PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF SCIENCE & TECHNOLOGY

NEP 2020 Compliant Curriculum for T.Y. B.Tech. Mechanical Engineering with effect from 2025-26

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF SCIENCE & TECHNOLOGY

NEP 2020 Compliant Curriculum of T.Y. B. Tech. Mechanical Engineering

With effect from 2025-2026

Semester -V

Distribution	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
PCC	MECHPCC-07	Advance Manufacturing Technology	2	-	2	03	70	30	25	-	125
PCC	MECHPCC-08	Design of Machine Elements	3	1		04	70	30	25	-	125
PCC	MECHPCC-09	Metallurgy	3	-	2	04	70	30	-	25	125
PEC	MECHPEC-01	Programme Elective Course-I	3	-	2	04	70	30	25	-	125
AEC	AEC-02	Creativity and Design Thinking	1	-	2	02	50*	-	25	-	75
OE	OE-03	Interdisciplinary Mini Project	1	-	2	02	-	-	25	25	50
MDM	MDM-03	Multidisciplinary Minor-III	2	-	2	03	70	30	25	-	125
		Total	**15**	**1**	**12**	**22**	**400**	**150**	**150**	**50**	**750**

*AEC-02 MCQ-based examination to be conducted.

PCC- Programme Core Course, PEC: Programme Elective Courses, OE- Open Elective, AEC- Ability Enhancement Course,

MDM-Multidisciplinary Minor,

MDM – Multidisciplinary Minor: It should be selected from other UG engineering minor programs.

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF SCIENCE & TECHNOLOGY

NEP 2020 Compliant Curriculum of T.Y. B. Tech. Mechanical Engineering

With effect from 2025-2026

Semester -VI

Distribution	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
PCC	MECHPCC-10	Transmission System Design	2	1		03	70	30	25		125
PCC	MECHPCC-11	Heat Transfer	2	-	2	03	70	30	-	25	125
PCC	MECHPCC-12	Instrumentation and Control Engineering	2	-	2	03	70	30	25	-	125
PEC	MECHPEC-02	Programme Elective Course-II	3	-	2	04	70	30	25	25	150
PEC	MECHPEC-03	Programme Elective Course -III	3	-	2	04	70	30	25	-	125
SEC	MECHSEC-03	Mini project on Industrial Applications (MPIA)	1	-	2	02	-	-	25	50	75
MDM	MDM-04	Multidisciplinary Minor-IV	2	-	2	03	70	30	25	-	125
		Total	**15**	**1**	**12**	**22**	**420**	**180**	**150**	**100**	**850**

PCC- Programme Core Course, PEC: Programme Elective Courses, MDM-Multidisciplinary Minor, SEC- Skill Enhancement Course

MDM – Multidisciplinary Minor: It should be selected from other UG engineering minor programs.

Basket of Programme Elective Course (PEC)

PEC/Sem	Course code and name
MECHPEC - 01/V	MECHPEC – 01A:Metrology and Quality Control MECHPEC – 01B:Internal Combustion Engines MECHPEC – 01C:Product Life cycle Management MECHPEC – 01D:Mechatronics systems
MECHPEC –02/VI	MECHPEC – 02A:Plastic Engineering MECHPEC – 02B: Tool engineering MECHPEC – 02C: Automobile Engineering MECHPEC – 02D: CAD-CAM-CAE
MECHPEC – 03/VI	MECHPEC – 03A:Finite Element Method MECHPEC – 03B: Industrial Engineering MECHPEC – 03C: Power plant and Energy Engineering MECHPEC – 03D: Railway Transportation
MECHPEC – 04/VII **OR**	MECHPEC – 04A: Production and Operation Management MECHPEC – 04B: Supply chain Management MECHPEC – 04C: Industrial Hydraulics and Pneumatics MECHPEC – 04D: Railway systems and Management
MECHPEC – 04/VII	MOOC Courses MECHPEC – 04E: <As per the list provided by BoS>
MECHPEC – 05/VIII **OR**	MECHPEC – 05A: Marketing Management MECHPEC – 05B: Industrial Safety and hazards MECHPEC – 05C: Material Handling System MECHPEC – 05D: Business Economics
MECHPEC – 05/VIII	MOOC Courses MECHPEC – 05E: <As per the list provided by BoS>

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

Semester	Course Code	Course Title
III	MECHMDM-01A	Fundamentals of Material Science and Engineering
IV	MECHMDM-02A	Materials for Technology Development
V	MECHMDM-03A	Advanced Materials and Manufacturing Process
VI	MECHMDM-04A	Renewable Energy Resources
VII	MECHMDM-05A	Energy Conversion Systems

B. Multidisciplinary Minor in "Industrial and Project Management"

Semester	Course Code	Course Title
III	MECHMDM-01B	Industrial Management
IV	MECHMDM-02B	Production and Operation Management
V	MECHMDM-03B	Operation Research
VI	MECHMDM-04B	Project Management
VII	MECHMDM-05B	Marketing Management

A. Honors in Robotics Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MechHon - 01A	Industrial Robotics	3	-	2	4	70	30	25	-	125
IV	MechHon - 02A	Machine Vision	3	-	2	4	70	30	25	-	125
V	MechHon - 03A	Industrial Networks and Controllers	2	-	2	3	70	30	25	-	125
VI	MechHon - 04A	Advanced topics in Robotics	3	-	2	4	70	30	25	-	125
VII	MechHon - 05A	Mini Project	1	-	4	3	-	-	50	-	50
		Total				**18**	**280**	**120**	**150**		**550**

Honors Course will be for the students of same Program

B. Honors in Electric Vehicle Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MechHon - 01B	Introduction to Automobile Engineering	3	-	2	4	70	30	25	-	125
IV	MechHon - 02B	Introduction to Electric and Hybrid Vehicles	3	-	2	4	70	30	25	-	125
V	MechHon - 03B	Battery Technology and Charging Infrastructure	2	-	2	3	70	30	25	-	125
VI	MechHon - 04B	Advanced topics in Electric Vehicles	3	-	2	4	70	30	25	-	125
VII	MechHon - 05B	Mini project	1	-	4	3	-	-	50	-	50
		Total				**18**	**280**	120	150		550

Honors Course will be for the students of same Program

Honors with Research

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*	*Credits*	*SA*		*Total*
			P		*ICA*	*OE*	
VII	MECHRES-01	Research Project Phase- 01	9 #	9	100	100	200
VIII	MECHRES-02	Research Project Phase-02	9 ##	9	100	100	200
		Total	18	18	200	200	400

Along with 9 hours of engagement hours, 4.5 Hrs. activities for preparation for community engagement and service, preparation of reports, etc.

Along with 9 hours of engagement hours 4.5 Hrs. activities for preparation for community engagement and service, preparation of reports, etc. and independent reading during Project Phase 2 and preferably related to Project Phase 2 activities.

These Courses are open for students of all the UG Engineering Program.

Semester: III List of Open Elective - I

Sr. No.	List of Open Electives
1.	OE-01A: Advanced Mathematics and Statistics
2.	OE-01B Digital Marketing and E- Commerce
3.	OE-01C Humanities and Social Sciences
4.	OE-01D Industrial and Quality Management
5.	OE-01E Mathematics for Software and Hardware
6.	OE-01F Soft Skills and Personality Development

Semester: IV List of Open Elective – II

Sr. No.	List of Open Electives
1.	OE-02A Entrepreneurship and Innovation
2.	OE-02B Environmental Sustainability
3.	OE-02C Renewable Energy
4.	OE-02 D Measurement, Instrumentation and Sensors
5.	OE-02E Operation Research
6..	OE-02F Computational Mathematics
7.	OE-02 G Professional Business Communication

Semester: V Open Elective – III

Sr. No.	List of Open Electives
1.	Interdisciplinary Mini Project

Third Year B.TECH. (Mechanical Engineering)
Semester-V

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHPCC-07: Advance Manufacturing Technology

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

- **Course Introduction**:

Machining is accomplished with the use of machines known as machine tools. For production of a variety of machined surfaces, different types of machine tools have been developed. The kind of surface produced depends upon the shape of cutting, the path of the tool as it passes through the material or both depending on metal cutting processes are called either turning or planning or boring or other operations performed by machine tools like lathe shaper, planer drilling milling grinding gear cutting, CNC or VMC and other Non-conventional machine.

- **Course Perquisite:**

In general, the manufacturing process is an economic term for making goods and services available to satisfy human wants. It involves a series of related activities and operation is called production System. It is depicted as an input –output system, where the inputs elements undergo technological transformation (machine tools) to yield a set of output elements called a product.

- **Course Objective:**

1. To study the conventional machining processes such as drilling, milling, shaping, planning carried out on typical machine tools for different applications.
2. To study unconventional machining processes such as EDM, ECM, AWJM and USM carried out on special purpose machine tools for typical applications.
3. To compare and select a suitable manufacturing process.

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

1. Explain lathe operations, taper turning, thread cutting, and CNC machine fundamentals with applications.
2. Describe the construction, working, and operations of drilling, boring, and broaching machines with their applications.
3. Explain the principles, types, construction, and operations of shaper, planer, and slotting machines.
4. Explain the classification, structure, working principles of milling machines, gear cutting techniques, and indexing calculations.
5. Describe grinding machine types, wheel selection, maintenance, and surface finishing processes like honing and lapping.
6. Explain the classification, principles, working, and applications of unconventional machining processes like EDM, ECM, USM, and AWJM.

SECTION- I

Unit -1 Conventional Lathe Machine **No. of lectures-04**

Introduction to Centre Lathe, parts and functions, specifications, accessories and attachments. Lathe operations, Taper turning methods, simple Numerical on Thread cutting. Introduction to CNC machine tools, Classification of CNC, advantages, limitations and application.

Unit -2 Hole making machine tools **No. of lectures-06**

Classification, construction and working of Pillar type and radial drilling machines, Job & Tool holding devices and accessories, various operations. Horizontal and vertical boring machines, construction and working, Boring tools and bars, Jig boring machines. Broaching, principal, classification, pull and push type broach, advantages, limitations and application.

Unit -3 Reciprocating Motion Machine Tools **No. of lectures-05**

Principle, types, specifications, operations on shaper, Types of shapers, Types of planers, standard double housing planer, construction, and operations. Introduction to construction and working of slotting machine.

SECTION II

Unit -4 Milling & Gear Manufacturing **No. of lectures-06**

Classification of Milling Machines, construction and working of column and knee type milling Machines, Milling methods – Up milling and down milling, milling operations, Gear cutting on milling machines, Gear Hobbing, gear shaving, gear burnishing ,indexing methods, Numerical on Indexing Methods.

Unit -5 Finishing Processes **No. of lectures-04**

Classifications – Cylindrical, Center less, Surface grinder etc. Selection mounting, glazing, loading, truing, balancing, Surface finishing process, Honing, Lapping, super finishing.

Unit –6 Unconventional Machining **No. of lectures-05**

Introduction, classification, significance of Unconventional machining, Electrical discharge machining (EDM), Electrochemical Machining (ECM), Ultrasonic machining (USM), Abrasive Water Jet Machining (AWJM), Principle, working, applications, advantages, limitations

- **Internal Continuous Assessment (ICA):**

1. Setting the lathe machine for taper turning by swiveling compound rest.
2. Setting the lathe machine for taper turning by set over of tail stock and taper turning attachment.
3. Setting the lathe machine for thread cutting operation.
4. Study and demonstration of attachments on a milling machine.
5. Study and demonstration of various types of milling cutters.
6. Setting the milling machine for gear cutting operation.
7. Study and demonstration of various types of grinding wheels and their specifications.
8. Visit at least one machine shop and one CNC shop.

- **Text Books:**

1. Workshop Technology (Volume II) by Hajra Chowdhary.
2. Workshop Technology (Volume II) by Raghuvanshi
3. Production Technology (Volume II) by Gupte-Patel.
4. Workshop Technology (Volume II) by A. J.Chapman.
5. Manufacturing Technology-P.N.Rao Vol. II.

- **Reference Books:**

1. Production Engineering by Dr. P. K. Neogy
2. Manufacturing Technology, Volume 2: Metal Cutting and Machine Tools by P.N. Rao
3. Machining Technology: Machine Tools and Operations by Helmi A. Youssef and Hassan El-Hofy

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHPCC-08: Design of Machine Elements

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Tutorial: 01 Hour/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

The Design of Machine Elements course provides fundamental knowledge and practical skills in mechanical component design, focusing on strength, durability, and manufacturability. It covers the engineering design process, types of loads, factor of safety, and failure theories, along with considerations for casting, forging, and machining. Students will learn to design components under fluctuating loads, analyze fatigue failure, and select belt drives using standard catalogs. The course also includes the design of shafts and couplings based on strength and torsional rigidity, as well as the design of helical springs, considering stress and deflection. Finally, students will explore bolted and welded joints, analyzing their strength under static and eccentric loading. Through theoretical concepts and numerical problem-solving, this course equips students with essential skills for designing safe and efficient machine elements

Course Objectives:

During this course, student is expected to:

1. To impart a systematic understanding of the engineering design process, including design considerations for casting, forging, and machining, while integrating aesthetics, ergonomics, and manufacturability aspects.
2. To develop analytical skills for designing mechanical components subjected to fluctuating loads, considering stress concentration, fatigue failure, and endurance limit using failure theories.
3. To equip students with the ability to select and design power transmission elements, such as belts, shafts, couplings, and springs, ensuring optimal performance under various loading conditions.
4. To enable students to analyze and design bolted and welded joints, considering static and eccentric loading, ensuring strength, reliability, and safety in mechanical assemblies.

Course Outcomes:

At the end of this course, student will be able to:

1. Apply the general design procedure considering aesthetics, ergonomics, and manufacturing constraints in engineering design.
2. Analyze the effect of fluctuating loads on mechanical components and design them using endurance limit and fatigue failure criteria.
3. Select appropriate belt drives (flat and V-belts) based on standard manufacturer catalogs for power transmission applications.
4. Design shafts and couplings considering strength, torsional rigidity, and industry codes such as ASME standards.
5. Design helical springs considering stress and deflection under different loading conditions.
6. Evaluate and design bolted and welded joints under various static and eccentric loading conditions.

Section I

Unit-1: Basics of engineering design **No. of lectures-05**

General Design process and procedure, types of loads, factor of safety- its selection and significance, theories of failure and their applications, aesthetic and ergonomic considerations in design Design considerations for casting, Design considerations for forging, Design considerations for machined parts, Design for manufacture and assembly.

Unit-2: Design against fluctuating loads **No. of lectures-09**

Stress concentration causes and remedies, fatigue failure, endurance limit, notch sensitivity, Goodman and Soderberg diagram Modified Goodman diagram (Theoretical Treatment), design for finite and infinite life under reversed and fluctuating stresses. (Numerical Treatment).

Unit-3: Selection of Belt **No. of lectures-06**

Selection of flat and V belt from standard manufacturers' catalogue / Design data book. (Numerical Treatment).

Section II

Unit-4: Design of shafts and Coupling **No. of lectures-06**

Materials for shaft, Design of solid and hollow shaft on strength basis (maximum principal stress theory and Maximum shear stress theory) and on basis of torsional rigidity, ASME code for shaft design. Splined shaft (Introductory treatment). Types of couplings- Muff, Rigid flange. (Numerical treatment).

Unit-5: Design of springs **No. of lectures-06**

Types of springs and their applications, terminology of helical spring, styles of end, spring materials, stress and deflection in helical spring, series and parallel springs, introduction to leaf spring. (Numerical treatment excluding leaf spring)

Unit-6: Design of Joints **No. of lectures- 08**

Bolted joint- Simple analysis, eccentrically loaded bolted joints in shear, eccentric load parallel to axis of bolt, eccentric load perpendicular to axis of bolt (Numerical limited to static loading).

Welded Joints- Strength of butt welds, transverse fillet welds, axially loaded unsymmetrical lap joint, eccentrically loaded welded joint in shear (Numerical treatment on design fillet weld).

- **Internal Continuous Assessment (ICA):**

List of Assignments/Case Studies, etc.

- **PART:A**

1. Assignment on basics of engineering design
2. Assignment on design against fluctuating loads
3. Assignment on selection of belt
4. Assignment on design of shafts and couplings
5. Assignment on design of springs
6. Assignment on design of joints (bolted and welded joints)

PART:B

7. Design and analysis of any one component from the syllabus. Use suitable CAD and CAE Package for analysis of components.

- **Text Books:**

1. Design of Machine Elements, V.B. Bhandari, 4th edition, McGraw Hill.
2. Machine Design Data Book, V.B. Bhandari, 2nd edition.

- **Reference Books**

1. Design of Machine Element by J.F. Shigley, McGraw Hill Publications.
2. Design of Machine Element by M.F. Spotts, Pearson Education Publication.
3. Design Data: Data Book of Engineers by PSG College - Kalaikathir Achchagam - Coimbatore

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHPCC-09: Metallurgy

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE: 70 Marks
ISE: 30 Marks
OE: 25 Marks

Course Introduction:

Metallurgy is an art of extracting the pure metals from its ore. Its full scope is in:

1. Mixing two or more metals to form an Alloy.
2. Shaping the metals & alloys by different processes such as Casting, Forming, Joining etc.
3. Undergoing suitable Heat treatment for modifying the properties.
4. And finally, in Inspecting & testing before putting the products into use.

Course Objectives:

During this course, student is expected to:

1. Discuss the relevance of principles of physical metallurgy and its significance.
2. Get acquainted with different types of Ferrous alloys with their Engineering applications.
3. Get to know about different types of Non-Ferrous alloys for Engineering applications.
4. Acquire knowledge of heat treatment processes for different types of steels.
5. Understand different methods of testing materials and its significance.
6. Acquire knowledge of powder metallurgy process and with its applications

Course Outcomes:

At the end of this course, student will be able to:

1. Discuss the relevance of principles of physical metallurgy and its significance.
2. Apply the knowledge for selection of suitable Ferrous alloys for Engineering applications.
3. Apply the knowledge for selection of suitable Non-Ferrous alloys for Engineering applications.
4. Select a suitable heat treatment process for obtaining desired properties in Steels.
5. Use suitable Destructive and non-destructive testing methods for material testing

Section I

Unit-1: Introduction to ferrous alloys **No. of lectures: 06**

Brief classification of Metals, Phase rule, Solid solution & its types, Intermetallic compounds, allotropy, Concept of alloying, Classification of cooling curves, Types of equilibrium diagram, Lever rule.

Unit-2: Ferrous metals and alloys **No. of lectures: 10**

Fe-Fe3C equilibrium diagram, Eutectic, Eutectoid and Peritectic transformations, critical temperatures, Plain carbon steels: composition, applications & properties, Effect of alloying elements on steels, Cast Iron: Introduction, Types of cast irons, composition, properties, applications.

Study of composition, properties and applications of following alloying steels. 1. HSLA steels 2. Spring steels 3. Silicon steels 4. Hadfield 'Mn' steels 5. HCHC steels 6. Water hardening steels 7. Oil hardening steel 8. Air hardening steel 9. Hot working tool 10. Free Cutting steels 11. HSS 12. ONHS 13. Stainless steels and its types.

Unit-3: Non-ferrous alloys, Composites and Nano materials **No. of lectures: 04**

Copper alloys: Cu-Zn equilibrium Diagram, brasses, bronzes. Aluminum alloys: Al-Si alloy, Al-Cu alloy, Steps in precipitation hardening, Study of Babbitts, Pb-Sn alloys, Composite materials: Classification, properties and Applications, Nano-materials: Classification, properties and Applications.

Section II

Unit-4: Heat treatments of steel **No. of lectures: 10**

Objectives of Heat Treatment, TTT and CCT diagram for eutectoid Steel.

Annealing: Concept, process, types (if any) advantages, limitations and applications,

Normalizing: Concept, process, types (if any) advantages, limitations and applications,

Hardening & Tempering: Concept, process, types (if any) advantages, limitations and applications,

Surface hardening treatments: Carburising- Concept, process, types (if any) advantages, limitations and applications, Nitriding- Concept, process, types (if any) advantages, limitations and applications, Carbonitriding-Concept, process, types (if any) advantages, limitations and applications, Induction hardening-Concept, process, types (if any) advantages, limitations and applications , Flame hardening-Concept, process, types (if any) advantages, limitations and applications.

Unit-5: Destructive and Non-Destructive Testing **No. of lectures: 06**

A. Destructive testing methods, test procedure in brief, significance of

i) Tensile testing, ii) Hardness testing, iii) Impact testing, iv) Creep, and v) Fatigue testing.

B. Study of Non-Destructive Testing methods (NDT) such as

i) dye penetrant test, ii) magnetic Particle test, iii) Ultrasonic test, iv) Radiography test, v) Eddy current test. Introduction to advanced NDT methods.

Unit-6: Introduction to Powder Metallurgy **No. of lectures: 04**

Definition of Powder Metallurgy, Methods of Powder production, Steps in manufacturing a component using Powder Metallurgy (P/M) technique, Advantages, Disadvantages and Applications of P/M technique, Typical powder metallurgy applications and their flow chart: Self lubricated bearings, cemented carbide cutting tools, friction materials.

- **Oral Examination (OE):**

List of Experiments/Assignments/Case Studies, etc. (ANY EIGHT FROM FOLLOWING)

1. Study of metallurgical microscope
2. Study of specimen preparation for microstructure observations
3. Study of microstructures of P.C. steels
4. Study of microstructures of white, grey, S.G. iron, Malleable iron
5. Study of microstructures of Bronzes, brasses
6. Demonstration of Annealing, Normalizing, Hardening and Tempering
7. Demonstration of Tensile, Impact, and Hardness tests.
8. Demonstration of at least one NDT method
9. Study of microstructures of carburized, nitrided, Induction hardened steels
10. Demonstration of Macro examination test such as Spark test

- **Text Books:**

1. Material Science and Metallurgy – Dr. V. D. Kodgire (Everest, Pune).
2. Engineering Metallurgy Vol. I & Vol. II – Prof. A. S. Gholap & Prof. M. S. Kulkarni
3. Introduction to Engineering Materials – Prof. B. K. Agarwal (TMH).

- **Reference Books**

1. Introduction to Physical metallurgy – Sidney H. Avner, TMH.
2. Heat treatment principles and technique - Prof. T.V. Rajan, C.P.Sharma & A. Sharma
3. Engineering Metallurgy Vol. I & Vol. II – Prof. R. A. Higgins (ELBS).
4. Engineering Metallurgy – Prof. E. C. Rollason (ELBS)
5. Engineering Physical Metallurgy - Prof. Y. Lakhtin (MIR Publishers).
6. Materials Science and Engineering- Prof. William D. Callister
7. Physical Metallurgy- Prof. Vijendra Singh

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHPEC-01A: Metrology and Quality Control

Teaching Scheme
Lectures : 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credits

Examination Scheme
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

Metrology and Quality Control are essential disciplines in mechanical engineering, ensuring precision, accuracy, and reliability in manufacturing and engineering processes. This course provides fundamental knowledge of measurement techniques, metrology instruments, and quality assurance principles, which are crucial for maintaining product standards and improving industrial efficiency.

Course Objectives:

During this course, student is expected to:

1. To introduce the fundamental concepts and importance of Metrology and Quality Control in manufacturing industries.
2. To familiarize students with linear, angular, and surface measurement techniques used in industrial applications.
3. To provide knowledge of gear and thread measurement techniques, including gear tooth profile and pitch measurement.
4. To understand the principles of Quality Control, Quality Assurance, and the role of statistical tools in maintaining product quality.
5. To apply Statistical Quality Control (SQC) techniques, such as control charts and process capability analysis, in manufacturing processes.
6. To introduce Quality Management Systems (QMS), including ISO standards, Total Quality Management (TQM), and Six Sigma for continuous improvement.

Course Outcomes:

At the end of this course, student will be able to:

1. Explain the fundamental principles of Metrology and its role in ensuring product quality.
2. Demonstrate the use of various measuring instruments for linear, angular, and surface measurements.
3. Analyze measurement data using advanced metrology techniques, including gear and thread measurement.
4. Apply statistical quality control tools to monitor and improve manufacturing processes.

5. Evaluate process capability and implement quality improvement methods in industrial applications.
6. Implement quality management practices, including ISO standards and TQM, to enhance product reliability and customer satisfaction.

Section I

Unit-1: Fundamentals of Metrology **No. of lectures- 06**

Introduction to Metrology Importance, Scope, and Applications in Manufacturing, Measurement Standards: Line, End, Wavelength, Atomic Measurement Errors and Calibration Systematic, Random, and Environmental Errors Calibration of Instruments and Traceability Measuring Instruments Overview Classification and Characteristics: Precision, Accuracy, Sensitivity

Unit-2: Linear, Angular, and Surface Metrology **No. of lectures- 08**

Linear Measurement Vernier Calipers, Micrometers, Slip Gauges, Dial Indicators Angular Measurement Sine Bar, Bevel Protractor, Angle Gauges Surface Metrology Surface Roughness Measurement, Parameters, Profilometers Comparators in Metrology Mechanical, Optical, Pneumatic, Electrical Comparators

Unit-3: Comparators **No. of lectures- 06**

Gear Measurement Techniques Gear Tooth Thickness, Pitch, Addendum, and Dedendum Measurement Gear Profile and Run out Measurement Gear Rolling Test, Composite Error Measurement Thread Measurement Major, Minor, and Effective Diameter of Threads

Section II

Unit-4: Introduction to Quality Control **No. of lectures-06**

Concepts of Quality Control & Assurance Definitions, Importance, Cost of Quality Inspection Methods 100% Inspection vs. Sampling Inspection Introduction to Six Sigma & Lean DMAIC Approach, Lean Principles

Unit-5: Statistical Quality Control & Process Capability **No. of lectures- 08**

Probability & Statistics in Quality Control Normal Distribution, Process Variability Control Charts for Process Monitoring $\bar{X}$-R Chart, P Chart, C Chart Applications Process Capability Analysis Cp, Cpk, Pp, Ppk Calculations Acceptance Sampling Single and Double Sampling Plans

Unit-6: Quality Management Systems & Tools **No. of lectures-06**

Introduction to ISO Standards & TQM ISO 9000, ISO 14000, Total Quality Management (TQM) Quality Improvement Methods Failure Mode and Effects Analysis (FMEA), PDCA Cycle 7 QC Tools for Problem Solving Pareto Chart, Cause-and-Effect Diagram, Histogram, Control Charts

Internal Continuous Assessment (ICA):
Any five from 1 to 7 experiments and any three from 8 to 11 assignments.
List of Experiments/Assignments/Case Studies, etc.

1. Linear measurement using vernier caliper and micrometer screw gauge
2. Calibration of Vernier Caliper and Micrometer
3. Measurement of Angle Using Sine Bar
4. Surface Roughness Measurement Using Profilometer
5. Study and Use of Optical Comparator
6. Gear Tooth Thickness Measurement Using Gear Tooth Vernier
7. Thread Measurement Using Floating Carriage Micrometer
8. Construction of $\bar{X}$-R Control Chart for a Given Process
9. Process Capability Analysis Using Cp & Cpk
10. Acceptance Sampling – Single & Double Sampling Plan
11. Application of Pareto Chart & Cause-and-Effect Diagram

Text Books:

1. R.K. Jain Engineering Metrology (Khanna Publishers)
2. I.C. Gupta A Textbook of Engineering Metrology (Dhanpat Rai Publications)
3. R.K. Rajput Engineering Metrology and Instrumentation (S.K. Kataria & Sons)
4. S.P. Venkateshan Mechanical Measurements (Ane Books)
5. J.P. Holman Experimental Methods for Engineers (McGraw Hill)

Reference Books:

1. M. Mahajan A Textbook of Metrology (Dhanpat Rai & Co.)
2. R.K. Jain & A.K. Chitale Quality Control and Total Quality Management (Khanna Publishers)
3. D.H. Besterfield Total Quality Management (Pearson Education)
4. Grant and Leavenworth Statistical Quality Control (McGraw Hill)
5. Juran and Gryna Juran's Quality Planning and Analysis (McGraw Hill)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHPEC-01B: Internal Combustion Engines

***Teaching Scheme**
Lectures: 03 Hours/week, 02 Credits
Practical: 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
This course studies the fundamentals of how the design and operation of internal combustion engines affect their performance, efficiency, fuel requirements, and environmental impact. Students examine the design features and operating characteristics of different types of internal combustion engines: spark-ignition, diesel engines. The class includes practical lab work in the Engine Laboratory.

Course Objectives:
During this course, student is expected to:

1. Distinguish the Different Types of Engine Construction and their Thermodynamics Principles.
2. Differentiate Fuel Systems for S. I. and C. I. Engines.
3. Identify Different Methods for Enhancing Engine Performance.
4. Correlate the Differences in S. I. and C. I. Engines Combustion Process along with Fuel Ratings.
5. Evaluate the Performance Parameters of I C Engines to Justify their Use in Different Applications.
6. Categorize Different Alternative Fuels Suitable for I C Engines and Compare the Engine Pollutants and its Control Methods.

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

1. Explain the fundamental concepts, classifications, and working of internal combustion engines including engine cycles and timing diagrams.
2. Calculate the air-fuel ratio and main dimensions of a simple carburetor for S.I. engines using exact and approximate methods.
3. Describe the need, working principles, and benefits of supercharging and turbocharging systems used in I.C. engines.
4. Explain the stages of combustion, knocking phenomena, and fuel rating systems in S.I. and C.I. engines.
5. Apply formulas and performance parameters to analyze engine performance and prepare a heat balance sheet.
6. Describe various alternative fuels, engine emissions, and emission control methods in compliance with emission norms.

Section I

Unit-1: Fundamentals of Internal Combustion Engines **No. of lectures- 08**

Introduction, Classification, Terminology, Details of Two Stroke and Four Stroke Engines, Firing Orders, Basic Engine Cycles (Otto and Diesel), Deviation of Actual Cycles from Air Standard Cycles, Difference Between S. I. and C. I. Engines, Valve Timing Diagram for Four Stroke Engines, Port Timing Diagram for Two Strokes Engines. [No Numerical Treatment]

Unit-2: Fuel System for S. I. Engine and C.I. Engine **No. of lectures- 08**

S. I. Engines - Fuel Requirements, Type of Mixtures, Air-Fuel Ratio, Simple Carburetor, Calculation of Air Fuel Ratio (Exact and Approximate Methods), Developments and Advancements in Fuel Systems for S. I. Engines- Electronic Petrol Injection System (MPFI System). [Numerical Treatment on Calculations of Main Dimensions of Carburetor]

C. I. Engines- Requirements of Fuel Injection System, Types of Injection Systems- Individual Pump, CRDI, Unit Injector. [No Numerical Treatment]

Unit-3: Engine Power Boosting Devices **No. of lectures- 04**

Requirement and Purpose of Engine Power Boosting, Power Boosting Devices, Working Principle of Supercharging and Turbocharging, Thermodynamic Cycle of Supercharged and Turbocharged Engines, Advantages and Limitations, Recent Development and Advancements in Engine Power Boosting Devices. [No Numerical Treatment]

Section II

Unit-4: Combustion in S.I. Engine and C.I. Engine **No. of lectures- 08**

S. I. Engine - Stages of Combustion, Factors Affecting Flame Speed, Abnormal Combustion, Influence of Operating Variables on Knocking, Fuel Rating, Octane Number, HUCR, Fuel Additives in S. I. Engines and its Requirements. [No Numerical Treatment]

C.I. Engine - Stages of Combustion, Factors Affecting Delay Period, Diesel Knock, Influence of Engine Design and Operating Variables on Diesel Knock, Comparison of Abnormal Combustion in S. I. and C. I. Engines, Cetane Number, Antiknock Agent, Fuel Additives in C.I. Engines. [No Numerical Treatment]

Unit-5: Engine Testing and performance **No. of lectures- 08**

Significance of Engine Testing and Performance, Different Engine Performance Measuring Instruments, Performance Parameters -Torque, Power, Volumetric Efficiency, Mechanical Efficiency, BSFC, Brake and Indicated Thermal Efficiencies etc., Heat Balance Sheet. [Numerical on Engine Performance and Heat Balance Sheet]

Unit-6: Alternative Fuels and Engine Emission **No. of lectures- 04**

Various Alternative Fuels and Their Suitability for S.I. and C.I. Engines, S.I. Engine Emissions (HC, CO, NOx), Emission Control Methods, Catalytic converters, C.I. Engines Emissions (CO, NOx, Smog, Particulate), Emission Control methods, EGR, Bharat Norms. [No Numerical Treatment]

- **Internal Continuous Assessment (ICA):**
  List of Experiments/Assignments/Case Studies, etc.

1. Study and Demonstration of Constructional Details of I.C. Engines.
2. Study of Engine Cooling and Lubrication systems.
3. Study of Ignition and Starting Systems.

4. Test on Computer Controlled I.C. Engine/ Variable Compression Ratio Diesel Engine.
5. Constant Speed Test (Influence of Load on Performance) and Heat balance sheet.
6. Morse Test on Petrol Engine.
7. Assignment on Modern Trends and Recent Developments in I.C. Engines. (Case Study)
8. Visit to An Engine Manufacturing Company / Repairing Unit.

- **Text Books:**

1. Internal Combustion Engines, Mathur and Sharma, Dhanpat Rai Publication.
2. Engineering Fundamentals of the Internal Combustion Engine, Willard Pulkrabeck, Prentice Hall Publication.
3. Internal Combustion Engines, R. K. Rajput, Dhanpat Rai Publication.
4. Internal Combustion Engines, V. Ganesan, McGraw Hill Publication.
5. Introduction to Internal Combustion Engines, Richard Stone, Springer Nature Publication.

- **Reference Books:**

1. Internal Combustion Engines Fundamentals, John Heywood, McGraw Hill Publication.
2. Internal Combustion Engines Emission and Control, EranSher, SAE Publication.
3. Engine Emissions, B.P. Pundir, Narosa Publication House.
4. Alternative Fuels, S.S. Thipse, Jaico Publication.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHPEC-01C: Product Life Cycle Management

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical :02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

Product lifecycle management (PLM) refers to the handling of a good as it moves through the typical stages of its product life: development and introduction, growth, maturity/stability, and decline. This handling involves both the manufacturing of the good and the marketing of it.

Course Objectives:
During this course, student is expected to:

1. Familiarize with various strategies of PLM
2. Understand the concept of product design and simulation
3. To study the significance of digital manufacturing
4. To develop new product management system and supporting systems
5. To understand product life cycle environment
6. To apply different analysis tools

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

1. Describe the concepts of product of life cycle management and its applications in product development process.
2. Apply the models of Product Life Cycle for product development process
3. Emphasize the significance of digital manufacturing and product structures.
4. Analyze the strategies of Product life Cycle Management and supporting systems
5. Explore the product life cycle environment
6. Select the appropriate product life cycle management tools

Section I

Unit-1: Introduction to Product Life Cycle Management **No. of lectures- 06**

Background, Overview, Need, Benefits, Concept of Product Life Cycle Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement

Unit-2: Constructing PLM & Driving Environment **No. of lectures- 08**

Product Life cycle model: plan, design, build, support & dispose, Threads of PLM: Computer Aided Design (CAD), Engineering Data Management (EDM), Product Data Management (PDM), Computer Integrated Manufacturing (CIM), Weaving the threads into PLM, Comparison of PLM to Engineering Resource Planning (ERP), PLM characteristics: singularity, cohesion, traceability, reflectiveness, Information Mirroring Model, External drivers: scale, complexity, cycle times, globalization & regulation, Internal drivers: productivity, innovation, collaboration & quality, Boardroom drivers: income, revenues & costs

Unit-3: Digital Manufacturing – PLM **No. of lectures- 06**

Digital manufacturing, Benefits of digital manufacturing, Manufacturing the first-one, Ramp up, Virtual learning curve, Manufacturing the rest, Production planning

Section II

Unit-4: Product Life Cycle Management System **No. of lectures- 06**

Product life cycle management system: system architecture, Information models and product structure, Information model, the product information data model, the product model, functioning of the system, Reasons for the deployment of PLM systems

Unit-5: Product Life Cycle Environment **No. of lectures- 06**

Product Data issues: access, applications, archiving, availability, change, confidentiality, Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company's PLM vision, The PLM strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change management for PLM

Unit-6: Types of Analysis Tools **No. of lectures- 08**

Design for manufacturing: machining, casting and metal forming, optimum design, Design for assembly and disassembly, Probabilistic design concepts, FMEA, QFD, Taguchi Method for design of experiments, Design for product life cycle, Estimation of manufacturing costs, reducing the component costs and assembly costs, Minimize system complexity

- **Internal Continuous Assessment (ICA):**

List of Assignments/Case Studies, etc.

1. Assignment on Product Life Cycle Management
2. Assignment on Product Life cycle model
3. Assignment on Digital Manufacturing
4. Assignment on Product Life Cycle Management System
5. Assignment on Product Life Cycle Environment
6. Assignment on PLM Analysis Tools
7. One hands-on case study using any suitable PLM related software

- **Text Books:**

1. Grieves, Michael. Product Lifecycle Management, McGraw-Hill, 2006.
2. Product Design & Process Engineering, McGraw Hill – Kogalkusha Ltd., Tokyo, 1974.
3. Product Design & Development – by Kari Ulrich and Steven D. Eppinger, McGraw Hill International Edns, 1999.
4. Stark, John. Product Lifecycle Management: Paradigm for 21st Century Product Realisation, Springer-Verlag, 2004.
5. A.K. Chitale; R.C. Gupta, "Product Design and Manufacturing" Prentice Hall India

- **Reference Books**

1. Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006. ISBN 0071452303
2. Antti Saaksvuori, AnselmiImmonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003)
3. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer Verlag, 2004. ISBN 1852338105.
4. Product Life Cycle Management - by AnttiSaaksvuori, AnselmiImmonen, Springer, 1st Edition (Nov.5, 2003)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B. TECH. (Mechanical Engineering)
Semester-V
MECHPEC-01D: Mechatronic Systems

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical: 02 Hours/week, 01 Credit

***Examination Scheme**
ESE: 70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
This introductory course focuses on designing mechatronic systems by integrating mechanical, electrical, electronic, and computing engineering disciplines within a unified framework. Key topics include mechatronic systems, sensors and actuators, and industrial applications of mechatronics. The second part of the course covers microcontrollers, development boards, and programmable logic controllers (PLCs). Hands-on practical sessions involve programming, hardware-software interfacing, digital logic, measurement and sensing, and ladder programming. The course includes five dedicated lab sessions on sensor interfacing, DC motor control, stepper motor control, servo motor control, and control using Arduino and PLCs.

Course Objectives:

During this course, the student is expected to:
1. Gain a comprehensive understanding of mechatronic systems and their components.
2. Learn the classification, operating principles, and characteristics of sensors and actuators.
3. Develop a strong foundation in microprocessors, microcontrollers, and Arduino boards.
4. Understand interfacing protocols and basic signal processing techniques.
5. Learn the fundamentals of Programmable Logic Controllers (PLCs) and how to program them using ladder logic.

Course Outcomes:

At the end of this course, students will be able to:
1. Identify and explain mechatronic systems and devices.
2. Describe the types and applications of sensors and actuators in mechatronic systems.
3. Program microcontrollers using assembly or C/C++.
4. Demonstrate sensor and actuator interfacing techniques.
5. Develop and implement PLC programs using ladder logic on both simulators and real hardware.

Section I

Unit-1: Mechatronic Systems **No. of lectures- 6**

Basic definition, key elements of mechatronics, historical perspective, introduction to mechatronic design, representation using block diagrams, open-loop, and closed-loop control systems, the concept of transfer functions, block diagrams, and reduction principles, examples of mechatronic systems (car engine management, white goods, domestic appliances).

Unit-2: Sensors and Actuators **No. of lectures- 8**

Sensors: Classification, principle of operation, characteristics, linear and rotational sensors, acceleration sensors, force sensors, torque sensors, flow sensors, temperature sensors, distance sensors, optical sensors, ultrasonic sensors, microsensors, and selection criteria.

Actuators: Classification, hydraulic and pneumatic actuators, DC motors, AC motors, stepper motors, servo motors, solenoids, piezoelectric actuators, variable frequency drives (VFDs), micro actuators.

Unit-3: Microcontrollers **No. of lectures- 6**

Microprocessors and microcontrollers, 8085 microprocessor (architecture, pin diagram), 8051 microcontroller, Arduino development boards, Arduino Uno R3 (ATmega328P), interfacing sensors and actuators with 8051 and Arduino, programming fundamentals.

Section II

Unit-4: Data acquisition systems and peripheral interfacing **No. of lectures-7**

Signal conditioning and interfacing, signal processing, source and sink currents, pull-up and pull-down configurations, motor drivers, relays, opto couplers, ADC/DAC, OPAMPs, DAQ, loggers, serial and parallel communications, bit and baud rate, protocols, data flow, handshaking, signal transmission, TIA/EIA serial standards (RS232, RS422, RS485), IEEE 488 General Purpose Interface Bus (GPIB), USB.

Unit-5: Programmable Logic Control **No. of lectures-8**

PLC architecture, I/O processing, NPN/PNP sourcing and sinking, ladder diagrams, SFC, FBD, internal relays, jump and call functions, timers, counters, shift registers, data handling, programming for temperature control and sequencing, PLC vs. PC-based systems, top manufacturers.

Unit-6: Mechatronics in the industry **No. of lectures-5**

DCS, HMI, SCADA, Modern HVACs, CNC machines and factory automation, IOT, Industry 4.0, Machine learning, and various systems in a modern automobile (ABS, TCS, DAS).

- **Internal Continuous Assessment (ICA):**

List of Experiments/Assignments/Case Studies, etc.

1. Survey assignment on mechatronic products.
2. Survey assignment on sensors and actuators.
3. One practical assignment on interfacing sensors with microcontrollers.
4. One practical assignment on DC motor control and stepper motor control using Microcontrollers.
5. One theory assignment on data acquisition system.
6. One PLC programming assignment of ladder diagram programming.
7. One practical assignment on interfacing sensors and actuators with PLC.
8. One practical assignment includes building a small Mechatronic system that contains a microprocessor/microcontroller/plc that receives input from sensors and control actuators.

- **Text Books:**

1. W. Bolton, Mechatronics, Pearson Publishing, 4th Edition
2. Shetty & Kolk, Mechatronics System Design, Cengage Learning, 2nd Edition
3. Mazidi, 8051 Microcontroller, Prentice Hall, 3rd Edition
4. Banzi, Getting Started with Arduino, McGraw Hill

- **Reference Books:**

1. Bishop et.al, Handbook of Mechatronics, CRC Press, 2nd Edition
2. Gaonkar Ramesh, The 8085 microprocessor, Penram International Publishing, 2nd Edition
3. W. Bolton, Programmable Logic Controllers, Pearson Publishing, 3rd Edition

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B. TECH. (Mechanical Engineering)
Semester-V
AEC-02: Creativity and Design Thinking

***Teaching Scheme**
Lectures: 01 Hour/week, 01 Credit
Practical: 02 Hours/week, 01 Credit

***Examination Scheme**
ESE: 50 Marks
ICA: 25 Marks

Course Introduction:

This course introduces the principles of creativity and design thinking, emphasizing innovative problem-solving through ideation, prototyping, and sustainable product development. Students will explore real-world applications, creative techniques, and environmental considerations to develop user-centric and impactful engineering solutions.

Course Objectives:
During this course, the student is expected to:

1. To introduce students to the concepts of creativity, innovation, and design thinking process.
2. To develop problem-solving skills using divergent and convergent thinking approaches for iterative design methodologies.
3. To familiarize students with prototyping methods and their applications in iterative design methodologies.
4. To emphasize sustainable design principles and their integration into product development processes.

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

1. Elaborate the critical design thinking skills needed to either improve an existing product or design a new product.
2. Demonstrate the ability to generate and evaluate creative ideas using ideation techniques.
3. Apply Creativity and Prototyping to refine product designs effectively.
4. Analyze and apply sustainable design principles into the engineering design process.

Section I

Unit 1: Introduction to Creativity and Design Thinking (4 Hrs)

Creativity and Innovation: Definition, importance, and characteristics, Design Thinking Process, Empathize, Define, Ideate, Prototype, Test, Barriers to Creativity and Techniques to Overcome them.

Unit 2: Ideation and Concept Development (3 Hrs)

Exploring Problem-Solving Approaches: Divergent and convergent thinking, Creative Ideation Methods: Different Method of Idea Generation such as Brainstorming, SCAMPER, TRIZ, Mind Mapping, Transforming Ideas into Concepts: Concept sketching, storytelling, and visualization techniques.

Section II

Unit 3: Creativity and Prototyping (4 Hrs)

Creativity in Design: Applying creativity, brainstorming, and concept generation in problem-solving, Prototyping Methods and Strategies: Low-fidelity vs. high-fidelity prototypes, rapid prototyping, and iterative design, Real-Life Applications: Case studies on Real-life applications demonstrating customer-driven designs and meeting product specifications.

Unit 4: Sustainable Design and Product Development (5 Hrs)

Design for Environment Principles: Applying environmental sustainability throughout the product life cycle., Product Development Processes: Selecting and implementing staged, spiral, and agile development models based on project needs. Case Studies: Sustainable product development in the electrical engineering domain.

- **Internal Continuous Assessment (ICA):**

  ICA should be based on assignments (Case studies) based on the above topics.

  1. Presentations — Idea pitching and storytelling exercises.

  2. Mini-Projects — Hands-on prototyping and testing (e.g., designing a sustainable electrical product)..

  3. Group Discussions — Exploring innovative business models and their applications.

  4. Participation — engaging in designs thinking workshops and brainstorming sessions.

- **Text Books:**

1. Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, Tata McGraw Hill.
2. Design Thinking: Understanding How Designers Think and Work by Nigel Cross.
3. Creative Confidence by Tom Kelley and David Kelley.

- **Reference Books:**

1. Product Design for Engineers by Devdas Shetty, Cengage Learning.
2. Product Design by Kevin Otto and Kristin Wood, Pearson Education.
3. Sustainable Design: A Critical Guide by David Bergman.
4. The Art of Innovation by Tom Kelley.
5. Entrepreneurship by Robert D. Hisrich, Michael Peters, and Dean Shepherd, Tata McGraw Hill.

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ

।। विद्यया संपन्नता ।।

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'B++' Grade (CGPA-2.96)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B. TECH. (Mechanical Engineering)
Semester-V
OE-03: Interdisciplinary Mini Project

***TeachingScheme**
Lectures: 01 Hours/Week, 01 Credit
Practical: 02 Hours/Week, 01 Credit

***Examination Scheme**
ICA: 25 Marks
POE: 25 Marks

Course Introduction:

An interdisciplinary mini-project is designed for interdisciplinary learning to help students to develop practical ability and knowledge about practical tools/techniques that integrate concepts from other fields like Electronics, Computer Science, Electrical and Environmental Engineering, with potential project ideas to solve real life problems related to the industry, academic institutions and society. The project types embrace both single-team projects and larger projects consisting of multiple teams working together on complex problems by application of their research skills, and to apply their knowledge to complex multidisciplinary engineering & computing problems. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

Course Objectives:

During this course, students are expected to:

1. Foster interdisciplinary collaboration among engineering students and familiarize them with cutting-edge technologies and trends in engineering.
2. Encourage the application of diverse engineering principles to enhance technical, analytical, and problem-solving skills through project-based learning for innovative solutions.
3. Equip students with knowledge of ethical considerations and sustainable development principles in engineering.
4. Develop project management, documentation, and presentation skills.

Course Outcomes:

At the end of this course, student will be able to:

1. Apply interdisciplinary knowledge, teamwork and collaboration skills to design and implement innovative solutions to engineering problems.
2. Develop integration to emerging technologies in engineering and their applications into project design and development.
3. Apply ethical principles and sustainable development goals in engineering design.
4. Produce and present a comprehensive project report with proper documentation.

Unit 1: Introduction to Interdisciplinary Projects **(4 Hrs)**

Definition and significance of interdisciplinary projects, Importance of interdisciplinary projects in engineering, Overview of project management: Planning, execution, and evaluation, Team formation and role allocation.

Unit 2: Problem Identification and Scope Definition **(3 Hrs)**

Techniques for identifying real-world problems, Defining project scope, objectives, and deliverables, Feasibility analysis: Technical, economic, and environmental considerations.

Unit 3: Design and Development Process **(3 Hrs)**

System design and architecture, Integration of core engineering disciplines (electrical, mechanical, electronics, computer science. civil), Prototyping and testing methodologies.

Unit 4: Ethics and Sustainability in Engineering Projects **(3 Hrs)**

Ethical considerations in engineering design and implementation, Sustainable development goals and their relevance to engineering projects.

Unit 5: Project Documentation and Presentation **(2 Hrs)**

Writing technical reports: Structure and guidelines, Effective presentation techniques, Intellectual property rights and patent filing basics.

General Guidelines for Interdisciplinary Mini Project:

1. Selection of Topic:

Selection of topics is a huge and important task in an Interdisciplinary Mini Project. One should have a clear idea about one's subject strengths and the selected topic should be relevant to it. Always select the project that has value addition.

As a graduate you should select a project which is either advantageous to a lot of people or enhance your technical and managerial skills. Your project must play its role towards a positive growth/development in that specific field.

Project domain may be from the following, but not limited to:

i. Thermal Systems

ii. Robotics Mechanisms/design systems

iii. Production/advance manufacturing, 3D Printing

iv. Materials: Composite/Nano Materials

v. Automation and Control Systems

vi. Mechatronics Systems

vii. Agriculture system.

viii. Smart systems using AI

2. Research about the selected topic online:

Do some online research about the selected topic. Go through the research papers from different researchers around the world on the topics related to Mini Project. Find some websites containing the information about the materials used for Mini Project.

3. Suggestions from subject experts:

Go to the subject experts in the institution and interact with them about the Mini Project topic. You can also meet many subject experts from various parts of India through social media and some discussion forums. This helps you in getting suggestions in different possible ways, through which you can get a clear idea on your Mini Project topic.

4. Planning:

After getting a clear idea about the topic, prepare a rough plan about procurement of resources, experimentation, analysis, simulation, survey, fabrication etc. along with your teammates. Make a rough schedule, adapt to it and distribute the work among your teammates. This will keep your Mini Project on track and individuals will come to know about their part in the Mini Project rather than any individual (leader) taking full responsibilities.

5. Execution of plans:

Make sure that the materials will be ready for the experimentation/fabrication by the scheduled time. Follow the schedule during experimentation/fabrication to get accurate and efficient results.

6. Presentation:

Experimentation/Fabrication does not make a Mini Project successful; one should be able to present the results in the proper way. So it should be prepared in such a way that it reflects the exact objective of your Mini Project.

The mini project shall be evaluated in two stages, Intermediate review and End Semester Review. Below points are considered for evaluation:

i. Quality of the presentation
ii. Quality of the report
iii. The quantum of the work
iv. Understanding of the subject selected
v. Deal with questions

Internal Continuous Assessment (ICA)-

Guidelines for Mini-Project content & Mark Distribution:

1. A group of maximum 04 students will be formed for Interdisciplinary Mini-Project work.
2. The project group should integrate at least two engineering disciplines.
3. Work diary and reporting to guide as per prescribed contact hours.
4. The contents of work diary shall reflect the efforts taken by project group for
   i. Searching suitable mini-project work
   ii. Brief report preferably on journals/ research or conference papers/ books or literature surveyed to select and bring out the mini-project area.

iii. Brief report of feasibility studies carried to implement the conclusion.

iv. Rough Sketches/ Design Calculations, etc.

5. An interdisciplinary mini-project may be based on software/experimental/analysis/fabrication work.
6. It will be preferable if student will work on the area of mini project in line with their proposed final year project.
7. The group has to give a powerpoint presentation in front of the faculty members / panel of department at the end of semester along with the spiral bound report (Limited to 20 Pages).
8. Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

TEXT BOOK

1. Project Management for Engineering and Technology by David L. Goetsch, Pearson Education.
2. Interdisciplinary Engineering Design Education by Michael A. Stylios, Springer.
3. Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold Kerzner.
4. Interdisciplinary Research: Process and Theory by Allen F. Repko and Rick Szostak.

REFERENCE BOOKS

1. Product Design for Engineers by Devdas Shetty, Cengage Learning.
2. Engineering Project Management by Nigel J. Smith.
3. Emerging Technologies: From Hype to Impact by Bruno Salgues.
4. Sustainable Engineering: Principles and Practice by David T. Allen and David R. Shonnard.

Third Year B.TECH. (Mechanical Engineering)
Semester-VI

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPCC-10: Transmission System Design

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Tutorial : 01 Hour/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
This course seeks to provide an introduction to design of various machine elements required in the transmission system and discusses various design procedures, requirements and design methods. It introduces the design procedure for various types of gears like spur gear, helical gear, bevel gear and worm gear along with the introduction to AGMA standard. The different types of bearings, their significance and the selection of the rolling contact bearings from Manufacturer's Catalogue and the design considerations for sliding contact bearing are also included in the course content. Design of friction drives such as clutches and brakes is included.

Course Objectives:

The course aims to:

1. Apply the process of design of the Spur gears.
2. Apply the helical gear design process.
3. Apply the design process for the bevel gear.
4. Apply the design process for the Worm gear.
5. Select the suitable bearing for a particular application from the manufacturer's catalogue.
6. Apply the design concepts of clutches and brakes.

Course Outcomes:

At the end of this course, student will be able to:

1. Design the spur gear considering criterion of bending and wear for particular application.
2. Design the helical gear considering criterion of bending and wear as per required application.
3. Design the Bevel gear considering criterion of bending and wear at particular location.
4. Design the worm gear considering criterion of strength, wear and thermal as per requirement.
5. Select the bearing from the manufacturer's catalogue and to use for suitable application.
6. Calculate of dimensions of clutches and brakes required for an application

Section I

Unit-1: Spur Gears **No. of lectures-06**

Design considerations of gears, gear materials, types of gear tooth failures, hunting tooth, gear tooth loads, minimum number of teeth, face width, Lewis equation, Spott's equation, Buckingham's' Equation (Introductory treatment), gear design for maximum power transmission, Introduction to AGMA code.

Unit-2: Helical Gears **No. of lectures- 04**

Introduction to helical gears, Virtual number of teeth, Design of helical gears based on beam strength and wear considerations, Effective load on gear tooth.

Unit-3: Worm Gears **No. of lectures- 05**

Terminology and geometrical relations, materials, standard dimensions and recommendations of worm gearing, friction in worm gear, efficiency and design criteria of worm drive as per IS7443-1974, load rating of worm drive, strength and wear rating of worm gear, thermal considerations in worm drive.

Section II

Unit-4: Bevel Gears **No. of lectures- 05**

Introduction to bevel gears, Terminology and geometrical relation, Virtual number of teeth, Design of bevel gears based on beam strength and wear strength, dynamic tooth load, Effective load on gear tooth.

Unit-5: Rolling Contact and Sliding Contact Bearings **No. of lectures-07**

Rolling Contact bearing: Types, static and dynamic load capacities, Equivalent bearing load, load life relationship, bearing life, load factor, selection of bearing from manufacturer's catalogue, Design for variable load and speed, Bearings with probability of survival other than 90 %
Sliding contact Bearing: Bearing material and their properties, bearing types and their construction details, Hydrodynamic and Hydrostatic Bearings (Introductory Treatment).

Unit-6: Friction clutches and Brakes **No. of lectures-04**

Clutches: Design of plate clutches (Single plate and Multi-plate clutch),cone clutches,centrifugal clutch, Energy equation and thermal considerations in clutches.
Brakes: Introduction, Energy equations, Band and Block brakes , external shoe brakes , Internal expanding shoe brake, Disc brake, thermal considerations.

- **Internal Continuous Assessment (ICA):**

List of Assignments/Case Studies, etc. (Any 6 out of 8)

1. Practice examples on design of spur gear.
2. Practice examples on design of helical gear.
3. Practice examples on design of bevel gear.
4. Practice examples on design of worm gear.
5. Practice examples on design of clutches and brakes
6. Assignment on Rolling contact bearing
7. Assignment on sliding contact bearing
8. A research based case study on failure analysis of gear

- **Text Books:**
  1. Bhandari V, “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill Book Co, 2017.
  2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, Tata McGraw-Hill.

- **Reference Books:**
  1. Machine Design by Robert L. Norton.
  2. Machine Design by Hall, Holowenko, Schaum’s outline series.
  3. Hand book of Mechanical Design, 2nd Edition, Gitin Maitra, L. Prasad “Tata McGrawHill,
  4. Design of Machine Elements, C.S.Sharma, Kamlesh Purohit, Prentice Hall of India, Pvt. Ltd.
  5. Design of Machine Elements M. F. Spotts, T. E. Shoup and L. E. Hornberger, 8th Edition, Printice Hall, 2003.
  6. PSG Design Data Book

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPCC-11: Heat Transfer

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical: 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
POE: 25 Marks

Course Introduction:
This course deals with study of various modes of heat transfer such as conduction, convection and radiation. After completing the course, the students will be able to formulate and analyze a heat Transfer problem involving any of the three modes of heat transfer. The students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer. The students will be able to analyze the performance of devices such as heat exchangers and also estimate the insulation needed to reduce heat losses wherever necessary.

Course Objectives:
During this course, student is expected to:

1. To classify and study the important modes of heat transfer.
2. To formulate and apply the general three-dimensional heat conduction equations
3. To elaborate the mechanism of radiative heat transfer.
4. To elaborate the mechanism of convective heat transfer.
5. To demonstrate and explain the mechanism of boiling and condensation.
6. To describe the various two-phase heat transfer phenomena.

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

1. Compare and distinguish the Modes of heat transfer.
2. Apply the laws of conduction heat transfer to the analysis.
3. Apply the different laws to the radiation heat transfer.
4. Analyze heat transfer in case of natural & forced convection.
5. Explain heat transfer in boiling & condensation.
6. Analyze the effectiveness, rating of heat exchangers.

Section I

Unit-1: Conduction **No. of lectures- 05**

Modes of Heat Transfer-
Modes of heat transfer. Basic laws of heat transfer, Thermal conductivity and its variation with temperature for various Engineering materials (Description Treatment).

Steady State Heat Conduction-
Derivation of Generalized Heat Conduction equation in Cartesian coordinate & its reduction to Fourier, Laplace and Poisson's equations. its reduction to one-dimension (1D) heat conduction through the plane wall. Heat Transfer Applications: composites, One dimensional steady state heat conduction with uniform heat generation for wall (Numerical Treatment)

Unit-2: Heat Transfer in Cylinders, Spheres and Extended Surfaces **No. of lectures- 06**

Generalized Heat conduction equation in cylindrical and spherical coordinates (no derivation) and its reduction to one-dimension (1D) heat conduction through cylinder and sphere**,** critical radius of insulation for cylinder and sphere**,** One dimensional steady state heat conduction with uniform heat generation for cylinder (Numerical Treatment)

Types and applications of fins, Governing equation for constant cross section area fins, Solution for fins with convective tip (derivation) , adequately long (with insulated end) and infinitely long (no derivation). Fin effectiveness and efficiency (Numerical Treatment)

Unit-3: Radiation **No. of lectures- 04**

Nature of thermal radiation, definitions of absorptivity, reflectivity, transmissivity, monochromatic emissive power. Total emissive power and emissivity, Concept of black body & gray body, Kirchhoff's law, Wien's law and Planck's law. Lambert cosine rule, Intensity of radiation. Energy exchange by radiation between two black surfaces with non-absorbing medium in between and in absence of reradiating surfaces.

Section II

Unit-4: Convection **No. of lectures- 06**

Forced Convection-

Mechanism of convection and its types, Concept of Hydrodynamic and thermal boundary layer, local and average convective coefficient. Dimensional analysis, dimensionless numbers and their physical significance, (Numerical Treatment)

Natural Convection-

Introduction, Dimensional analysis, dimensionless numbers and their physical significance, (Numerical Treatment)

Unit-5: Boiling and condensation **No. of lectures- 03**

Boiling Heat Transfer, types of boiling, Pool boiling curves, Force boiling phenomenon, Condensation Heat transfer, Film wise and drop wise condensation (Descriptive Treatment)

Unit-6: Heat Exchangers **No. of lectures- 06**

Classification & Types of Heat exchangers, Fouling factor, and Overall heat transfer coefficient, Analysis by LMTD and NTU method for parallel and counter flow, Design consideration for Heat exchangers. (Numerical Treatment).

List of Experiments for Practical Oral Examination

Any 06 Experiments based on following list

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity & thermal resistance of Composite wall .
3. Determination of thermal conductivity of metal rod .
4. Determination of Heat Transfer Coefficient for natural convection.
5. Determination of Heat Transfer Coefficient for forced convection.
6. Determination of Emissivity of test plate.
7. Determination of Stefan Boltzmann Constant.
8. Determination of critical heat flux in boiling heat transfer.
9. Determination of heat transfer coefficient in dropwise and film wise condensation.

10. Determination of LMTD and effectiveness of Heat Exchanger.
11. Heat Pipe Demonstration/Trial.
12. Determination of temperature distribution, fin efficiency in Natural /forced convection.
13. Computer programme for any one of the above experiments.

Instructions for Practical Exam:

1. Four to Five experiments may be selected for Practical Examination.
2. The Number of Students for each practical set up may not be more than 04 Students.

- **Text Books:**

1. A Text Book on Heat Transfer by Dr. S. P. Sukhatme, Orient Longman Publication, Hyderabad
2. Heat Transfer by P.K. Nag, Tata McGraw hill Publishing Company Ltd., New Delhi.
3. Engineering Heat and Mass Transfer, Mahesh M. Rathore, University Science Press, New Delhi-110002
4. Heat and Mass Transfer by Dr. D. S.Kumar S.K. Kataria & Sons, Delhi.
5. Heat and Mass Transfer, S.C. Arora and S. Dokoundwar, Dhanpat Rai and Sons, Delhi.

- **Reference Books**

1. Heat Transfer by J.P. Holman , McGraw Hill Book Company, New York.
2. Fundamentals of Heat and Mass Transfer by R.C. Sachdev, Wiley Eastern Ltd.
3. Heat Transfer – A Practical approach by – Yunus -A – Cengel(Tata McGraw Hill)
4. Fundamentals of Heat & Mass Transfer (Fifth Edi.), Frank P.Incropera, David P.

PunyashlokAhilyadeviHolkarSolapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPCC-12: Instrumentation and Control Engineering

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical: 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA:25 Marks

Course Introduction:
In recent years, the importance of Instrumentation & Control systems has been rapidly increasing in all fields of engineering. The applications of Instrumentation & Control cover a very wide range, from design of precision control devices such as delicate electronic equipment to the design of massive equipment such as those used for the manufacture of steel or other industrial processes. The principles of control theory are applicable to engineering as well as non –engineering fields.

Course Objectives:
During this course, student is expected to:

1. Describe the generalised measurement system and various characteristics of instruments.
2. Use various measuring instruments for measurement of temperature.
3. Use various measuring instruments for measurement of pressure and vacuum.
4. Identify & describe various types of control systems and apply block diagram algebra.
5. Construct the Root Locus for a given control system and comment on system stability.
6. Construct Bode Plots for a given control system and comment on system stability.

CourseOutcomes:

At the end of this course, student will be able to:

1. Describe the generalised measurement system, explain various characteristics of instruments.
2. Use various measuring instruments for measurement of temperature.
3. Use various measuring instruments for measurement of pressure and vacuum.
4. Identify & describe various types of control systems and apply block diagram algebra.
5. Construct the Root Locus for a given control system and comment on system stability.
6. Construct Bode Plots for a given control system and comment on system stability.

Section I

Unit-1: Fundamentals of Instrumentation **No. of lectures- 6**
Instrument and Instrumentation, its importance, measurement, monitoring & control, measurement methods, standards of measurement, calibration, classification of instruments, Generalised Measurement System and its functional elements, Classification of sensors and transducers, Static and Dynamic characteristics of instruments

Unit-2: Measurement of Temperature **No. of lectures- 4**
Measurement of Temperature : Concept of Temperature, scales of temperature, Thermometer, Thermocouples, basic principle, characteristics of thermocouple materials, classification, laws of thermocouples, series and parallel combinations, RTD, Thermistor, construction and principle of working, Materials used, applications

Unit-3: Measurement of Pressure, Flow and Motion **No. of lectures- 5**

Terminology of pressure & vacuum, Bourdon tube pressure gauge, Deadweight pressure gauge tester, Diaphragm gauge, vacuum gauges- McLeod'sgauge, Pirani gauge, Measurement of fluid flow : Rate meters and Quantity Meters, Turbine Meter, Rotameter, Hot wire anemometer, Measurement of Linear Position & displacement : LVDT, Angular Speed Measurement : Mechanical Tachometer, Inductive pickup, Photoelectric pickup, Stroboscope

Section II

Unit-4: Fundamentals of Automatic Control **No. of lectures- 5**

Control – Need, Control System, Manual and automatic control systems, Open loop and Closed loop (feedback) control systems, Modes of Control : P - Control, P+I Control, P+I+D Control, Block diagram Algebra: General representation of a feedback control system, transfer functions, rules of block diagram algebra, reduction of block diagram to obtain closed loop transfer function.

Unit-5: Root Locus Method **No. of lectures- 5**

Significance of Root locus, angle and magnitude conditions, pole-zero plot, sections of R.L. on the real axis, asymptotes & centroid, breakaway points, intersection with the imaginary axis, angles of departure and arrival, construction of root locus (on graph paper) using general rules and steps, comment on system stability

Unit-6: Bode Plots **No. of lectures- 5**

Magnitude and Phase angle plots, standard form of open loop T.F. G(jω) H(jω), Bode plots for standard factors of G(jω) H(jω),steps to sketch Bode plots for following factors :System gain K, Poles & zeros at the origin, simple poles & simple zeroes, frequency response specifications, construction of Bode plots using a semilog paper, calculation of Gain Margin and Phase margin, comment on system stability

- **Internal Continuous Assessment (ICA):**
  List of Experiments/Assignments/Case Studies, etc.
  Any Four from (1) to (5) and any four from (6) to (10)

1. Temperature Measurement using thermocouples, RTD, Thermistor.
2. Testing of mechanical pressure gauge using Dead weight pressure gauge tester.
3. Flow measurement using Rotameter.
4. Displacement Measurement using LVDT
5. Angular speed measurement using a mechanical tachometer and a stroboscope or photoelectric pickup or inductive pickup tachometer.
6. An experiment on open and closed loop control actions (motor speed or temperature controller)
7. Assignment on fundamentals of automatic control
8. Assignment on Block Diagram Algebra
9. Assignment on Root Locus Method using suitable software.
10. Assignment on Bode Plots

- **Text Books:**

1. Mechanical Measurements & Control: Dr. D. S. Kumar, Metropolitan Book Co. Pvt. Ltd. New Delhi 110 002 (4^{th}/ latest edition)
2. Automatic control Engineering: F. H. Raven., McGraw Hill International editions, New Delhi, fifth / latest edition.
3. Control Systems: U.A. Bakshi and V.U. Bakshi : Technical Publications, Pune, Fifth revised Edition 2007 / (latest edition)

- **Reference Books**

1. Mechanical Measurements : R S Sirohi & H C Radha Krikshna, New Age International Publishers (latest edition)
2. Mechanical Measurements : Thomas Beckwith, Roy D Marangoni, John H Lienhard V, Pearson International Edition (6^{th}/latest edition)
3. Modern Control Engineering: K.Ogata, Prentice Hall of India Pvt. Ltd., New Delhi., 4th / latest edition
4. Process Control Instrumentation Technology: Curtis Johnson: Prentice Hall of India Pvt. Ltd.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPEC-02A: Plastic Engineering

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks
OE: 25 Marks

- **Course Introduction:**

During this course, student is exposed to following knowledge-

1. Study of extraction, manufacturing of plastic material and classification.
2. Study of various properties of plastic materials, comparative study of the plastics on the basis of parameters like structure, cost and processing time etc.
3. Study and Comparison of the different processes on the basis of parameters like design of plastic parts, cost and processing time etc.
4. Design of plastic part, die/molds, correct selection & design leads to compact & less cost of systems.

- **Course Objectives:**

During this course, student is expected to:

1. Understand the fundamental concept of structure and properties of different kinds of plastics and the mechanism of polymerization.
2. Understand processing of plastics.
3. Design the plastic products.
4. Design compression and transfer molds incorporating essential components.
5. Analyze and design injection molds
6. Understand the cooling system of plastic injection mould.

- **Course Outcomes:**

At the end of this course, student will be able to:

1. Predict the structure and properties of different kinds of plastic material and select the plastic materials for particular end user application.
2. Explain the processing of various plastic materials in relation to end-user requirements.
3. Design the plastic products.
4. Design compression and transfer molds.
5. Design Injection Moulds.
6. Analyze and design efficient cooling systems for injection molds.

Section I

Unit-1: Study of Plastic Materials **No. of lectures- 06**

Definition and Classification of Plastic Materials, Properties of plastics, applications, Testing methods for plastics, additives in plastics, Monomers & Polymers, Polymerization - Types of Polymerization.

Introduction to composite plastics, Introduction of polymer degradation and biodegradable plastics, advanced application like Agriculture, Packaging, Building, Transport, Electrical, Electronics, Medical and Furniture.

Unit-2: Processing of Plastics and Welding of Plastics **No. of lectures- 07**

Processing of Plastics: Injection molding, Extrusion molding, sheet forming processes, calendaring, Blow molding, Processing of thermosetting plastics, compression molding, Transfer molding, rotational molding.

Welding of Plastics: Hot gas welding, hot tool welding, High frequency induction welding, laser welding, Infrared welding, ultrasonic welding, friction welding.

Unit-3: Design of Plastic Parts **No. of lectures- 07**

Basic design features, Tolerances of molded plastics parts, allowances in plastics, Design corners, undercuts, curing time, ribs, minimum wall thickness, design of inserts, cores mold materials.

Section II

Unit-4: Design of compression and transfer molds **No. of lectures- 08**

a) Design and main parts of compression mould, standard insert mould body, design of loading chamber, design of punch, ejectors, stripper guided pin.

b) Technology of transfer mould, types, main parts, automation in transfer mould.

Unit-5: Injection Mould Design **No. of lectures- 06**

Injection mould design, Single, multi cavity, semi-automatic and automatic moulds. Types of injection mould, detailed structure and working. Feed system, Temperature control system, Ejection System, application.

Unit-6: Cooling of plastic injection mould **No. of lectures- 06**

Determining the heat quantity dissipated with cooling, heat dissipation with natural cooling, mean temperature, thermal resistance of mold body, summary of dimension and construction of correct cooling system.

- **Internal Continuous Assessment (ICA):**
  List of Experiments/Assignments/Case Studies, etc.

1. Study of plastic material- Polymerization, properties and specific applications in wide areas.
2. Design of Plastic product.
3. Injection mould design for simple component.
4. Design of Compression mould.
5. Design of Blow Mould.
6. Two Case studies for mould manufacturing-At least one case study with any CAD/CAM software.

7. Study and applications of advanced Plastics.
8. Industry Visit to Plastic Part Manufacturing Units (Minimum. Two Units).

- **Text Books:**

1. Prof.(Dr.) Sanjay K. Nayak, Fundamentals of Plastics Mould Design, Tata McGraw Hill Education Private Limited, New Delhi.
2. Fred W. Billmeyer, JR., "TextBook of Polymer Science", John Wiley & Sons, Singapore, 1994
3.

- **Reference Book**

1. J. A. Brydson, "Plastics Materials", Butter worth Heinemann Oxford,1999
2. Schwartz & good man "Plastics materials and processing"
3. Irwin Rubin "Handbook of Plastic Materials and Technology"
4. Charles A. Harper, "Handbook of Plastic Processes", WILEY India Pvt.Ltd., 2014
5. R.C.Batra, "Comprehensive Injection Moulding", CBS Publishers and Distributors Pvt. Ltd., 2011

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPEC-02B: Tool Engineering

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE: 70 Marks
ISE: 30 Marks
ICA: 25 Marks
OE : 25 Marks

Course Introduction:

This course seeks to provide an introduction to tool engineering and discusses various procedures, requirements, tooling methods. It introduces engineering materials and describes the different kinds of tools, jigs & fixtures used in industries. A further content explains in detail the design of press tool draw tool jig & fixture as well as tool nomenclature and geometry.

Course Objectives:

During this course, student is expected to:

1. Understand the fundamentals of mechanics involved in cutting and non-cutting operations.
2. Comprehend the basic economic considerations related to cutting and non-cutting processes.
3. Explain the concepts, principles, and practices involved in the design of various tooling systems.

Course Outcomes:

At the end of this course, student will be able to:

1. Calculate various cutting forces acting on single point cutting tools.
2. Design and draw press tool assembly bending tool and draw tools.
3. Design and draw deep draw tool assembly
4. Design and draw jig assembly
5. Design and draw fixture assembly
6. Estimate cost and break even analysis for production process

Section I

Unit-1: Basics of Tool Engineering **No. of lectures-08**

a) Single point cutting tools- Geometry & Tool signature as per ASA system & ORS system, effect of geometry on tool life, cutting force, surface finish.
b) Types of metal cutting process –orthogonal and oblique cutting, Force analysis for orthogonal cutting, types of chips, chip thickness ratio, shear angle, Tool dynamometers and Merchant circle.
c) Geometry and nomenclature of multi point cutting tools like a drill, milling cutter, broaches, and reamers.
d) Cutting tool materials - types, composition, properties and applications

Unit-2: Machinability & Tool Life **No. of lectures-04**

a) Machinability Index, factors affecting Machinability.
b) Tool life- Flank & crater wear, effect of variables on tool life, Taylor's equation of tool life
c) Coolants- Heat generation, types of coolants.

Unit-3: Press Tools **No. of lectures-08**

a) Elements of press tools, types of dies, types of operations.
b) Design of die for cutting operation, mechanics of shearing, cutting force estimation, punch & die clearance, stock strip lay out, design of punches & die block functioning & place of other elements.
c) Centre of pressure, selection of die set & press
d) Design of drawing dies determination of blank size, no. of draws, stage wise component drawing, drawing radii, clearance, and estimation of drawing force.
e) Types of Bending die, related estimates.

Section II

Unit-4: Locating & Clamping Devices for jig and fixture. **No. of lectures-08**

a) Definition concept of locating and clamping.
b) Types of locating and clamping devices.
c) Types of redundant locations.
d) Fool proofing and indexing techniques.

Unit-5: Design of Jigs & Fixtures **No. of lectures-08**

a) Design of Jigs- Principles of Jig design, types & applications, types of bushes & selection, use of standard parts, design procedure & drawing.
b) Design of Fixtures- Principles of Fixture design, standard elements & types of fixtures, design of milling fixtures.

Unit-6: Economics of Tooling **No. of lectures-04**

a) Elements of cost: methods of depreciation
b) Estimation of total cost & sales price
c) Break- even analysis for equipment selection
d) Economics of small tool selection, equipment replacement
e) Economic Order Quantity for Batch production

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.

1. Exercise on theory of metal cutting.
2. Design and drawing of press tool for particular components.
3. Design and drawing of a draw tool for particular component.
4. Design and drawing of a jig for a given component.
5. Design and drawing of milling fixture for particular component.
6. Demonstration of lathe tool dynamometer
7. Drawing sheet on geometry and nomenclature of multi point cutting tool like a drill, milling cutter, broaches, reamers.
8. Software modeling - Jig design- Exercise & modeling

Text Books:

1. Text Book of Production Engineering – P.C.Sharma (S.Chand Publication)
2. Machine Tool Engineering – G.R. Nagpal (khanna Publication)
3. Press Tools – P.H.Joshi (S.Chand Publication)
4. Jigs & Fixtures - P.H.Joshi (S.Chand Publication)

Reference Books

1. Metal cutting Theory & tool design- Mr. Arshinnov (MIR Publication)
2. Fundamentals of Tool design- ASTME Publication
3. Tool design – Donaldson (TMH Publication)
4. Jig & Fixture Design – Kempster (ELBS Publication)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHPEC-02 C: Automobile Engineering

Teaching Scheme
Lectures : 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credits

Examination Scheme
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks
OE: 25 Marks

Course Introduction:

An automobile is a self-propelled vehicle which contains the power source for its propulsion and is used for carrying passengers and goods on the ground, such as cars, buses, trucks, etc.

Automobile engineering plays a vital role in engineering and the day-to-day modern world. It gained so much recognition and importance since vehicles became a fundamental mode of transportation. People want their own mode of transportation, such as motorcycles, cars, etc. Public transportation is present as a mode of transportation, making automobile engineering an important and rapidly growing field of engineering. Automobile engineering has great career scope and broad scope in engineering. It offers wide opportunities for students who want to become automobile engineers and want to build successful careers in the field. It includes automobile components manufacturing industries, vehicle manufacturing companies, production plants, transport companies, research and development departments, service stations, motor vehicle departments, private transport companies and many more.

Course Objectives:

During this course, student is expected to:

1. Study basic principles of actual automobile systems
2. Study important systems in an automobile
3. Study recent and modern trends in automobile sector
4. To make students aware about the entrepreneurial opportunities in automobile engineering field.

Course Outcomes:

At the end of this course, student will be able to:

1. Demonstrate & explain various systems in an automobile
2. Describe importance and features of different elements like axle, differential, brakes, steering, suspension, wheel balancing etc.
3. Explain principle of operation, construction and applications of various sensors used in modern automobiles.

Section I

Unit-1: Introduction to Automobiles **No. of lectures- 06**

Broad classification of Automobiles. Major Components and their functions. Types of vehicle layouts, Front engine rear wheel drive, Front engine front wheel drive, Rear engine rear wheel drive, All wheel drive, specifications of vehicles. Types of bodies, Body construction and materials, and safety devices.

Unit-2: Performance of Automobiles **No. of lectures- 06**

Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Grade ability and draw bar pull, Traction and Tractive effort, Distribution of weight, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio. (Numerical)

Unit-3: Transmission System **No. of lectures- 08**

Requirements of transmission system, Automobile clutch- requirements, types & functions, Single plate, Multi-plate, Centrifugal, Electromagnetic & Fluid flywheel. Types of automotive gearboxes, Working of sliding mesh, Constant mesh and Synchromesh gearbox, Overdrive, Principle of operation of automatic transmission, Torque converter, Epicyclical gear trains,Propeller shaft, Universal and slip joint, Final drive and its types, Differential, Construction and types of rear axles, Introduction to wheels and tyres

Section II

Unit-4: Steering System: **No. of lectures-06**

Function of steering, Steering system layout, Automotive steering mechanism- Ackerman and Davis. Types of steering gear boxes, Condition for true rolling, Steering geometry-Camber, Caster, King pin inclination, included angle, Toe-in and Toe-out, Wheel alignment, Slip angle, Under steer & over steer, Types and working of power steering. (Numerical)

Unit-5: Braking System **No. of lectures- 06**

Function of automotive brake system, Types of braking mechanism, internal expanding & Disc brake, Mechanical, Hydraulic & Air brake system, power brakes, Anti lock braking, Calculation of braking force required, stopping distance and dynamic weight transfer. (Numerical)

Unit-6: Suspension Systems **No. of lectures-08**

Suspension requirements, Sprung and Unsprung mass, Types of automotive suspension systems. Conventional and Independent, Shock absorber, Types of springs, Hotch- kiss and Torque tube drive, Reaction members-Radius rod, Stabilizer bar, Air suspension system.

Internal Continuous Assessment (ICA):

Any five from 1 to 8 experiments and any three from 8 to 12 assignments.

List of Experiments/Assignments/Case Studies, etc.

1. Study and demonstration of four wheeler chassis layout. Two-wheel & four wheel drive layouts.
2. Study and Demonstration of working of single plate automobile clutch.
3. Study and demonstration of synchromesh gearbox.
4. Study and demonstration of final drive and differential.
5. Study and demonstration of a working Hydraulic braking system.
6. Study and demonstration of front wheel steering geometry and steering mechanism.
7. Study and demonstration of the suspension system of a four-wheeler.
8. Study and demonstration of battery and electrical starting system
9. Study and demonstration of (a) Electric horn. (b) Electric fuel Gauge. (c) Flasher unit. (d) Wiper circuit
10. Experiment on wheel balancing & front wheel alignment.
11. Visit to the servicing station for study of vehicle maintenance, repairs and report.
12. Study of Awareness and Practice of Road Safety Rules

Text Books:

1. Kripal Singh - Automobile Engineering – Standard publisher.
2. N. K. Giri- Automobile Mechanics. Khanna Publishers
3. P. S. Kohali -Automobile Electrical Equipment. McGraw Hill Publishing House

Reference Books

1. K. Newton and W. Seeds, T.K. Garrett, Motor Vehicle, Elsevier publications
2. Hans Hermann Braess, Ulrich Seiffen, Handbook of Automotive Engineering, SAE Publications

3. William H. Crouse. Automotive Mechanics - Tata McGraw Hill Publishing House
4. Joseph Heitner, Automotive Mechanics -C.B.S Publishers And Distributors
5. SAE Manuals and Standard
6. Narang G. B. S - Automobile Engineering - S. Chand and Company Ltd.
7. Singh Kripal - Automobile Engineering –Standard publisher

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPEC-02D: CAD-CAM-CAE

Teaching Scheme
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

Examination Scheme
ESE: 70 Marks
ISE: 30 Marks
ICA: 25 Marks
POE: 25 Marks

Course Introduction:

In today's competitive world, industries need to develop high-quality products at lower costs and in less time to stay ahead. To achieve this, they use computers for their fast processing, large memory, and easy-to-use graphics to automate and connect different stages of product development and manufacturing. Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), and Computer-Aided Engineering (CAE) help improve product quality while reducing costs. It is important for students to understand these technologies. This course covers key topics related to CAD, CAM, and CAE, helping students learn how they are used in product design and manufacturing.

Course Objectives:
During this course, student is expected to:

1. Understand the role of CAD, CAM, and CAE in product development and smart manufacturing.
2. Learn computer graphics, geometric modeling, and data exchange standards.
3. Explore automation in manufacturing, including CIM, CAPP, and additive manufacturing.
4. Gain knowledge of NC, CNC, and DNC systems, their components, and advantages.
5. Develop CNC programming skills, including tool compensation and machining cycles.
6. Understand the basics of the Finite Element Method (FEM) and its applications in analysis.

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

1. Explain the role and integration of CAD, CAM and CAE in product development and manufacturing.
2. Apply geometric modeling and transformations for designing and analyzing engineering components.
3. Analyze automation techniques, including CIM, CAPP, and additive manufacturing.
4. Demonstrate knowledge of NC, CNC, and DNC systems and their operational advantages.
5. Develop and execute CNC programs for machining operations using G&M Codes
6. Apply the Finite Element Method (FEM) for structural and thermal analysis using modern software.

Section I

Unit-1: Introduction to CAD, CAM, and CAE **No. of lectures- 05**

Product Lifecycle and Digital Manufacturing: Overview of Product Development Cycle, Role of CAD, CAM, and CAE in Product Lifecycle Management (PLM), Integration of CAD, CAM, and CAE in Smart Manufacturing. Advantages and Applications of CAD, CAM, and CAE. Hardware and Software for CAD/CAM/CAE Systems: Types, Input/Output Devices including 3D Scanners, Digital Tablets, VR/AR Interfaces. Graphics Software and CAD/CAM/CAE Software Selection: Functions of Graphics Software, Rendering, Simulation & Finite Element Analysis, Selection of CAD / CAM/ CAE Software.

Unit-2: Computer Graphics and Geometric Modeling **No. of lectures- 08**

Geometric Transformations, Homogeneous Coordinates, Windowing and Viewing Transformations, Coordinate Transformations, Standardization in Graphics Software, CAD /CAM Data Exchange. Introduction to Geometric Modeling and its types, Parametric representation of basic entities like line and circle, Introduction to basic curves - Bezier, B-Spline, NURBS, concept of CSG and Boolean operations

Unit-3: Automation in Manufacturing **No. of lectures- 07**

Concept & Definition of Automation, Types, Advantages and Limitations of Automation, Automation and CAD/CAM, CIM and CAD/CAM, Group Technology, Part Family, Classification and Codification System, Merits and Demerits of Group Technology, CAPP, Retrieval and Generative type of CAPP, MRP, ERP. Introduction to Rapid Prototyping (RP) and Additive Manufacturing: Concept and Importance of Rapid Prototyping, Overview of Additive Manufacturing Technologies, Applications of 3D Printing in Product Development.

Section II

Unit-4: NC, CNC, DNC **No. of lectures- 07**

Evolution of NC and Retrofitting, Elements of NC Manufacturing System, concept of work zero and machine zero, Types of NC systems, Steps in NC Manufacturing, Advantages and Disadvantages of NC Technology, Classification of CNC machine tools, CNC controllers, Features and Advantages of CNC, Direct Numerical Control, Types of Direct Numerical Control, Advantages and Disadvantages of Direct Numerical Control, Adaptive Control, Advantages of Adaptive Control.

Unit-5: CNC Programming and Machining Cycles **No. of lectures- 08**

Principles of an NC Program, Word Address Format (WAF), Basic Formulae, Tool Length and Cutter Diameter Compensation, Canned Cycles for Lathe, Milling and Drilling, Introductory treatment of Subprogram, Subroutines, DO Loop, Macros.

Unit-6: Finite Element Method **No. of lectures- 05**

Finite Element Method: Definition, Types of analysis, terms used in FEM, types of nodes and elements, General Steps of the FEM, Structural and thermal analysis of 1-D bar elements, Introduction to latest FEA software.

Internal Continuous Assessment (ICA):
List of Experiments/Assignments/Case Studies, etc.
(Any Eight Assignments with suitable FEA software)

1. One assignment on FEA fundamentals and comparison with other techniques.
2. One assignment with numerical exercises on variational formulation and method of weighted residuals formulation.
3. One software based assignment supported by hand calculations on 1D structural and thermal analysis.
4. One software based assignment (supported by hand calculations if applicable) on 3D Structural and thermal analysis.
5. One software based assignment (supported by hand calculations if applicable) on 3D structural analysis.
6. One software based assignment on non-linear FEA.
7. One software based assignment on dynamic FEA.
8. One assignment on Natural Coordinates and Isoperimetric formulation.
9. One assignment on FEA applications and future developments.
10. One software based assignment on fatigue analysis using FEA.

Text Books:

1. David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill Education Pvt. Ltd
2. P. Seshu, Text book of Finite Element Analysis, PHI Learning Private Ltd., New Delhi.
3. U. S. Dixit, Finite Element Methods, Cengage Learning.
4. S.S Bhavikatti, Introduction to Finite Elements, New Age International Publications.
5. Daryl Logan, A First Course in the Finite Element Method, Cengage.

Reference Books

1. R. D. Cook, et al., Concepts and Applications of Finite Element Analysis. Wiley, India
2. K. J. Bathe, Finite Element Procedures Prentice, Hall of India (P) Ltd., New Delhi.
3. O. C. Zienkiewicz, R. I. Taylor, The Finite Element Method, Butterworth – Heinemann.
4. M. J. Fagan, Finite Element Analysis, Theory and Practice, Pearson Education Limited.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPEC-03A: Finite Element Method

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
The Finite Element Method (FEM) or Finite Element Analysis (FEA) is a numerical technique to find approximate solutions of partial differential equations. FEM is an integral part of CAE and is extensively used in analysis and design of real life complex problems. Several sophisticated commercial and free FEM software are available in the market, but to use these effectively and to understand & analyze the results, theoretical foundations of FEM are essential. This course is designed to cover both aspects (theory and software) of FEM. This course will enable the student to formulate and solve the mathematical equations for 1D, 2D and 3D finite by hand and using FEM software.

Course Objectives:

During this course, student is expected to:

1. Understand general procedure involved in FEM as applied to structural & thermal problems.
2. Apply a direct method to formulate FEM equations for 1D, 2D and 3D elements.
3. Understand the use of variational formulation and method of weighted residuals in solving field problems.
4. Use the latest FEM software in solving problems for research and industry.

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

1. Implement general procedure of FEA for structural and thermal problems.
2. Write down shape functions for 1D, 2D and 3D elements.
3. Solve 1D, 2D and 3D problems using the FEA procedure.
4. Solve boundary value problems using variational calculus and weighted residuals methods.
5. Analyze of 1D, 2D and 3D problems for static and dynamic loads in commercial or open source FEA software.
6. Analyze of 1D, 2D and 3D problems for linear and non-linear responses in commercial or open source FEA software.

Section I

Unit-1: Introduction to FEM **No. of lectures- 6**

History and fundamentals of FEA, General FEM procedure, direct formulation for uniaxial elements using matrix methods, applications of FEM, comparison to other computational techniques such as FDM, BEM, FVM and their applications, merits and demerits of FEM compared to exact solutions and experimentation. Types of elements.

Unit-2: Model Validity, Solvers, Software capability and comparison **No. of lectures- 6**

Model validity, mesh design & refinement, element distortion. Sub modelling and sub structuring. Overview of solvers, selection of solvers. Overview review of free and commercial software, comparison of capabilities, Preprocessors, Solvers, Post Processors, Comparison of capabilities of free and commercial software packages.

Unit-3: Finite element formulation for 1D elements **No. of lectures- 8**

Types of 1D elements, interpolation functions for 1D elements such as truss, bar, beams and thermal elements, shape functions for the same, formulation of system equations for trusses and beam elements, calculation of stresses and strains. Shape functions for 1D elements in global and natural coordinates. Applications of 1D elements.(Derivations using Lagrangian Polynomials and Simple Numerical Exercises).

Section II

Unit-4: Finite element formulation for 2D elements **No. of lectures- 8**

2D Elements such as triangles and quadrilaterals, Pascal triangle for formulating interpolation functions, shape functions for 2D elements, LST, CST, linear and parabolic quads, axisymmetric elements, 2D shell elements. Shape functions for 2D elements in global and natural coordinates. Applications of 2D elements.(Derivations using Lagrangian Polynomials and Simple Numerical treatment on simplex elements).

Unit-5: Finite Element Formulation for 3D elements **No. of lectures-6**

3D elements such as tetrahedrons and brick elements, Interpolation functions for 3D elements, Pascal 25 Tetrahedron, shape functions, formulation of system equations, calculation of stresses and strains. Applications of 3D elements (Only theoretical treatment).

Unit-6: Nonlinear and Dynamic Analysis **No. of lectures- 6**

Nonlinear elasticity problems: Material, geometric and boundary condition non-linearity, contact and gaps. Dynamic Problems: Modal Analysis, transient response analysis, harmonic analysis, spectrum analysis, transient thermal analysis. Introduction to explicit analysis, fatigue. (Only theoretical treatment).

Internal Continuous Assessment (ICA):

List of Experiments/Assignments/Case Studies, etc.

(Any Eight Assignments with suitable FEA Software)

1. One assignment on FEA fundamentals and comparison with other techniques.
2. One assignment with numerical exercises on variational formulation and method of weighted residuals formulation.
3. One software based assignment supported by hand calculations on 1D structural and thermal analysis.
4. One software based assignment (supported by hand calculations if applicable) on 3D Structural and thermal analysis.
5. One software based assignment (supported by hand calculations if applicable) on 3D structural analysis.

6. One software based assignment on non-linear FEA.
7. One software based assignment on dynamic FEA.
8. One assignment based on Natural Coordinates and Isoperimetric formulation.
9. One assignment based on FEA applications and future developments.
10. One software based assignment on fatigue analysis using FEA.

Text Books:

1. David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill Education Pvt. Ltd
2. P. Seshu, Text book of Finite Element Analysis, PHI Learning Private Ltd., New Delhi.
3. U. S. Dixit, Finite Element Methods, Cengage Learning.
4. S.S Bhavikatti, Introduction to Finite Elements, New Age International Publications.
5. Daryl Logan, A First Course in the Finite Element Method, Cengage.

Reference Books

1. R. D. Cook, et al., Concepts and Applications of Finite Element Analysis. Wiley, India
2. K. J. Bathe, Finite Element Procedures Prentice, Hall of India (P) Ltd., New Delhi.
3. O. C. Zienkiewicz, R. I. Taylor, The Finite Element Method, Butterworth – Heinemann.
4. M. J. Fagan, Finite Element Analysis, Theory and Practice, Pearson Education Limited.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPEC-03B: Industrial Engineering

Teaching Scheme
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

Examination Scheme
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

Industrial Engineering is concerned with the design, improvement and installation of an integrated system of people, material, information, equipment and energy. It draws upon specialized knowledge and skill in mathematical, physical and social science together with the principles and methods of engineering analysis and design, to specify, predict and evaluate the results to be obtained from such systems. This course includes, Introduction of basic concepts of IE and its applications to improve productivity for the manufacturing and service sector. To understand the concept of method study, work measurement, Job evaluation and merit rating for improving overall productivity. To acquire knowledge about plant layout, facility location, safety and ergonomic consideration for improving productivity.

Course Objectives:

During this course, student is expected to:

1. Apply the concept of productivity and illustrate different methods to improve it.
2. acquire about knowledge of charts and apply for method study
3. understand concepts of ergonomics and industrial safety
4. establish standard time for work.
5. select facility location and design plant layout.
6. acquire knowledge of job evaluation and merit rating

Course Outcomes:

At the end of this course, student will be able to:

1. Analyze & measure productivity.
2. Perform method study
3. Apply knowledge of ergonomics and industrial safety
4. Perform work measurement'
5. Select facility location and design plant layout
6. Apply knowledge of job evaluation and merit rating

Section I

Unit-1: Introduction to Industrial Engineering **No. of lectures- 06**

Definitions and meaning of I.E., contribution by F.W. Taylor, Gilbreth, objectives of I.E. Productivity - Factors affecting productivity and ways to improve productivity. Work Study – Definitions, objectives, Importance of work study procedure, Relation of work study with – work Simplification, Human Relation. (Numerical treatment)

Unit-2: Method Study **No. of lectures- 08**

Definition, objective, Scope of method study, Basic procedure symbols and recording of facts, Charting conventions, Charts – Operation process chart, Flow process chart, Multiple activity hart, Two handed process chart, Diagrams – Flow and string diagram, travel chart Templates and models, Micro motion study. Therbligs simo chart, Critical examination and selection, Implementation method

Unit-3: Ergonomics and Industrial Safety **No. of lectures- 06**

Definition, Man Machine system, Types of display, types of control, manual material handling, Anthropometry, Design of work place and working conditions, ILO Norms. Definition of accident, Cause of accident, Prevention of accident, safety measures factor acts, minimum wages act, Employers state Insurance act.

Section II

Unit-4: Work Measurements **No. of lectures-06**

Definition, objective and techniques of work measurement, time study, stop watch method, performance rating, allowance, relaxation interference contingency, policy, calculation of standard time, work sampling its need and procedure, predetermined motion time study (PMTS). (Numerical treatment)

Unit-5: Facility Locations and Plant Layout **No. of lectures- 08**

a) Factors affecting site selection:

- Intangible factors for facility location, tangible factor for facility location, advantages and disadvantages of facility location in urban and rural areas.

b) Plant Layout:

- Characterization of an efficient layout, objectives of plant layout, principles of plant layout, procedure in planning layout, types of plant, layout product/line layout, process / functional layout, fixed position/static layout, cellular/Group Technology layout, selection of material handling equipment.

Unit-6: Job Evaluations and Merit Rating **No. of lectures- 06**

Job evaluation: objectives, advantages and procedure, job analysis, job description, job specification, methods of evolution. Merit rating: Objectives and Method of Merit rating.

Internal Continuous Assessment (ICA):

List of/Assignments/Case Studies, etc.

1. Assignment based on Introduction to Industrial Engineering
2. Assignment based on Method Study
3. Assignment based on Ergonomics and Industrial Safety
4. Assignment based on Work Measurements
5. Assignment based on Facility Locations and Plant Layout
6. Assignment based on Job Evaluations and Merit Rating

Text Books

1. Industrial engineering and Production management by Martand Telsang. (S. Chand)
2. Engineering management by A. K. Gupta (S. Chand)
3. Industrial Engineering and Management by O. P. Khanna.

Reference Books

1. Introduction to work study by ILO. (Universal Publication)
2. Work Study by O. P. Khanna. (Dhanpat Rai and Sons)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPEC-03C: Power Plant and Energy Engineering

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
A Power Plant and Energy Engineering course for Mechanical Engineering students introduces the fundamentals and advanced concepts involved in the generation, transmission, and distribution of energy, as well as the operation of power plants. It focuses on various energy conversion processes, technologies, and the engineering principles required for efficient and sustainable energy production.

Availability of power is the one key area where most of the Indian industry is facing problems. Fuel supply and distribution is also an area where the country is still developing smooth lines of supply. Since power and energy is required by every sector of the economy, growth in this sector is must if the Indian economy grows in any sector. Many of the job opportunities in the private as well as public sector are therefore waiting for students in this field. Hence, this course attempts to provide them basic knowledge of the technologies available at plant level and would also acquaint them with the latest technological advances taking place in this sector

Course Objectives:
During this course, student is expected to:

1. Study of Power Station performance evaluation & economic analysis.
2. Study of various non-conventional energy sources & principles of energy
3. Explain various loads on the power plant.
4. Illustrate Significance of different load curves and load factors on power plants.
5. Explain variable load on power plants.
6. Study & explain economics of power plants.

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

1. Describe forms of energy source and their impact on the environment.
2. Calculate performance parameters related to power plants.
3. Explain the economics of power plant & categorize power plant as base load & peak load plant.
4. Explain solar geometry & different types of solar collectors
5. Compare various renewable energy sources with their features.
6. Recognize energy conversion opportunities & explain energy audit concept

Section I

Unit-1: Introduction **No. of lectures-05**

Classification of energy sources Organization of Power Sector in India, NTPC, NHPC, NPCIL and their role in Power development in India, Role of private sector in energy management, Power distribution, Power Grid Corporation of India (PGCIL)

Unit-2: Loads on Power Plant **No. of lectures- 08**

Introduction, classification of loads on power plant, Different load curves and load factors, Effect of variable load on power plant, (Numerical treatment) design & operation, comparison of the thermal, hydroelectric, nuclear and diesel power plants.

Classification of plants, Requirements of peak load plant, Pumped storage plants, Compressed air storage plants, Load sharing between base load & peak load power stations.

Unit-3: Economic Analysis of Power Plants **No. of lectures- 07**

Introduction, Cost of electric energy, Fixed and operating cost, Methods of determining depreciation, Selection of site for Power station (thermal, hydro, nuclear), Tariff methods. (Numerical treatment) Selection of Boilers, Selection of Prime movers, selection of size and number of generating units.

Section II

Unit-4: Solar Energy **No. of lectures- 08**

Solar radiation outside the earth's atmosphere & at the earth's surface, Solar radiation measurement – Pyranometer & Pyrheliometer, solar radiation geometry. LAT & SCT, Solar concentrators-Method and classification, Types of concentrators.

Liquid flat plate collector – General, Performance analysis, Effects of various parameters. Solar Power Plant: Introduction, components, Types of Collectors & Solar Ponds, Low & High Temperature Solar Power Plant. Photovoltaic Power System, Heliostat

Unit-5: Other Non-Conventional Power Plants **No. of lectures- 07**

Wind Power plant: Introduction, Power of wind, Basic components of 'WECS', Classification of WEC systems. Horizontal axis machines, Vertical axis machines, Advantages & Disadvantages of WECS,Application of wind energy. Tidal energy, wave energy, OTEC, geothermal, magneto hydrodynamics, hybrid power plants, Challenges in commercialization of Non-Conventional Power Plants

Unit-6: Energy conservation and Energy Audit **No. of lectures- 05**

Energy Conservation- Introduction, energy conservation act 2001 & its feature, energy conservation in industries. Energy Audit- Introduction, need of energy audit, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Role of Bureau of Energy Efficiency (BEE)

- **Internal Continuous Assessment (ICA):**

List of Experiments/Assignments/Case Studies, etc.

Group - I: Any two Experiments from Expt. No. 1 to 5

1. Efficiency measurement of standalone solar P-V system
2. Solar radiation & its measurement
3. Study of components of windmill
4. Test on solar water heater
5. Trial on Diesel Power Plant.

Group - II: Minimum Six Assignments based on following topics

1. Study of typical load curve (Residential/Commercial/Industrial)
2. Economic Analysis of power plants (Numerical Treatment)
3. Study of Biogas plants
4. Study of Nuclear Power Plants
5. Study of solar collectors
6. Study of solar thermal applications- solar water heating, space heating, power
7. Study of solar pond / solar photovoltaic
8. Study of various Energy storage devices
9. **Industrial Visit:** The report based on any Industrial Visit to renewable energy appliances or power generation transmission station

- **Text Books:**

1. A course in Power Plant Engineering – Arora Domkundwar, Dhanpat Rai & Co.
2. Energy Technology – S. Rao & Dr. B. B. Purulekar, Khanna Publishers.
3. Generation of Electrical Energy – B. R. Gupta, S. Chand & Co. Ltd.
4. Power Plant Engineering – P. K. Nag, Tata McGraw Hill Publishing Co.
5. Power Plant Engineering- R. K. Rajput, Laxmi Publications, New Delhi
6. Solar Energy – S. P. Sukhatme, Tata McGraw Hill Co.

- **Reference Books**

1. Bureau of Energy Efficiency Manual
2. Principles of Power System- V.K. Mehta
3. Power System Analysis - Grainger John J, and Stevenson Jr. W.D. Tata McGraw Hill
4. Power Plant Technology – M. M. El Wakil

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHPEC – 03D: Railway Transportation

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

This course presents a comprehensive overview of passenger and freight railway transport systems, from design through to construction and operation. Moreover, it thoroughly covers freight railway systems transporting conventional loads, heavy loads and dangerous goods. For each system it provides a definition, a brief overview of its evolution and examples of good practice, the main design, construction and operational characteristics, the preconditions for its selection and the steps required to verify the feasibility of its implementation. This subject includes all means of transport whose rolling systems involve at least one iron component.

Course Objectives:

The course aims to:

1. To make a student understand concepts of various types of railway transport systems.
2. To make a student understand the different aspects of railway engineering, their uses, capabilities and limitations.
3. To introduce track engineering and fundamental calculations for railway tracks.
4. To give students an introduction to rolling stock and their dynamics.
5. To introduce a student to the concept of derailment railway systems.
6. To make a student aware about concepts of Wheel Rail behavior.

Course Outcomes:

At the end of this course, student will be able to:

1. Summaries different components of a railway transportation system
2. Interpreting various stresses & deflections generated in track under various loads.
3. Analysis of forces on track due to various loads.
4. Design track under various loads.
5. Interpretation of behavior of railway track with rolling stock.
6. Evaluating derailment of railway vehicles.

Section I

Unit-1: Introduction to Railway Transportation Systems No. of lectures-08

Introduction to railway systems, Components of railway systems: Railway infrastructure, Rolling stock and Railway operation, Fundamental functional principles: Running on a straight path, running in curves, Distinctive features of railway systems, Classification of railway systems. The capabilities of the railway transportation system: Advantages and disadvantages of the railway, Comparison of the characteristics of railway systems, Comparison of the capabilities of different transportation systems**.**

Unit-2: Behavior of rolling stock on track No. of lectures-08

Behavior of a single railway wheel set: Movement on straight path, Movement in curves, Behavior of a whole vehicle: Operational and technical characteristics of bogies- Object and purposes of bogies, Conventional bogies, Bogies with self-steering wheel sets, Bogies with independently rotating wheels, Bogies with creep-controlled wheel sets, Bogies with wheels with mixed behavior. Wheel rolling conditions and bogies inscription behavior in curves. Lateral behavior of a whole vehicle- Vehicles with conventional bogies, Vehicles with bogies with self-steering wheel sets, Vehicles with independently rotating wheels, Comparative assessment**.**

Unit-3: Derailment of railway vehicles No. of lectures-04

Derailment of railway vehicles: Definition, Derailment through displacement of track, Derailment as a result of vehicle overturning, Derailment with wheel climb- Description of the phenomenon, Derailment criteria, Factors affecting derailment.

Section II

Unit-4: Vertical loads on track No. of lectures-08

Classification of loads, Vertical loads on track: Static vertical loads- Axle load, Wheel weight, Daily traffic load. Quasi-static vertical loads: Vertical wheel load due to crosswinds, Vertical wheel load due to residual centrifugal force. Dynamic vertical loads- Dynamic vertical wheel load, Total vertical wheel load, Design vertical wheel load, Design loads of bridges.

Unit-5: : Transverse loads on track No. of lectures-08

Transverse loads on track: Gravitational forces, Creep forces- Running on straight path, running in curves, Crosswind forces, Residual centrifugal force, Guidance forces, Forces due to vehicle oscillations, Total transversal force.

Unit-6: Longitudinal force Analysis No. of lectures-04

Longitudinal forces: Temperature forces, Rail creep forces, Braking forces: Acceleration forces, Traction forces: Adhesion forces, Fishplate forces.

Internal Continuous Assessment (ICA):
List of Assignments/Case Studies, etc.
Minimum Four case studies on:

1. Assignment on Longitudinal force Analysis
2. Assignment on Longitudinal force Analysis
3. Assignment on Longitudinal force Analysis
4. Assignment on Longitudinal force Analysis
5. Assignment on Longitudinal force Analysis

Minimum Four assignments on:

1. Assignment on Railway Transportation System
2. Assignment on Behavior of rolling stock on track
3. Assignment on Derailment of railway vehicles
4. Assignment on Vertical loads on track
5. Assignment on Transverse loads on track
6. Assignment on Longitudinal force Analysis

Text Books:

1. Railway Transportation Systems —Design, Construction and Operation, Christos N. Pyrgidis, 2019, CRC Press
2. A Text Book of Railway Engineering, S.C. Saxena, S.P.Arora, Dhanpat Rai Publications (p) Ltd.-new, Delhi, 2010.
3. Electric Traction for Railway Trains: A Book for Students, Electrical & Mechanical Engineers, Superintendents of Motive Power & Others, E. P. Burch, McGraw- Hill Book Company

Reference Books

1. Handbook of Railway Vehicle Dynamics, Simon Iwnicki, Taylor & Francis Group, CRC Press, ISBN: 9780849333217, 0849333210
2. Railway Track Engineering, J.S.Mundrey, Tata McGrow Hill Publication. Principles of Railway Engineering, S.C. Rangawala, Charotar Publication, 2015.
3. Traction Rolling Stock- Three Phase Technology, A.K. Rawal, Indian Railway Institute of Electrical Engineering, Nasik Road.
4. Traction Distribution- Power Supply Electric Traction, A.K. Rawal, Indian Railway Institute of Electrical Engineering, Nasik Road.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHSEC-03: Mini Project on Industrial Applications (MPIA)

***Teaching Scheme**
Lectures: 01 Hours/week, 01 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ICA: 25 Marks
POE: 50 Marks

Course Introduction:
This course is designed to provide students with hands-on experience in solving real-world industrial problems. It emphasizes the application of core mechanical engineering principles through project-based learning. Students will work in teams to identify problems, design solutions, and develop prototypes or models. The course also focuses on enhancing skills in project management, communication, documentation, and presentation, preparing students for industry-ready roles.

Course Objectives:
The course aims to:

1. Provide hands-on experience in identifying and solving real-world industrial problems.
2. Promote the application of mechanical engineering principles in practical and industry-relevant scenarios.
3. Develop teamwork, communication, documentation, and project management skills.

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

1. Identify and define real-life industrial problems suitable for a mini project.
2. Apply mechanical engineering knowledge to develop feasible solutions.
3. Design, model, or simulate components or systems as part of the project.
4. Demonstrate teamwork, communication, and project documentation skills.
5. Present project outcomes effectively in both oral and written formats.

Unit 1: Project Initiation and Industrial Problem Identification (4 Hours)
Introduction to Mini Projects and Industrial Relevance, Identifying Industrial Problems – Case Studies & Problem Framing, Need Analysis & Formulating Effective Problem Statements, Project Planning – Time Management, Milestones, and Gantt Charts

Unit 2: Concept Development and Design Thinking (4 Hours)
Literature Review – How to Research Existing Solutions, Design Thinking and Engineering Design Process, Concept Generation – Brainstorming and Feasibility Analysis, Selection of Materials and Manufacturing Processes

Unit 3: Design and Testing (3 Hours)
CAD Modeling and Basics of Simulation Tools (Intro level), Prototyping Techniques – Physical and Digital, Testing, Data Collection, and Result Analysis

Unit 4: Documentation, Presentation & Professional Ethics (3 Hours)
Documentation Standards – Writing a Technical Project Report, Presentation Skills – Posters and Oral Presentation Techniques, Ethics in Engineering Projects and Sustainable Design Considerations

Practical Sessions (2 Hours/Week)

Practical sessions (2 hours/week) will run in parallel, allowing students to:

- Select a project topic
- Perform background study
- Develop and implement solutions
- Prepare documentation and present outcomes

Internal Continuous Assessment (ICA)-

<u>Guidelines for Mini-Project Work</u>

1. **Project Group Formation:**
   Each mini-project group shall consist of a maximum of **four (04) students**. The group must be finalized in the initial weeks of the semester in consultation with the faculty guide.
2. **Work Diary and Progress Monitoring:**
   Every group must maintain a **work diary**, documenting weekly progress and tasks undertaken. The diary should be submitted periodically to the guide during scheduled contact hours for review and feedback.
3. **Contents of Work Diary:**
   The work diary should systematically include:
   - **Problem Search and Identification:** Efforts made to explore and finalize a suitable mini-project topic, preferably with industrial relevance.
   - **Literature Survey:** A brief summary of references such as journals, conference papers, books, or web resources reviewed to understand the selected topic.
   - **Feasibility Study:** An outline of studies or research done to assess the practical implementation of the selected mini-project idea.
   - **Design Inputs:** Initial design sketches, basic design calculations, modeling concepts, or process flows relevant to the project.
4. **Nature of Mini-Project Work:**
   The **Mini Project on Industrial Applications (MPIA)** focuses on applying mechanical engineering knowledge to address practical challenges and opportunities in real-world industrial settings. The project work should be aligned with current industrial practices, needs, or technologies, enabling students to develop hands-on experience and professional problem-solving skills. The nature of mini-project work may include:
   - **Industry Problem-Based Projects:**
     Identification and solution of existing problems in industries such as manufacturing, automation, HVAC, automotive, renewable energy, or process engineering.
   - **Design and Process Improvement Projects:**
     Optimization of existing industrial processes, machines, or components to improve productivity, reduce waste, or enhance performance and safety.
   - **CAD/CAE Based Design Projects:**
     Designing and simulating industrial components or systems using suitable software tools for real-life industrial applications.

- **Automation and Mechatronics Projects:**
  Development of small-scale automation systems using sensors, actuators, PLCs, or Arduino-based solutions tailored for industrial processes.
- **Energy Efficiency and Sustainability Projects:**
  Projects focused on energy-saving techniques, waste heat recovery, lean manufacturing practices, or sustainable materials applicable in an industrial setup.
- **Fabrication and Prototype Development:**
  Creating prototypes of components or mechanisms used in industry, such as jigs, fixtures, gearboxes, conveyors, or material handling systems.
- **Industrial Case Studies and Benchmarking:**
  Detailed analysis of existing industrial systems or workflows, identifying gaps or inefficiencies, and proposing feasible modifications or innovations.

Students are encouraged to collaborate with industry professionals or visit industrial units to understand real-time problems. Preference should be given to projects that relate to the student's proposed final-year topic and contribute to industrial productivity, efficiency, or innovation.

5. **Final Submission and Presentation:**
   At the end of the semester, each group is required to:
   - Deliver a **PowerPoint presentation** before a departmental panel/faculty team summarizing project work and outcomes.
   - Submit a **spiral-bound report (Minimum 20 pages)** including title page, abstract, introduction, methodology, results, and references.

Suggested Mark Distribution (Total: 25 Marks)

Component	Marks
Problem Identification and Literature Review	4
Feasibility Study and Project Planning	2
Design/Methodology and Execution	6
Innovation and Technical Depth	2
Work Diary and Regularity	2
Final Report (Documentation Quality)	2
Oral Presentation (Clarity, Confidence, Response)	7
Total	**25**

A. Multidisciplinary Minor in "Material Science and Energy Engineering"

Semester	Course Code	Course Title
III	MECHMDM-01A	Fundamentals of Material Science and Engineering
IV	MECHMDM-02A	Materials for Technology Development
V	MECHMDM-03A	Advanced Materials and Manufacturing Process
VI	MECHMDM-04A	Renewable Energy Resources
VII	MECHMDM-05A	Energy Conversion Systems

B. Multidisciplinary Minor in "Industrial and Project Management"

Semester	Course Code	Course Title
III	MECHMDM-01B	Industrial Management
IV	MECHMDM-02B	Production and Operation Management
V	MECHMDM-03B	Operation Research
VI	MECHMDM-04B	Project Management
VII	MECHMDM-05B	Marketing Management

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHMDM-03A: Advanced Materials and Manufacturing Process

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
This course provides a comprehensive understanding of materials selection, composite materials, smart materials, and advanced manufacturing techniques. It covers both traditional and modern material processing methods, along with non-traditional machining and laser applications in manufacturing.

Course Objectives:

During this course, student is expected to:

1. Explain the concepts and principles of advanced materials and manufacturing processes.
2. Understand the applications of all kinds of Industrial materials.
3. Understand the behaviour and applications of smart materials, ceramics, glasses and non-metallic materials.
4. To introduce non-traditional machining processes, their need, working principles, mechanics of cutting, and applications in advanced manufacturing.
5. To understand the characteristics, classification, and applications of ceramics and composites.
6. Demonstrate an understanding of grinding technologies and Laser applications in manufacturing, such as cutting, welding, and surface treatment.

Course Outcomes:

At the end of this course, student will be able to:

1. Understand the classification, properties, and selection criteria of engineering materials for various applications.
2. Explain the composition, properties, and applications of composite materials with metallic and non-metallic matrices..
3. Describe the characteristics, types, and applications of smart materials and nanomaterials in engineering and biomedical fields.
4. Explain the principles and applications of various non-traditional machining processes.
5. Describe the processing methods, properties, and applications of ceramics and composite materials.
6. Understand modern manufacturing technologies, including advanced grinding, hard machining, and laser applications.

Section I

Unit-1: Classification and Selection of Materials: **No. of lectures- 05**

Classification of materials, properties required in Engineering materials, Selection of Materials; Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance, Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

Unit-2: Composite Materials: **No. of lectures-05**

Fiber reinforced, laminated and dispersed materials with metallic matrix of aluminium, copper and Titanium alloys and with non-metallic matrix of unsaturated polyesters and epoxy resins. Development, Important properties and applications of these materials.

Unit-3: Smart Materials **No. of lectures-05**

Shape Memory Alloys, Varistors and Intelligent materials for bio-medical applications. Nanomaterial's: Definition, Types of nanomaterial's including carbon nanotubes and Nano composites, Physical and mechanical properties, Applications of nanomaterial's.

Section II

Unit-4: Non-Traditional Machining Processes **No. of lectures-05**

Non-Traditional Machining: Introduction, need, AJM, USM –Mechanics of cutting, models, Water Jet Machining, EDM, Laser Beam Machining, Plasma Arc Machining, Electron Beam Machining, Electro Chemical Machining– Principle of working.

Unit-5: Processing of ceramics and composites **No. of lectures-05**

Processing of ceramics: Characteristics, classification, applications. Processing of particulate ceramics, Powder preparations, consolidation, drying, sintering, Hot compaction, Area of application, finishing of ceramics.

Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

Unit-6: Modern Technologies **No. of lectures-05**

Modern grinding technologies, high speed and high performance grinding. Hard machining using single point tools.

Laser applications in manufacture: Cutting, welding, surface treatment, automation and in-process sensing.

- **Internal Continuous Assessment (ICA):**

List of Experiments/Assignments/Case Studies, etc.

Any Four Case studies on:

1. Material Selection for Aircraft Turbine Blades
2. Material Selection for Aerospace Structural Components Using Fiber-Reinforced Composites.
3. Comparison of EDM and Laser Beam Machining for Precision Manufacturing
4. Advancements in Ceramic Processing for High-Temperature Applications
5. High-Speed Grinding vs. Hard Machining for Precision Manufacturing

Any Four Assignments on:

1. Comparative Study of Material Selection for Automotive and Marine Applications
2. Comparative Analysis of Metallic vs. Non-Metallic Matrix Composites
3. Applications and Advancements in Nanomaterial's
4. Selection of Non-Traditional Machining Processes for Hard-to-Machine Materials
5. Laser Applications in Advanced Manufacturing

- **Text Books:**

1. Manufacturing Science and Technology, Rao, K Vara Prasada, New Edge publication New Delhi.
2. Unconventional Manufacturing Processes, Singh M. K. New Edge publication New Delhi.
3. Advanced Machining Processes by V. K. Jain, Allied Publications.
4. Manufacturing Engineering and Technology by Kalpakijian, Addison Wesley, 1995.

- **Reference Books**

1. Engineering Material Technology James A. Jacobs & Thomas F. Kilduff Prentice Hall
2. Materials Science and Engineering WD. Callister Jr. Wiley India Pvt. Ltd 2010
3. Process and Materials of Manufacturing by R. A. Lindburg, 4th edition, PHI 1990.
4. Introduction to Manufacturing Processes by John A Schey, Mc Graw Hill.
5. Non-Traditional Manufacturing Processes by Gary F Benedict, CRC Press.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHMDM-04A: Renewable Energy Resources

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

In this course an attempt has been made to emphasize on the fundamental of non conventional energy sources (solar, wind, and biomass). Harnessing the energy through these sources using efficient technologies is expected to play an important role in serving as clean energy source for mankind. Thus, processes to harness energy are steadily gaining technical and economic importance worldwide. Therefore, it is necessary for energy planners/ users to know the facts as well as limitations of these technologies. This course aims at bringing the technological developments and research trends in the field of non-conventional energy sources with emphasis on engineering and design aspects. After attending this course student will have insight of Solar, Wind, Biomass, other energy sources and their resource utilization for extraction of energy.

Course Objectives:

During this course, student is expected to:

1. Understand energy scenario, energy sources and their utilization
2. Explore society's present needs and future energy demands
3. Study the principles of renewable energy conversion systems.
4. Understand some other renewable energy sources.

Course Outcomes:

At the end of this course, student will be able to:

1. Identify available nonconventional (renewable) energy resources and techniques to utilize them effectively.
2. Explore the potential of solar energy and Solar Cell material to generate electric power
3. Explain the construction and working of wind and Biomass Energy
4. Describe necessity and utilization Energy Storage devices
5. Explain the working principle, performance and limitation of Hydro-electric Power plant
6. Illustrate the working principle, performance and limitation of OTEC, Wave and Tidal Energy

Section I

Unit-1:Introduction **No. of lectures 04**

Principles of renewable energy; energy and sustainable development, fundamentals and social implications. worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, oil shale.

Unit-2:Solar Energy **No. of lectures 06**

Fundamentals; Solar Radiation; solar radiation on earth surfaces; solar radiation Measurements - Pyrheliometers, Pyrometer, Sunshine Recorder. Solar Thermal systems: Flat plate collector; solar distillation; solar pond electric power plant. Solar electric power generation:- Principle of Solar cell, Photovoltaic system for electric power Generation, advantages, Disadvantages and applications of solar photovoltaic system

Unit-3:Wind and Bio-mass Energy **No. of lectures 05**

Wind Energy: - Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS; Horizontal and vertical axis wind Turbines. **Biomass Energy: -** Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies- fixed dome; Urban waste to energy conversion; Biomass gasification

Section II

Unit-4: Energy Storage **No. of lectures 05**

Energy Storage, Energy Storage Introduction, necessity, specifications of energy storage devices, simple methods of energy storage

Unit-5: Hydropower Engineering **No. of lectures 05**

General Layout of a dam based hydroelectric plant, Power Estimation, Classification of Hydropower Plants.

Unit-6: : Other Energy Sources **No. of lectures 05**

Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. **Ocean Thermal Energy Conversion (OTEC) -** Hydrogen Production and Storage.

Internal Continuous Assessment (ICA):
List of Assignments, Case studies, etc.

1. Assignment based on Introduction to Renewable Energy
2. Assignment based on Solar Energy and Electric Power Generation
3. Assignment based on Wind and Biomass Energy
4. Assignment based on Energy Storage
5. Assignment based on Hydropower Engineering
6. Assignment based on Tidal and Ocean Thermal Energy

Text Books:

1. Koushika M.D., "Solar Energy Principles and Applications", IBT publications, 1988
2. Mital K.M, "Biogas systems: Principles and Applications", New Age International Publishers (P) Ltd., 1996
3. Venkata Ramana P. and Srinivas S.N., “Biomass Energy Systems”, TERI, 1996
4. Rai, G.D., "Non-Conventional Sources of Energy", Khanna Publishers, Delhi 1995
5. Rao S, Parulekar B.B, “Energy Technology – Non conventional, Renewable and Conventional” Khanna Publishers,1999
6. H.G. Stoll, Least Cost Electrical Utility / Planning, John Wiley & Sons, 1989

Reference Books

1. S.P.Sukhatme, “Solar Energy” , TATA McGraw Publishing company , Delhi, 1997.
2. Sinduja S. “ Renewable Energy Sources” Anuradha Publication, 2012.
3. Chetan Singh Solankhi, “ Solar Photovoltaic Fundamentals, Technologies and Applications, PHI learning Pvt.Ltd. New Delhi 2009.
4. Tasneem Abbasi and T.A.Abbasi, “ Renewable energy sources: Their impact on Global warming and Pollution”, Prentice Hall India Learning Pvt.Ltd. 2010.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MECHMDM-03B: Operation Research

Teaching Scheme
Lectures: 02 Hours/week, 02 Credits
Practical : 02 Hours/week, 01 Credit

Examination Scheme
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
Industries across the globe are facing the problems of global unrest due to multiple reasons. Hence, they continuously try to adopt various optimization techniques in their organizations. Which help them to reduce the time and cost of production. This course covers different optimization techniques assisting the Organizations in managing their resources optimally had better decision making, transportation issues, effective planning, replacement policies and allied issues in conducting their activities. These optimization techniques are expected to offer maximum profit and reduced cost and time.

Course Objectives:
During this course, student is expected to:

1. Acquire knowledge of various techniques under operations research.
2. Study quantitative techniques in management decision-making and its applications
3. Apply maximization and minimization techniques for real life problems.
4. Create awareness about preparation of Project Plan
5. Solve problems of waiting line and average time
6. Acquire knowledge of various financial terms

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

1. Apply LPP theory to solve the industrial problems
2. Apply the concept of Assignment models to maximize profit and minimize time for production.
3. Apply the concept of Transportation models to optimize available resources.
4. Apply the sequencing and waiting line theory to solve real life problems.
5. Determine project duration & different floats & probability of project completion
6. Apply the financial concept for real life problems

Section I

Unit-1: Introduction to OR & LPP **No. of lectures- 06**

History and development of OR, methodology in operation research, O.R. models and their applications. Introduction to LPP, Formulation of problem, Graphical solution, Simplex method.

Unit-2: Assignment Model **No. of lectures- 04**

Mathematical statement, Methods to solve balanced and unbalanced assignment problems, Maximization problems, Assignment with restrictions.

Unit-3: Transportation Model **No. of lectures- 05**

Mathematical formulation, methods to obtain initial basic feasible solution (IBFS), NWCR, LCM, VAM method for balanced and unbalanced problem.

Section II

Unit-4: Job sequencing and Queuing or waiting line theory **No. of lectures- 05**

Job sequencing, Johnson's Rule for optimal sequence of n jobs on two machines, process Jobs on three Machines. Applications, Characteristics, Waiting Time and Idle Time costs, Single channel Queuing Problems for calculating average number of customers and average time in system and queue.

Unit-5: CPM & PERT **No. of lectures- 06**

Fundamentals of CPM / PERT networks, CPM – construction of networks, critical path, forward and backward pass, floats & their significance. PERT – Time Estimates, Construction of Networks, Probability of completing projects by scheduled date.

Unit-6: Engineering Economics **No. of lectures- 04**

Importance, demand and supply, types of costs, Interest- Simple, compound, continuous, and effective interest. Value of money - time and equivalence, tangible and intangible factors, Introduction to inflation. Cash flow diagram.

- **Internal Continuous Assessment (ICA):**

List of Assignments/Case Studies, etc.

1. Numerical problems on Simplex method.
2. Numerical problems on Assignment model.
3. Numerical problems on Transportation model.
4. Case study of one of the application of waiting line theory.
5. Case study of one of the project report.
6. Case study of one of the financial report.

- **Text Books:**

1. Hira and Gupta, "Operation Research", S. Chand and Co.
2. S. D. Sharma, "Operation Research", Kedarnath and Rannalt Pub.
3. Hamdy Taha, "Operations Research – An Introduction", 7th edition PHI (2003)

4. N. D. Vohra, “Quantitative Techniques in Management”, TMGH

- **Reference Books**

1. Operations Research by Hillier and Lieberman TMGH
2. R. Panneerselvam, “Operations Research”, PHI (2002)
3. Swarop Kanti Gupta P.K. & Manmohan- OR - S.Chand & Sons, New Delhi
4. Shrinath L.S.: PERT & CPM –Affiliate East West Press

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHMDM-04B: Project Management

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements. It is broken into five different categories like planning, scheduling, monitoring and controlling. Some software might be used to help or manage various projects, with each project having unique requirements.

Course Objectives:
During this course, student is expected to:
1. Understand the concepts of Project Management and phases.
2. Carry out the feasibility analysis in Project Management and risk analysis and mitigation.
3. Evaluate project cost using various methods
4. Carry out planning and scheduling of projects using various techniques such as WBS, PERT, CPM, GANTT Chart etc.
5. Understand monitoring and controlling methods in Project Management
6. Become familiar with PMIS and Microsoft Project in performing project management tasks.

Course Outcomes:
At the end of this course, student will be able to:
1. Describe concept, importance & Professional responsibilities of project management.
2. Evaluate projects from financial perspectives and identify, analyse and mitigate risks.
3. Use various techniques used for cost estimation of a project.
4. Use methods for planning and scheduling of a project.
5. Understand importance and requirements of PMIS to monitor and control the project.
6. Use computer tools at various stages of a project.

Section I

Unit-1: Introduction to Project Management **No. of lectures-6**
Definition & Characteristics of Project, Classification of Projects, Project Management, Benefits, Project Management Process, Role of Project Manager, Project Lifecycle.

Unit-2: Project Management Techniques and Risk Management **No. of lectures-8**
Feasibility Studies, Numerical Models (Payback Period, Return on Investment, Net Present Value, Internal rate of Return), Scoring Models, Break Even Analysis.
Project Risk Management: Introduction of Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks.

Unit-3: Project Cost Estimating **No. of lectures-6**

Estimating terminology, Project Costs, Estimating Methods (Jobbing, Factoring, Inflation, Economies of Sales, Unit Rates, Day Work), Analogous Estimating, Parametric Estimating, Bottom-Up Estimating, Three-Point Estimates, Monte Carlo Simulation, Project Budgeting, Resource Allocation, Cost Forecasts.

Section II

Unit-4: Project Planning and Scheduling **No. of lectures-6**

Project Planning: Introduction, Need of Project Planning, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS) Scheduling: Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model (Numerical Treatment)

Unit-5: Project Monitoring and Control **No. of lectures-8**

Project Execution and Control: Introduction, Project Execution, Project Control Process, Purpose of Project Execution and Control.

Project Management Information System: Introduction, Project Management Information System (PMIS), Planning of PMIS, Design of PMIS.

Project Performance Measurement and Evaluation: Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects

Unit-6: Computer Applications in Project Management **No. of lectures-6**

Introduction to MS Projects – Understanding the MS Project screen & different views, Defining the project, Working with calendar, Outline the project, Create dependencies between tasks, Creating WBS, Format task list and Gantt chart, Resource planning, leveling and preparing resource graph, Working with baseline, tracking the project.

Use of MS project for feasibility studies, risk management, project cost estimating, project planning and scheduling etc.

- **Internal Continuous Assessment (ICA):**

List of Experiments/Assignments/Case Studies, etc.

1. Assignment on Project Management concepts
2. Case study on numerical model based feasibility study.
3. Assignment on risk identification, analysis and mitigation with one case study.
4. Assignment on project planning and scheduling with case study on WBS.
5. Assignment on project Monitoring and Control.
6. Case Study on project planning.
7. Case Study on WBS.
8. Two computer based exercises on Microsoft Project.

- **Text Books:**

1. S. Choudary, Project Management, Tata McGraw Hill

2. Narendra Singh; Project Management & Control; Himalaya Publishing House, Mumbai
3. Prasanna Chandra. Project Planning, Appraisal, Budgeting and Implementation, Tata McGraw Hill Publishing Company Limited, New Delhi.

- **Reference Books:**

1. Project Management, Harvey Maylor, Pearson Education

2. Project Management Institute; “A Guide to the Project Management Body of Knowledge (PMBOK Guide)”

3. Harold Kerzner; “Project Management: A Systems Approach to Planning, Scheduling and Controlling Paperback”; Wiley

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ

।। विद्यया संपन्नता ।।

NAAC Accredited-2022
'B++' Grade (CGPA-2.96)

A. Honors in Robotics Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MechHon-01A	Industrial Robotics	3	-	2	4	70	30	25	-	125
IV	MechHon - 02A	Machine Vision	3	-	2	4	70	30	25	-	125
V	MechHon - 03A	Industrial Networks and Controllers	2	-	2	3	70	30	25	-	125
VI	MechHon - 04A	Advanced topics in Robotics	3	-	2	4	70	30	25	-	125
VII	MechHon - 05A	Mini Project	1	-	4	3	-	-	50	-	50
		Total				**18**	**280**	**120**	**150**		**550**

Honors Course will be for the students of same Program

B. Honors in Electric Vehicle Engineering

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*			*Credits*	*FA*	*SA*			*Total*
			L	*T*	*P*		*ESE*	*ISE*	*ICA*	*OE/ POE*	
III	MechHon - 01B	Introduction to Automobile Engineering	3	-	2	4	70	30	25	-	125
IV	MechHon - 02B	Introduction to Electric and Hybrid Vehicles	3	-	2	4	70	30	25	-	125
V	MechHon - 03B	Battery Technology and Charging Infrastructure	2	-	2	3	70	30	25	-	125
VI	MechHon - 04B	Advanced topics in Electric Vehicles	3	-	2	4	70	30	25	-	125
VII	MechHon - 05B	Mini project	1	-	4	3	-	-	50	-	50
		Total				**18**	**280**	120	150		550

Honors Course will be for the students of same Program

Honors with Research

Semester	*Course Code*	*Name of the Course*	*Engagement Hours*	*Credits*	*SA*		*Total*
			P		*ICA*	*OE*	
VII	MECHRES-01	Research Project Phase-01	9 #	9	100	100	200
VIII	MECHRES-02	Research Project Phase-02	9 ##	9	100	100	200
		Total	18	18	200	200	400

Along with 9 hours of engagement hours, 4.5 Hrs. activities for preparation for community engagement and service, preparation of reports, etc.

Along with 9 hours of engagement hours 4.5 Hrs. activities for preparation for community engagement and service, preparation of reports, etc. and independent reading during Project Phase 2 and preferably related to Project Phase 2 activities.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MechHon - 03A: Honors Course: Industrial Networks and Controllers

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical: 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

This course is designed to give the student an in-depth understanding of Industrial Networks. This course covers the fundamentals of Controllers and the control problem, state equations, actuator dynamics, set point tracking trajectory planning, joint space schemes, Cartesian space Schemes, issues in trajectory planning Simple block diagrams and transfer function, simple trajectory calculations. Mobile robotics. Design, classification, navigation, AGVs, applications. This course requires the students to take part in site visits and case study presentations.

Course Objectives:

During this course, student is expected to:

1. Understand fundamentals of industrial networks
2. Understand fundamentals of the control system.
3. Understand modern control strategies used in industrial robot
4. Understand the fundamentals of trajectory planning.
5. Understand robot programming languages and types of programming.
6. Understand the scope of AGVs and other mobile robots for industrial applications.

Course Outcomes:

At the end of this course, student will be able to:

1. Identify industrial networks and application of it.
2. Develop mathematical model and transfer function for control system.
3. Understand different control techniques and their application.
4. Generate a smooth and efficient motion path for a robot or other moving system
5. Identify robot programing languages used by different robot manufacturers
6. Select AGV or mobile robots configuration based on applications.

Section I

Unit-1: Introduction to Industrial Networks **No. of lectures- 5**

Overview of industrial network, Network topologies, OSI model, Internet terminology, LAN, WAN, MAN, CAN bus, PROFI bus, Fieldbus, Modbus, HART and SCADA, devices such as routers, switches, gateways, hubs, modems.

Unit-2: Control System **No. of lectures-5**

Basic control systems concepts and models, Mathematical Models ,transfer function, Generalized block diagram for robot joint control, The control problem, state equations, actuator dynamics.

Unit-3: Robot controllers **No. of lectures-5**

Overview of advanced control techniques such as force control, controllers, On-off control, proportional control, Integral control, PI control, PD control, PID control, control system analysis, transient, steady state response.

Section II

Unit-4: Trajectory Planning and Obstacle Avoidance **No. of lectures-5**

Basics of Trajectory, obstacle and collision avoidance, Set point tracking trajectory planning, joint space schemes, Cartesian space schemes, issues in trajectory planning

Unit-5: Robot Workcell Design and Programming Methods **No. of lectures-5**

Robot cell layout, considerations in workcell design, workcell control, cell safety, human machine interface, robot cell controller. Lead through programming, walk through programming, offline programming**.**

Unit-6: Automated Guided Vehicles (AGVs) and Mobile Robots **No. of lectures-5**

AGVs: classification, navigation techniques, applications.

Mobile Robots: Classification, wheeled and tracked robots, autonomous navigation and control methods and applications.

- **Internal Continuous Assessment (ICA):**

List of Experiments/Assignments/Case Studies, etc.

1. Theory assignment on industrial networks
2. Theory assignment on robot control.
3. One assignment PID control using suitable software(e.g matlab)
4. One software assignment robot motor control using a suitable software package.
5. One assignment on Generalized block diagram for robot joint control
6. One assignment on work cell simulation in any suitable robot simulation software.
7. Survey assignment on robots, AGVs, Navigation..
8. Survey assignment on obstacle and collision avoidance.
9. One particle on AGV navigation techniques (any one)
10. Industrial visit: take part in site visits.

- **Text Books:**

1. S.K Saha, Introduction to Robotics, McGraw-Hill.
2. Mikell Groover et.al, Industrial Robotics, McGraw Hill.
3. Stuart Russel & Peter Norvig, Artificial Intelligence a Modern Approach.
4. Gary D. Anderson : Industrial Network Basics: Practical Guides for the Industrial Technician.
5. W. Bolton, Mechatronics, Pearson Publishing, 4th Edition

- **Reference Books**

1. Bishop et.al, Handbook of Mechatronics, CRC Press.
2. Schilling, Fundamentals of Robotics, Prentice Hall India.
3. Robert Babuška, Fuzzy Modeling for Control, Springer.
4. Siegwart et.al, Autonomous Mobile Robots, Prentice Hall India.

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MechHon-04A: Advanced Topics in Robotics

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:

This course is designed to give the student an in-depth understanding of advanced topics in robotics using any suitable Software. This course requires the students to take part in site visits and case study presentations. This course covers the fundamentals of advanced topics in robotics, Cameras (CCD, CMOS, Area Scan, and Line Scan), camera specification and selection etc. This course requires the students to take part in site visits and case study presentations. Students are also required to complete a Robot and image processing simulation in suitable simulation software.

Course Objectives:

During this course, student is expected to:

1. Understand the need of advanced topics in robotics.
2. Acquaint with existing market distribution and future trends.
3. Understand the technology behind a modem robot such as sensors, actuators, grippers, Controllers, machine vision etc.
4. Understand advanced applications of industrial robots in welding, spray painting, Material transfer operations.
5. Understand the scope and applications of modem machine vision systems.
6. Understand and bridge the gap (regarding industrial robots) between text books & industry

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

1. Select appropriate robot configuration and specifications for a given application.
2. Explain robot workcell layout and their features.
3. Evaluate and compare robots based on their specifications
4. Identify control issues and suggest control techniques based on applications.
5. Explain construction and applications of different types of robots.
6. Evaluate and select sensors & drives used in the construction of an industrial robot and its work cell.

Section I

Unit-1: Advanced Topics in Robotics **No. of lectures- 07**

The robotics market and future prospects, Robot Intelligence, Characteristics of future robot tasks, service industry and similar application, current market scenario, concept of UGV.

Unit-2: Robot Workcells & Programming **No. of lectures- 07**

Multiple Robots and machine interference, Robot cell layout, considerations in work cell design, workcell control, cell safety, human machine interface, robot cell controller. Lead through programming, walk through programming, offline programming.

Unit-3: Modeling and Analysis of Wheeled Mobile Robots **No. of lectures- 06**

Introduction and some well-known wheeled mobile robots (WMR), two and three wheeled WMR on flat surfaces, Slip and its modeling, WMR on uneven terrain, Design of slip-free motion on uneven terrain, Kinematics .

Section II

Unit-4: Industrial Robot Applications **No. of lectures- 07**

General considerations for selecting robots (including layout and workcell) for material handling and machine tending, spot welding, continuous welding, sealant application, spray painting, assembly, inspection, electronics assembly.

Unit-5: Approach for Implementing Robots **No. of lectures- 07**

Initial familiarization with robotics technology, selection of best application, detailed economics analysis and capital authorization, planning and Engineering the installation.

Unit-6: Safety Training Maintenance and Quality **No. of lectures- 06**

Safety in robotics, Education and Training, maintenance, Plant survey to identify potential application. Robotics and labor.

Internal Continuous Assessment (ICA):

Any 8 assignments of the following:

1. Survey assignment on robots, UGVs, control by using machine vision.
2. Theory assignment on wheeled mobile robots.
3. Assignment on workcell simulation in any robot simulation software.
4. Assignment on Image Analysis using suitable Lab view software.
5. Survey assignment on robots industry and manufacturers and applications.
6. Assignment on Safety Training, maintenance & quality
7. Assignment on Characteristics of future robot tasks
8. Assignment on Plant survey
9. Theory assignment on detailed economics analysis and capital authorization.

Text Books:

1. S.K Saha, Introduction to Robotics, McGraw-Hill.
2. Mikell Groover et.al, Industrial Robotics, McGraw Hill.
3. Stuart Russel & Peter Norvig, Artificial Intelligence a Modern Approach.
4. E. Rich and K. Knight, "Artificial intelligence", TMH.
5. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 2000.

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Reference Books:

1. Asitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press.
2. Siegwart et.al, Autonomous Mobile Robots, Prentice Hall India.
3. Robin R Murphy, Introduction to AI Robotics, PHI Publication, 2000.
4. Bishop et.al, Handbook of Mechatronics, CRC Press.
5. Schilling, Fundamentals of Robotics, Prentice Hall India.
6. Robert Babuška, Fuzzy Modeling for Control, Springer.
7. Dan Patterson, Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall.
8. International Federation of Robotics - https://www/ifr.org

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-V
MechHon-03B: Battery Technology and Charging Infrastructure

***Teaching Scheme**
Lectures: 02 Hours/week, 02 Credits
Practical: 02 Hours/week, 01 Credit

***Examination Scheme**
ESE: 70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction: The objective of this course is to provide a fundamental understanding of the various systems of battery for electric vehicles and hybrid electric vehicles. The topics covered include battery fundamentals, types of battery, battery chemistry, battery parameters, and battery design considerations including mechanical and thermal design considerations. The course also covers battery charging, swappable batteries, protocols, and standards.

Course Objectives:

During this course, student is expected to:

1. Define various battery terminology parameters.
2. Describe the construction and working of Li-ion batteries
3. Compare alternative battery types for EV
4. Explain Battery pack design and mechanical considerations
5. Identify Thermal Design considerations of EV Battery.
6. Describe Battery Swapping and Charging standards

Course Outcomes:

At the end of this course, student will be able to:

1. Define various battery terminology parameters.
2. Describe the construction and working of Li-ion batteries
3. Compare alternative battery types for EV
4. Explain Battery pack design and mechanical considerations
5. Identify Thermal Design considerations of EV Battery.
6. Describe Battery Swapping and Charging standards

Section I

Unit-1: Introduction to Battery Parameters **No. of lectures- 5**

State of Charge, Depth of Discharge, Charging at C-Rate of battery, discharging at C-Rate of battery, Specific Energy Density, Life-cycles, EV Battery Life, Energy Capacity, Useable Capacity, Parameters for EV battery selection, Battery Chemistry, battery cost and economics

Unit-2: Li-ion battery **No. of lectures-6**

Li-Ion battery chemistries, battery safety, cost per kWh, LCO, NMC, LMO, LFP, LTO, NCA LiIon battery cell construction, Container, Cylindrical cells, Pouch cells, Prismatic Cells, Cell failure, Battery Pack Design, Cell Balancing, Equal Charge, Equal Discharge,Battery Management System, Design considerations for pack, Electrical Design of battery pack, mPnS, nSmP

Unit-3: Other types of battery **No. of lectures-4**

Li-Polymer, Lithium-air, Li-metal, Solid-state Lithium, Lithium-Sulphur, Sodium-ion, LithiumManganese-iron-phosphate Nickel rich cathode.

Section II

Unit-4: Battery pack design and mechanical considerations **No. of lectures-5**

Needs of a battery pack, Battery Pack Development Process, Electrical Design, Thermal Design, Mechanical Design, BMS Design, Stages of Battery Pack Design, Mechanical considerations: Forces acting on the battery pack, Base Plate dimension calculations, Material Selection Criteria, Ashby Methodology, Endplate support, vibration analysis.

Unit-5: Thermal Design considerations **No. of lectures-5**

Thermal Considerations: Required functions of Thermal Design, Battery Pack Temperature Considerations, Heat Generation in the battery pack, Heat Load Determination, Thermal Resistance, Conduction, Convection, Radiation, Active thermal management, Passive Thermal Management, Forced Air Convection, Liquid cooling of the battery pack, Immersion Cooling, Peltier cooling, Determination of Thermal Management, Heat Sink Natural Convection, Heat Pipe Cooling, Thermal Interface Material, Phase Change Material.

Unit-6: Battery Swapping and Charging **No. of lectures-5**

EV Charger Introduction, Charger Architecture, Additional Interfaces, On-board and Off-board chargers, Slow and Fast Charge Chargers, Charging Infrastructure, Charging Protocols, EV Chargers Types, Charging Standards, AC Chargers, Protocol Standards, Charging States Battery Swapping, Energy Operator, Battery Leasing Charges, Investments by EO, Locked Smart Swappable batteries, Standardization, Bulk Charger Standardization, Swappable battery standardization, Battery Specification, CC and CV Mode of Charging, Chargers and Power Electronics, Distributed Architecture, Standalone Model, Centralized Architecture, Hub and Spoke Model, International Swap Standards, Comparisons between Swap standards, LS - VBCC Protocol, India Open Standard

- **Internal Continuous Assessment (ICA):**

List of Assignments/Case Studies, etc. (any eight)

1. Types of batteries for EVs
2. Lion battery construction
3. New battery technology
4. Battery swapping
5. Charging infrastructure and protocols
6. AC and DC charging methods
7. Mechanical design of battery
8. Thermal design of battery
9. Alternative to Lion batteries
10. Protocols and standards regarding battery and charging

- **Text Books:**

1. Kiehne, Battery Technology Handbook, Marcel Decker
2. Dhameja Sandeep, Electric Vehicle Battery Systems, Newnes

- **Reference Books**

1. John G. Hayes, G. Abas Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, Wiley 2017
2. Iqbal Husain, Electric and Hybrid Vehicles Design Fundamentals, Taylor and Francis, 2021
3. Rahn,Wang, Battery Systems Engineering, Wiley 2020

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Third Year B.TECH. (Mechanical Engineering)
Semester-VI
MECHHON-04B: Advanced Topics in Electric Vehicles

***Teaching Scheme**
Lectures: 03 Hours/week, 03 Credits
Practical : 02 Hours/week, 01 Credit

***Examination Scheme**
ESE:70 Marks
ISE: 30 Marks
ICA: 25 Marks

Course Introduction:
Learning about advancements in electric vehicles (EVs) is essential for understanding the evolving landscape of sustainable transportation. Fuel cells play a crucial role in extending EV range and enhancing efficiency, making hydrogen-powered EVs a viable option. Advanced control systems improve vehicle performance, battery management, and energy optimization. Electronics and sensor-less control in EVs reduce costs and increase reliability, enhancing motor efficiency. Autonomous vehicles integrate AI, sensors, and automation, shaping the future of self-driving EVs. Security in EVs is vital to protect against cyber threats, ensuring data and system safety. Future electric mobility focuses on smart grids, wireless charging, and connected ecosystems, driving innovation in the transportation sector.

Course Objectives:
During this course, student is expected to:

1. Learn advanced knowledge of the electric vehicle.
2. Explain the various types and working principle of fuel cells
3. Acquaint about the working principle of electronics and sensor less control in electric vehicles.
4. Explain principle of operation, construction and applications of various sensors used in modern automobiles.
5. Know the impact of electric vehicles and emerging technologies.

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

1. Explain the advanced knowledge of the electric vehicle.
2. Illustrate the various types and working principle of fuel cells
3. Explain the working principle of electronics and sensor less control in electric vehicles.
4. Explain principle of operation, construction and applications of various sensors used in modern automobiles.
5. Explain the impact of electric vehicles and emerging technologies.

Section I

Unit-1: Fuel Cells for Electric vehicles **No. of lectures- 06**

Fuel cell – Introduction, Technologies & Types, Obstacles. Operation principles, Potential and I-V curve, Fuel and Oxidation Consumption, Fuel cell Characteristics – Efficiency, Durability, Specific power, Factors affecting, Power design of fuel Cell Vehicle and freeze capacity. Lifetime cost of Fuel cell Vehicle – System, Components, maintenance.

Unit-2: Controls in electric vehicle **No. of lectures- 08**

Traction control (motor control), Electronic Transmission Control, Adaptive Power Steering, Adaptive cruise control Safety and comfort systems Antilock braking, Traction Control and Electronic Stability, Active suspension control. Body electronics including lighting control, remote keyless entry, immobilizers etc. Electronic instrument clusters and dashboard electronics. Aspects of hardware design for automotive including electro-magnetic interference suppression, Electromagnetic Compatibility etc. An introduction to Future Cars (Hybrid, Hydrogen Fueled, Solar Powered, autonomous vehicle).

Unit-3: Electronics and Sensor-less control in EV **No. of lectures- 06**

Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self-driven Cars, Hacking; Sensor less – Control methods- Phase Flux Linkage-Based Method, Phase Inductance Based, Modulated Signal Injection, Mutually Induced Voltage-Based, Observer-Based.

Section II

Unit-4: Autonomous vehicles **No. of lectures-06**

Layers of autonomy, unmanned ground vehicle (UGV), Advanced Driver Assistance Systems (ADAS), Smart sensors, radar, Lidar, Path control.

Unit-5: EV and security **No. of lectures- 08**

Advantage and disadvantage of EVs, Autocrypt V2G, EV accidents and safety, EV maintenance, Internet of Thing (IoT) for EVs, Intra vehicle security, Vehicle to Data Center security

Unit-6: Future electric mobility **No. of lectures- 06**

Future trends in electric cars, Wireless charging of EVs, Battery Swap, Charging EV from renewables, Case study: Nuna Solar car.

- **Internal Continuous Assessment (ICA):**

List of Assignments/Case Studies, etc.

1. Assignment based on Fuel Cells for Electric vehicles
2. Assignment based on Controls in electric vehicle
3. Assignment based on Electronics and Sensor-less control in EV
4. Assignment based on Autonomous vehicles
5. Assignment based on EV and security
6. Assignment based on Future electric mobility

- **Textbooks:**
  1. James Larminie and John Lowry, Electric Vehicle Technology Explained, Wiley, 2012.
  2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2011.
  3. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, Oxford University Press, 2001.

- **Reference Books:**
  1. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.
  2. Jack Erjavec and Jeff Arias, "Alternative Fuel Technology – Electric, Hybrid and Fuel Cell Vehicles", Cengage Learning Pvt. Ltd., New Delhi, 2007
  3. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2009.
  4. Tom Denton, "Electric and Hybrid Vehicles", Routledge, Taylor & Francis Group,2018.
  5. Hanky Sjafri. "Introduction to Self-Driving Vehicle Technology", Chapman & Hall/CRC Artificial Intelligence and Robotics Series, 2019