propulsion and Power distribution: Unicycle, Two-Wheeler (Bicycle, Dicycle, Motorcycle, Scooter, Scooteretts, Mopeds and Underbone), Three-Wheeler, and Four-Wheeler Electric Vehicles, Steering and Propulsion Configuration, Placement of Motors, Battery and Motion Transmission Systems

Electric Drive-Trains: Basic concept of Electric Traction, introduction to various Electric Drive-Train Topologies, Power flow Control in Electric Drive-Train Topologies, Fuel Efficiency Analysis, Mechanical Differential Vs. Electric Differential

Mechanics of Vehicle Movement: General description of vehicle movement, Power train Components and Sizing, Wheels and Tires, Load calculation, Torque/Traction Calculations, Power Calculation, Effect of Rolling, Pitch & Yaw on velocity and moments, Rolling resistance and its equation, Aerodynamic Drag/Lift and its equation, Grading resistance, Road</td></tr>
</table>

resistance, Acceleration resistance, Total driving resistance, Dynamic equation, Brake System

Unit 5	Electric Vehicle Design, Manufacturing, Testing & Homologation

Frames and Suspension Design for varieties of Electric Vehicle Configuration: Introduction to Body loads, Driving dynamics and Comfort, Strength and Stiffness of chassis/frames, Types and constructional details of frames, Frame Materials, Frame building Problems, frame components, Front and Rear Suspension Systems, Panel meters and controls on Handle-bar/Dash-board, Body Manufacturing, Aesthetics and Ergonomics Consideration, Retrofitting and its associated Problems

Vehicle Testing & Homologation: Need of vehicle Testing and Homologation, National/International Testing/Regulation/Licensing/Approval Organizations and their Standards (AIS) for e-Vehicles, Hierarchy of Testing, Conformity of Production tests, Crash test, Side Impact Test, Rollover Test, Impact Test, Track Testing

Unit 6	EV Charging Infrastructure Management

Battery Charging: Basic Requirements for Charging System, Charging Methods and Standards, Converters, Charger Architectures, Grid Voltages, Frequencies and Wiring, Charger Functions, Real Power, Apparent Power, and Power Factor, Boost Converter for Power Factor Correction, Examples, Vehicle to Grid operation of EV's

Battery Management Systems: Necessity of Battery Management Systems, Typical Structure of BMSs, Representative Products, Keypoints of BMSs in Future Generation, Hazard/Safety Management

Books and other resources

Text Books:

1. Iqbal Hussein, (2021), "Electric and Hybrid Vehicles: Design Fundamentals," CRC Press, ISBN: 9780367693930
2. Denton, Tom, (2020), "Electric and Hybrid Vehicles," 2nd Ed., Routledge, ISBN:9780367273248
3. John Lowry, James Larminie, (2012), "Electric Vehicle Technology Explained," Wiley, ISBN: 9781119942733
4. Knowles, Don, (2011), "Automotive Suspension & Steering Systems," Cengage learning, ISBN: 9781435481152
5. Malen, Donald E., (2011), "Fundamentals of Automobile Body Structure Design," SAE International, ISBN: 9780768021691
6. R. Krishnan, (2001), "Electric Motor Drives: Modeling, Analysis, and Control," Pearson, ISBN: 9780130910141
7. Mohammad Saad Alam, Reji Kumar Pillai, N. Murugesan, (2021), "Developing Charging Infrastructure and Technologies for Electric Vehicles," IGI Global/ Business Science Reference, ISBN: 9781799868583

References Books:

1. Mehrdad Ehsani, Yimi Gao, Sefano Longo, Kambiz Ebrahimi, (2019), "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design," CRC Press,

ISBN: 9780367137465

2. Tariq Muneer, Mohan Kolhe, Aisling Doyle, (2017), “Electric Vehicles: Prospects and Challenges,” Electric Vehicles: Prospects and Challenges, ISBN: 9780128030219
3. Sandeep Dhameja, (2001), “Electric Vehicle Battery Systems,”, Newnes, ISBN: 9780750699167
4. Bruno Scrosati, Jürgen Garche, Werner Tillmetz, (2015), “Advances in Battery Technologies for Electric Vehicles,” Woodhead Publishing, ISBN: 9781782423775
5. Shunli Wang, Carlos Fernandez, Yu Chunmei, Yongcun Fan, Cao Wen, Daniel-Ioan Stroe, Zonghai Chen, (2021), “Battery System Modeling,” Elsevier, ISBN: 9780323904728
6. Andrea, Davide, (2010), “Battery management systems for large lithium battery packs,”Artech House Publishers, ISBN: 9781608071043
7. Dixon, John C., (2009), “Suspension Analysis and Computational Geometry,” Wiley, ISBN: 9780470510216
8. Day, Andrew J., (2014), “Braking of Road Vehicles,” Butterworth Heinemann, ISBN: 9780123973146
9. Guiggiani, Massimo, (2018), "The Science of Vehicle Dynamics: Handling, Braking, and Ride of Road and Race Cars," Springer, ISBN: 978-3319732190
10. Chen, Yong, (2021), “Automotive Transmissions: Design, Theory and Applications,” Springer, ISBN: 9789811567025
11. Bentley Publishers, (2002), “Bosch Automotive Handbook,” Bentley Publishers, ISBN: 0837610974
12. Prasad, Priya and Belwafa, Jamel E., (2004), “Vehicle Crashworthiness and Occupant Protection,” American Iron and Steel Institute Southfield, Michigan, www.roadsafellc.com
13. Macey, Stuart and Wardle, Geoff, (2008), “H-Point: The Fundamentals of Car Design & Packaging,” designstudio Press, ISBN: 9781933492377
14. Sulabh Sachan, Sanjeevikumar Padmanaban, and Sanchari Deb, (2022), “Smart Charging Solutions for Hybrid and Electric Vehicles,” Scrivener Publishing, ISBN: 9781119768951

Web References:

- Majhi, S. and Kumar, P., (2019), “Introduction to Hybrid and Electric Vehicles,” IIT Guwahati, http://nptel.ac.in/courses/108103009/
- https://evreporter.com/

402052: Mechanical Systems Analysis Laboratory					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**02 Hrs.**	**Practical**	**01**	**Term Work**	**25 Marks**
				Oral	**25 Marks**

Prerequisites: Systems in Mechanical Engineering, All Mechanical Engineering subjects, Solid Modelling and Drafting, Computer Aided Engineering, Computational Fluid Dynamics, Computational Multi Body Dynamics, Project Based Learning -I,-II, Skill Development, Internship/Mini project, All Electives

Course Objectives:

1. Develop an understanding of the Systems Engineering Process and the range of factors that influence the product need, concept development, system's mathematical modelling, analysis, synthesis, simulation, design, validation, redesign, planning, production, evaluation and use of a system using manual calculation, mathematical modelling, computational tools to automate product development process.
2. Understand the concepts of and use the developed skills in last three and half year of engineering studies for the design, construction, fault-finding, diagnosis, performance analysis, maintenance, modification, and control of technological systems.
3. Acquire knowledge of new developments and innovations in technological systems to be carried forward to next stage of employment after passing your Undergraduate Degree Examination.
4. Develop an understanding of how technologies have transformed people's lives and can be used to solve challenges associated with climate change, efficient energy use, security, health, education and transport, which will be coming your ways in the coming future.
5. Gain an awareness of quality and standards, including systems reliability, safety and fitness for the intended purpose.
6. Build yourself to face the challenges of future technologies and their associated Problems.

Course Outcomes:

On completion of the course the learner will be able to;

CO1. **DEVELOP** an understanding of the Systems Engineering Process and the range of factors that influence the product need, problem-specific information collection, Problem Definition, Task Specification, Solution Concept inception, Concept Development, System's Mathematical Modelling, Synthesis, Analysis, final solution Selection, Simulation, Detailed Design, Construction, Prototyping, Testing, fault-finding, Diagnosis, Performance Analysis, and Evaluation, Maintenance, Modification, Validation, Planning, Production, Evaluation and use of a system using manual calculation, computational tools to automate product development process, redesign from customer feedback and control of technological systems.

CO2. **ILLUSTRATE** the concepts and USE the developed skill-set of use of computational tools (FEA, CFD, MBD, FSI, CAE) to automate the complete product development process.

CO3. **EVALUATE** the knowledge of new developments and innovations in technological systems to carry forward to next stage of employment after passing your Undergraduate Degree Examination.

CO4. **APPRAISE** how technologies have transformed people's lives and can be used to **SOLVE** challenges associated with climate change, efficient energy use, security, health, education and transport, which will be coming your ways in the coming future.

CO5. **PRIORITIZE** the concept of quality and standards, including systems reliability, safety and fitness for the intended purpose.

CO6. **INVENT** yourself to face the challenges of future technologies and their associated Problems.

Course Contents

Preamble:
Engineering is the application of science to develop, design, and produce logical and/or physical objects such as buildings, machines, or a computer program to fulfill a desired need or to achieve an objective. So the object or goal of engineering is a design. So Systems Engineering is the engineering of a system - it is the application of science to design a system.

This lab is intended for developing an analysis skill-set with logical reasoning expected by industries to solve their problems during Product (Hardware, Software and Services) Development Process as a part of Company's System Engineering to survive in the open competitive Market, where there is no Textbook available.

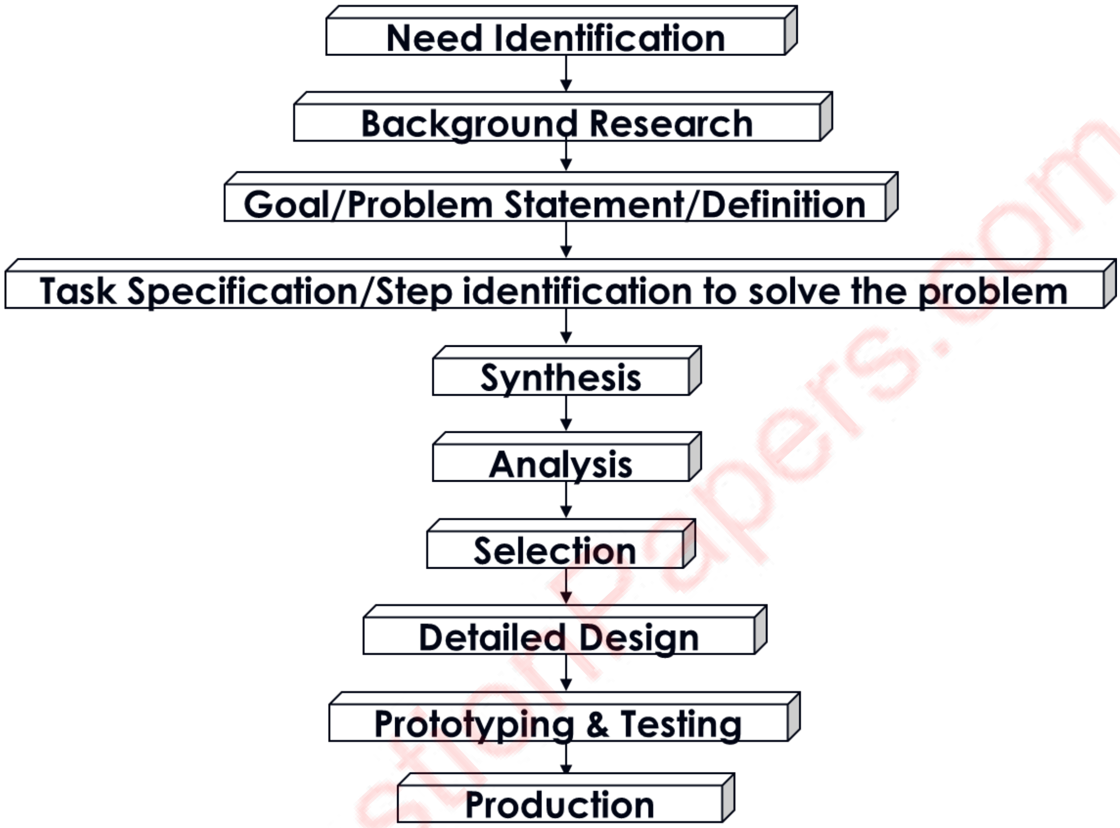
TERM WORK:
The term work shall consist of following **two parts**, each carry **equal weightage**:

A] Product based Case study

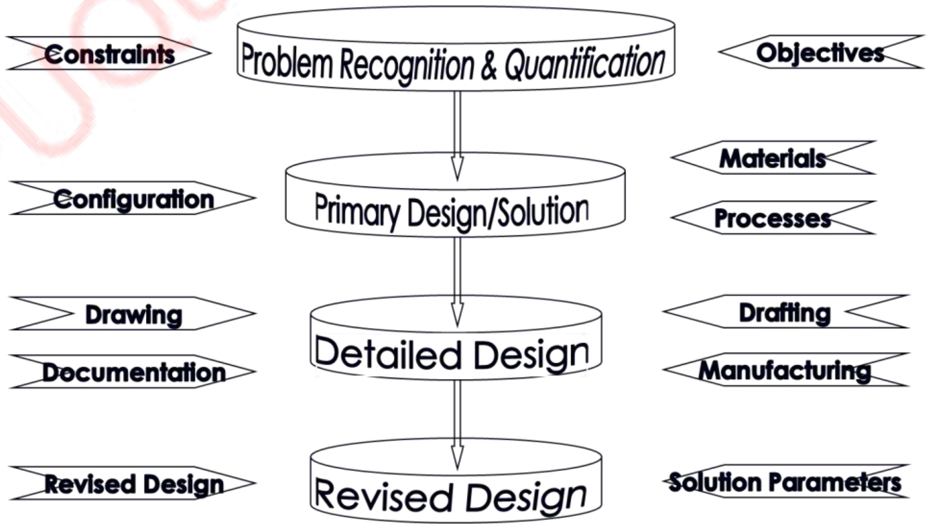
- **Individual student** will take up **one product based system analysis activity** by consultation with associated faculty and followed by development using available and learned computational tool. It will be in the form of Complete Report.

- The product can be but not limited to: any household product, Utility products, Hand/Process Tools/Equipments, Thermal Systems like, Heat exchangers, Mass production jigs/fixtures, robotics and automation products, etc.

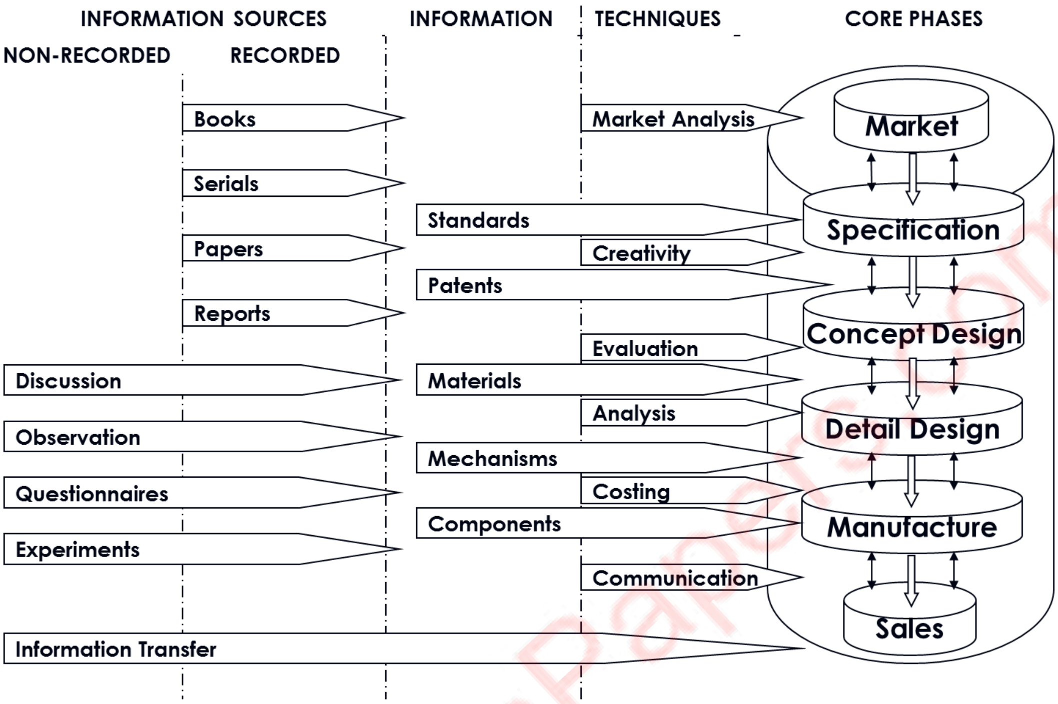
- Product Systems Analysis must follow following approach for developing the final prototype (Hardware, Software and Services).



- The Decision Making Approach with required inputs will be as follows:



- The Resources & flow of Information for System Analysis Activity for Product development must follow:



- **Demonstration by Faculty (guiding role) -** Faculty shall demonstrate complete design, analysis and synthesis of any one mechanical system from need to the end use comprising of deployment of appropriate analysis tool for modelling of the prototype. Philosophy must be told and demonstrated by faculty.

NOTE: This work should not be replication of your Project Work

B] List of Assignments (Any Five from each category)

- Following Assignment must be completely in a Computer Lab using Computational Fluid Dynamics and Multibody Dynamics Open source or Commercial Software:

B1) **CFD Assignments**

1. Numerical simulation and analysis of boundary layer over a flat plate (Blausius Equation)
2. Numerical simulation and analysis of boundary layer for a Developing flow through Pipe
3. Fully developed flow through a pipe
4. CFD Analysis of external flow: Circular Cylinder or Airfoil (NACA 0012)
5. CFD analysis of heat transfer in pin fin.
6. Numerical simulation and analysis of 2D square lid driven cavity.
7. Effect of Reynolds number on the vorticity patterns.
8. Mini project on any practical application. Students should take a problem of their choice and verify the CFD solution with experimental data / research paper. (Mandatory)

B2) **MBD Assignments**

Kinematic and Dynamic analysis of the following Multibody Systems:

1. Four bar mechanism/Slider crank mechanism
2. Cam and follower System
3. Serial Robot Manipulators
4. Parallel Robot Manipulators

5. Mobile Robot
6. Leg Mechanisms/Grippers Mechanisms
7. Automation/ Material Transporting Mechanism
8. Mini project on any practical application. Students should take a problem of their choice and verify the MBD solution with experimental data / research paper. (Mandatory)

Books and other resources

Text Books:

1. National Aeronautics and Space Administration, (2007), "NASA Systems Engineering Handbook," NASA, ISBN: 9780160797477
2. Space & Missile Systems Center, (2004), "SMC Systems Engineering Primer & Handbook: Concepts, Processes, and Techniques," SMC, U.S. Air Force
3. Oliver, D. W., Kelliher, T. P., Keegan, Jr., J. G., (1997), "Engineering Complex Systems With Models and Objects," McGraw-Hill, ISBN: 978-0070481886
4. Bi, Zhuming (2018), "Finite Element Analysis Applications: A Systematic and Practical Approach, Academic Press, ISBN: 9780128099520

References Books:

1. Rao, J.S., (2017), "Simulation Based Engineering in Fluid Flow Design," Springer, ISBN: 9783319463810
2. Tu, J., Yeoh, G-H. and Liu, C., (2018), "Computational Fluid Dynamics: A practical approach," Butterworth-Heinemann, ISBN: 9780081011270
3. Nikravesh, P.E., (2019), "Planar multibody dynamics: formulation, programming with MATLAB®, and applications," CRC Press, ISBN: 9781138096127
4. Rao, J.S., (2011), "Kinematics of Machinery Through HyperWorks," Springer, ISBN: 9789400711556

Assessment of Term Work

The student shall complete the above mentioned activities and prepare a **Term Work Journal** and **Product based Case Study Report**

Important Note:
Term Work of the Student shall be evaluated based on the completion of individual **Product based Case study Report** and **Assignments**. Continuous evaluation by the faculty shall be done for the award of the credit associated with the course. No practical examination shall be conducted for the award of the credit.

Savitribai Phule Pune University
Board of Studies - Mechanical and Automobile Engineering
Undergraduate Program – Final Year Mechanical Engineering (2019 pattern)

402053: Project (Stage II)					
Teaching Scheme		**Credits**		**Examination Scheme**	
Practical	**10 Hrs./Week**	**Practical**	**5**	**Term Work**	**100 Marks**
				Oral	**50 Marks**

Prerequisites: Project Based Learning, Internship/Mini Project, Laboratory works, Skill Development, Audit Courses, Industrial Visits, Project (Stage I)

Project Stage II is the extension of Project Stage I.

Course Objectives, Course Outcomes, Course Contents and Guidelines for Project Execution are same as that of Project Stage I

Term Work Evaluation

1. In Project Stage II, two reviews shall be taken for total 100 marks (50 marks each)
2. Review III shall be based on the approximate end of fabrication / design validation etc. in front of an expert panel from the department.
3. Review IV shall be third party evaluation by Faculty/Student/Industry person/Alumni
4. Evaluation committee shall consist of Guide, One Industry person and One Faculty appointed by the Institution.
5. Students shall be encouraged to publish a research paper/patent/technical note. Their credential shall be considered while term work evaluation.

Examination Scheme

1. Examination committee shall consist of Internal Examiner and External Examiner appointed by University. (External Examiner shall be a competent Industry/Research/Laboratory person. A list shall be provided by Board of Studies)
2. Well in advance soft copies of the project shall be shared with examination committee.

Presentation of Project Work

Presentation of work in the form of Project Report (s), Understanding individual capacity, Role & involvement in the project, Team Work (Distribution of work, intra-team communication and togetherness), Participation in various contests, Publications and IPR, Manuals (Project Report, Quick reference, System, Installation guide) among other parameters. Team members with guide information shall be added at the end of the report.

Project Report

1. The report shall be both side print hard bound. A hardbound report shall be made after examination and examiner and guide's expected correction, before that report must be loosely bound.
2. Plagiarism check is must, and certificate shall be attached in the report.
3. A group activity shall be presented in report.
4. Report copies shall be submitted in the department, one for university and one for supervisor.
5. For standardization of the project reports the following format shall be strictly followed.
   Page size: Trimmed A4
   Top Margin: 1"
   Bottom Margin: 1.32"
   Left Margin: 1.5"
   Right Margin: 1"
   Para Text: Times New Roman 12-point font
   Line Spacing: 1.15 Lines
   Page Numbers: Right aligned at footer. Font 12 point Times New Roman
   Headings: Times New Roman, 14 Points, Boldface 10.

Certificate

1. All students shall attach a standard format of Certificate as described by the department.
2. Certificates shall be awarded to project groups and not individual students of the group.
3. Certificates shall have signatures of Guide, External Examiner, HOD and Principal.

Index of Report

1. Title Sheet
2. Certificate (Institution)
3. Certificate (Company, if sponsored by company)
4. Acknowledgement
5. Abstract of the Project
6. List of Figures
7. List of Photographs / Plates
8. List of Tables
9. Table of Contents
10. Introduction
11. Literature Survey / Theory
12. Design / Experimentation / Fabrication / Production / Actual work carried out for the same
13. Observation Results
14. Discussion on Result and Conclusion
15. Student and Guide details. (A common photograph with project)

402055: Audit Course VIII					
Teaching Scheme		**Credits**	**Examination Scheme**		
		Non- Credit			

GUIDELINES FOR CONDUCTION OF AUDIT COURSE

Faculty mentor shall be allotted for individual courses and he/she shall monitor the progress for successful accomplishment of the course. Such monitoring is necessary for ensuring that the concept of self-learning is being pursued by the students 'in true letter and spirit'

- If any of the following listed course is selected through Swayam/ NPTEL/ virtual platform, the minimum duration shall be of 8 weeks.
- However, if any of the course duration is less than the desired (8 weeks) the mentor shall ensure that other activities in form of assignments, quizzes, group discussion etc. (allied with the course) for the balance duration should be undertaken.
- Students can join any online platform or can participate any online/offline workshop to complete the Audit course with prior-permission of mentor.

In addition to credits courses, it is mandatory that there should be an audit course (non-credit course) from Final year of Engineering. The student will be awarded grade as AP on successful completion of the audit course. The student may opt for any one of the audit courses in each semester. Such audit courses can help the student to get awareness of different issues which make an impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in the semester is provided in the curriculum. Students can choose one of the audit courses from the list of courses mentioned. Evaluation of the audit course will be done at institute level. The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not considered in the calculation of the performance indices SGPA and CGPA. Evaluation of the audit course will be done at institute level itself

List of Courses to be opted (Any one) under Audit Course
A. Managing Innovation **B.** Operations Management Note:-The title indicated above are subject to change in time to come and such an alteration (if any) should be brought to the notice of the BoS.
Using NPTEL Platform: (preferable)
NPTEL is an initiative by MHRD to enhance learning effectiveness in the field of technical education by developing curriculum based video courses and web based e-courses. The details of NPTEL courses are available on its official website www.nptel.ac.in • Students can select any one of the courses mentioned above and has to register for the corresponding online course available on the NPTEL platform as an Audit course. • Once the course is completed the student can appear for the examination as per the guidelines on the NPTEL portal. • After clearing the examination successfully; student will be awarded with a certificate.
Assessment of an Audit Course
• The assessment of the course will be done at the institute level. The institute has to maintain the record of the various audit courses opted by the students. The audit course opted by the students could be interdisciplinary • During the course students will be submitting the online assignments/report/course completion certificate etc. A copy of the same can be submitted as a part of term work for the corresponding Audit course. • On the satisfactory submission of assignments/report/course completion certificate etc., the institute can mark as "Present" and the student will be awarded the grade AP on the mark-sheet.

Training & Placement Cell

Summary of MOUs (2023-24)

Sr. No.	Name of the Organization	Purpose of MOU	Date of MOU
1	CADD Center - Pune	Training/Workshop/Internship	16th July-2023
2	Anudip Foundation Kolkata	IBM Certification Workshop & Placement	1st April-2024
3	TNS India Foundation	Java Full Stack Training & Placement	19th June-2024
4	Education Experts Pune	Abroad Study training	25th June-2024

TPO

(Mr. A.M. Solanki)

Training & Placement Officer
J.S.P.M. Bhivrabai Sawant Institute of Technology & Research
Wagholi, Pune-412207.

JSPM Bhivrabai Sawant Institute of Technology & Research
Wagholi Pune

Principal

(Dr. T.K. Nagaraj)

PRINCIPAL
JSPM's Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune - 412 207

MOU
CADD CENTRE
&
JSPM's Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune

Memorandum of Understanding

July16, 2023

CADD CENTRE WAGHOLI PUNE

CADD CENTRE
Driving Digital Designs!

30 YEARS OF SKILLING THE WORLD

Skill India
कौशल भारत - कुशल भारत

N·S·D·C
National Skill Development Corporation
Transforming the skill landscape

CADD CENTRE
Driving Digital Designs!

Date: 16th- Jul- 2023,

Memorandum of Understanding

To,

The Principal

JSPM's Bhivrabai Sawant Institute of

Technology & Research, Wagholi, Pune

Dear Sir,

Sub: MOU Sign for Training CAD/CAM/BIM/PPM for MECHANICAL Department,

We thank you for choosing CADD Centre for training requirement. **CADD centre** is pleased to extend its hand to tie-up with **JSPM's Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune.**
to offer training on leading **CAD/CAE/BIM/PPM** software to the students of **Mechanical** Department.

I request you to kindly, go through below the Various Software available for MECHANICAL

students.Software:

CAD- Auto CAD, CATIA, CREO, SOLIDWORK's, NX-CAD.

CAE- ANSYS,HYPERMESH,NX-NASTRAN.

CAM- NX-CAM,POWERMILL.

TECHNOLOGY & MANAGEMENT- ELECTRIC VEHICAL DESIGN, HVAC, 3D PRINTING, MSP, PRIMAVERA, MATLAB, PYTHON.

We at **CADD Centre** value our relationship with **JSPM's Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune**
and look forward for a long term relationship with **JSPM's Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune**
.

MOU Duration: *16th July-2023 to 15th July-2026*

Assuring you for the best of our services in the months to come.

With warm Regards,

Aparna Gautam,

Business Manager.

CADD Centre
Nagar Road
ChandanNagar Wagholi
M: 8888851150

This Memorandum of Understanding, dated the 16th day of July, Two Thousand and Twenty three, is entered between **JSPM's Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune**, Maharashtra, India (hereinafter referred to as **Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune**) represented by

Dr. T.K. Nagaraj-Principal, & **Dr. P.S. Kachare**– HOD of MECHANICAL Dept., **Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune** and **M/s. CADD Centre, Wagholi** Pune-412207 (hereinafter referred to as **CADD Centre**) represented by

Mrs. APARNA GAUTAM - Centre Head.

1. Background

i) CADD centre is pleased to extend its hand to sign **MOU "Memorandum Of Understanding"** with **Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune** for training CAD/CAE/BIM/PPM

ii) Assistance in final year projects and Placement to the students.

2. OBJECTIVE :

The Memorandum of Understanding states the terms and conditions under which the On-site Training Program shall be conducted by **CADD Centre** at the **Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune** or CADD CENTRE and lists herein the respective responsibilities of both parties.

3. Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune SHALL PROVIDE

i) Computer Lab with relevant Hardware facilities may be provided by **Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune** for the conduct of the Practical sessions according to availability and for thesame, CADD CENTRE has to seek separate permission every time,

ii) LCD / OHP and Classroom facilities for Theory sessions, with separate permission to use every time.

iii) Disciplinary support for the smooth conduct and timely completion of the entire course.

CADD Centre
Nagar Road
ChandanNagar Wagholi
M: 8888851150

4. CADD CENTRE SHALL PROVIDE

i) One lead instructor to give lecture sessions for the relevant program and to be supported by Lab Instructor(s) to provide guidance during practical sessions.

ii) The proprietary and internationally acclaimed CADD CENTRE course material to each of the participant.

iii) Certificates to the students who have successfully completed in all respects of the course for which he / she has enrolled. These certificates will be issued by CADD Centre within 60 days of completion.

iv) Instructor to handle classes on agreed time only

v) Instructor to handle classes with respect to the given syllabus.

vi) Implant training for students (7 to 10 days)

5. CADD Centre Investment for LAB

i) CADD Centre will provide LAB maintenance as per the software installation requirement with prior permission every time.

ii) As we are sponsoring, please grant the permission for advertising software & CADD Centre in CAD lab.

6. PARTICIPANTS

The students of the First, Second, Third and Final are eligible to avail the relevant course offering specific to their discipline.

Note:

- The training missed will be repeated.
- Students once enrolled cannot drop out.
- In the event someone drops out, the fee paid by the trainee will be forfeited.

7. Duration & TIME SCHEDULE

i) Each Software training will be **80hrs to 120hrs** duration, in which **50%** Duration will be for **Theory** & **50%** will for **Lab practice.**

ii) The program(s) will be conducted with the convenience of **student** and **Bhivrabai Sawant Institute of Technology & Research, Wagholi, and Pune.**

CADD Centre
Nagar Road
ChandanNagar Wagholi
M: 8888851150

iii) The students will be divided into batches, depending on the **total systems** in the lab

8. **JURISDICTION**

All matters, queries, disputes or differences, whatsoever, arising between the parties touching the construction, meaning, operation or effect of this Memorandum of Understanding or out of or relating to this Memorandum of Understanding or breach thereof shall be settled through arbitration in accordance with the relevant Arbitration Act in force at such time. The Arbitration award shall be binding on both parties

9. **Exit**

In case either party decides to withdraw the MOU, can do so by giving 30 days notice in writing. However before such exit occurs either party should complete the commitments to each other.

The above terms detailed in this Memorandum of Understanding alone shall govern the participation agreed to between **Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune** and **CADD Centre, Chandan Nagar/Wagholi.**

10. **MOU Duration**

This Memorandum of Understanding shall come into effect from **16th, July 2023,** Next MOU Renewal come's in **15th-July 2026.**

11. **FINANCE:- There is no any financial binding on both sides by either parties.**

For **Bhivrabai Sawant Institute of Technology & Research, Wagholi, Pune**

HOD Mechanical
(Dr. P.S. Kachare)

For **CADD Centre**

Mrs. Aparna Gautam,
Centre HeadCADD Centre,
Nagar Road Pune,

CADD Centre Nagar Road ChandanNagar Wagholi M: 8888851150

Principal
(Dr. T. K. Nagaraj)

Bhivrabai Sawant Institute of Technology & Research Wagholi Pune

IBM

Anudip
Life. Transformed.

Memorandum of Understanding

This Memorandum of Understanding is hereby executed on 1st April 2024, between Anudip Foundation for Social Welfare, having its head office at Mira Tower, 8th Floor -Plot -27, DN Block, Sector V, Bidhannagar, Kolkata, West Bengal 700091.

Represented Through:

Mr. Tanmay Mukherjee, VP- Training & Operations, Anudip Foundation Authorized Signatory in One Part and and **Dr.T.K Nagaraj Principal JSPM's Bhivarabai Sawant Institute of Technology and Research) , Gate No. 720/2, Nagar Road, Wagholi, Pune, Maharashtra 41220**

in Second Part.

Background of Anudip Foundation:

Anudip Foundation for Social Welfare, set up in 2007, is a Section 8 non- profit company as per Companies Act, 2013 having its head office at Vishnu Chambers, 2nd floor, J4, Block GP, Sector-V, Salt Lake, Kolkata-700091, Anudip creates livelihood opportunities for marginalized women and youth of India.

Over the past 12 years Anudip has worked with international and national agencies, government units, corporations and community- based organizations to offer sustainable livelihood programs for disadvantaged groups residing in the rural and semi-urban West Bengal, Odisha, Jharkhand, Andhra Pradesh, Telangana, Tamil Nadu, Rajasthan, Maharashtra, Northeast and Delhi. Anudip aims at improving the socioeconomic status of these people and locality by developing their employability and entrepreneurial skills for IT- enabled jobs and businesses.

Background of JSPM's Bhivrabai Sawant Institute of Technology & Research:

JSPM's Bhivrabai Sawant Institute of Technology & Research began its humble journey under the visionary leadership of Dr. (Prof.) T. J. Sawant in 2001 with the establishment of Rajarshi Shahu College of Engineering at Tathawade. Today JSPM is an agglomerate of more than 70 Institutes spread across Six campuses providing quality education ranging from Pre-School to Doctoral Research for over 50000+ students in the metropolitan region of Pune and Pimpri-Chinchwad.

Armed with the vision of making higher education available and affordable to all those who are desirous of pursuing it, JSPM has in a short span expanded itself into a major education provider across Maharashtra. Along the way JSPM has also acquired two more education trusts The Shetkari Shikshan Mandal and Shri Bhagwant Education and Research Charitable Trust Barshi.

JSPM Bhivrabai Sawant Institute of Technology & Research, Wagholi Pune

Anudip Foundation for Social Welfare, Kolkata

PRINCIPAL
JSPM's Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune 412 207

Anudip
Life. Transformed.

Students.Training Methodology:

Anudip's digital PBL program follows a technology-driven, blended learning methodology that has evolved based on employer and student feedback, team evaluation, and impact studies conducted externally and internally. The Anudip team continuously tries to align with changing jobmarkets, digital trends, employer demand, and the state of the training technology worldwide.
Anudip utilizes its multimedia and game-based learning programs which allows them to retain the learnings more effectively. This industry-aligned digital skills training program will train these youth through customized and digitized multimedia content in video, audio, presentation, and game formats, which will enable students to be attracted to and enjoy their classroom experience on aPilot Basis for onward successful placement. This Project is sponsored **by IBM (International Business Machines Corporation).** The Project Certification Done by IBM.

Curriculum:

The sector-specific job-oriented skills require a special curriculum built to enhance students' employability skills. Anudip's curriculum team works at developing and adding new components to the customized curriculum based on the market demand and job requirement.

Financial Clause:
There are no financial clauses between Anudip Foundation & **JSPM's Bhivrabai Sawant Institute of Technology & Research**

These are the list of courses offered:

LIVELIHOOD

Sr No:	Course	SL	ILT/Project	ILT/ Project Resource	Duration of the course (in Hrs)
1	Artificial intelligence (AI)	From IBM Portal	Anudip Content	ILT / Project based workshop (6 hrs/week x 3 weeks = 18 hrs)	**AI Fundamental (10hrs) + Critical thinking (7.5 hrs) + Problem Solving (5 hrs)**

Class Schedule:

Anudip would impart training to each batch of students as per the mutual consent of JSPM's Bhivrabai Sawant Institute of Technology & Research Total training period for each batch of students would be according to the course opted by student.

Beneficiaries' Profile:

The minimum age for the target group is 18 years and maximum age is 25 years. Minimum educational qualification HSC or 12th Passed as per the eligibility criteriaof the particular given program.

JSPM's Bhivrabai Sawant Institute of Technology & Research Wagholi Pune

ANUDIP FOUNDATION FOR SOCIAL WELFARE ★ Kolkata

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Program Deliverable:

- To impart market aligned Skill development and training programs for Minimum 150 (One Hundred Fifty)Students for PBL The entire enrollment is to be completed by 15/06/2024.

Training and Training location:

- All the training programs in the institute premises should be communicated and conducted with due knowledge to the **JSPM's Bhivrabai Sawant Institute of Technology & Research**
- Any offices of Individual from Anudip Foundation will not directly contact the students for any other paid courses or Training program.
- Anudip Foundation will appoint a training coordinator at their cost, who will be responsible for the overall conduct of the training. Anudip will act as a source point of contact for all logistic/administrative requirements, like monitoring the smooth conduct of lectures, maintaining attendance sheets, progress of the course, and other related matters.
- Anudip Foundation shall be solely responsible for payment of salary, allowances and any other form of remuneration to all the staff appointed by them.
- IBM will provide and undertake certification of those students who havesuccessfully passed all course requirements and guidelines.
- All the details and information about students will be kept confidential.
- The college will provide batch wise coordinators for smooth operational processes.
- The college will be responsible and ensure the students' attendance.
- After 100 % completion of the training Anudip will provide the synopsis report to the college and based on that college will provide appreciation or thanks letter to Anudip.

Termination:

Either party may terminate this Memorandum of Understanding by giving 30 days prior notice.

The agreement valid up to 31st March 2025.

For, Anudip Foundation for Social Welfare	**For, JSPM's Bhivrabai Sawant Institute of Technology & Research**
ANUDIP FOUNDATION FOR SOCIAL WELFARE Authorised Signatory	11/6/2024
Mr. Tanmay Mukherjee **VP-Operations**	**Dr. T.K Nagaraj** **Principal** PRINCIPAL JSPM's Bhivarabai Sawant Institute of Technology & Research Wagholi, Pune- 412 207

ANUDIP FOUNDATION FOR SOCIAL WELFARE Kolkata

JSPM Bhivrabai Sawant Institute ... & Research Wagholi Pune

This document constitutes a Memorandum of Understanding (MoU) between TNS India Foundation (TNSIF) and JSPM's Bhivrabai Sawant Institute of Technology and Research, Wagholi, Pune

This MoU is effective from, 19th June 2024, for 2 years hereinafter mentioned as "Effective Date" by and between JSPM's Bhivrabai Sawant Institute of Technology and Research, Wagholi, Pune, affiliated to the Savitribai Phule Pune University and hereinafter referred to as "The College", represented by Principal, Dr. T. K. Nagaraj.

AND

TNS India Foundation, a charitable organization registered under section 25 of the Companies Act 1956, having PAN number AAECT4021D, and having its registered office at 302, Wellington Business Park 2, Andheri-Kurla Road, Andheri East, Mumbai- 400069, Maharashtra, India, hereinafter referred as "TNSIF", represented by its Managing Director, Rupa Bohra.

Background

TNS India Foundation (TNSIF), a section 25 Company incorporated under the provision of The Companies Act, 1956 is conducting a "Future Skills Program" for the enhancement of employability and workplace skills for deserving youth.

In this connection, TNSIF intends to be associated and work closely with JSPM's Bhivrabai Sawant Institute of Technology and Research, Wagholi, Pune to conduct employability training for the final year college students. This will include activities throughout the year. Further, TNSIF will continue to support trained students on placements for 6-10 months post their final examinations

Facets of the Program:

1. The employability training program includes Communication readiness, Interview readiness, Personal Development, Work readiness, and Digital readiness.
2. There is **no cost** for students to attend the above-mentioned training.
3. Each training batch size will be about 50- 60 students. Students will be required to complete the training provided within a designated period of time.
4. Sessions of duration 2 hours each or more are to be conducted weekly for each batch by TNSIF.
5. Students will be provided a certificate on successful completion of the course with minimum attendance criteria of 90% (for both in-person and online training).
6. Students will be further supported in job linkages and placements by TNSIF from the time of training completion till they are placed i.e. 6-10 months after their training is complete.
7. College is expected to support the successful training and placements of all students, once they take up this service with TNSIF.

For this purpose, TNSIF requires support of the college in the following areas:

1. Facilitating discussions and engagement with the 4th year degree students. This involves the following:
    1. Assistance in student mobilization and batch scheduling with Candidates of JSPM's Bhivrabai Sawant Institute of Technology and Research, Wagholi, Pune
    2. Support in allocating batches (of about 50- 60 students approximately) per faculty member for optimum utilization of resources and training effectiveness. Provide

JSPM Bhivrabai Sawant Institute of Technology & Research ★ Wagholi Pune assistance w.r.t. conducting career fests drive and continued student participation.

2. Infrastructure support for the following:
   - Lecture schedules / slots to conduct the batches
   - Computer Lab equipped with adequate seating capacity for batch/s
   - Software required for the execution of program
   - Projector & White board facility for training.

Upon a request by TNSIF for this support, JSPM's Bhivrabai Sawant Institute of Technology and Research, Wagholi, Pune has agreed to support and provide the appropriate assistance to TNSIF, as mentioned in this MoU.

Based on the above, this MOU lays out immediate next steps to be taken by both parties.

TNSIF agrees to -

- Selection eligible candidates.
- Trainers to conduct the training [Technical & Soft skill]
- Certificates to be issued to the candidates on successful completion of program.
- Job opportunities for the candidates.

JSPM's Bhivrabai Sawant Institute of Technology and Research, Wagholi, Pune agrees to

1. Mobilize candidates for the program
2. Lecture schedules / slots to conduct the batches
3. Class room and Computer Lab equipped with seating capacity for batch/s
4. Software required for the execution of program
5. Projector & White board facility for training.
6. Provide one contact point who could be approached for any support related to this program.

This MOU is neither a contract, nor is it legally binding in any way, nor does it commit any financial expenditure from or for either party.

Signed:

Rupa Bohra

MS. Rupa Bohra
Managing Director,
TNS India Foundation

19/ 06 / 2024

Signed:

27/6/2024

Dr. T. K. Nagaraj
Principal
JSPM's Bhivrabai Sawant Institute of Technology and Research, Wagholi, Pune
27/06/2024

Sawant Institute of Technology & Research
Wagholi
Pune

EDUCATION EXPERTS
Overseas Education Consultant

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MoU) records the understanding arrived on this 25th day of June- 2024.

EDUCATION EXPERTS, Pune is an Overseas Education Consultant bearing official name of Education Experts, registered under the Proprietorship with Company registration number 1831000312614073 having its registered office at Prestige Chambers A, Office no 37, Jangali Maharaj Rd, Deccan Gymkhana, Pune, Maharashtra 411004 represented by Satish Sirsat (Managing Director) (hereinafter called as ("EDUCATION EXPERTS"), which expression shall, unless repugnant to the context or meaning thereof, be deemed to mean and include its successors and assigns of the one Part;

AND

JSPM College and recognized by (UGC ACT and other affiliations to mention), having its main campus at JSPM's BSIOTR, through its Principal. (hereinafter referred to as "Principal."), which expression shall, unless repugnant to the context or meaning thereof, be deemed to mean and include its successors and assigns of the other part;

The Parties to this MoU hereinafter shall be jointly referred to as 'the Parties' and individually as 'the Party'.

WHEREAS EDUCATION EXPERTS entering into this MoU with JSPM's BSIOTR (University) on non-exclusive basis.

1. **Objective of MoU:**

   WHEREAS EDUCATION EXPERTS is an Overseas Education Consultant, who represent 750+ Universities in 31 countries across the globe.

   And WHEREAS Since 2014, EDUCATION EXPERTS has helped many students to join Overseas universities, secure scholarships and ace the English exams. They continue to support students from their initial enquiries to their arrival in desired country as well as throughout their life at university, an endeavor is taken to provide

JSPM Bhivrabai Sawant Institute of Technology & Research
Wagholi
Pune

opportunities of higher education to students of **JSPM's BSIOTR** as a part of their collaborating activities and with an aim to provide a platform to the students of **JSPM's BSIOTR** to continue their higher studies in foreign Universities, giving them necessary support for entire process right from counseling, scrutinizing of their academic profile, University suggestion, documentations for applications to the university, IELTS training, assistance in education loan, visa application, accommodation and forex all under one roof, **EDUCATION EXPERTS** is collaborating with **JSPM's BSIOTR** where students of **JSPM's BSIOTR** will be benefited by the projects of EDUCATION EXPERTS.

2. Obligations:

Both the organizations acknowledge the fact that non contractual relationship has been created out of the MoU and they agree to work in unison towards their respective goals and targets to make this collaboration a success and thereby exemplify the spirit of transparency and responsibility.

3. Cooperation in view of this Collaboration:

The roles for both the parties would be:

Role of EDUCATION EXPERTS:

1. EDUCATION EXPERTS will be bringing faculty members from Overseas Universities to conduct guest lectures, seminars and interactive workshops at **JSPM's BSIOTR** on the availability.
2. EDUCATION EXPERTS will Organize large scale exclusive University Counseling Days for **JSPM's BSIOTR** , among other exciting events.
3. EDUCATION EXPERTS will help students of **JSPM's BSIOTR** , to apply through UCAS, Oxbridge premium service and consequently help them prepare for an interview and secure admission and scholarships from UK and all other Universities in other countries.
4. EDUCATION EXPERTS can facilitate and develop a program jointly with **JSPM's BSIOTR** :"STUDY EXPLORE PROGRAM-Overseas Education" by providing counselling days on the campus of **JSPM's BSIOTR** for students of different faculties on regular basis. This will include counselling and providing

JSPM Bhivrabai Sawant Institute of Technology & Research Wagholi Pune thorough information about Overseas Universities, clearing the doubts of the students, career counselling etc.Such programs can be jointly designed by both organizations as per the availability of the students.

5. EDUCATION EXPERTS will facilitate arranging post-arrival services to the students from **JSPM's BSIOTR** such as arranging accommodation for students, opening the UK bank account, assisting them for part-time jobs, career counselling post-course completion, student visa assistance, and keeping parents up to date with the latest status of the student.

4. Role of the JSPM's BSIOTR :

1. Ensuring to provide a platform for the students to be part of the programs of EDUCATION EXPERTS and will intimate about the benefits that the organization can provide.
2. Encourage students to join the programs conducted by EDUCATION EXPERTS and give them permission to attend events and classes during the weekends.
3. The **JSPM's BSIOTR** shall provide platforms to EDUCATION EXPERTS to organize academic programs, seminar/webinars, various other activities for students of **JSPM's BSIOTR** .

Financials:

EDUCATION EXPERTS will be responsible for its own costs and expenses involved in its efforts to negotiate, conclude and fulfil its obligation under this MoU. Notwithstanding anything to the contrary contained herein, EDUCATION EXPERTS shall render entire of its services under this MoU on pro bono basis i.e., without charging or seeking reimbursement of any payment, fee, charges whatsoever from the interns or **JSPM's BSIOTR** .

Use of LOGO/ Name:

Permission is given to both the parties to use the official marks of the other party specifically the institutional name and/ or institutional logo solely for the purposes of promoting and administering the collaborative activities between the institutions; provided that the party using the official marks of the other party shall take all such reasonable degree of care as an institution of good ethical and normal prudence would expect in its own case.

JSPM Bhivrabai Sawant Institute of Technology & Research
Wagholi
Pune

EDUCATION EXPERTS
Overseas Education Consultant

Arbitration and jurisdiction:

In case of any dispute between the parties in respect to any of the terms in this MoU, the parties undertake to settle the same by issuing a notice within 15 days from the date of the issue becoming known to either party. In case no such settlement is arrived at after mutual negotiations, the matter may be resolved by arbitration and shall be governed by the provisions of the Arbitration and Conciliation Act 1996 subject to any statutory modification, amendment or re-enactment, from time to time.

MoU effective date:

This Memorandum of Understanding shall be effective from the date of signing by both parties.

Term of MoU:

This MoU, unless extended by mutual written agreement of the parties, shall expire 5 years after the effective date specified hereinabove. This MoU may be amended or terminated earlier by mutual written understanding of the parties at any time. However, no such early termination of this MoU, whether mutual or unilateral, shall affect the current obligations of the parties under the MoU. Notwithstanding, either party may terminate this MoU after giving 90 days written notice to the other party. However, EDUCATION EXPERTS shall be at liberty to terminate the MoU forthwith in the event of any breach of confidentiality.

IN WITNESS WHEREOF BOTH THE PARTIES HAVE SIGNED THIS MEMORANDUM OF UNDERSTANDING ON THE DAY AND DATE FIRST ABOVE WRITTEN:

FOR EDUCATION EXPERTS:

Ssirsat

Signature:

Name: Satish Sirsat

FOR University:

Signature: 25/6/24

Name: Dr. T. K. Nagaraj

PRINCIPAL
JSPM's Bhivarabai Sawant Institute of Technology & Research
Wagholi, Pune- 412 207

JSPM Bhivarabai Sawant Institute of Technology & Research
Wagholi
Pune

Nagaraj Kalyanappa Timalapur

Digitally signed by Nagaraj Kalyanappa Timalapur
DN: CN = Nagaraj Kalyanappa Timalapur, C = IN, S = Maharashtra, O = JSPM'S Bhivarabai Sawant Institute of Technology & Research, OU = OTHERS
Reason: I attest to the accuracy and integrity of this document
Date: 2025.01.22 12:40:15 +05'30'