Savitribai Phule Pune University, Pune

Maharashtra, India

Faculty of Science and Technology

National Education Policy (NEP)-2020 Compliant Curriculum

SE - Second Year Engineering (2024 Pattern) in

Mechatronics Engineering

(With effect from Academic Year 2025-26)

Contents

Nomenclature

AEC	Ability Enhancement Course
AICTE	All India Council for Technical Education
CCE	Comprehensive Continuous Evaluation
CEP	Community Engagement Project
EEM	Entrepreneurship/Economics/Management Courses
MDM	Multidisciplinary Minor (Courses from other programs within faculty)
MOOC	Massive Open Online Course
NEP	National Educational Policy
NPTEL	National Programme on Technology Enhanced Learning
OEL	Open Elective (Courses from other Faculties)
PCC	Program Core Course
PEO	Programme Educational Objectives
PSO	Program Specific Outcomes
VEC	Value Education Course
VSE	Vocational and Skill Enhancement Course
WK	Knowledge and Attitude Profile

Preface by Board of Studies

Dear Students and Teachers,

We, the members of Board of Studies Mechatronics Engineering, are very happy to present Second Year Mechatronics Engineering syllabus effective from the Academic Year 2025-26. The present curriculum will be implemented for Second Year of Engineering from the academic year 2025-26. Subsequently this will be carried forward for TE and BE in AY 2026-27, 2027-28, respectively.

Mechatronics Engineering is a field that integrates mechanical, electrical, instrumentation and computer engineering principles to design and build intelligent systems. It focuses on creating automated systems and devices that combine mechanical components with electronics and software. Mechatronics engineers work in various industries, including manufacturing, automotive, healthcare, automation and robotics. This curriculum is designed to provide students with a comprehensive understanding of the fundamental principles, theories, and practices related to Mechatronics engineering, while also preparing them for the ever-evolving technological landscape.

The revised syllabus falls in line with the objectives of NEP-2020, Savitribai Phule Pune University, AICTE New Delhi, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.Wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided at the end of each course. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

This curriculum is the result of extensive consultation with academic experts, industry professionals, and alumni to ensure relevance and excellence. It is designed not only to meet the current industry standards but also to prepare students for higher studies and research in the field of Mechatronics Engineering.

We hope that this curriculum will inspire students to become competent professionals, responsible citizens, and contributors to the technological advancement of society.

Dr. Vaibhav V. Dixit
Chairman
Board of Studies
Mechatronics Engineering

Member of Board of Studies- Mechatronics Engineering
1. Dr. Mukesh Ghogare- Marathwada Mitramandal's Institute of Technology, Lohegaon, Pune
2. Dr. Dhananjay Khankal- Sinhagad College of Engineeing, Vadgaon Bk, Pune
3. Shri. Ajay Nagarkar- MAPYN Technologies Pvt Ltd, Pune
4. Dr. Kailas Karande- SKN, Sinhagad College of Engineering, Phandarpur, Dist: Solapur

Program Specific Outcomes (PSO)

- **PSO1:** Inculcate professional skills: Ability to adapt a multi-disciplinary approach to develop solutions for industrial and societal related problems.
- **PSO2:** Cultivate employability and entrepreneurship: Entrepreneurship and inculcation of continuous learning towards professional career.

Programme Educational Objectives (PEO)

Program Educational Objectives (PEOs): Program Educational Objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

PEO	PEO Focus	PEO Statements
PEO1	Core competence	To prepare a graduate to inculcate Knowledge of Basic Engineering Sciences and Fundamentals of Mechanical, Electrical and Computer Systems.
PEO2	Skills and Ethics	To Design, Develop Product and applications in the field of Automation and Mechatronics and be able to use Engineering Tools that will Enhance their Productivity.
PEO3	Professionalism and Lifelong Learning	To prepare a graduate for acquiring Professional Ethics and Oral, Written and Graphical Communication Skills..

Knowledge and Attitude Profile (WK)

A Knowledge and Attitude Profile (KAP), often represented as WK (Knowledge and Attitude Profile) in some contexts, is a framework or assessment tool used to evaluate an individual's knowledge and attitudes related to a specific area, topic, or domain.

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Board of Studies in Mechatronics Engineering

Programme Outcomes (PO)

Program Outcomes 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, attitude and behaviour that students acquire through the program. On successful completion of B.E. in Mechatronics Engineering, graduating students/graduates will be able to:

PO1	Engineering knowledge	Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO2	Problem analysis	Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	Design / Development of Solutions	Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	Conduct Investigations of Complex Problems	Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO5	Engineering Tool Usage	Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	The Engineer and The World	Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO7	Ethics	Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	Individual and Collaborative Team work	Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO9	Communication	Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO10	Project Management and Finance	Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	Life-Long Learning	Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

General Rules and Guidelines

- Course Outcomes (CO): Course Outcomes are narrower statements that describe what students are expected to know, and are able to do at the end of each course. These relate to the skills, knowledge and behaviour that students acquire in their progress through the course.
- Assessment: Assessment is one or more processes, carried out by the institution, that identify, collect, and prepare data to evaluate the achievement of Program Educational Objectives and Program Outcomes.
- Evaluation: Evaluation is one or more processes, done by the Evaluation Team, for interpreting the data and evidence accumulated through assessment practices. Evaluation determines the extent to which Program Educational Objectives or Program Outcomes are being achieved, and results in decisions and actions to improve the program

Guidelines for Examination Scheme

Theory Examination: The theory examination shall be conducted in two different parts Comprehensive Continuous Evaluation (CCE) and End-Semester Examination (ESE).

Comprehensive Continuous Evaluation (CCE) of 30 marks based on all the Units of course syllabus to be scheduled and conducted at institute level. To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 30 marks with the specified parameters, the allocation of marks and the structure can be detailed as follows:

Sr.	Parameters	Marks	Coverage of Units
1	Unit Test	12 Marks	Units 1 & Unit 2 (6 Marks/Unit)
2	Assignments / Case Study	12 Marks	Units 3 & Unit 4 (6 Marks/Unit)
3	Seminar Presentation / Open Book Test/ Quiz	06 Marks	Unit 5

Format and Implementation of Comprehensive Continuous Evaluation (CCE)

- **Unit Test**
  - **Format :** Questions designed as per Bloom's Taxonomy guidelines to assess various cognitive levels (Remember, Understand, Apply, Analyze, Evaluate, Create).
  - **Implementation**: Schedule the test after completing Units 1 and 2. Ensure the question paper is balanced and covers key concepts and applications.
- **Sample Question Distribution**
  - Remembering (2 Marks): Define key terms related to [Topic from Units 1 and 2].
  - Understanding (2 Marks): Explain the principle of [Concept] in [Context].
  - Applying (2 Marks): Demonstrate how [Concept] can be used in [Scenario].
  - Analyzing (3 Marks): Compare & contrast [Two related concepts] from Units 1 and 2.
  - Evaluating (3 Marks): Evaluate the effectiveness of [Theory/Model] in [Situation].
- **Assignments / Case Study** : Students should submit one assignment or one Case Study Report based on Unit 3 and one assignment or one Case Study Report based on Unit 4.
  - **Format:** Problem-solving tasks, theoretical questions, practical exercises, or case studies that require in-depth analysis and application of concepts.
  - **Implementation:** Distribute the assignments or case study after covering Units 3 and 4. Provide clear guidelines and a rubric for evaluation.
- **Seminar Presentation:**
  - **Format:** Oral presentation on a topic from Unit 5, followed by a Q&A session.

- **Deliverables:** Presentation slides, a summary report in 2 to 3 pages, and performance during the presentation.
- **Implementation:** Schedule the seminar presentations towards the end of the course. Provide students with ample time to prepare and offer guidance on presentation skills.

- **Open Book Test:**
  - **Format:** Analytical and application-based questions to assess depth of understanding.
  - **Implementation:** Schedule the open book test towards the end of the course, ensuring it covers critical aspects of Unit 5.

- **Quiz :**
  - **Format:** Quizzes can help your students practice existing knowledge while stimulating interest in learning about new topic in that course. You can set your quizzes to be completed individually or in small groups.
  - **Implementation:** Online tools and software can be used create quiz. Each quiz is made up of a variety of question types including multiple choice, missing words, true or false etc

- **Example Timeline for conducting CCE:**
  - Weeks 1-4 : Cover Units 1 and 2
  - Week 5 : Conduct Unit Test (12 marks)
  - Weeks 6-8 : Cover Units 3 and 4
  - Week 9 : Distribute and collect Assignments / Case Study (12 marks)
  - Weeks 10-12 : Cover Unit 5
  - Week 13 : Conduct Seminar Presentations or Open Book Test or Quiz (6 marks)

- **Evaluation and Feedback:**
  - **Unit Test:** Evaluate promptly and provide constructive feedback on strengths and areas for improvement.
  - **Assignments / Case Study:** Assess the quality of submissions based on the provided rubric. Offer feedback to help students understand their performance.
  - **Seminar Presentation:** Evaluate based on content, delivery, and engagement during the Q&A session. Provide feedback on presentation skills and comprehension of the topic.
  - **Open Book Test**: Evaluate based on the depth of analysis and application of concepts. Provide feedback on critical thinking and problem-solving skills.

End-Semester Examination (ESE)

End-Semester Examination (ESE) of 70 marks written theory examination based on all the unit of course syllabus scheduled by university. Question papers will be sent by the University through QPD (Question Paper Delivery). University will schedule and conduct ESE at the end of the semester.

- **Format and Implementation :**
  - **Question Paper Design** : Below structure is to be followed to design an End-Semester Examination (ESE) for a theory subject of 70 marks on all 5 units of the syllabus with questions set as per Bloom's Taxonomy guidelines and 14 marks allocated per unit.
  - **Balanced Coverage**: Ensure balanced coverage of all units with questions that assess different cognitive levels of Bloom's Taxonomy: Remember, Understand, Apply, Analyze, Evaluate, and Create. The questions should be structured to cover:
    - Remembering: Basic recall of facts and concepts.
    - Understanding: Explanation of ideas or concepts.

- Applying: Use of information in new situations.
- Analyzing: Drawing connections among ideas.
- Evaluating: Justifying a decision or course of action.
- Creating: Producing new or original work (if applicable).

– **Detailed Scheme for 70 marks:** Unit-Wise Allocation (14 Marks per Unit): Each unit will have a combination of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students' understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

– **Detailed Scheme for 35 marks**: Unit wise allocation (08 Marks for Unit- 1, 09 Marks for Unit- 2, Unit- 3 and Unit- 4): Each unit will have a combinations of questions designed to assess different cognitive levels. By following this scheme, you can ensure a comprehensive and fair assessment of students understanding and application of the course material, adhering to Bloom's Taxonomy guidelines for cognitive skills evaluation.

Open Electives and Value Education Evaluation

Comprehensive Continuous Evaluation (CCE) of 15 marks based on all units of course syllabus to be scheduled and conducted at institute level. To design a Comprehensive Continuous Evaluation (CCE) scheme for a theory subject of 15 marks with the specified parameters, the allocation of the marks and the structure is detailed as follows:

Sr. No	Parameters	Marks	Coverage of units
1.	Unit Test	10 Marks	Unit- 1 and Unit-2 (5 Marks per Unit)
2.	Seminar Presentation/ Open Book Test/ Assignment/ Case Study	5 Marks	Unit- 3 and Unit- 4

Second Year Engineering (2024 Pattern) – Mechatronics Engineering

Semester I

Course Code	Course Type	Course Name	Teaching Scheme			Examination Scheme						Credits			
			Theory	Tutorial	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
PCC-201-MXE	Program Core Course	Sensors and Instrumentation	3	-	2	30	70	-	50	-	150	3	-	1	4
PCC-202-MXE	Program Core Course	Engineering Thermodynamics	3	-	2	30	70	-	-	25	125	3	-	1	4
PCC-203-MXE	Program Core Course	Linear Integrated Circuits	2	-	2	30	70	-	25	-	125	2	-	1	3
	*Open Elective	*Open Elective-I	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-230-MXE	Multidisciplinary Minor	Control System Components	3	-	2	30	70	–	–	25	125	3	-	1	4
EEM-240-MXE	Entrepreneurship / Economics / Management	Fundamentals of Economics and Business Management	-	-	2	-	-	25	-	-	25	-	-	1	1
VEC-250-MXE	Value Education	Universal Human Values and Ethics	2	-	-	15	35	-	-	-	50	2	-	-	2
CEP-260-MXE	Field Projects /Community Engagement Projects	Community Engagement Projects	-	-	4	-	-	50	-	-	50	-	-	2	2
Total			15	-	14	150	350	75	75	50	700	15	-	7	22

***Note:**

Students can opt for Open Electives offered by different faculty like Arts, Science, Commerce ,Management, Humanities or Inter-Disciplinary studies.

Example – Open Elective I - Probability and Statics, Financial Accounting, Digital Finance, Digital Marketing can be opted from Science, Commerce and Management faculty.

Second Year Engineering (2024 Pattern) – Mechatronics Engineering

Semester II

Course Code	Course Type	Course Name	Teaching Scheme			Examination Scheme						Credits			
			Theory	Tutorial	Practical	CCE	EndSem	Term Work	Practical	Oral	Total	Theory	Tutorial	Practical	Total
PCC-204-MXE	Program Core Course	Automatic Control System	3	-	2	30	70	-	25	-	125	3	-	1	4
PCC-205-MXE	Program Core Course	Analysis of Mechanical Structures	3	-	2	30	70	-	-	50	150	3	-	1	4
PCC-206-MXE	Program Core Course	Digital Electronics	2	-	2	30	70	-	25	-	125	2	-	1	3
	*Open Elective	*Open Elective-II	2	-	-	15	35	-	-	-	50	2	-	-	2
MDM-231-MXE	Multidisciplinary Minor	Data Structures	2	-	2	30	70	-	-	25	125	2	-	1	3
VSE- 270-MXE	Vocational and Skill Enhancement Course	Computer Aided Drafting and Computing	-	1	2	-	-	25	-	-	25	-	1	1	2
AEC-280-MXE	Ability Enhancement Course	Modern Indian Language (Marathi/ Hindi)	-	-	2	-	-	25	-	-	25	-	-	1	1
EEM-241-MXE	Entrepreneurship / Economics / Management / Industrial Organization	Economics for Engineers	-	1	-	-	-	25	-	-	25	-	1	-	1
VEC-251-MXE	Value Education Course	Environmental Studies	2	-	-	15	35	-	-	-	50	2	-	-	2
Total			14	02	12	150	350	75	50	75	700	14	2	6	22

***Note:**

Students can opt for Open Electives offered by different faculty like Arts, Science, Commerce ,Management, Humanities or Inter-Disciplinary studies.

Example – Open Elective II - Project Management, Business Analytical, Financial Management can be opted from Inter-Disciplinary studies, Commerce and Management faculty respectively.

Savitribai Phule Pune University, Pune

Maharashtra, India

SE - Mechatronics Engineering

2024 Pattern

Semester I

With effect from Academic Year 2025-26

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
PCC-201-MXE: Sensors and Instrumentation		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week **Practical :** 02 Hours/Week	03 01	**CCE** : 30 Marks **End-Semester**: 70 Marks **Practical**: 50 Marks

Prerequisite Courses, if any :

1. Basic Electrical and Electronics Engineering

Course Objectives:

1. This course gives idea about variety of sensors available and its applications in various fields.
2. Student will learn to design a sensor for a given application at the end of this course.
3. Students also learn about the sensor characteristics and data acquisition for a system under investigation.

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

- **CO1:** Understand the working principle, construction, operation, characteristics and features of sensors and transducers.
- **CO2**: Examine the performance specifications of various sensors and transducers.
- **CO3:** Select sensors and transducers for measurement applications.
- **CO4:** Make use of CRO for measurement of voltage, current and frequency
- **CO5**: Understand the basics of smart sensors.

Course Contents

Unit I - Introduction to Sensors (08 Hours)

Significance of Sensor Measurements, Classification of Sensors, Static characteristics, Dynamic Characteristics, generalized measurement system

Introduction to DAQ, Types, Components of a Data Acquisition System (Sensor, Signal conditioning, processing, controlling and storage/display/action. Amplifier, Conversion, Filtering, Impedance Buffering , Selection criteria of sensors for mechatronic systems

Unit II - Displacement Sensors (08 Hours)

Displacement Measurement: Transducers for displacement, displacement measurement, potentiometer, LVDT, Capacitance Types, Digital Transducers (optical encoder),

Strain Measurement: Theory of Strain Gauges, gauge factor, temperature Compensation, Wheatstone Bridge circuit, orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors

Measurement of Angular Velocity: Tachometers, Digital tachometers and Stroboscopic Methods. Acceleration Measurement, theory of accelerometer and vibrometers

Unit III - Pressure , Flow, Temperature sensors (08 Hours)

Pressure Measurement: Manometers, Bourdon gauges, Elastic pressure transducers, bellows and piezoelectric pressure sensors. Vacuum measurement

Flow Measurement: Bernoullis flowmeters, Ultrasonic Flowmeter, Magnetic flow meter, rotameter.

Temperature Measurement: Resistance thermometers, Thermistors and thermocouples, Pyrometers, thermal cameras

Unit IV - Oscilloscope (08 Hours)

Introduction, General purpose oscilloscope Block Diagram, Cathode Ray Tube, deflection sensitivity, front panel controls, Oscilloscope Probes 1:1 and 10:1, Dual trace CRO, ALT and CHOP modes, measurement of electrical parameters like voltage, current, frequency and phase, frequency measurement by Lissajous pattern and Z-modulation.

Digital Storage oscilloscope block diagram, sampling rate, bandwidth, roll mode

Unit V - Introduction to Smart Sensors (08 Hours)

Evolution from traditional to smart sensors, Definition and architecture of smart sensors, Differences between conventional and smart sensors, Sensing elements and transduction principles, Signal conditioning circuits (amplifiers, filters), DAQ in smart sensors, Communication protocols used in smart sensors. Introduction to wireless sensors.

List of Experiments

Out of following experiment, Any 8 Experiment need to conduct in Lab as part of Practical Examination

1. Study of Measurement Systems
2. Measurement of displacement using LVDT.
3. Evaluate performance characteristics of strain gauge load cell for weight measurement.
4. Compare performance of Orifice and Venturi for flow measurement.
5. Design a signal conditioning circuit for temperature measurement using Thermocouple.
6. Measurement of speed using stroboscope.
7. Measurement of weight using strain gauge load cell.
8. Measurement of Pressure using manometer.
9. Measurement of Pressure using Bellows
10. Characterization of Thermocouples (J/T/K/R/S)
11. Characterization of RTD (PT100)
12. Measurement of voltage, current, time period, frequency & phase angle using CRO.
13. Study of Data Acquisition System.

Learning Resources

- **Text Books:**

1. A. K. Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai & Co.
2. J. B. Gupta, "A Course in Electronics and Electrical Measurements and Instrumentation", S. K. Kataria & Sons
3. W. D. Cooper & A. D. Helfrick, 'Electronic Instrumentation and Measurement Techniques', PHI, 4th e/d, 1987.
4. David Bell, 'Electronic Instrumentation and Measurements', PHI, 2e/d,
5. G. P. Holman,"Experimental Methods for Engineers", McGrawHill, 8th e/d

- **Reference Books:**

1. Anand M. M. S., 'Electronic Instruments and Instrumentation Technology', PHI, 2004, 02nd Ed.
2. Kalsi H. S., 'Electronic Instrumentation', TMH, 2nd or 3rd e/d, 2004/2010.
3. E. W. Golding & F. C. Widdies, "Electrical Measurements & Measuring Instruments", Reem Publications.
4. Dr. Rajendra Prasad, "Electronic Measurements & Instrumentation", Khanna Publishers.
5. Arun K. Ghosh, "Introduction to Measurements and Instrumentation", PHI Publication
6. R. Subburaj, ' Calibration the Foundation for ISO 9000 and TQM
7. Bouwens A. J., 'Digital Instrumentation, McGraw-Hill, second edition

- **MOOC / NPTEL/YouTube Links: -**

1. Biomedical Instrumentation
   https://onlinecourses.nptel.ac.in/noc25_bt49/preview
2. Transducers For Instrumentation
   https://onlinecourses.nptel.ac.in/noc23_ee105/preview
3. Sensors and Actuators
   https://onlinecourses.nptel.ac.in/noc21_ee32/preview
4. Youtube Links
   a) https://www.youtube.com/playlist?list=PLVsrfTSlZ_40qYhVeqtLiNhnQ_40IfOyM
   b) https://www.youtube.com/watch?list=PL5vhyNmOQ5OSOSy63jf7tStFM2p78aUS4

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
PCC-202-MXE: Engineering Thermodynamics		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week **Practical :** 02 Hours/Week	03 01	**CCE** : 30 Marks **End-Semester**: 70 Marks **Oral**: 25 Marks

Prerequisite Courses, if any :

Course Objectives:

1. To introduce the fundamentals of thermodynamics
2. To understand the concepts of laws of thermodynamics
3. To identify the laws for different modes of heat transfer
4. To Understand the fuel combustion process and products of combustion.
5. To undertake the working of a steam generator

Course Outcomes: Upon successful completion of this course, students 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**: IDENTIFY the laws for different modes of heat transfer
- **CO4**: ANALYSE the fuel combustion process and products of combustion
- **CO5**: DESCRIBE the basics of thermodynamics with heat and work interactions

Course Contents

Unit I - Fundamentals of Thermodynamics (06 Hours)

Introduction, Review of basic definitions Macro and Microscopic, Approach, State Postulate, State, Path, Process and Cycles, Point function and Path function, quasistatic 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.

Unit II - Laws of Thermodynamics (10 Hours)

Zeroth law of Thermodynamics, Concept of heat and work, Sign convention and its conversion. First law of thermodynamics, Joules experiments, Equivalence of heat and work., PMM-I kind, 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

Unit III - Modes of Heat Transfers (08 Hours)

Different Modes and Laws of heat transfer, 3-D heat conduction equation in Cartesian coordinates (without derivation), and its simplified equations, simplified equations in cylindrical and spherical coordinates (simplified equations, no derivation) thermal conductivity, Local and average heat transfer coefficient, Hydrodynamic and Thermal boundary layer for a flat plate and pipe flow. 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 .

Unit IV - Fuels and Combustion (08 Hours)

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 V - Steam Generators (08 Hours)

Fire tube and Water tube boiler, Low pressure and high pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories, Layout of a modern HP boiler, Boiler performance, and Boiler efficiency (No Numerical approach). Classification, Necessity of Draught, Natural draught, Determination of Height of chimney, Diameter of chimney, condition for maximum discharge,

List of Experiments

Out of following experiment, Any 8 Experiment need to conduct in Lab as part of Practical Examination

1. Joule's experiment to validate, first law of thermodynamics.
2. Survey of temperature sensors used in various thermal systems.
3. Determination Thermal conductivity of insulating powder.
4. Determination of Emissivity of Test Surface.
5. Determination of HCV of solid or gaseous fuel using Bomb or Junker's calorimeter respectively.
6. Thermodynamic Analysis of any System / Model by using any Computer Software.
7. Determination of local and average heat transfer coefficient in Natural Convection
8. A presentation based case study on fuel supply systems
9. A industrial visit for automobile manufacturing or servicing / boiler System. The visit report consists of :

   a) Details about the Industry/Process Plant.

   b) Operational description of the Equipment with specification, its use, capacity, application etc.

V -LAB LINKS :

1. To determine thermal conductivity of metal s and effect of temperature ,

   https://ht-iitb.vlabs.ac.in/exp/thermal-conductivity-metals/

2. To study conduction through composite slab,

   https://htc1-iitb.vlabs.ac.in/exp/conduction-composite-slab/

Learning Resources

- **Text Books:**

1. P. K. Nag, “Engineering Thermodynamics”, Tata McGraw Hill Publications
2. R. K. Rajput, “Engineering Thermodynamics”, EVSS Thermo, Laxmi Publications
3. Domkundwar, Kothandaraman and Domkundwar,“Thermal Engineering”,Dhanpat Rai Publishers
4. . L Ballaney, “Thermal Engineering”, Khanna Publishers
5. C.P. Arora, “Thermodynamics”, Tata McGraw Hill
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. Van Wylen, 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

- **MOOC / NPTEL/YouTube Links: -**

1. NPTEL Course: Engineering Themodynamics, https://www.youtube.com/watch?v=9GMBpZZtjXM
2. NPTEL Course: Engineering Themodynamics, https://onlinecourses.nptel.ac.in/noc25_ch22/preview

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
PCC-203-MXE: Linear Integrated Circuits		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week **Practical :** 02 Hours/Week	02 01	**CCE** : 30 Marks **End-Semester**: 70 Marks **Practica**l: 25 Marks

Prerequisite Courses, if any :

- Basic Electronics

Course Objectives:

1. To understand fundamental principles of standard linear integrated circuits.
2. To develop an overall approach for students from selection of integrated circuit, study its specification, the functionality, design and practical applications

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

- **CO1:** Analyze and design various linear applications of Op-Amps
- **CO2:** Evaluate and implement non-linear applications of Op-Amps
- **CO3**: Understand and Analyze Converters and Voltage Regulator
- **CO4:** Design applications using Integrated circuit

Course Contents

Unit I - Introduction to Operational Amplifers (06 Hours)

Amplifiers: Adder, subtractor, integrator, differentiator, current amplifier, difference amplifier, instrumentation amplifier

Converters: Current to voltage converters, voltage to current converters

Active Filters: First order active finite gain low pass, high pass, band pass and band reject filters

Sine Wave Oscillators: RC phase shift oscillator and Wien bridge oscillator

Unit II - Applications of the Operational Amplifiers (06 Hours)

Comparators: Inverting comparator, non-inverting comparator, zero crossing detector.

Schmitt Triggers: Inverting and non-inverting Schmitt trigger Waveform Generators: Square wave generator and triangular wave generator with duty cycle modulation

Precision Rectifiers: Half wave and full wave precision rectifiers and their applications, voltage to frequency converter, frequency to voltage converter, logarithmic converters and antilog converters

Unit III - Basic Convertors (08 Hours)

Sample and Hold Circuit, Analog to Digital: Performance parameters of ADC, Single Ramp ADC, ADC using DAC, Dual Slope ADC, Successive Approximation ADC, Flash ADC, ADC0808/0809 and its interfacing

Digital to Analog: Performance parameters of DAC, Binary weighted register DAC, R/2R ladder DAC, Inverted R/2R ladder DAC, DAC0808 and its interfacing

Unit IV - Timers and Regulators (07 Hours)

Functional block diagram, working modes and applications of Timer 555. Functional block diagram, working and applications of VCO 566, PLL 565, multiplier 534, waveform generator XR 2206, power amplifier LM380.

Functional block diagram, working and design of three terminal fixed (78XX series) and three terminals adjustable (LM337) voltage regulators.

List of Experiments

Out of following experiment Any 8 Experiment need to conduct in Lab as part of Practical Examination. Practical should be performed on hardware/ kits. For demonstration and Simulation, one can use simulation-based software like LTSpice,NI Multisim

1. Design/demonstrate the use of op-amp as summing amplifier ii) subtractor
2. Design and obtain frequency response of first/second order Active filter.
3. Design an inverting/non-inverting voltage comparator.
4. Design a Schmitt trigger using IC741 and study its operation.
5. Design and Demonstrate/Simulate a Wien bridge oscillator and observe its output.
6. Design and simulate a precision full wave rectifier.
7. Design a 4- Bit digital to analog converter circuit.
8. Design an Astable Multivibrator Circuit using 555 Timer.
9. Obtain the regulation characteristics of three terminal voltage regulators 7805 and 7812.
10. Design An audio Power Amplifier using LM380.
11. Design a low voltage variable regulator of 2 to 7V using IC 723

Learning Resources

- Text books

1. D. Roy Choudhry, Shail Jain, -Linear Integrated Circuits, New Age International Pvt. Ltd., 2018, Fifth Edition.
2. Sergio Franco, -Design with Operational Amplifiers and Analog Integrated Circuits, 4th Edition, Tata Mc Graw-Hill, 2016

- **Reference Books:**

1. Ramakant A. Gayakwad, -Operational Amplifiers and Linear IC, 4th Edition, Prentice Hall / Pearson Education, 2015.
2. Robert F. Coughlin, Frederick F. Driscoll, -Operational Amplifiers and Linear Integrated Circuits, Sixth Edition, PHI, 2001.
3. B. S. Sonde, -System design using Integrated Circuits , 2nd Edition, New Age Pub, 2001.
4. Gray and Meyer, -Analysis and Design of Analog Integrated Circuits, Wiley International,5th Edition, 2009.
5. William D. Stanley, -Operational Amplifiers with Linear Integrated Circuits, Pearson Education,4th Edition,2001.
6. S. Salivahanan & V.S. Kanchana Bhaskaran, -Linear Integrated Circuits, TMH,2nd Edition, 4 th Reprint, 2016

- **MOOC / NPTEL/YouTube Links: -**

1. NPTEL Course: Integrated Circuits and Applications,
   https://onlinecourses.nptel.ac.in/noc24_ee73/preview
2. NPTEL Course: Digital Electronics Circuit ,
   https://onlinecourses.nptel.ac.in/noc20_ee55/preview

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
MDM-230-MXE: Control System Components		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week **Practical :** 02 Hours/Week	03 01	**CCE** : 30 Marks **End-Semester**: 70 Marks **Oral:** 25 Marks

Prerequisite Courses, if any :
- Basic Electrical and Electronics Engineering
- DC/AC Motors

Course Objectives:

1. To Understand basic principles of sensing various parameters
2. To Develop mathematical background of sensor design
3. To Learn selection of sensors for typical applications

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

- **CO1:** Implement logic gates using relays.
- **CO2:** Develop electrical circuits for motor control operations.
- **CO3:** Construct pneumatic circuits for control applications using appropriate pneumatic components
- **CO4:** Construct hydraulic circuits for control applications using appropriate hydraulic components.
- **CO5:** Understand the need of electronic safety circuits.

Course Contents

Unit I - Industrial Control Devices (08 Hours)

Switches: Construction, symbolic representation, working, application of Toggle switch, Slide switch, DIP switch, Rotary switch, Thumb wheel switch, Selector switch, Push button, Drum switch, Limit switch, Temperature switch, Pressure switch, Level switch, Flow switch.

Relays: Construction, working, specifications/selection criteria and applications of Electromechanical relay, Reed relay, Hermetically sealed relay, Solid state relays.

Contactors: Construction, working, specifications and applications of contactors and their comparison with relays

Unit II - DC Motors (08 Hours)

DC Motor: Types of DC Motors, principle of operation, EMF equation-characteristics and control.

DC Servomotor – Types of PMDC & BLDC motors – principle of operation- EMF and torque equations – characteristics and control

Construction, working & applications of: Synchros (Transmitter and Receiver), Standard symbols used for Electrical Wiring Diagram, Electrical Wiring Diagram in relation to motors

Unit III - AC Motors (08 Hours)

Three phase Induction Motor: Constructional features, working principle types, torque equation, torque-slip characteristics, control

Single Phase Induction Motor: Constructional features, working principle, types, torque equation, torque-slip characteristics, control

Protection of motors: Short circuit protection, over load protection, Low/Under voltage protection, Phase reversal Protection, Over temperature protection.

Unit IV - Introduction to Pneumatic Components (08 Hours)

Pneumatic components: Pneumatic Power Supply and its components ,Pneumatic relay Single acting & Double acting cylinder, Special cylinders: Cushion, Double rod, Tandem, Multiple position, and Rotary, Pneumatic valves,

Pneumatic Circuits: Standard Symbols used for developing pneumatic circuits, Different Pneumatic Circuits: Reciprocating, Sequencing, Direction control and Speed regulation.

Unit IV - Introduction to Hydraulic components (08 Hours)

Hydraulic components: Hydraulic supply, Hydraulic pumps, Actuator (cylinder & motor), Hydraulic valves

Hydraulic Circuits: Standard Symbols for developing hydraulic circuits, Different Hydraulic Circuits: Meter in, Meter out, Reciprocating, speed control, Sequencing of cylinders and Direction
control.
Comparison of Pneumatic, Hydraulic & Electrical systems.

List of Experiments

Students are expected to perform Minimum 8 Experiments :

1. Implementation of Logic Gates using relays.
2. Study of various pneumatic and hydraulic components and power supplies.
3. Implementation and testing of Pneumatic circuits.
4. Implementation and testing of Hydraulic circuits.
5. Study of Synchro transmitter and receiver system
6. Study of Pressure/temperature/level/flow Switches (any two).
7. Study of Motor control Center based on industrial visit.
8. Study and Calibration of P/I converter.
9. Demonstration & study of auxiliary components
10. Evaluate a performance of a dc motor by load test.
11. Perform a load test on a synchronous motor to estimate its efficiency
12. Study of commercial AC and DC drives.

Learning Resources

- Text books

1. Industrial Electronics, Petruzella, McGraw-Hill, ISE Editions
2. Pneumatic Instrumentation, Majumdhar, TMH, 01st Edition
3. Industrial Hydraulics, Pipenger, McGraw-Hill Education, 3rd Edition
4. Process Control, Instrument Engineering Hand book, B.G. Liptak, Butterworth-Heinemann Ltd, 3rd Edition

- **Reference Books:**

1. Pneumatics, Festo Didactic
2. Hydraulics, Festo Didactic

3. Process control and Instrument technology, C.D.Johnson, TMH, 07th Ed.

- **MOOC / NPTEL/YouTube Links: -**

1. Industrial Automation and Control
   https://onlinecourses.nptel.ac.in/noc25_ee42/preview
2. https://archive.nptel.ac.in/courses/108/105/108105062/
3. Youtube Video
   (a) https://www.youtube.com/watch?v=OvUvYQttDQg
   (b) https://www.youtube.com/watch?v=hSXSu7wYepE
   (c) https://www.youtube.com/watch?v=WYJVkeXlv5M

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
EEM-240-MXE: Fundamentals of Economics and Business Management		
Teaching /scheme	**Credits**	**Examination Scheme**
Practical : 02 Hours/Week	01	**Term Work**: 25 Marks

Prerequisite Courses, if any :
Course Objectives:

1. To facilitate students in understanding the fundamental concepts and principles of business management;
2. Need for setting the objectives, the basic roles, skills, functions of management, basic concepts of economics with major emphasis on demand and supply
3. To make them aware about the essential factors of production, various types of costs along with break-even analysis and market structure.

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

- **CO-1** Acquainted with the basic concepts of Economics with major emphasis on demand and supply, essential factors of production, various types of costs along with break-even analysis and market structure.
- **CO-2** Acquainted with the fundamental concepts and principles of management; need for setting the objectives, the basic roles, skills, functions of management.
- **CO-3** Acquainted with marketing fundamentals and financial management with an insight to managerial and financial accounting reports.
- **CO-4** Acquainted with production management containing methods of production, plant location, plant layout and production planning & control, human resource management and concept and principles of TQM, ISO9000 and Six Sigma

Course Contents

Unit I -

Nature of Organization: Aim of organization, Need for corporate objectives, Types of business organization. Introduction to Management: Definitions, Management & Administration, levels, skill, types and roles of managers, Management concepts: Scientific Management Theory, Classical Organization Theory, Management Science Approach, Functions of Management: Planning, Organizing, Staffing, Directing, Controlling, Coordinating

Unit II

Human Resource Management: Recruitment & Selection, Appraisal of employees; Theories of Motivation: Maslow's theory of Hierarchy of needs and McGregory's theory X and Y, Introduction to Corporate Social Responsibility; Ethics Financial Management: Need for monetary control, financial accounting- balance sheet, profit and loss account, ratio analysis; Management accounting: costing, marginal costing, depreciation

Unit III

Introduction to Marketing management: Marketing Mix, concepts of marketing, demand forecasting and its qualitative methods, market segmentation Markets: Meaning, types of markets & their characteristics (Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly)

Unit IV

Production Management: Organization of manufacturing- Job production, batch production, flow production, group technology; Production planning & control: Planning, routing, scheduling, dispatching, expediting, inspection; Plant location and plant layout Introduction to TQM, ISO9000, Six Sigma: Basic concept, principle, brief methodology

Unit IV

Introduction to Economics: Definitions, foundation stones of economics, types of goods; Difference between Microeconomics & Macroeconomics; Theory of Demand & Supply: meaning, determinants, law of demand, law of supply, equilibrium between demand & supply; Elasticity: elasticity of demand, price elasticity, income elasticity, cross elasticity

List of Experiments

Practical's are based on the above units.

Guidelines for Internal Evaluation:

The internal evaluation comprised of assignment along with combination of various components such as Certification courses Mini Project, Simulation, Model making, Case study, Group activity, Seminar, Poster Presentation, Unit test, Quiz, Class Participation, Attendance.

Learning Resources

- Text books

1. Management in Engineering – Principles and Practice, by Gail Freeman-Bell & James Balkwill, Prentice Hall India Publication
2. Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publication
3. Engineering Management, By A. K. Gupta, S. Chand Publication

- **Reference Books:**

1. Fundamentals of Business Organization & Management by Y K Bhushan, S. Chand & Sons, New Delhi
2. Principles of Economics, By N. Gregory Mankiw, Thomson- South Western Publication
3. Management by Stoner, J., PEARSON EDUCATION

- **MOOC / NPTEL/YouTube Links: -**

1. NPTEL: https://nptel.ac.in/courses/110/105/110105067/
2. NPTEL: https://nptel.ac.in/courses/110/105/110105123/

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
VEC-250-MXE: Universal Human Values and Professional Ethics		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory: 02 Hours/Week	02	**CCE:** 15 Marks **End-Semester**: 35 Marks

Prerequisite Courses, if any :

1. Student Induction Program (SIP)

Course Objectives: The course aims to:

1. To help the students develop a holistic, humane world-vision, and appreciate the essential complementarity between values and skills to ensure mutual happiness and prosperity
2. To elaborate on 'Self-exploration' as the process for Value Education
3. To facilitate the understanding of harmony at various levels starting from self and going towards family and society.
4. To elaborate on the salient aspects of harmony in nature and the entire existence
5. To explain how the Right understanding forms the basis of Universal human values and definitiveness of Ethical human conduct.
6. To provide the vision for a holistic way of living and facilitate transition from chaotic life to an orderly life.

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

- **CO1**: Recognize the concept of self-exploration as the process of value education and see they have the potential to explore on their own right.
- **CO2**: Explore the human being as the coexistence of self and body to see their real needs / basic aspirations clearly.
- **CO3**: Explain relationship between one self and the other self as the essential part of relationship and harmony in the family.
- **CO4**: Interpret the interconnectedness, harmony and mutual fulfilment inherent in the nature and the entire existence.
- **CO5**: Draw ethical conclusions in the light of Right understanding facilitating the development of holistic technologies production systems and management models.

Course Contents

Unit I - Introduction to Value Education (03 Hours)

(i) Understanding Value Education
(ii) Self-exploration as the Process for Value Education
(iii) Continuous Happiness and Prosperity - the Basic Human Aspirations and their Fulfilment
(iv) Right Understanding, Relationship and Physical Facility
(v) Happiness and Prosperity - Current Scenario
(vi) Method to Fulfil the Basic Human Aspirations

Unit II - Harmony in the Human Being (03 Hours)

(i) Understanding Human being as the Co-existence of the Self and the Body
(ii) Distinguishing between the Needs of the Self and the Body
(iii) The Body as an Instrument of the Self
(iv) Understanding Harmony in the Self

(v) Harmony of the Self with the Body
(vi) Programme to Ensure self-regulation and Health

Unit III -Harmony in the Family and Society (03Hours)

(i) Harmony in the Family - the Basic Unit of Human Interaction "Trust' - the Foundational Value in Relationship
(ii) 'Respect' - as the Right Evaluation
(iii) Values in Human-to-Human Relationship
(iv) Understanding Harmony in the Society
(v) Vision for the Universal Human Order
Case study:

Unit IV -Harmony in the Nature (Existence) (03 Hours)

(i) Understanding Harmony in the Nature
(ii) Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature
(iii) Realizing Existence as Co-existence at All Levels
(iv) The Holistic Perception of Harmony in Existence
Case study :

Unit V -Implications of the Holistic Understanding - Professional Ethics Look (08Hours)

(i) Basis for Universal Human Values
(ii) Definitiveness of (Ethical) Human Conduct
(iii) Professional Ethics in the light of Right Understanding
(iv) A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order
(v) Holistic Technologies, Production Systems and Management Models Typical Case Studies
(vi) Strategies for Transition towards Value-based Life and Profession
Case study:

Learning Resources

Text Books:

1. A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-7-3 (Printed Copy), 978-81-957703-6-6 (e-book)
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, GP Bagaria, 3rd revised edition, UHV Publications, 2023, ISBN: 978-81-957703-5-9 (Printed Copy), 978-81-957703-0-4 (e-Book)

Reference Books:

1. P. L. Dhar, R. R. Gaur, 1990, Science and Humanism, Commonwealth Publishers.
2. A. Nagaraj, 1999, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak
3. B. P. Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
4. A. N. Tripathy, 2003, Human Values, New Age International Publishers.
5. E. G. Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press
6. B. L. Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
7. M. Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics and Human Values, Eastern Economy Edition, Prentice Hall of India Ltd.
8. M. K. Gandhi, "The Story of my Experiments with Truth", Discovery Publisher

MOOC / NPTEL/YouTube Links: -

1. Swayam Course on "Understanding Human Being Nature and Existence Comprehensively" by Dr. Kumar Sambhav, Director, UP Institute of Design (UPID), Noida.

   https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

2. NPTEL Course on "Exploring Human Values: Visions of Happiness and Perfect Society" by Prof. A. K. Sharma, Department of Humanities and Social Sciences, IIT Kanpur.

   https://nptel.ac.in/courses/109104068

E-Resources: -

1. https://fdp-si.aicte-india.org/download.php#1/
2. https://madhyasth-darshan.info/postulations/knowledge/knowledge-of-humane-conduct/
3. https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

Guidelines for Continuous Assessment

Considering the specific nature of this course, the methodology is exploration based and thus universally adaptable. In order to connect the content of this course with practice, minimum two group activities must be conducted with active involvement of the students. 50 % of the continuous assessment should be strictly based on the participation of the students in the following activities.

Sr	Objectives	Expected Outcome
1	Sharing about Oneself : Introduction of students with following points yourself, family, friends, achievements and failures, your aspirations from life. How do you expect to fulfil these aspirations and live a life of fulfillment?	The students start exploring themselves; get comfortable with each other and with the teacher and start appreciating the need and relevance of the course.
2	Exploring Human Consciousness Watch and discuss the documentary video "Story of Stuff". It is a about the materials economy – its motivation, process and outcome. (Source: http://storyofstuff.org/movies/story-of-stuff)	The students start finding that right understanding is the basic need of human being; followed by relationship and physical facility. They also start feeling that lack of understanding of human values is the root cause
3	Exploring right understanding Make a list of your desires. Now for each item on the list, find out what would be necessary to fulfil it, i.e. will it require: (a) Right understanding? (b) Relationship (right feeling)? (c) Physical facility?	Students start feeling that lack of understanding of human values is the root cause of all problems and the sustained solution could emerge only through understanding of human values and value-based living.
4	Exploring Natural Acceptance Observation within the faculty of 'Natural Acceptance', based on which you can verify what is right or what is not right for you. Make a list of the problems in your family. For each problem, find out the most significant reason: is it related to lack of right understanding, lack of feelings in relationship or lack of physical facility? Also, find out how much time and effort you have devoted for each in the last one week.	The students are able to see that self-verification must be based on their natural acceptance. In many cases, their actual living is not in accordance with their natural acceptance. In addition, lack of feeling in relationship is the major cause of problems in their family and with friends.

5	Exploring the difference of Needs of Self and Body Take the list of desires you made in Practical 2. Update it if required. Now classify the desires as being related to the need of the Self or need of the Body	The students are able to relate their desires to need of the Self and the Body distinctly. They are able to see that the Self and the Body are two distinct realities, and large parts of their desires are related to the need of the Self (and not the Body).
6	Exploring Sources of Imagination in the Self Recall the times that your body has been ill (in disharmony) in the last 3 years. What steps were taken to restore the harmony of the Body? If you were to take full responsibility for your body, (i.e. you had the feeling of self-regulation), what kind of daily schedule would you have? Approximately how much time would you allocate for keeping your body in good health?	The students are able to list down activities related to proper upkeep of the Body and practice them in their daily routine. They are also able to appreciate the plants growing in and around the campus, which can be beneficial in maintaining their health and even curing common ailments.
7	Exploring the Feeling of Trust Show & discuss the video "Right Here Right Now". It is a short film directed by Anand Gandhi about human behaviour and its propagation. www.youtube.com/watch?v=OVAokeqQuFM www.youtube.com/watch?v=gIYJePEnvUY).	The students are able to see that the natural acceptance (intention) of everyone is to be happy and make others happy! It is the competence is lacking in themselves and in others. They are able to distinguish between reaction and response, appreciate the need for 100% response in human-human interaction and make effort towards it.
8	Exploring the Feeling of Respect List out ten or more of your interactions with other people in your family and friends in the last one week. Now analyse these interactions were over-evaluation, under/ otherwise evaluation or right evaluation of the other? In each interaction, were you comfortable within, uncomfortable within or unaware of your state?	The students are able to see that respect is the right evaluation (of intention and competence). Only right evaluation leads to fulfillment in relationship. Over evaluation leads to ego and under/otherwise evaluation leads to depression.
9	Exploring Systems to fulfil Human Goal Assuming that you would like to see your hostel/ educational institution/ workplace/ neighborhood as a model of human society, write down its goal(s) and the system to achieve these goals.	The students are able to see that as a family, a society, the comprehensive human goal is naturally acceptable to all. They are able to see that the systems required for their fulfilment include; Education-Sanskar, Health-Self regulation, Production-Work, Justice-Preservation and Exchange-Storage. Meaningful participation by every individual, every family, every family cluster... every village, town, city... country and the whole world is required in these systems for the human goals to be fulfilled.
10	Exploring the Four Orders of Nature Watch and discuss the documentary video "An Inconvenient Truth". It is about global climate change presented by Former US Vice President Al Gore. He raises the question "What were you doing when you had the time to do something?" (Source: http://an-inconvenient-truth.com/)	The students are able to appreciate the interconnectedness, interdependence and the relationship of mutual fulfilment existing in nature. They are able to see that they have a natural acceptance to participate in a mutually fulfilling manner in nature.

11	Exploring Co-existence in Existence Observe your Self. Are you in space? Are you getting energy from the body? Is your energy dependent on the body? When your body is sick, does your energy to think diminish? Are you energized in space? Is the body dictating you? Are you self-organized in space?	The students are able to obtain a holistic vision about the existence. It is in the form of co-existence, rather than a chaos. Every unit is energized, self-organized and is participating with other units in an orderly manner for mutual-fulfilment. It is only the human being without right understanding, which is violating this underlying co-existence. They are able to appreciate the need to understand the co-existence in existence.

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
CEF-260- MXE: : Community Engagement Project		
Teaching /scheme	**Credits**	**Examination Scheme**
Practical : 04 Hours/Week	02	**Term Work :** 50 Marks

Companion Course :

1. CEP is an experiential learning approach that combines education, learning, community development, and meaningful community service.
2. Project involves students in community development and service activities and applies the experience to personal and academic development.
3. The targeted contribution of college students to the village/local development will benefit the community.
4. The college has an opportunity to help students become more socially conscious and responsible while simultaneously becoming a socially conscious organization.

Course Objectives: The course aims to:

1. Establish a mutually beneficial relationship between the college and the community
2. Opportunities to engage with their local community, fostering empathy, teamwork, and problem-solving skills while contributing positively to their surroundings.
3. An understanding of the challenges faced by the local community and the role of engineering in addressing those challenges.
4. The ability to apply technical knowledge and skills to design solutions or interventions that create a positive impact on the community.
5. The skills to evaluate and critically analyze the outcomes of their engagement activities, deriving actionable insights for sustainable impact

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

1. **CO1** - **Identify** and **Analyze** local community needs and challenges by engaging with stakeholders and evaluating real-world problems.
2. **CO2**- **Design** and **Implement** practical, creative, and context-specific solutions using engineering principles to address community issues.
3. **CO3** - **Reflect** and **Evaluate** the effectiveness of their interventions and articulate lessons learned through reports and presentations.

Course Contents

Implementation

- A group of 3 to 4 students or a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay/college premise.
- Each group is allotted to a faculty member of the department as a mentor.
- The group of students will be associated with a government official / village authorities /NGOs etc. concerned, allotted by the district administration, during the duration of the project.
- The Community Engagement Project should be different from the regular programmes of NSS/NCC/Green Club/Hobby Clubs, Special Interests Groups etc
- An activity book has to be maintained by each of the students to record the activities undertaken/involved and will be countersigned by the concerned mentor/HoD.

- Project report shall be submitted by each student/group of students.
- An internal evaluation shall also be conducted by a committee constituted by the HoD. Evaluation to be done based on the active participation of the student and marks could be awarded by the mentor/HoD.
- Students groups can conduct an awareness programme on Health and Hygiene or in Organic Farming or in Fisheries or in advocating prohibition of liquor or about renewable energy, e-waste management or any other activity in an area of their studies and as per his/her aptitude.

Suggestive list of topics under Community Engagement Project

The below lists are not exhaustive and open for HoD's or mentors to add, delete or modify. It is expected that the focus should be on specific local issues in their nearby areas.

The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a student/group of students shall

- Use and/or miss-use of cell phones
- Career orientation of youth
- Water facilities and drinking water availability
- Health and hygiene of the school going students, home makers and old personals
- Health intervention and awareness programmes
- Horticulture
- Herbal and Nutrition
- Traditional and Modern health care methods
- Food habits
- Air /Sound /Water pollution
- Plantation and Soil protection
- Renewable energy and Solar Systems
- Yoga awareness and practice
- Health care awareness programmes and their impact
- Organic farming
- Food adulteration
- Incidence of Diabetes and other chronic diseases
- Blood groups and blood levels
- Chemicals in daily life
- Music and dance
- Women education and empowerment

Project Scope

- Conduct workshops or awareness drives on topics like digital literacy, environmental sustainability, mental health, or career planning for local stakeholders.

- Develop a simple prototype or solution that addresses a real-world problem (e.g., a water-saving device, simple mobile apps, or tools for community use).
- Organize clean-up drives, tree plantations, recycling campaigns, or energy conservation initiatives.
- Promote health through awareness programs on hygiene, nutrition, and exercise.
- Teach basic computer or technical skills to students, staff, or the community

Proposal Submission

CEP Group should Submit a two-page project proposal, preferably prior to the term commencement outlining the following:-

- Title of the project
- Aim, Objective and expected outcome
- Plan of execution (timeline and activities).
- Place of the CEP and involvement of any local authority, NGP
- Required resources (if any).
- Get approval from the designated faculty mentor.

Learning Resources

Text Books:

1. Waterman, A. Service-Learning: A Guide to Planning, Implementing, and Assessing Student Projects. Routledge, 1997.
2. Beckman, M., and Long, J. F. Community-Based Research: Teaching for Community Impact. Stylus Publishing, 2016.
3. Design Thinking for Social Innovation. IDEO Press, 2015.
4. Dostilio, L. D., et al. The Community Engagement Professional's Guidebook: A Companion to The Community Engagement Professional in Higher Education. Stylus Publishing, 2017

- **MOOC / NPTEL/YouTube Links:**

1. NPTEL course: Ecology and Society https://onlinecourses.nptel.ac.in/noc20_hs77/preview

Web Links: -

1. UNESCO: Education for Sustainable Development https://www.unesco.org
2. EPICS (Engineering Projects in Community Service) https://engineering.purdue.edu/EPICS
3. Ashoka: Innovators for the Public https://www.ashoka.org
4. Design for Change https://www.dfcworld.com

Savitribai Phule Pune University, Pune

Maharashtra, India

SE - Mechatronics Engineering

2024 Pattern

Semester II

With effect from Academic Year 2025-26

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
PCC-204-MXE: Automatic Control System		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week **Practical :** 02 Hours/Week	03 01	**CCE** : 30 Marks **End-Semester**: 70 Marks **Practical:** 25 Marks

Prerequisite Courses, if any :

- Concepts of Network theory and Mathematics

Course Objectives:

1. Understand the basic components of control system, types of control systems.
2. Learn to determine relationship between system input / output.
3. Learn to develop system's mathematical models.
4. To understand the basic mathematical tools for analysis of the control systems

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

- **CO1:** Classify the control systems.
- **CO2:** Develop mathematical models of control systems.
- **CO3:** Analyze the Linear time invariant system in time and frequency domain.
- **CO4:** Get familiar with modern control theory.

Course Contents

Unit I - Introduction to Control Systems (10 Hours)

Basic concept of control system, classification of control systems: Open Loop and Closed Control System, Laplace Transform and inverse Laplace transform, its properties, solving linear differential equation using Laplace Transform, Transfer Function, concept of pole and zero, Modeling of Electrical and Mechanical systems using differential equations and transfer function, analogy between electrical and mechanical systems, Block diagram algebra, Signal Flow Graph: Mason's gain formula

Unit II - Time domain analysis of Control System (08 Hours)

Standard test signals: step, ramp, parabolic and impulse signal, type and order of control system, Concept of transient and steady state response, 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, steady state error and static error coefficients.

Unit III - Stability Analysis (08 Hours)

Concept of Stability in s domain, Classification of Stability (BIBO stability and asymptotic stability), stability analysis by Hurwitz criterion and Routh array, concept of relative stability and its analysis using Routh array.

Stability in Time Domain: Concept of Root Locus, Root Locus Design Techniques, Parameter Design by the Root Locus Method, Sensitivity, and the Root Locus

.

Unit IV - Frequency Domain Analysis (08 Hours)

Fundamentals of frequency response, Bode plot, with and without dead time, determination of transfer function from asymptotic Bode plot, Polar plot, Nyquist plot

Unit V - Control Actions and Tuning (06 Hours)

Process Characteristics: Process equation, capacity, self – regulation, disturbances, control lag, process lag, distance/velocity lag (dead time). Control actions (ON-OFF, proportional, integral, derivative, proportional

plus integral, proportional plus derivative, proportional plus integral plus derivative, Controller tuning by Ziegler-Nichols methods, Cohen Coon tuning method.

List of Experiments

Students are expected to perform Minimum 8 Experiments :

1. Introduction to Control System Toolbox in MATLAB.
2. Introduction to Simulink (Basic blocks used in Control system).
3. Calculation of time domain specifications.
4. Stability analysis using root locus approach.
5. Calculation of Steady state error of Type 0, 1, 2 systems.
6. Stability analysis using frequency response approach (Bode plot approach).
7. Simulation of controller settings of P, PI, PID controllers (Kp, Ti, Td) obtained through Ziegler Nichols method, Cohen-Coon method.
8. Step Response of RC electrical system.
9. Study of under damped, over damped and critically damped response of second order system (RLC electrical ckt).
10. Case study on control system.

(Experiment No:1 to 7 to be performed on MATLAB software, Expt.No.8 and 9 to be performed on hardware setup.)

Learning Resources

- Text books

1. I. J. Nagrath, M. Gopal, “Control System Engineering”, New Age International Publishers, 05th Ed.
2. B. S. Manke, “Linear Control Systems”, Khanna Publishers, New Delhi, 02nd Ed.
3. A. K. Jairath, “Problems and Solutions of Control Systems”, CBS Publishes, New Delhi, 06th Ed.
4. S. K. Bhattacharya, “Control System Engineering”, Pearson India, 02nd Ed.

- **Reference Books:**

1. K. Ogata, “Modern Control Engineering”, PHI, New Delhi, 06th Ed..
2. Norman S. Nise, “Control System Engineering”, John Wiley and Sons, 07th Ed.
3. B. C. Kuo, “Automatic Control Systems”, PHI, New Delhi, 07th Ed.

- **MOOC / NPTEL/YouTube Links: -**

1. Control Systems
   https://onlinecourses.nptel.ac.in/noc20_ee90/preview
2. Control Engineering
   https://onlinecourses.nptel.ac.in/noc19_ee42/preview
3. Industrial Automation and Control
   https://onlinecourses.nptel.ac.in/noc25_ee42/preview

4. https://archive.nptel.ac.in/courses/108/105/108105062/
5. Youtube Video
    (a) https://www.youtube.com/watch?v=OvUvYQttDQg
    (b) https://www.youtube.com/watch?v=hSXSu7wYepE
    (c) https://www.youtube.com/watch?v=WYJVkeXlv5M

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
PCC-205-MXE: Analysis of Mechanical Structures		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 03 Hours/Week **Practical :** 02 Hours/Week	03 01	**CCE** : 30 Marks **End-Semester**: 70 Marks **Oral:** 50 Marks

Prerequisite Courses, if any :

• 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

Course Outcomes: Upon successful completion of this course, students 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.

Course Contents

Unit I - Simple Stress & Strain (08 Hours)

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 - SFD & BMD (06 Hours)

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 - Bending Stress on a Beam (10 Hours)

Introduction to bending stress on a beam with application, Theory of Simple bending, assumptions in pure bending, 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

Unit IV -Torsion of circular shafts (08 Hours)

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 (08 Hours)

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

List of Experiments

Students are expected to perform Minimum 8 Experiments :

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 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

Learning 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

MOOC / NPTEL/YouTube Links: -

1. NPTEL Course: Strength of Materials,
   https://nptel.ac.in/courses/112107146
2. NPTEL Course: Solid Mechanics,
   https://archive.nptel.ac.in/courses/112/102/112102284/#
3. Prof. S.K. Bhattacharyya, IIT Kharagpur , “NPTEL Web course material”
   https://drive.google.com/file/d/1N2Eyv9ofPimIT2OSMZeMrSxe68Ulclei/view?usp=sharing

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
PCC-206-MXE: Digital Electronics		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week **Practical :** 02 Hours/Week	02 01	**CCE** : 30 Marks **End-Semester**: 70 Marks **Practical:** 25 Marks

Prerequisite Courses, if any :

- Basic Electrical and Electronics Engineering
- Engineering Physics / Applied Physics
- Mathematics for Engineers

Course Objectives:

1. To provide students with a strong foundation in Boolean algebra and logic circuit design, enabling them to analyze and construct optimized combinational and sequential digital circuits.
2. To familiarize students with various digital circuit components such as subtractors, multiplexers, encoders, decoders, counters, and shift registers, and their applications in Mechatronics systems.
3. To introduce different logic families and memory devices, highlighting their characteristics and role in modern digital systems.
4. To prepare students for applying digital design principles in embedded systems, industrial automation, and intelligent electromechanical systems, which are core areas of Mechatronics Engineering.

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

- **CO1**: ANALYZE AND SIMPLIFY Boolean expressions using algebraic and graphical methods (K-Map) for logic circuit optimization.
- **CO2**: DESIGN AND IMPLEMENT combinational logic circuits such as multiplexers, demultiplexers, encoders, decoders, comparators, and subtractors.
- **CO3**: CONSTRUCT AND ANALYZE sequential logic circuits including flip-flops, counters, and shift registers.
- **CO4**: COMPARE AND EVALUATE digital logic families and memory devices used in embedded and control systems.

Course Contents

Unit I - Boolean Algebra and Combinational Logic Design (06 Hours)

Overview of Digital System Design in Mechatronics, Boolean Algebra: Basic Identities, Laws, Algebraic Simplification Techniques, Standard Forms: SOP and POS, Karnaugh Map Simplification (Up to 4 Variables), Don't Care Conditions in K-Map, Design and Implementation of Simple Combinational Circuits

Unit II - Combinational Circuits and Applications (06 Hours)

Design of Adders: Ripple Carry Adder, Subtractors: Half and Full Subtractors, Multiplexers (MUX): Concept and Applications, Demultiplexers (DEMUX), Encoders and Decoders, Comparators: 1-bit and 4-bit,Parity Generators and Checkers, Use of Combinational Circuits in Mechatronics Subsystems

Unit III - Sequential Logic Circuits (06 Hours)

Concept of Clocking and Timing in Digital Circuits, Flip-Flops: SR, D, JK, T (Edge-triggered), Master-Slave Flip-Flops, Applications of Flip-Flops, Counters: Asynchronous and Synchronous (Up/Down),Mod-N Counters, Shift Registers: SISO, SIPO, PISO, PIPO, Use of Sequential Circuits in Mechatronic Devices

Unit IV - Logic Families and Memory Devices (07 Hours)

Logic Families: TTL, CMOS – Characteristics and Comparison, Parameters: Fan-in, Fan-out, Propagation Delay, Noise Margin, Memory Types: ROM, RAM (Static & Dynamic), PROM, EPROM, EEPROM, Basics of Memory Organization and Addressing, Memory Interfacing Techniques (Basic Concepts), Introduction to Programmable Logic Devices: PAL, PLA, FPGA – Basic Architecture & Use Case

List of Experiments

Students are expected to perform Minimum 8 Experiments :

1. Implementation of SOP and POS Expressions using Logic Gates
2. Algebraic Simplification and Realization of Boolean Expressions
3. Simplification Using Karnaugh Map (K-Map) – 3 and 4 Variables
4. Design and Implementation of 4-bit Ripple Carry Adder using IC 7483
5. Design and Implementation of Half and Full Subtractor
6. Design and Implementation of a 2-to-1 and 4-to-1 Multiplexer using Basic Gates
7. Design and Verification of 3-to-8 Decoder using IC 74138
8. Implementation of a Binary to Gray Code Converter using Logic Gates
9. Design and Implementation of 4-bit Comparator using ICs
10. Design and Implementation of a Parity Generator and Checker (Even/Odd)
11. Application-Based Practical: Use MUX as Logic Function Generator (e.g., F = AB + A'C)

Learning Resources

- Text books

1. Thomas L. Floyd – Digital Fundamentals, Pearson Education
2. R. P. Jain – Modern Digital Electronics, Tata McGraw-Hill
3. M. Morris Mano – Digital Logic and Computer Design, Pearson Education

- **Reference Books:**

1. Donald P. Leach and Albert Paul Malvino – Digital Principles and Applications, McGraw-Hill
2. John F. Wakerly – Digital Design: Principles and Practices, Pearson
3. Anand Kumar – Fundamentals of Digital Circuits, PHI Learning

4. William H. Gothmann – Digital Electronics: An Introduction to Theory and Practice, Prentice Hall

MOOC / NPTEL/YouTube Links: -

1. Digital Circuits – Prof. S. Srinivasan, IIT Madras,
   https://nptel.ac.in/courses/117106086
2. Digital Systems Design – Prof. D. Roy Choudhury, IIT Delhi,
   https://nptel.ac.in/courses/117102061
3. Switching Circuits and Logic Design – Prof. A.N. Chandorkar, IIT Bombay,
   https://nptel.ac.in/courses/108101090
4. Neso Academy – Digital Electronics Full Course,
   https://www.youtube.com/playlist?list=PLBlnK6fEyqRh6isJ01MBnbNpV3ZsktSyS
5. Gate Smashers – Digital Electronics (Beginner to Advanced,
   https://www.youtube.com/playlist?list=PLmXKhU9FNesQn2tMvv3t2xw6CJ2hRYIQv

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
MDM-231-MXE: Data Structures		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week **Practical :** 02 Hours/Week	02 01	**CCE** : 30 Marks **End-Semester**: 70 Marks **Oral:** 25 Marks

Prerequisite Courses, if any :

- Basic Electrical and Electronics Engineering
- Engineering Physics / Applied Physics
- Mathematics for Engineers

Course Objectives:

1. To provide students with a strong foundation in Boolean algebra and logic circuit design, enabling them to analyze and construct optimized combinational and sequential digital circuits.
2. To familiarize students with various digital circuit components such as subtractors, multiplexers, encoders, decoders, counters, and shift registers, and their applications in Mechatronics systems.
3. To introduce different logic families and memory devices, highlighting their characteristics and role in modern digital systems.
4. To prepare students for applying digital design principles in embedded systems, industrial automation, and intelligent electromechanical systems, which are core areas of Mechatronics Engineering.

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

- **CO1**: Understand various data representation techniques in the real world.
- **CO2**: Analyze and implement various searching and sorting techniques
- **CO3**: Analyze various algorithms based on their time and space complexity.
- **CO4**: Implement tree and graph algorithms and identify suitable data structure to solve various computing problems

Course Contents

Unit I - Python Basics (06 Hours)

Variables, Data Types, Loops and Conditionals, Functions, Lambda Expressions, List Comprehension, Python Modules (Collections, Queue, Etc.).

Unit II - Linked List and Sorting Algorithms (06 Hours)

Linked List - Node Creation, Node Structure, Insert, Delete, Traverse, Singly Linked List, Doubly Linked, Reversing a Linked Lit, List, Circular Linked List, Comparison to Python Lists and Applications of Linked Lists.

Unit III - Recursion, Searching and Sorting Algorithms (06 Hours)

Recursion- Base Case and Recursive Case, Call Stack Visualization, Examples Like Factorial, Fibonacci, Reverse String, Tower of Hanoi, Recursion Vs Iteration.

Sorting & Searching Algorithms - Bubble Sort, Insertion Sort, Merge Sort, Quicksort, Stable

Sorting, Linear Search and Binary Search.

Unit IV - Trees & Graphs (07 Hours)

Trees - Tree Terminology: Root, Leaf, Height, Depth, Binary Tree Structure

Binary Search Tree: Insert, Search, Delete, Traversal Methods: Inorder, Preorder, Postorder, Level-Order (Using Queue)

Graphs: What is a Graph, Representation: Adjacency Matrix, Adjacency List (Dict of Lists), Directed Vs Undirected, Weighted Vs Unweighted.

Graph Traversal - Depth-First Search (DFS), Breadth-First Search (BFS)

List of Experiments

Students are expected to perform Minimum 8 Experiments :

1. Write a Python program to implement Singly Linked List.
2. Write a Python program to implement Doubly Linked List.
3. Write a Python program to implement Circular Linked List.
4. Write a Python program to implement bubble sort.
5. Write a Python program to implement selection sort.
6. Write a Python program to implement merge sort, quick sort.
7. Write a Python program on linear search and binary search.
8. Write a Python programs to implement stacks using arrays / linked lists.
9. Write a Python programs to implement queues using arrays / linked lists.
10. Write a Python program to perform Binary Tree traversal operations.
11. Write a Python programs to perform Binary search tree operations.
12. Write a Python program to Travers in a graph using Depth first search.
13. Write a Python program to Travers in a graph using breadth first.

Learning Resources

- **Text books**

1. Data Structures and Algorithms in Python by Michael Goodrich, Roberto Tamassia, Michael Goldwasser, Wiley Publication.
2. Open Data Structures (in pseudocode), Pat Mortin

   https://opendatastructures.org/ods-python/
3. Hands-On Data Structures and Algorithms with Python, Dr. Basant Agarwal, Packt publication

- **Reference Books:**

1. A First Course on Data Structures in Python, Donald R. Sheehy.
   https://donsheehy.github.io/datastructures/fullbook.pdf
2. Data Structures and Algorithms with Python, Kent D. Lee • Steve Hubbard, Springer Publication.

- **MOOC / NPTEL/YouTube Links**

1. https://onlinecourses.swayam2.ac.in/cec25_ma15/preview
2. https://www.coursera.org/learn/data-structures
3. https://www.geeksforgeeks.org/courses/dsa-self-paced
4. https://nptel.ac.in/courses/106102064
5. https://nptel.ac.in/courses/106106145
6. https://nptel.ac.in/courses/106105085

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
VSE-270-MXE: Computer Aided Drafting and Computing		
Teaching /scheme	**Credits**	**Examination Scheme**
Tutorial: 01 Hours/ Week **Practical :** 02 Hours/Week	01 01	**Term Work:** 25 Marks

Prerequisite Courses, if any :

- Programming Skills

Course Objectives:

- To provide background and fundamentals of advanced CAD and computing tools like AUTOCAD, SCILAB, MATLAB and OCTAVE for enhancing design, analysis and mathematical computing skills.

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

- **CO-1** Apply 2D-3D drafting and modeling knowledge for Computer aided designing.
- **CO-2** Apply computational tools like SCILAB/MATLAB/OCTAVE for advanced analysis and mathematical computation

Course Contents

Unit I - Introduction to CAD tools (12 Hours)

Introduction of different CAD tools, Commands, Interactive Techniques, Toggle Drawing Modes, Units and Limit Command, Coordinate System

Geometry & Selection Commands: Lines, Circles, Rectangles, Polylines, Arcs, Polygons, Ellipses, Construction Line, Move, Copy, Rotate, Mirror, Scale, Lengthen, Stretch, Zoom, Ortho and Polar Tracking, Object Snaps and Tracking, Layer States, Properties by Layer, Layer Tools

Advanced Commands: Trim, Extend, Fillet, Chamfer, Polyline Edit, Spline, Offset, Explode, Join, Align, Break, Divide, Array, Helix, Donut, Wipeout, blocks, Text Adding in Drawing, Multiline Text, Hatch, Dimension Style, Geometric Dimensioning & Tolerancing, Multileader, System Variables, The Properties Palette, Quick Select, Geometry Measurement Tools

Layout and Printing: Using Layouts and Viewports, Scaling Viewports, DWF Printing and Publishing

Unit II - Introduction to computational tool for engineers (18 Hours)

Basics: Working in command window, Arithmetic operations with scalars; Display formats, elementary math built-in functions, defining scalar variables: the assignment operator, rules about variable names, predefined variables and keywords, Commands for managing variables

Creating arrays: Creating 1-Dimensional array (vector), 2-Dimensional array (Matrix); The zeros, ones and, eye Commands, the transpose operator, addressing array: Using colon: in addressing arrays, Adding elements to existing variables, Deleting elements from existing variables, Built-in functions for handling arrays, Strings and Strings as variables

Mathematical Operations with Arrays: Addition and subtraction, multiplication and division of arrays, Element-by-element operations

Using Script Files and Managing Data: The workspace and workspace window, Input to script file, Output commands: the disp command, the fprintf command, the save and load commands, commands for Importing and exporting data.

2-D and 3-D Plots:

The plot command: Plot of Given Data, Plot of a Function, the fplot command, plotting multiple graphs in the same plot: Using the hold on and hold off Commands, Using the line Command, formatting a plot: Formatting a Plot Using Commands, formatting a Plot Using the Plot Editor, Plots with logarithmic axes, Histograms, Polar plots, Putting multiple plots on the same page, Multiple figure windows, mesh and surface plots

Programming using computational tools: Relational and logical operators, Conditional statements: The if-end Structure, the ifelse-end Structure, the if-elseif-else-end Structure, the switch-case statement, Loops: for-end Loops, while-end Loops, nested loops and nested conditional statements, the break and continue commands

User-Defined Functions and Function Files: Creating a function file, Structure of a function file: function definition line, input and output arguments, the help text lines, function body, Local and global variable, saving a function file, Using a user-defined function, comparison between script and function files

List of Experiments

1. Introduction to AutoCAD/Creo/Solidwork
2. To learn Drafting Skills: Drawing with AutoCAD
3. To learn Editing Techniques though Advanced Commands
4. To learn Detailing of drawing using Annotating commands
5. To Prepare orthographic drawings of any mechanical component
6. To study the basics and Language fundamentals of MATLAB
7. To learn the Elementary and higher order Mathematical operations using MATLAB
8. To learn 2D-3D plotting and basic programming using MATLAB
9. To learn of usign loops in MATLAB
10. To create the function files in MATLAB.

Learning Resources

- **Refernce books**

1. AutoCAD 2019: A Problem - Solving Approach, Basic and Intermediate by Sham Tickoo, Purdue University Northwest
2. Beginning AutoCAD 2019 by Cheryl R Shrock &Steve Heather, Industrial Press, Inc
3. Up and Running with AutoCAD 2020 2D Drafting and Design by Elliot J. Gindis, Robert C. Kaebisch
4. MATLAB for Beginners: A Gentle Approach – MathWorks
5. Parametric Modeling with Creo Parametric by Randy H. Shih
6. Learn SOLIDWORKS 2020- Tayseer Almattar

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
AEC-280- MXE: Modern Indian Language (Marathi/Hindi)		
Teaching /scheme	**Credits**	**Examination Scheme**
Tutorial : 00 Hour/Week **Practical** : 02 Hours/Week	01	**Term Work** : 25 Marks

Course Objectives: The course aims to:

अभ्यासक्रमाची उद्दिष्टे :

१. प्रगत भाषिक कौशल्यांची क्षमता विकसित करणे.
२. प्रसारमाध्यमांतील संज्ञापनातील स्वरूप आणि स्थान स्पष्ट करणे.
३. व्यक्तिमत्त्व विकास आणि भाषा यांच्यातील सहसंबंध स्पष्ट करणे.
४. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे यांचे परस्पर संबंध स्पष्ट करणे.
५. प्रसारमाध्यमांसाठी लेखनक्षमता विकसित करणे.

Course Contents

Unit I & II

घटक	तपशील
१	१. भाषा आणि व्यक्तिमत्त्व विकास : सहसंबंध २. लोकशाहीतील जीवनव्यवहार आणि प्रसारमाध्यमे
२	प्रसारमाध्यमांसाठी लेखन १ वृत्तपत्रासाठी बातमीलेखन आणि मुद्रितशोधन २ नभोवाणीसाठी भाषणाची संहितालेखन ३ दूरचित्रवाणीसाठी माहितीपटासाठी संहितालेखन

Case Study:

Unit III & IV

१	१. भाषा, जीवन व्यवहार आणि नवमाध्यमे, समाजमाध्यमे २. नवमाध्यमे आणि समाजमाध्यमांचे प्रकार : ब्लॉग, फेसबुक, ट्विटर. ३. नवमाध्यमे आणि समाजमाध्यमांविषयक साक्षरता, दक्षता, वापर आणि परिणाम
२	१. वेबसाईट आणि ब्लॉग, ट्विटरसाठी लेखन २. व्यावसायिक पत्रव्यवहार

Learning Resources

Text Books:

संदर्भ ग्रंथ :

१ सायबर संस्कृती, डॉ. रमेश वरखेडे
२ उपयोजित मराठी, संपादक डॉ. केतकी मोडक, संतोष शेणई, सुजाता शेणई
३ ओळख माहिती तंत्रज्ञानाची, टिमोथी जे. ओ लिअरी
४ संगणक, अच्युत गोडबोले, मौज प्रकाशन, मुंबई.
५ इंटरनेट, डॉ. प्रबोध चोबे, मनोरमा प्रकाशन, मुंबई.
६ व्यावहारिक मराठी, डॉ. ल. रा. नसिराबादकर, फडके प्रकाशन, कोल्हापूर.
७ आधुनिक माहिती तंत्रज्ञानाच्या विश्वात, शिक्रापूरकर दीपक, मराठे उज्ज्वल, उत्कर्ष प्रकाशन, पुणे.

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
AEC-280- MXE: Modern Indian Language (Hindi)		
Teaching /scheme	**Credits**	**Examination Scheme**
Tutorial : 00 Hour/Week **Practical** : 02 Hours/Week	01	**Term Work** : 25 Marks

Course Objectives: The course aims to:

उद्देश्य :

१. छात्रों में हिंदी भाषा श्रवण कौशल विकसित करना।

२. छात्रों में हिंदी भाषा संवाद कौशल विकसित करना।

३. छात्रों में हिंदी भाषा वाचन कौशल विकसित करना।

४. छात्रों में हिंदी भाषा लेखन कौशल विकसित करना।

५. हिंदी भाषा–विधि तथा भाषा–व्यवहार से अवगत करना।

Course Contents

Unit I & II

इकाई	पाठ्यविषय
इकाई– I	**वर्ण विचार** : १) हिंदी वर्णमाला – परिचय २) लिपि – परिचय ३) वर्णो का उच्चारण और वर्गीकरण ४) स्वराघात ५) संधि : स्वर संधि, व्यंजन संधि, विसर्ग संधि।

Case Study:

Unit III & IV

इकाई– II	**भाषा कौशल शिक्षण : लघुकथाओं द्वारा भाषा कौशल शिक्षण (श्रवण, संवाद, वाचन, लेखन)** १) शिक्षा – ज्योति जैन २) पानी के पेड़ – ज्योति जैन ३) पशुभाषा – ज्योति जैन ४) अपशगुन – ज्योति जैन

Learning Resources

Text Books:

संदर्भ ग्रंथ :

१. हिंदी भाषा शिक्षण – संपा. हिंदी अध्ययन मंडल, सावित्रीबाई फुले पुणे विश्वविद्यालय, पुणे, राजकमल प्रकाशन, नई दिल्ली।

२. हिंदी व्याकरण – पं. कामताप्रसाद गुरु, प्रकाशन संस्थान, नई दिल्ली।

३. प्रयोजनमूलक हिंदी – डॉ. माधव सोनटक्के, लोकभारती प्रकाशन, नई दिल्ली।

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
EEM-241-MXE: Economics for Engineers		
Teaching /scheme	**Credits**	**Examination Scheme**
Tutorial: 01 Hours/ Week	01	**Term Work:** 25 Marks

Prerequisite Courses, if any :
Course Objectives:

- To enable students to understand the economics principles applicable to engineering.
- To learn the techniques of economic decision making.
- To familiarize the students with basic fundamentals of Indian financial economy

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

- **CO-1** Understand the concepts of economics and will also learn to use the principles of economics in the engineering discipline
- **CO-2** Develop the insight of students in understanding the consumer and production behavior and functioning of market economy.
- **CO-3** Implications of monetary and fiscal policies in Indian economy.

Course Contents

Unit I - Introduction and Demand Analysis

Principles of economics, how markets work: market forces of supply and demand, Elasticity and its application, Consumer equilibrium.

Unit II - Theory of Production, Cost and Firms

Firms' production, cost and revenue behavior; resources optimization; Firms' behavior under- competitive markets, monopoly, monopolistic competition and oligopoly.

Unit III - Engineering Economy

Time value of money: Single-Payment and Uniform Series, Nominal and Effective

Interest Rates, Evaluation Methods: Present Worth Analysis, Annual Worth Analysis, Rate of Return Analysis

Unit IV- Indian Economy

Nature and size of Indian Economy, Problems- Poverty, Unemployment, Inflation, measures for controlling these problems, Monetary policy- meaning, objectives, tools, fiscal policy-meaning, objectives, tools.

List of Assignments

1. Role of Economics in Engineering Decision-Making
2. Supply and Demand Analysis in the Context of Engineering Products
3. Opportunity Cost and its Relevance in Engineering Projects
4. Time Value of Money: Applications in Engineering Projects
5. Cost-Benefit Analysis in Infrastructure Planning
6. Fixed, Variable, and Marginal Cost Analysis in Production
7. Engineering Project Cash Flow Estimation

8. Life-Cycle Costing in Engineering Design
9. Economics of Renewable Energy Projects
10. Smart Cities: Cost, Benefit, and Economic Feasibility
11. Cost Estimation in Civil Construction Projects
12. Economic Feasibility of Electric Vehicle Infrastructure
13. Economics of Automation and Robotics in Manufacturing

Learning Resources

- **Reference books**

1. N. Gregory Mankiw. Principles of Microeconomics,
2. Krugman, Paul, and Robin Wells. Microeconomics. New York, NY
3. WG Sulliman, EM Wicks and CP Koelling, Engineering Economy, Pearson
4. Chan S Park, Fundamentals of Engineering Economics, Always Learning
5. Anindya Sen, Microeconomics, OUP India
6. Leland T. Blank & Anthony J. Tarquin, Engineering Economy, McGraw-Hill
7. Hal R. Varian Intermediate Microeconomics, W. W. Norton and Company
8. Ruder Dutt and Sundaram, Indian Economy, S. Chand

Savitribai Phule Pune University Second Year of Mechatronics Engineering (2024 Course)		
VEC-251- MXE - Environmental Studies		
Teaching /scheme	**Credits**	**Examination Scheme**
Theory : 02 Hours/Week	02	**CCE :** 15 Marks **End- Semester**: 35 Marks

Course Objectives: The course aims to:

1. To introduce the multidisciplinary nature and scope of environmental studies.
2. To understand ecosystem structures, biodiversity, and ecological balance through hands-on observation and documentation.
3. To examine the use and impact of natural resources on environmental sustainability.
4. To explore biodiversity conservation practices and develop eco-sensitive thinking through field-based inquiry.

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

- **CO1.** Illustrate the interdependence of ecosystems through activity-based exploration
- **CO2**. Analyze the role of natural resources in sustainable development using real-world data.
- **CO3**. Investigate biodiversity threats and conservation strategies through surveys and projects
- **CO4.** Create awareness tools or reports promoting sustainability based on their findings.

Course Contents

Environment and Ecosystem

a) Environment Meaning of Environment, Types of Environment, Components of Environment,
b) Man- Environment relationship, importance of environment,
c) Need for Public Awareness
d) Ecosystem-Meaning, Major Components of Ecosystem
e) Case studies of Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem
f) Stability of Ecosystem in Sustainable Environment

Environment Pollution

a) Definition of Pollution, Types of Pollution
b) Air Pollution-Meaning, Sources, effects of air pollution, Air Pollution Act
c) Water Pollution Meaning, Sources, Effects of Water pollution, Water Pollution Act
d) Noise Pollution Meaning, Sources, Effect of Noise Pollution
e) Solid Waste Pollution Meaning, sources, Effect of Waste Pollution
f) Environment Protection Act Air (Prevention and control of Pollution) Act,
g) Water Act (Prevention and control of Pollution) Act ,
h) Solid waste Pollution Act in India
i) E-waste management

Practical Assignments

Week	Topic to be covered
1	Introduction : Group discussion and poster making on "Why Environmental Studies Matter for Technologists"
2	Eco Mapping: Identify and document elements of an ecosystem within the college campus
3	Model the Food Web: Create food chains and food webs using flowcharts (digital tools like Canva / Lucid chart)
4	Case Study Review: Present real-world examples of forest, grassland, and aquatic ecosystems

5	Soil and Water Testing Activity: Test soil pH, water quality (use school-level kits), and interpret results
6	Field Visit / Virtual Tour: Document deforestation or mining impact in a chosen region; students prepare a comparative report
7	Water Audit Exercise: Estimate water usage at home/hostel and identify areas of overuse; propose conservation measures
8	Renewable Energy Models: Create a simple model or PPT on any renewable energy source (e.g., solar cooker, wind energy demo)
9	Biodiversity Documentation: Survey nearby areas for plant/animal species; identify any endemic/endangered species
10	Conservation Proposal Pitch: In groups, students prepare a mini proposal for biodiversity conservation at local level
11	Group Project Work: Work on mini project report/documentation on any ecosystem/natural resource/e-waste management topics
12	Presentation & Viva: Final presentation and oral examination based on project work and learning portfolio

Learning Resources

Text Books:

1. Odum, Eugene P. “Fundamentals of Ecology”
2. R. Rajagopalan, “Environmental Studies – From Crisis to Cure”, Oxford

Reference Books:

1. Erach Bharucha, “Textbook of Environmental Studies”, UGC
2. Anubha Kaushik and C.P. Kaushik, “Environmental Studies”, New Age International

E-Books Links: -

1. https://www.environment.gov.in
2. https://www.unep.org

Savitribai Phule Pune University, Pune

Maharashtra, India

Task Force for Curriculum Design and Development

Programme Coordinator

Dr. Mukesh Ghogare - Member, Board of Studies - Mechatronics Engineering

Chairman

Dr. Vaibhav Dixit - Board of Studies Mechatronics Engineering

Savitribai Phule Pune University, Pune

Dean

Dr. Pramod Patil - Dean – Science and Technology

Savitribai Phule Pune University, Pune

***