Jharkhand University of Technology, Ranchi
NEP-2020 based Syllabus w.e.f – 2025-26 batch
B.Tech in Mechanical Engineering

Semester- VIth

S.No.	Course Code	Course Title	L	T	P	J	Cr	FM	Overall Pass Marks	Internal	External	Categorization
			Contact Hours per week									
		PROGRAMME CORE COURSES (PCC)										
01	MECC601	PCC-I (Machine Design)	3	1	0		4	100	35	30	70	
02	MECC602	PCC-II (Refrigeration and Air-Conditioning)	3	1	0		4	100	35	30	70	
		PROGRAMME ELECTIVES III & IV										
03	MECPEIII601, MECPEIII602, MECPEIII603, MECPEIII604, MECPEIII605, MECPEIII606, MECPEIII607, MECPEIII608, MECPEIII609, MECPEIII610	PE-III (Any one from the given basket of PE-III)	3	0	0		3	100	35	30	70	
04	MECPEIV601, MECPEIV602, MECPEIV603, MECPEIV604, MECPEIV605, MECPEIV606, MECPEIV607, MECPEIV608, MECPEIV609, MECPEIV610	PE-IV (Any one from the given basket of PE-IV)	3	0	0		3	100	35	30	70	
		OPEN ELECTIVE-I										
05	MECOEI601, MECOEI602, MECOEI603, MECOEI604, MECOEI605, MECOEI606, MECOEI607, MECOEI608, MECOEI609, MECOEI610, MECOEI611,	OE-I (Any one from the given basket of OE-I)	3	0	0	6	3	100	35	30	70	

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	MECOEI612, MECOEI613, MECOEI614, MECOEI615, MECOEI616, MECOEI617											
Total			**15**	**2**	**0**		**17**	**500**	--	--	--	
Practical			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
06	MECP601	**Lab-I** (Refrigeration and Air-Conditioning Laboratory)	0	0	3		1	50	25	30	20	
07	MECP602	**Lab-II** (Computational Laboratory)	0	0	3		1	50	25	30	20	
08	MECP603	**Lab-III** (Automobile Laboratory)	0	0	3		1	50	25	30	20	
Total			**0**	**0**	**9**		**3**	**150**	--	--	--	
Audit Course			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
09	AUC601, AUC602, AUC603, AUC604, AUC605, AUC606, AUC607	**FOREIGN LANGUAGE (ANY ONE THROUGH NPTEL / SWAYAM)** 1. GERMAN 2. JAPANESE 3. CHINESE 4. KOREAN 5. SPAINISH 6. RUSSIAN 7. FRENCH					-	100	35	30	70	
							Student will complete this Audit Paper of 12 weeks duration from NPTEL/SWAYAM. It is mandatory to pass this paper in order to pass this semester. Students may register on NPTEL/SWAYAM at any time from 1st to 6th semester also but the passing marks and credits will be reflected only in the 6th semester. The passing marks and certificate shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.				
10	AUC608	Sports/NCC/NSS/YOGA/Painting/Music/ Classical Dance					--	50	25	30	20	
							Students shall participate actively in one of the activities and for Passing of the semester "Participation Certificate" in activity will be mandatory student participation shall be monitored and participation record shall be maintained at institute level. The marks obtained shall be forwarded to controller of Examination (CoE), JUT, Ranchi timely.					
Internship			**L**	**T**	**P**		**Cr**	**FM**	**Overall Pass Marks**	**Internal**	**External**	**Categorization**
11	INT601	Industrial Internship	08 weeks				**2**	**50**	**25**	**30**	**20**	
Minor Project (For Exit Option)			12 weeks				**4**	**100**	**50**	**60**	**40**	

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Total	**--**	**--**	**--**		**2**	**200**	**--**	**--**	**--**	
Grand Total	**15**	**2**	**9**		**22**	**850**	**--**	**--**	**--**	

Professional Elective- III

S. No.	Course Code	Subject
01	MECPEIII601	**Advanced IC Engines**
02	MECPEIII602	**Product Design and Development**
03	MECPEIII603	**Industrial Tribology**
04	MECPEIII604	**Advanced Casting Technology**
05	MECPEIII605	**Solar and Wind Power Technologies**
06	MECPEIII606	**Aerospace Engineering**
07	MECPEIII607	**Nano Technology and Surface Engineering**
08	MECPEIII608	**Finite Element Method**
09	MECPEIII609	**Fracture Mechanics**
10	MECPEIII610	**Automobile Engineering**

Professional Elective- IV

S. No.	Course Code	Subject
01	MECPEIV601	**Computer Aided Design and Manufacturing**
02	MECPEIV602	**Compressible Flow and Jet Propulsion**
03	MECPEIV603	**Advanced Welding Technology**
04	MECPEIV604	**Gas Dynamics & Jet Propulsion**
05	MECPEIV605	**Fundamentals of HVAC Systems**
06	MECPEIV606	**Fundamentals of Biomechanics**
07	MECPEIV607	**Advanced Forming Technology**
08	MECPEIV608	**Industrial Safety Engineering**
09	MECPEIV609	**Micro and Nano Manufacturing**
10	MECPEIV610	**Geometric Modelling for CAD**

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Open Elective I

S. No.	Course Code	Subject	S. No.	Course Code	Subject
01	MECOEI601	**Pollution and Control**	**10**	MECOEI610	**Welding Technology**
02	MECOEI602	**Design of Thermal systems**	**11**	MECOEI611	**Elementary Continuum Mechanics**
03	MECOEI603	**Smart Materials and Structure**	**12**	MECOEI612	**Modern Automotive Technology**
04	MECOEI604	**Optimization in Engineering Design**	**13**	MECOEI613	**Hydrogen – Production Handling and Storage**
05	MECOEI605	**Energy Conservation andManagement**	**14**	MECOEI614	**Alternative Sources of Energy**
06	MECOEI606	**Energy Storage Technology**	**15**	MECOEI615	**3D Printing**
07	MECOEI607	**Waste to Energy Conversion Techniques**	**16**	MECOEI616	**Industrial Management**

08	MECOEI608	**Low Temperature Technology**	**17**	MECOEI617	**Project management**
09	MECOEI609	**Non-Destructive Testing**	**18**		

Abbreviations: - AU-Audit Course; L: Lecture, T: Tutorial, P: Practice.
J-Self learning hours shall not be reflected in the Time table. Self-learning includes micro projects/assignments/other activities as mentioned in earlier semesters.
***Passing in the Audit Course shall be mandatory.**
Note:- Students may choose their two Professional Electives (PE-II1 & PE-IV) & Open Elective-I from NPTEL/SWAYAM also on the approval of departmental academic council if that subject is not mentioned in the above basket.
Students will complete the Elective Papers (Professional or Open) of 12 weeks duration from NPTEL/SWAYAM. Student may register on NPTEL/SWAYAM at any time between 1st to 6th semester but the passing marks and credits will be reflected only in the 6th semester.
The secured percentage of marks and passing certificate of the subject shall be forwarded by the institute to Controller of Examination (CoE), JUT, Ranchi timely.
The institute will inform University Examination Session about selection of PE and OE subjects by the students also before 1" mid-semester examination of that semester.

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Semester- VIth

Machine Design

Course Code: MECC601 **L:3 T:1 P:0**

Rationale:

Course Outcomes:

Prerequisites:

CO1	Identify the preferred sizes and codes and selection of proper material for designing machine elements.
CO2	Design the machine element under static and dynamic loading conditions.
CO3	Design the temporary and permanent joints required to assemble the machine elements.
CO4	Design the required spring for the given application.

Course Content

UNIT I

Introduction:

General design process, Limit Fits and Tolerances, Standardization, Selection of preferred sizes.

Engineering Materials: Engineering materials and its classification, Mechanical properties of engineering materials, Selection of materials, Manufacturing considerations and their selection.

UNIT II

Static Loading: Basics Stresses in members subjected to different types of loads, Modes of failure, Principal stresses, Theories of failure: Rankine theory, Guest theory and Von Mises theory, Selection of failure theories to design simple machine parts.

UNIT III

Dynamic Loading: Fatigue strength and the S-N diagram, Fatigue failure, Endurance limit & strength, S-N Diagram, Stress concentration and its importance in design, Methods to reduce stress concentration

UNIT IV

Design of Riveted Joints: Rivet heads, Terminology, Caulking and fullering, Analysis of riveted joint, Efficiency of a riveted joint, Design of boiler joints and structural joints.

UNIT V

Design of Welded Joints: Welding process, merits and demerits of welded joint over riveted joints, weld symbols, Strength of parallel and fillet weld, Weld subject to bending moment and torsional moment

UNIT VI

Design of Springs: Types of Springs, Design of Helical and Leaf Springs

Text Books:

1. Shigley, Mechanical Engineering Design, McGraw-Hill Science Engineering
2. V.B. Bhandari, Design of Machine Elements, Tata McGraw Hill Education Private Limited, 2020, Fifth edition.
3. P.C. Sharma, D.K. Aggarwal, A Textbook of Machine Design, S.K. Kataria & Sons
4. R.K. Jain, Machine Design, Khanna Publishers

Reference Books:

1. Robert L Norton, Machine design an integrated approach, Pearson Education, 2018, Fifth edition.
2. Richard G. Budynas, J Keith Nisbett, Mechanical Engineering Design, Shigley's. McGraw Hill, 2011, Ninth edition.
3. Black and Adams, Machine Design, McGraw Hill and Co, New Delhi, 2002.

Refrigeration and Air-Conditioning

Course Code: MECC602 **L:3 T:1 P:0**

Rationale:

Course Outcomes:

CO1	Demonstrate the working principles of various refrigeration systems using thermodynamic principles.
CO2	Evaluate the performance of basic refrigeration and air-conditioning machines.
CO3	Identify the Psychrometric processes for different applications and design the parameters of the air-conditioning system as per standards.
CO4	Analyze the performance of compressors using thermodynamic concepts, principles of design and their control during its operation.

Course Content

UNIT I

Introduction: Basic Definitions of Refrigeration and Air-Conditioning, History of Refrigeration, Natural and Artificial Refrigeration Methods, Techniques to produce low temperatures, refrigerants.

UNIT II

Thermodynamic analysis of Refrigeration cycles: Working principles and thermodynamic analysis of Refrigeration cycles such as air refrigeration, VCRS, VARS, Steam jet, Vortex tube refrigeration etc. Methods to improve performance of VCRS, concept of Multistage VCRS and Cascade Refrigeration systems.

UNIT III

Psychrometry and air-conditioning: Psychrometry - Air-water vapor mixtures, Psychrometric Properties, Psychrometric or Air-Conditioning processes, Psychrometric Chart, Thermal Comfort.

UNIT IV

Analysis of psychrometric processes for the purpose of comfort air-conditioning. Mathematical Analysis of Air-Conditioning Systems. Overview of Cooling and Heating Load Estimation.

UNIT V

Compressors: Reciprocating compressors - Construction, P-V diagram, Clearance volume, Multi-stage compressors, Efficiency. Centrifugal and Axial Flow Compressors - Principle of Operation, T-s diagram, Performance Characteristics

Text Books:

1. Arora Ramesh Chandra, Refrigeration and Air Conditioning, PHI Learning Pvt. Ltd., India, 2012
2. Arora, C. P., Refrigeration and Air-Conditioning, Tata McGraw - Hill, New Delhi, 2000.

Reference Books:

1. Roy J. Dossat, Principles of Refrigeration, Wiley Limited, 1978
2. Stoecker, W. F., and Jones, J. W., Refrigeration and Air-Conditioning, McGraw - Hill, New Delhi, 1983.
3. Yahya, S.M., Compressors and Fans, Turbines, 4th Edition, McGraw Hill Education, 2017.

Data Books:

1. M. L. Mathur, and F. S. Mehta,Refrigerant and Psychrometric Properties - Tables andCharts [SI Units], Jain Brothers, 2020 (Revised Edition).

Refrigeration and Air Conditioning Laboratory

Course Code: MECP601 **L:0 T:0 P:3**

Rationale:

Course Outcomes:

Course Contents:

List of Experiments

(1) To determine the COP of vapour compression refrigeration system

(2) To study of various component of Window, Split and ceiling air conditioning system.

(3) To study vapour absorption system and its components.

(4) To study of ice plant

(5) To Study the Mechanical heat pump and find its C.O.P.

(6) To study of vehicle air conditioning system

(7) To study the cut sectional model of reciprocating, rotary and centrifugal compressor.

(8) To design and load calculation for residential and commercial building using CLTD method.

Computational Laboratory

Course Code: MECP602 **L:0 T:0 P:3**

The major software packages available are:

Name of the Software	Purpose of the Software
CARIS Software	Mapping, spatial data analysis
STRAAP software	Structural analysis
AUTOCAD with AUTOCIVIL	Drafting
STAAD / Pro	Design
ARC GIS – University Lab kit 8.3 software	Mapping
REI HEADS Ver 2002	Highway Engineering design system
Geo Concept	Data interchange between maps
ENVI Ver 4.2	Image analysis
Build super fast	Estimation
Visual Modflow	Ground water flow modeling
Map info Professional Version 8	Mapping
GT STRUDL	Structural analysis and design
Bentley MX Road Max 2004	Road design
PLAXIS Professional V 8.2 + Dynamic Module + 3D Foundation V1.5	Analysis of Geotechnical problems
ANSYS	Stress analysis
STAAD Pro-2006	Structural analysis and design

Apart from above software , the department has developed many packages for specific engineering applications Principal among them are:

- RAPID:Rural Action Plan Integrated Database. A GIS based monitoring system developed in VB. TIMS:Travelers Information Management System OPERA : Online Processing of Electoral Results and Analysis MIGRAN:Model with Interactive Graphics for Route Analysis on Network . SPY:Simulation of Paddy Yield. DAM:Dam Safety Against

Earthquake Load. WASP:Waste Data Acquisition and Analysis System for Online Processing

- AIMIL GEOTECHNICAL ANALYSIS SOFTWARE (AIMIL GAS) AIMIL Geotechnical Analysis Software (AIMIL GAS) is a suite of analysis software for common geotechnical tests . It uses the data acquired by the AIMIL Data Acquisition System (AIMIL DAS) and generate a number of analysis graphs and data . Even though it can use the data acquired by AIMILDAS directly , it is not a constraint . It can use data in the proper format from any source . It accepts additional test data from the user and performs the analysis . The analysis data can be viewed on screen or printed on any PC compatible printer .
- AIMILDAS is an auto calibrating 16 channel , 16-bit Data Acquisition System which gathers data from energized transducers and saves the data. The AIMILDAS is designed to provide a bridge between existing test apparatus and the latest PC based technology using State of the art Graphical user interface on Windows. The Data Acquired by the energized transducer is converted into working units and presented in either a tabulated form or in a format which can be read directly by AIMILGAS. The acquired data can be post processed to produce various graphs of interest .

Automobile Laboratory

Course Code: MECP603 **L:0 T:0 P:3**

Rationale:

Course Outcomes:

Course Contents:

List of Experiments

1. To study and prepare report on the constructional details, workingprinciples and components/parts of the **Automotive Engine.**

2. To study and prepare report on the constructional details, working principles and operation of the **Automotive Clutches**.

3. To study and prepare report on the constructional details, working principles and operation of the **Automotive Drive Lines & Differentials**.

4. To study and prepare report on the constructional details, working principles and operation of the **Automotive Transmission systems**.

5. To study and prepare report on the constructional details, workingprinciples and operation of the **Automotive Brake systems**

6. To study and prepare report on the constructional details, working principles and operation of the **Automotive Steering Systems.**

7. To study and prepare report on the constructional details, working principles and operation of the **Automotive Ignition Systems**.

Program Elective-III

Advanced IC Engines

Course Code: MECPEIII601 L:3 T:0 P:0

Rationale:

Course Outcomes:

CO1: Explain the design and operating parameters of an engine and analyze thermodynamic concepts of fuel- air cycles.
CO2: Summarize the concepts of volumetric efficiency, turbo charging and supercharging.
CO3: Explain the concepts of types of charge motion within the cylinder and flow in intake manifold.
CO4: Analyze different stages of combustion in SI and CI engines and explain the formation of different pollutants, their affect and their treatment.
CO5: Discuss the concepts of modern trends in IC engines.

UNIT-I: (08-Lectures)

Engine types and their operation, engine design and operating parameters, Characterization of flames, first law of thermodynamics and combustion, second law of thermodynamics and combustion, Effects of Fuel/Air Ration Non uniformity, Comparison with real engine cycles.

UNIT-II: (08-Lectures)

Gas Exchange Processes - Volumetric efficiency, flow through valves, residual gas fraction, exhaust gas flow rate and temperature variation, flow through ports, supercharging and turbo charging.

UNIT-III: (08-Lectures)

Charge motion- Mean velocity and turbulence characteristics, swirl, squish, pre-chamber engine flows, crevice flows and blowby. Fuel metering and manifold phenomenon-SI engine mixture requirements, carburetors, Fuel injection systems.

UNIT-IV: (08-Lectures)

SI Engine combustion-Stages, Effect of engine variables on ignition lag, effect of engine variables on flame propagation and abnormal combustion.

CI Engine combustion-Stage, effect of engine variable on delay period, fuel spray behavior, ignition delay. Pollutant formation and control- Nature and extent of problem, nitrogen oxides, carbon monoxide, unburned hydrocarbon emissions, particulate emissions, exhaust gas treatment.

UNIT-V: (08-Lectures)

Modern trends in I.C. engines, Duel fuel and multi fuel engines, Stratified charge Engine, Variable compression ratio engine, Free Piston Engine, lean burning engines-rotary engines, modification in I.C engines to suit Bio – fuels, GDI concepts.

TEXT BOOKS:

1. John B. Heywood, "Internal Combustion Engine Fundamental", 1st Edition, Tata McGraw-Hill Education, 2011. (Units I,II,III, & Partially IV).

2. M.L. Mathur and R.P. Sharma, "Internal Combustion Engines", DhanpatRai, 2008. (Units IV& V)

REFERENCE BOOKS:

1. Heinz Heisler, "Advanced Engine Technology", Trafalgar Square, 1997.

2. V. Ganesan, "Internal Combustion Engines", 2nd Edition, Tata McGraw Hill, 2002.

Product Design and Development

Course Code: MECPEIII602 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Develop conceptual product models using creativity and product design techniques
CO-2	Apply embodiment principles in the product development process.
CO-3	Develop products by considering the social, environmental and ethical concerns.
CO-4	Experience by developing CAD/ physical models using the concepts of product design theory.

Course Contents:

UNIT I: Introduction

Design thinking philosophy - Empathy, Define, Ideate, Prototype, Test. Product design context-types of designs, Asimov model, Design method vs scientific method, Considerations of a good design, Design activities/ Process, Product life and technological insertion cycles, organisational structures, business models, Design in teams-Team behavior and dynamics. Team formation and Course project assignment.

UNIT II: Problem identification

Need analysis, customer study and need identification tools, Product Quality and classification of Customer requirements, Kano Diagram. Establishing Engineering characteristics-Benchmarking, Quality Function Deployment- HOQ, Preparation of Initial PDS for the Course Project.

UNIT III: Gathering Information

Transformation from Data to knowledge, types and sources of information, intellectual property rights- classification, Patent searching, stages of patent filing. Importance of Codes and standards in Product Design

UNIT IV: Concept Generation/Improvement and Decision making

Creative thinking models, creative thinking aids and barriers, structured and unstructured creative design methods/theories- Brainstorming techniques, Random input technique and Synectics, concept map, Functional decomposition, Morphological analysis, TRIZ, Axiomatic Design, practice exercises. Decision making theories- criteria based selection, Pugh's concept, AHP.

UNIT V: Embodiment and Detailed Design

Product Architecture, Configuration and Parametric design Concepts, Detailed design, Engineering Requirements- failure mode and effects analyses, Legal and ethical issues in design. DFX, Course Project Reviews

Text Books:

1. George E Dieter, Engineering Design, Publisher, McGraw Hill, 4th edition.

Reference Books:

1. Kevin N. Otto, Kristin L. Wood, "Product Design", Pearson Education, 2004.
2. W. Ernest Eder, S. Hosendl., "Design Engineering", CRC Press, 2008.

Other Suggested Readings:

1. https://nptel.ac.in/courses/107/103/107103082/

INDUSTRIAL TRIBOLOGY

Course Code: MECPEIII603 **L:3 T:0 P:0**

Rationale:

- To familiarize the various types of engineering surfaces in contact.
- To provide comprehensive knowledge of friction, wear, lubrication between various engineering surfaces and bearings.
- To provide comprehensive knowledge of various surface modifications and coatings techniques.
- A wealth of real world engineering problems and examples towards gaining the experience for how the knowledge of tribology is applied in engineering practice.
- The effective use of the knowledge of tribology to various engineering problems to enhance the performance of the mechanical elements.

Course Outcomes:

CO1	Analyze the failures due to friction in engineering surfaces
CO2	Analyze the failures due to wear in engineering surfaces
CO3	Apply the knowledge of lubrication and bearings in engineering applications
CO4	Apply the knowledge of surface engineering to engineering applications

Course Contents:

Unit 1: Friction and its types

Introduction to tribology, engineering surfaces, fundamentals of contact between the surfaces, surface roughness, stick slip phenomenon, friction of metals and non-metals, friction mechanisms – ploughing and adhesion, friction of ceramic materials, friction of polymers, friction measurement. [12 hours]

Unit 2: Wear and wear mechanisms

Introduction to wear, abrasive wear, abrasivity of particles, abrasive resistance of engineering materials, adhesive wear, adhesion mechanisms, effects of adhesion between mating surfaces, controlling adhesive wear, erosive wear, cavitation, corrosive wear, tribo-corrosion and tribochemical polishing, oxidative wear in various engineering environments, controlling

oxidative wear, fretting, fatigue wear during sliding, fatigue wear during rolling, wear of metals, wear of polymers, wear of ceramics, wear of non-metals. Wear measurements. [12 hours]

Unit 3: Lubricants, lubrication mechanisms and bearings

Types of lubricants and their properties, Stribeck curve and regimes of lubrication, Greases, Solid lubricants, Reynolds equation, Hydrodynamic lubrication, Pad bearings, Journal bearings, Porous bearings, Elastohydrodynamic lubrication, Boundary and extreme pressure lubrication [12 hours]

Unit 4: Surface Engineering

Surface treatments, Wear resistant coatings and surface treatments, Physical vapor deposition, chemical vapor deposition, ion implantation, surface welding, thermal spraying, laser surface hardening and alloying, diamond like coatings, carbon based composite coatings, multi-layered coatings, nano-engineered coatings, Thick coatings. [9 hours]

Textbooks:

1. GwidonStachowiak, Andrew W Batchelor., "Engineering tribology", Elsevier Butterworth – Heinemann, USA, 2005.

Reference Books:

1. Hutchings.I.M and Shipway P, "Tribology, Friction and Wear of Engineering Material, Elsevier Butterworth –Heinemann , UK, 2017.
2. Bharat Bhushan, "Introduction to tribology", Wiley Publication, 2013.
3. Williams.J.A, "Engineering Tribology", Oxford University Press, 2005.
4. Stolarski.T.A, "Tribology in Machine Design", Industrial Press Inc., 1990.
5. Cameron.A, "Basic Lubrication Theory", Longman, U.K., 1981.
6. Neale.M.J., "Tribology Handbook", Newnes Butter worth, Heinemann, U.K., 1975.
7. Tomasz Liskiewicz and Daniele Dini, Fretting Wear and Fretting Fatigue, Elsevier UK, 2023.

ADVANCED CASTING TECHNOLOGY

Course Code: MECPEIII604 **L:3 T:0 P:0**

Rationale:

- To understand the advanced casting processes and equipment
- To facilitate the usage of software packages in design and application for advanced casting methods
- To impart knowledge on the characterization and inspection methods for advanced casting.

Course Outcomes:

CO1	Design the basic tooling requirements for the advanced casting process.
CO2	Select a suitable process for manufacturing casting components.
CO3	Analyze the liquid metal flow and solidification characteristics using casting software.
CO4	Identify the defects in castings and suggest improvements

Course Contents:

Unit 1

Melt processing techniques for ferrous and non-ferrous alloys such as stainless steels, nickel, titanium alloys. Vacuum melting equipment and practice.

Unit 2

Elementary aspects of pattern and mould design using CAD software. Resin-bonded mould and core making processes and machines.

Unit 3

Special casting processes and their applications- low-pressure die casting, investment casting, squeeze casting, thixo-forming. Illustrations of automotive and aerospace applications.

Unit 4

Gating and riser design - principles of fluid flow, governing equations, heat transfer applied to casting solidification, governing equations, boundary conditions for different casting methods, the concept of directional solidification, gating, and risers, and application of simulation methods. Use of casting software in solving practical problems.

Unit 5

Casting defects and remedies. Inspection methods - visual, penetrant, magnetic, metallurgical, X-ray and Gamma ray radiography and Mechanization and Automation.

Textbooks:

1. Jain P. L. - 'Principles of Foundry Technology' - Tata McGraw Hill, New Delhi - 2011 - 3rd Edition

Reference Books:

1. Heine R. W., Loper C. R., and Rosenthal P. C. - 'Principles of Metal Castings' - Tata McGraw Hill, New Delhi - 1997 - 2nd Edition
2. Beeley- P. R.- 'Foundry Technology' - Butterworth Scientific, London – 2001

SOLAR AND WIND POWER TECHNOLOGIES

Course Code: MECPEIII605 **L:3 T:0 P:0**

Rationale:

- To introduce the conversion technologies related to solar and wind power
- To familiarize the photovoltaic and thermal conversion of solar radiation
- To inculcate the feasibility of harvesting wind power

Course Outcomes:

CO1	Develop knowledge in solar radiation, its measurement and associated conversion technologies
CO2	Compare the different forms of solar thermal collectors
CO3	Understand the basics of wind energy conversion
CO4	Assess potential of wind energy as an alternate form of nonconventional energy

Course Contents:

Unit 1

Properties of Sun Light- Solar Radiation - Atmospheric effects - Solar Geometry - Measuring Instruments – Estimation of Solar Radiation. Solar cell physics & characteristics - Stand Alone PV System, Cost analysis and pay back calculations; Environmental and safety issues.

Unit 2

Solar Thermal Collectors – Flat plate collector construction and analysis – Thermal resistance network model –Heat transfer correlations – Concentrating type collectors – Construction and working – Tracking mechanisms.

Unit 3

Solar thermal energy utilisation – Heliostats with central receiver – Solar air heater – Solar chimney; Solar thermal power plants– Low, medium and high temperature systems – Performance analysis. Solar water heaters – Thermosyphon heaters – Active and passiveheating. Solar Ponds – Convective and non-convective ponds – Salt gradient solar pond – Experimental studies; Water desalination using solar still; Solar refrigeration.

Unit 4

Meteorology of wind: Global circulation, Forces influencing wind, Local Wind systems, Wind Turbines: Types, Rotor elements;

Unit 5

Horizontal and vertical axis wind turbines, Power in the wind, Power extracted from wind, Betz limit, Lift and drag coefficients, thrust and torque, power coefficient, thrust coefficient, axial interference factor. Pitch and stall regulation, power curve, and energy calculation.

Textbooks:

1. Wenham SR, "Applied Photovoltaic", 2/e, Earthscan Publications Ltd, 2007
2. G.N. Tiwari, "Solar Energy-Fundamentals, Design, Modeling and Applications", Narosa Publishers, 2002.
3. Joshua Earnest and Tore Wizelius, "Wind Power Plants and Project Development", PHI Learning Pvt. Ltd., New Delhi, 2011.

Reference Books:

1. Garrett T. K., Newton K., and Steeds W. - 'Motor Vehicles' - Butterworth Heinemann - 2001
2. Fenton J. - 'Handbook of Automotive Body and System Design' - Professional Engineering Publishing, UK - 2005
3. Giri N. K. - 'Automobile Mechanics', Khanna Publishers, New Delhi - 2006 - 8th Edition
4. Bishop R. - 'Intelligent Vehicle Technology and Trends' - AR Tech House Inc. – 1999

AEROSPACE ENGINEERING

Course Code: MECPEIII606 **L:3 T:0 P:0**

Rationale:

- Understand and describe the various types of aircrafts and its systems.
- To make students aware of the types of propulsion systems used and its merits and demerits

Course Outcomes:

CO1	Understand the earth's atmosphere and its properties
CO2	Select an appropriate propulsion method based on the requirement from the aircraft
CO3	Compare different engine systems used in aerospace applications
CO4	Understand the various instruments used in the aircraft and its working

Course Contents:

Unit 1

The atmosphere: Characteristics of Troposphere, Stratosphere, Mesosphere and Ionosphere - International Standard Atmosphere – Pressure, Temperature and Density variations in the ISA. Review of basic fluid dynamics – continuity, momentum and energy for incompressible and compressible flows – static, dynamic and stagnation pressures – phenomena in supersonic flows.

Unit 2

Application of dimensional analysis to 2D viscous flow over bodies (Basics only) – Reynolds number– Mach number similarity – Aerofoil characteristics – Pressure distribution – Centre of Pressure and Aerodynamic Center – Horse shoe vortex.

Unit 3

Straight and Level Flight – Stalling Speed – Minimum Drag and Minimum Power conditions – Performance Curves – Gliding – Gliding angle and speed of flattest glide – Climbing – Rate of Climb

– Service and Absolute Ceilings – Take off and Landing Performance – Length of Runway Required

– Circling Flight – Banked Flight – High Lift Devices – Range and Endurance of Air planes.

Unit 4

Propulsion: Momentum and Blade Element Theories (Basics only) – Propeller co-efficients and charts

– Aircraft engines – Reciprocating engines, Turbo jet, Turbo fan and Ram Jet engines – Bypass and After Burners.

Unit 5

Aircraft Instruments: Air speed indicators – Calculation of True Air Speed – Altimeters – Rate of Climb meter – Gyro Compass, Artificial horizon etc. Rocket Motors – Solid and Liquid Propellant Rockets – Calculation of Earth Orbiting and Escape Velocities Ignoring Air Resistance and assuming Circular Orbit.

Textbooks:

1. Mechanics of Flight - Kermode A. C.
2. Aerodynamics for Engineering Students - Houghton and Brock
3. Anderson J.D. Jr., (2007), Fundamentals of Aerodynamics, Tata McGraw-Hill, New Delhi.

Reference Books:

1. Bertin J.J., (2002), Aerodynamics for Engineers, 4th Ed. Prentice-Hall Inc.
2. Kuethe A. M. and Chow C.-Y., (1986), Foundations of Aerodynamics, John Wiley & Sons Inc.

Nano Technology and Surface Engineering

Course Code: MECPEIII607 **L:3 T:0 P:0**

Rationale:

Nanotechnology and surface engineering are emerging fields that focus on manipulating materials at the nanoscale to enhance their physical, chemical, and mechanical properties. Surface engineering techniques improve the performance, durability, and corrosion resistance of engineering components. This course introduces students to the fundamentals of nanotechnology, nanomaterials, surface modification techniques, and their applications in modern engineering industries.

Course Outcomes:

No.	Course Outcomes
CO-1	Understand the basic concepts and principles of nanotechnology and nanomaterials.
CO-2	Analyse the properties and synthesis methods of nanomaterials.
CO-3	Understand different surface engineering and coating techniques.
CO-4	Evaluate the role of nanotechnology and surface engineering in improving material performance.
CO-5	Apply nanotechnology and surface engineering concepts in industrial and engineering applications.

Course Contents:

UNIT I:

Introduction to Nanotechnology:
Definition and scope of nanotechnology, Historical development of nanotechnology, Nanoscale materials and structures, Unique properties of nanomaterials, Classification of nanomaterials, Applications of nanotechnology in engineering and industry.

UNIT II:

Synthesis and Characterization of Nanomaterials:
Top-down and bottom-up approaches, Methods for synthesis of nanomaterials such as mechanical milling, chemical vapor deposition, sol-gel process, and electrochemical methods,

Characterization techniques including scanning electron microscopy (SEM), transmission electron microscopy (TEM), X-ray diffraction (XRD), and atomic force microscopy (AFM).

UNIT III:

Surface Engineering Fundamentals:
Concept of surface engineering, Importance of surface properties in engineering materials, Surface modification techniques, Surface coating technologies, Surface treatments for improving wear resistance and corrosion resistance.

UNIT IV:

Surface Coating and Treatment Techniques:
Thermal spraying, Electroplating and electroless plating, Chemical vapor deposition (CVD), Physical vapor deposition (PVD), Ion implantation, Laser surface treatment.

UNIT V:

Applications of Nanotechnology and Surface Engineering:
Nanotechnology in electronics, energy systems, and biomedical applications, Nanocoatings and protective coatings, Applications in automotive and aerospace industries, Environmental and safety aspects of nanotechnology.

Text Books:

1. **Introduction to Nanotechnology** – Charles P. Poole Jr. and Frank J. Owens, Wiley.
2. **Surface Engineering for Corrosion and Wear Resistance** – J. R. Davis, ASM International.

Reference Books:

1. **Nanotechnology: Principles and Practices** – Sulabha K. Kulkarni, Springer.
2. **Handbook of Surface Engineering** – K. Holmberg and A. Matthews, Elsevier.

Other Suggested Readings:

1. **Nanotechnology: Fundamentals and Applications**
   Instructor: Prof. K. Vijayamohanan, Indian Institute of Science https://nptel.ac.in/courses/118106017
2. **Surface Engineering**
   Instructor: Prof. S. K. Biswas, Indian Institute of Science Bangalore https://nptel.ac.in/courses/112108150

Finite Element Method

Course Code: MECPEIII608 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

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

1. Understand the concepts behind formulation methods in FEM.

2. Identify the application and characteristics of FEM elements such as bars, beams, plane and isoperimetric elements.

3. Develop element characteristic equation and generation of global equation.

4. Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts,

heat transfer, fluid flow, axisymmetric and dynamic problems

Course Contents:

Unit 1

Introduction to FEM: Introduction to FEM, engineering applications, advantages, General steps, Element types, Convergence criteria, Coordinate systems, commercial packagespreprocessor, solver and post processor. Principles of Elasticity: Strain displacement relations, Stressstrain relations for 1D, 2D, and 3D cases, Plain stress and Plain strain conditions, Introduction to Numerical Methods.

Unit 2

One Dimensional Element: Formulation of a linear bar element, Shape Functions Polynomial, The Potential Energy Approach, derivation of stiffness matrix, Properties of stiffness matrix, Assembly of Global Stiffness Matrix and Load Vector, Boundary conditions elimination method and penalty method.

Unit 3

Trusses and Beams: Formulation plane trusses element, Stiffness matrix (No derivation), Numerical Problems on point load, Formulation beam element, derivation of Hermite shape functions, stiffness matrix and load vector (No derivations)

Unit 4

Two dimensional Element: Formulation of triangular and quadrilateral elements. Displacement models and shape functions for linear and higher order elements, Lagrangian and serendipity elements, Iso parametric – sub parametric – super parametric elements, Introduction to axisymetric-triangular elements. Convergence criteria, Pascal Traingle.

Unit 5

Dynamic considerations and Heat Transfer: Dynamic considerations: Formulation for point mass and distributed masses, Consistent mass matrices for 1D bar element, computation of eigen values and eigen vectors. Numerical Problems on straight and stepped bars. Heat Transfer Problems.

Text Books:

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergaman Int. Library of Science, 2010.

3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

Reference Books:

1. J.N.Reddy, “Finite Element Method” McGraw Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.

2. Cook R. D., et al. “Conceptsand Application of Finite Elements Analysis” 4th Edition, Wiley & Sons, 2003.

3. C.S.Krishnamoorty, Finite ElementAnalysis, Tata McGrawHill David V. Hutton, Fundamentals of Finite ElementAnalysis, McGraw Hill

4. D. Maity, Computer Analysis of Framed Structures, I.K. International Pvt. Ltd. New Delhi

Fracture Mechanics

Course Code: MECPEIII609 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand the concept of crack propagation leading to fracture failure.
CO-2	Analyze the fracture strength of mechanical components under different fracture modes.
CO-3	Apply fracture mechanics principles for determining Fracture Parameters using Experimental Methods.
CO-4	Design mechanical components against fracture
CO-5	Analyze the mechanical components against fracture through Non-Destructive Testing.

Course Contents:

UNIT I:

Introduction: Brittle and Ductile Fracture, Modes of Fracture Failure, Surface Energy, Griffith's Dilemma,

Realization and Analysis. Energy Release Rate, Energy Release Rate of DCB Specimen, Anelastic Deformation at Crack-tip, Crack Resistance, Stable and Unstable Crack Growth, Critical Energy Release Rate.

UNIT II:

Stress Intensity Factor: Linear Elastic Fracture Mechanics (LEFM), Stress and Displacement Fields in Isotropic Elastic Materials, Westergaard's Approach.

UNIT III:

SIF of More Complex Cases: Applications of Westergaard Approach, Crack in a Plate of Finite Dimensions, Edge Cracks, Embedded Cracks, The Relation between GIand KI, Critical Stress Intensity Factor.

J-Integral: Definition of the J-Integral, Path Independence, Stress-Strain Relation, Experiments to Determine the Critical J-Integral,Comments on the Numerical Evaluation ofJ- Integral, A Simplified Relation for the J-Integral, Applications to Engineering Problems.

UNIT IV:

Test Methods: KIC-Test Technique, Test Methods to Determine JIC ,Test Methods to Determine GIC and GIIC ,Determination of Critical CTOD.

UNIT V:

Fracture Parameters: Direct Methods to Determine Fracture Parameters. Indirect Methods to Determine Fracture Parameters. Mixed Mode Crack Initiation and Growth.

Crack Detection through Non-Destructive Testing: Examination through Human Senses, Liquid Penetration Inspection, Ultrasonic Testing, Radiographic Imaging, Magnetic Particle Inspection.

Text Books:

1. Prashant Kumar, Elements of fracture mechanics, Tata McGraw-Hill Education, 2009

Reference Books:

1. Anderson, Ted L., Fracture mechanics: fundamentals and applications, CRC press, 2017
2. Broek, David, Elementary engineering fracture mechanics, Springer Science & Business Media, 2012
3. S.T. Rolfe and J.M. Barson, Fracture and Fatigue control in Structures, Prentice Hall Inc. New Jersy, 1977
4. M.F. Kanninen and C.H. Popelar, Advanced Fracture Mechanics, Oxford University Press, 1985
5. J.W. Hutchinson, Nonlinear Fracture Mechanics, Department of Solid Mechanics, The Technical University of Denmark Publications, 1979
6. Maiti, Surjya Kumar, Fracture mechanics: Fundamentals and applications. Cambridge University Press, 2015

Automobile Engineering

Course Code: MECPEI509 / MECPEIII610 **L:3 T:0 P:0**

Course Outcomes:

CO1	Understand the basic layout of an automobile.
CO2	Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
CO3	Analyze the vehicle transmission, suspension, steering and braking systems.
CO4	Understand automotive electronics.
CO5	Explore latest developments in automobiles.

Course Content

UNIT I

Introduction and Vehicle structure: Types of automobiles, vehicle construction andlayouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, variable valve timing (VVT). **(7)**

UNIT II

Fuel supply System, Ignition System and Electrical system: Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition & capacitive discharge ignition systems, turbo chargers(WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms .**(10)**

UNIT III

Transmission System: Transmission systems, clutch types & construction, gear boxes-manual and automatic gearshift mechanisms over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive. **(7)**

UNIT IV

Steering and Braking System: Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems.

Pneumatic and hydraulic braking systems, power brake, antilock braking system(ABS), electronic brake force distribution (EBD) and traction control.**(10)**

UNIT V

Alternative fuel, Hybrid and Electric Vehicle: Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion &emission characteristics of alternative fuels in SI and CI engines. Electric and Hybrid vehicles, application of Fuel Cells. **(8)**

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Text Books:

1. K.M. Gupta.l, Automobile Engineering, Vol.I& II, Umesh Pub, 2010.
2. W.H. Crouse and D.L. Anglin, Automotive Mechanics, Tata McGraw Hill, New Delhi,2005.
3. J. Heitner, Automotive Mechanics, Affiliated South West Press, New Delhi, 2000.
4. Anderson, J. D., Fundamentals of Aerodynamics,McGraw-Hill Education, 2016, 6th edition

Reference Books:

1. G.B. Narang, Automobile Engineering, Khanna Publishers, New Delhi, 2001.
2. Kamaraju Ramakrishna, Automobile Engineering,PHI Learning pvt. Ltd., New delhi-2012.
3. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), Encyclopedia of Automotive Engineering, Parts 1-6, Wiley, 2015.
4. R. Stone and J. K. Ball, Automotive Engineering Fundamentals,SAE International, 2004.
5. Kirpal Singh, Automobile Engineering, 7thed., Standard Publishers, New Delhi, 1997.
6. Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.

Program Elective-IV

COMPUTER AIDED DESIGN AND MANUFACTURING

Course Code: MECPEII504 / MECPEIV601 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

Course Contents:

UNIT I

Basic concepts of CAD - CAD workstation - principles of computer graphics - graphics programming - mechanical drafting package.

UNIT II

Advanced modeling techniques - surface modeling - solid modeling, rendering methods. CAD/CAM data base development and data base management systems.

UNIT III

Principles of optimum design - CAD optimization techniques, Application of CAD - computer-aided process planning - post processing - NC code generation - principles of computer aided engineering and concurrent engineering.

UNIT IV

Computer aided manufacturing, programming and interface hardware – computer aided process monitoring - adaptive control, on-line search strategies.

UNIT V

Production systems at the operation level - computer generated time standards - machinability data systems - cutting conditions optimization - production planning - capacity planning - shop floor control - computer integrated manufacturing systems, system components, application.

References:

1) Radhakrishnan P & Kothandaraman C.P, “Computer Graphics and Design”, DhanpatRai& Sons, 1990.

2) Groover M P, “Automation, Production System and Computer Aided Manufacture”, Prentice Hall, 1984.

3) William M Newman & Robert Sproul,, “Principle of Interactice Computer Graphics”, Mc Graw Hill, 1984.

Compressible Flow and Jet Propulsion

Course Code: MECPEIV602 **L:3 T:0 P:0**

Course Outcomes:

ADVANCED WELDING TECHNOLOGY

Course Code: MECPEIV603 **L:3 T:0 P:0**

Rationale:

- Elucidate the concepts of continuity, mechanism, physics, and design elements in welding process
- Comprehend the characteristics of weldable materials and welding technologies
- Demonstrate the importance of modelling and simulation of welding process
- Develop intellectual skills for correlating the microstructural evolution with the defects and properties of weldments

Course Outcomes:

CO1	Describe welding processes, welding symbols, joint configurations, and heat source characteristics
CO2	Formulate governing equations and boundary conditions to simulate the thermal phenomenon in the course of a welding process
CO3	Evaluate the microstructural evolution on the properties of weldments
CO4	Identify appropriate techniques for detecting the welding defects

Course Contents:

Unit 1

Overview of welding processes and their classification, types of joints, edge preparation, weld symbols, weld nomenclature, bead geometry, power density, heat sources - Gaussian distribution of heat flux, welding techniques - linear and orbital. Arc characteristics.

Unit 2

Voltage-current characteristics. Types of welding manipulators and their applications. Advanced welding processes: submerged arc, TIG, MIG, electro-slag, ultrasonic, electron beam and laser beam welding. Case studies and applications - industrial, automotive and aerospace.

Unit 3

Thermal modeling and simulation of welding processes - governing heat transfer equations and boundary conditions for various types of welding processes. Estimation of cooling rates. Prediction of mechanical properties, micro/macro-structures of weldments and heat-affected zone.

Unit 4

Prediction of weld defects such a crack, segregation, lack of fusion. Modeling and simulation of pulsed arc processes. Use of softwares for simulation. Solidification behaviour of fusion weld: structural zones, epitaxial growth, weld pool shape and columnar grain structures. Weldability of metals- steels, stainless steels, aluminium, copper, nickel and titanium alloys.

Unit 5

Microstructures of weldment.Segregation of alloying elements.Impact of micro/macro-structures and segregation on mechanical properties.Pre- and post-treatment. Effects of heat flow on residual stresses and distortion. Weldability tests. Welding defects - causes and remedies.Methods of testing weldments - mechanical, pressure and leak testing.Inspection methods - visual, penetrant, magnetic, ultrasonic, x-ray and gamma radiography.Use of imaging techniques for online monitoring

Textbooks:

1. Khanna O. P. - 'A Text Book on Welding Technology' – DhanpatRai and Sons, New Delhi - 2013
2. Parmar R. S. - 'Welding Process and Technology' - Khanna Publishers, Delhi – 1992

Reference Books:

8. Little R. L. - 'Welding and Welding Technology' - Tata McGraw Hill Publishing Company Limited, New Delhi – 1989
9. Grong O. - 'Metallurgical Modelling of Welding' - The Institute of Materials - 1997 - 2nd Edition
10. Kou S. - 'Welding Metallurgy' - John Wiley Publications, New York - 2003 - 2nd Edition.

GAS DYNAMICS AND JET PROPULSION

Course Code: MECPEIV604 **L:3 T:0 P:0**

Rationale:

- To discuss the effect of compressibility in gas flow
- To derive the steady one-dimensional isentropic flow equation
- To discuss the effects of friction and heat transfer on compressible flows through constant area duct
- To familiarize the occurrence of shocks and calculate property changes across a shock wave
- To derive the thrust equation and discuss its application in jet and rocket propulsion

Course Outcomes:

CO1	Apply the thermodynamics concepts in relation to compressible flows and derive relationships between various compressible flow parameters.
CO2	Understanding of isentropic compressible flows in variable area ducts and apply in design of static components like nozzles and diffusers
CO3	Solve for compressible flow characteristics with friction and heat transfer
CO4	Develop relationship for shocks and determine their characteristics under various conditions
CO5	Analyse the performance of aircraft and rocket propulsion engines

Course Contents:

Unit 1: Basic concepts:

Energy and momentum equations of compressible fluid flows - Stagnation states - Mach waves and Mach cone - Effect of Mach number on compressibility. Isentropic flows: Isentropic flow through variable area ducts. [10 hours]

UNIT 2: Isentropic Flow:

Nozzle and Diffusers, compressors and turbines - Use of Gas tables. Flow through ducts: Flow through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) - Variation of flow properties - Use of tables and charts - Generalized gas dynamics. [10 hours]

Unit 3: Normal and oblique shocks:

Governing equations - Variation of flow parameters across the normal and oblique shocks - Prandtl Meyer relations – Expansion of supersonic flow, Use of table and charts - Applications. [10 hours]

Unit 4: Jet propulsion:

Theory of jet propulsion - Thrust equation - Thrust power and propulsive efficiency - Operation principle - cycle analysis and use of stagnation state performance of ramjet, turbojet, turbofan and turbo-prop engines – Aircraft combustors. [7 hours]

UNIT 5: **Space propulsion**:

Types of rocket engines - Propellants - Ignition and combustion - Theory of rocket propulsion – Performance study - Staging - Terminal and characteristic velocity - Applications - Space flights. [8 hours]

Textbooks:

1.Yahya S. M. “Fundamentals of Compressible Flow with aircraft and rocket propulsion”, 5/e,New Age International publishers, 2016

Reference Books:

1. Balachandran P. “Fundamentals of Compressible Fluid Dynamics”, PHI Learning India Private Ltd., 2009.
2. John D. Anderson Jr. “Modern Compressible Flow with historical perspective”, 2/e, McGraw Hill Publishing company, International Edition, 1990. S
3. Shapiro A. H. “Dynamics and Thermodynamics of Compressible Fluid Flow – Volume I”, John Wiley, New York, 1953.

Fundamentals of HVAC Systems

Course Code: MECPEIV605 **L:3 T:0 P:0**

Rationale:

- To learn climate variation and its effects on the building heat load.
- To learn building material characteristics and their influence on building heating /cooling load for all weather conditions.
- To study various conversation techniques related to build environment and codes for the same.
- To study various Testing and Balancing Air Systems.
- To study various techniques involved in industry air conditioning systems

Course Outcomes:

CO1	Estimate heating loads, space heat gains and space cooling loads using accepted engineering methods.
CO2	Determine the coil loads for cooling and heating systems
CO3	Select equipment and design systems to provide comfort conditions within the building.
CO4	Understand different testing and balancing air conditioning systems
CO5	To apply the principles of producing air conditioning for human comfort and industry applications

Course Contents:

UNIT I

Introduction to Air Conditioning and Refrigeration – Basic Thermodynamics of HVAC, Types of Refrigeration Systems, the Refrigeration Cycle, Refrigerants and their Properties, Plotting the Refrigeration Cycle, Piping and Tubing, Soldering and Brazing, Refrigerant Leak Testing, Refrigerant System Evacuation, Refrigerant System Charging, Control Systems.

UNIT II

Heating systems - Gas Furnaces, Gas Furnace Controls, Gas Furnace Installation, Troubleshooting Gas Furnaces, Oil Fired Heating Systems, Oil Furnace and Boiler Service, Residential Oil Heating Installation, troubleshooting of oil heating systems, Electric Heat, Electric Heat Installation, troubleshooting of electric heat, Heat Pump System Fundamentals,

Heat Pumps Applications, Geothermal Heat Pumps, Heat Pump Installation, Troubleshooting of Heat Pump Systems.

UNIT III

Comfort and Psychometrics - Fundamentals: Psychometrics & Airflow, Air Filters, Ventilation and Dehumidification, Heat transmission in building structures -Solar radiation -Infiltration and Ventilation-Cooling/heating load calculations, Residential Load Calculations, Green Buildings and Systems, Indoor Air Quality (IAQ), Building energy calculations .

UNIT IV

Duct Installation, Duct Design, Zone Control Systems, Testing and Balancing Air Systems.

UNIT V

Chilled Water Systems, Cooling Towers, Commercial Refrigeration Systems, Supermarket Equipment, Ice Machines.

References:

1. Handbook of heating, ventilation and Air-conditioning, Jan. F. Kreider, CRC press.
2. Automotive heating and Air-conditioning, Mike Stubblefield and John H Haynes
3. Heating ventilation and air conditioning – Jan F. Kreider
4. Control systems for Heating, ventilating and air conditioning, Roger W. Haines, Springer
5. HVAC Equations, Data, and Rules of Thumb - Arthur A. Bell Jr., PE, McGraw-Hill

Fundamentals of Biomechanics

Course Code: MECPEIV606 **L:3 T:0 P:0**

Rationale:

- The principles of mechanics and their application in biomechanics.
- Biomechanics of skeletal joints and tissues.
- Solving equations of motion for simple models of human movement.
- Applying biomechanics principles to implant design and gait analysis.
- Developing skills in biomechanical analysis and problem-solving.

Course Outcomes

CO1	Analyze and apply the principles of mechanics to solve problems in biomechanics and human movement analysis.
CO2	Assess the forces and stresses in human joints and tissues, using free-body diagrams and biomechanical analysis techniques to evaluate the functionality and limitations of different anatomical structures.
CO3	Model the mechanical properties of hard and soft tissues, such as bones, cartilage, tendons, ligaments, and muscles, and predict their behavior under various conditions and loads.
CO4	Design, develop, and evaluate prosthetic and orthopedic implants, considering biomechanical requirements, biocompatibility, and material characteristics to enhance patient outcomes.
CO5	Apply knowledge of cardiovascular and respiratory mechanics to interpret and predict the behavior of blood flow and respiratory dynamics, and to evaluate the performance of artificial heart valves and respiratory models.

Course Content

UNIT I

Introduction to Biomechanics- Review of the principles of mechanics, Vector mechanics, biomechanics, anatomical terminology, Anthropometry, motion in the human machine.

Biomechanics of Joints- Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle, Introduction to bio fluid Mechanics, Rheological properties of blood, laminar flow, Couette flow and Hagen Poiseuille equation, turbulent flow.

UNIT II

Hard and Soft Tissue- Bone structure, composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, maxwell&voight models, Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modeling of soft tissues, Hills's muscle model.

UNIT III

Cardiovascular and Respiratory Mechanics– Cardiovascular system, artificial heart valves, biological and mechanical valves development, testing of valves, Blood Flow Models, Blood Vessel Mechanics, Heart valve dynamics, prosthetic valve dynamics.

UNIT IV

Mechanism of air flow, respiratory cycle, lung ventilation model, methods of determining pressure, flow rate and volume spirometry.

Applied Biomechanics and Biomechanics of Implants- Engineering approaches to standing, sitting and lying, Biomechanics of gait, application of gait and locomotion analysis, Fluid mechanics and energetics: Forms of energy and energy transfer,

UNIT V

Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.

References

1.Ronald Huston, "Principles of Biomechanics", CRC Press - 1st Edition, 2019, ISBN: 978-0367452469

2.SusanJ.Hall, "Basic Bio Mechanics", McGraw -Hill Publishing Co, Newyork - 8th Edition, 2019, ISBN: 978-1259913877.

3.Zatsiorsky and Prilutsky, Biomechanics of Skeletal muscles, Human Kinetics publishers, 2012.

4.Valdimir M. Zatsiorsky, "Kinetics of Human motion", Human Kinetics publishers, 2002, ISBN: 978-0736037785.

5.Vladimir M. Zatsiorsky, and Boris I. Prilutsky, "Biomechanics of Skeletal muscles", Human Kinetics publishers - 1st Edition, 2012, ISBN: 978-0736080200.

ADVANCED FORMING TECHNOLOGY

Course Code: MECPEIV607 **L:3 T:0 P:0**

Rationale:

- To understand the fundamental concepts of different types of forming processes, plasticity theories, and material selection methods to optimize tooling design and improve formability.
- To inculcate the practical implications of advanced forming processes in real-world manufacturing scenarios.
- To attain the design skills required for forming processes to manufacture complex parts with quality assurance.
- To gain skills and hands-on experience with various forming processes through laboratory exercises and projects.

Course Outcomes:

CO1	Analyze material behavior during forming processes using plasticity theories
CO2	Design optimized parts and tooling for forming processes using CAD software and simulation tools
CO3	Apply advanced forming processes to produce complex parts
CO4	Evaluate formability using testing methods and formability limit diagrams
CO5	Conduct laboratory exercises and solve practical manufacturing problems with design considerations using advanced forming technology

Course Contents:

Unit 1: Fundamentals of Forming Processes

Overview of forming processes - Plasticity theories for forming processes - Material selection and material flow analysis - Tooling design and selection - Formability testing methods - Forming limit diagrams – Spring back effect. [8 Hours]

Unit 2: Advanced Forming Processes

High-energy rate-forming processes - Incremental forming processes - Hydroforming processes - Powder metallurgy forming – Flow forming - Innovative and hybrid forming processes. [8 Hours]

Unit 3: Design for Forming Processes and Manufacturing of Complex Parts

Design considerations for forming processes - Part and die design principles - Tolerance analysis and control - Computer-aided design (CAD) for forming processes - Simulation and modeling for forming processes - Design for manufacturing (DFM) principles - Manufacturing of complex parts and quality assurance. [14 Hours]

Unit 4: Laboratory Exercises and Projects

Laboratory exercises on various forming processes - Design and optimization of tooling for forming processes - Project on the application of advanced forming technology to solve a practical manufacturing problem with design considerations.

Textbooks:

1. Advanced Forming Technology: Principles, Applications, and Manufacturing Processes by Ming Wang Fu

Reference Books:

1. Fundamentals of Metal Forming Technology by TaylanAltan, Gracious Ngaile, and GangshuShen
2. Introduction to Materials Science for Engineers by James F. Shackelford
3. Metal Forming: Mechanics and Metallurgy by William F. Hosford and Robert M. Caddell
4. Advances in Metal Forming: Expert System for Metal Forming by Taylan Altan, M. Akif Ezan, and Faruk Birol
5. Fundamentals of Metal Forming" by Harold W. Paxton and Frank W. Koehler

Industrial Safety Engineering

Course Code: MECPEIV608 **L:3 T:0 P:0**

Rationale:

- Effective Safety management system and BBS
- Accident reporting & investigation procedure
- Workplace, physical and chemical hazards
- Occupational physiological requirement of jobs.
- Fire safety and firefighting equipment

Course Outcomes:

CO1	Apply principles of safety management, its functions and technique in any organization
CO2	Classify and categorize the factors contributing to various hazards
CO3	Formulate accident investigation program in an organization, practice and develop accident reporting system within an organization
CO4	Apply material handling and machine guarding principles in industrial applications
CO5	Identify and analysis physical and chemical hazards and its control measures

Course Content:

UNIT I

Evolution of modern safety concept- Behaviour Based Safety (BBS) -Safety Culture-Effective Safety management system -Safety training.

UNIT II

Concept of an accident, reportable and non-reportable accidents, reporting to statutory authorities-principles of accident prevention – accident investigation and analysis– unsafe act and condition – Accident Causation Theories

UNIT III

Workplace Hazards - Machine Guarding, guarding of hazards, Machine Guarding types and its application – Safety in welding and Gas cutting – Safety in Manual and Mechanical material handling- Safety in use of electricity

UNIT IV

Occupational Hygiene - Chemical Hazards-Airborne particulate matters- TLV- Occupational Diseases-Physical hazards and its effects – Evaluation and control measures.

UNIT V

Occupational physiology-Man as a system component – allocation of functions – efficiency – occupational work capacity – aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements – categorization of job heaviness –fatigue – rest pauses.

Fire triangle- Types of fire - first aid firefighting equipment – flammability limit- LPG safety - Hazard identification and Risk Analysis.

Overview of factories act 1948 – ISO-45001

References

1. N.S.C., 1982. Accident Prevention Manual for Industrial Operations. Chicago: N.S.C. Blake, R.B., 1973. Industrial Safety. New Jersey: Prentice Hall, Inc..
2. Heinrich, H.W., 1980. Industrial Accident Prevention. New York: McGraw-Hill Company.
3. Krishnan, N.V., 1997. Safety Management in Industry. Bombay: Jaico Publishing House.
4. Ridley, J., 1983. Safety at Work. London: Butterworth & Co.
5. Deshmukh, L.M., 2017. Industrial Safety Management. New Delhi: Tata McGraw-Hill Education.

Micro and Nano Manufacturing

Course Code: MECPEIV609 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO1	Understand different techniques for the synthesis and characterization of nano-materials
CO2	Design and analyze methods and tools for micro and nano-manufacturing.
CO3	Select micro and nano-manufacturing methods and identify key variables to improve the quality of MEMS.
CO4	Choose appropriate industrially viable process, equipment and tools for a specific product.

Course Contents:

UNIT I:

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology, Scaling Laws in Mechanics, fluids, thermodynamics, Electromagnetism, tribology and Examples.

UNIT II:

Nano-materials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nano-materials-sol-gel process, Liquid solid reactions; Gas Phase synthesis of nano-materials.

UNIT III:

Structural Characterization: X-ray diffraction, Optical Microscope and their description, Scanning Electron Microscopy (SEM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM).

Micro fabrication Techniques: Lithography – LIGA, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding, MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining

UNIT IV:

Nanofabrication Techniques: Laser based nana manufacturing, E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.

UNIT V:

MEMS devices and applications: Pressure sensor, inertial sensor, Optical MEMS and RF-MEMS, Micro-actuators for dual-stage servo systems.

Text Books:

1. Tai-Ran Hsu, MEMS and Microsystems: Design and Manufacture, McGraw- Hill, 2008
2. Marc Madou, Fundamentals of Microfabrication: The Science of Miniaturization, CRC Press, 2002, Second Edition.
3. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.

Reference Books:

1. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009.
2. Ray F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Springer, 2005.
3. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc. New York, 1994.
4. B.D. Cullity, Elements of X-Ray Diffraction, Prentice Hall, 2002, 3rd edition.

Geometric Modelling for CAD

Course Code: MECPEI510 / MECPEIV610 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO1	Apply geometric transformations and projection methods in CAD.
CO2	Develop geometric models to represent curves.
CO3	Design surface and solid models for engineering design.
CO4	Apply mesh generation method for engineering analysis.

Course Content

UNIT I
Introduction: Definition and scope of CAD/CAM, Introduction to design process and role of computers in the design process. CAD Hardware and Software, Types of systems and system considerations, input and output devices.

UNIT II
Computer graphics: Graphic primitives, point, line ellipse etc. Bresenham'sline, line, circle and ellipse algorithm. 2D and 3D transformations.

UNIT II
Geometric Modeling Techniques: Solid modelling, surface modelling, wire frame modelling. Representation of curves and surfaces. Parametric representation of analytic curves, parametric representation of synthetic curves.

UNIT IV
Solid modeling: Solid models, Fundamentals of solid modeling, Different solid representation schemes, Half -spaces, Boundary representation (B-rep), Constructive solid geometry (CSG).

UNIT IV
CAD/CAM Data Exchange Formats, Graphics standards. Finite Element Mesh Generation Methods.

References:

1. Ibrahim Zeid—CAD/CAM, Theory and Practice.
2. P.Radhakrishnan/S.Subramanyam /V.Raju,—CAD/CAM/CIM.

3. D. Hearn. Computer graphics, C version. Pearson Education India, 2014.
4. D. F. Rogers, J. A. Adams. Mathematical elements for computer graphics. McGraw-Hill, Inc, Second edition, 2017.
5. Rooney, J. and Steadman, P., Principles of Computer Aided Design, prentice Hall (1988).

Open Elective-I

Pollution and Control

Course Code: MECOEI601 **L:3 T:0 P:0**

Course Outcomes:

DESIGN OF THERMAL SYSTEMS

Course Code: MECOEI602 **L:3 T:0 P:0**

Rationale:

- To impart the knowledge about the concept of design of thermal systems.
- To know the design procedure of heat exchangers related to different thermal applications like condensers, evaporators, cooling towers etc.
- To know the design procedure of cooling of electronic components.

Course Outcomes:

CO1	Understand the types of heat exchanger and use LMTD and NTU approaches to solve problems.
CO2	Analyse the design procedures in double pipe and shell and tube heat exchangers.
CO3	Describe the working procedures and calculate the heat transfer aspects in condenser and evaporators.
CO4	Distinguishes the performance parameters in cooling tower performance and heat pipe applications.
CO5	Identify various techniques for cooling of electronic equipment.

Course Contents:

Unit 1

Classification of Heat Exchangers: Introduction- Recuperation & Regeneration-Tubular heat exchangers-Double pipe, Shell and Tube heat exchangers, Plate heat exchanger Exchangers-Plate fin and Tubular fin heat exchangers BASIC DESIGN METHODS OF HEAT EXCHANGERS: Basic equations in Design, Overall heat transfer coefficient-LMTD method and Effectiveness method (NTU) for heat exchanger analysis-Parallel flow, counter flow, Multi pass, Cross flow heat exchangers.

Unit 2

Double Pipe Heat Exchanger: Film coefficient for fluids in annulus, fouling factors, calorific temperature, Average fluid temperature, Calculation of double pipe exchanger, double pipe exchangers in series parallel arrangements.

Shell & Tube Heat Exchangers: General design considerations, Construction details, Tube layouts, Baffles, Shell side and tube side film coefficients. Analysis of performance and design

of shell & tube heat exchangers, Flow arrangements, Shell side pressure drop and Tube side pressure drop.

UNIT 3

Condensers & Evaporators: Types of Condensers-Air cooled condenser –Water-cooled condensers-Evaporative condensers Heat Transfer in condensers- Types of Evaporators-Heat transfer in Evaporators-Pool boiling – Heat transfer coefficient for nucleate pool boiling-Flow or forced convection boiling-Forced convection boiling correlations

UNIT 4

Direct Contact Heat Exchangers: Cooling towers, relation between wet bulb & dew bulb temperatures, and calculation of cooling tower performance. Heat Pipe: Gravity assisted thermo-syphons, micro heat pipes, pulsating heat pipes, loop heat pipe operation and working principles.

UNIT 5

Cooling of Electronic Equipment: Introduction-The chip carrier-Printed circuit boards-Cooling load of

Electronic equipment Conduction cooling: Conduction in chip carriers-conduction in printed circuit board heat frames. Air-cooling: Natural convection and radiation- Forced convection- Fan selection-cooling personal computers.

Textbooks:

1. Serth. R. W, Process Heat Transfer-Principles and Applications, Elsevier, 2007.

Reference Books:

1. Coulson & Richardson’s series, Sinnott R. K., Chemical Engineering Design, Elsevier, 2005
2. Kern D, Q, Process Heat Transfer, McGraw-Hill, 1965
3. Shah R K and Sekulic D P, Fundamentals of Heat Exchanger Design, John Wiley and plyk\ vdfkpSons, 2002.
4. Kays W M and London A L, Compact Heat Exchanger, Krieger Publishing Company,1998
5. A.P. Frass and M.N. Ozisik, Heat Exchanger Design- John Wieley& Sons, New York

Smart Materials and Structures

Course Code: MECOEI603 **L:3 T:0 P:0**

Course Outcomes:

Optimization in Engineering Design

Course Code: MECOEI604 **L:3 T:0 P:0**

Rationale:

- Understand the need and origin of the optimization methods.
- Get a broader picture of the various applications of optimization methods used in engineering.
- Define an optimization problem and its various components
- Formulate optimization problems as mathematical programming problems.
- Briefly learn about classical and advanced techniques in optimizations.

Course Outcomes:

CO1	Enumerate the necessity of optimization in engineering design.
CO2	Identify the various optimization techniques pertaining to design-oriented problems.
CO3	Solve problems with single and multi – variable
CO4	Distinguish between integer and geometric specialized algorithm
CO5	Apply non-traditional algorithms for optimization of typical problems requiring their application

Course Contents:

UNIT I

Introduction to optimization. Classical optimization techniques. Single variable optimization, Unconstrained multivariable optimization.

UNIT II

Nonlinear programming: equality constraint, KKT conditions

Numerical optimization: Region elimination techniques, Fibonacci Method, Golden Section Method, Interpolation Methods

UNIT III

Unconstrained optimization techniques: Direct and indirect search method, Nonlinear programming: constrained optimization techniques, **Introduction to Geometric and integer Programming** Constrained Geometric Programming Problem

UNIT IV

Nontraditional algorithms: Introduction and Principles of Evolutionary Computation (EC), Binary-Coded Genetic (BCGA), Differential Evolution (DE), Particle Swarm Optimization (PSO).

UNIT V

Introduction to Multi-Objective Optimization: Introduction, Generalized Formulation, Concept of Dominance and Pareto-optimality, Graphical Examples, Terminologies.

References:

1. Rao, Singiresu S. “Engineering optimization: theory and practice.” John Wiley & Sons, 2019.
2. Deb, Kalyanmoy. “Optimization for engineering design: Algorithms and examples”. PHI Learning Pvt. Ltd., 2012.
3. Chong EK, Żak SH. “An introduction to optimization”. John Wiley & Sons; 2013
4. Nocedal, Jorge, and Wright, Stephen. Numerical “Optimization. Germany”, Springer New York, 2006.
5. Belegundu, Ashok D., and Chandrupatla, TirupathiR.. “Optimization Concepts and Applications in Engineering”. India, Cambridge University Press, 2019.

Energy Conservation and Management

Course Code: MECOEI605 **L:3 T:0 P:0**

Rationale:

- To learn the present energy scenario and the need for energy conservation
- To understand the monitoring / targeting aspects of Energy
- To study the different measures for energy conservation of various thermal energy systems
- To learn economic analysis and project planning on energy conservation
- To understand the energy conservation principle with electrical equipment

Course Outcomes:

CO1	Apply energy conservation principles for practical devices
CO2	Assess the performance and energy efficiency of various thermal energy systems
CO3	Evaluate the energy loss with various electrical equipment
CO4	Perform energy audit in thermal and electrical systems
CO5	Execute techno-economic analysis and project planning on energy conservation

Course Contents:

UNIT I

Energy Scenario - Basics of Energy and its various forms - Energy Management and Audit - Material and Energy Balance -Energy Action Planning-Financial Management -Project Management -Energy Monitoring and Targeting -Global Environmental Concerns

UNIT II

Energy Efficiency in Thermal Utilities - Fuels and Combustion-Boilers-Steam System-Furnaces - Insulation and Refractory -FBC Boilers -Cogeneration -Waste heat recovery

UNIT III

Energy Efficiency in Electrical Utilities-Electrical Systems-Electric MotorsCompressed Air System-HVAC and Refrigeration System-Fans and Blowers-Pumps and Pumping System.

Cooling Tower-Lighting System-Diesel Generating SystemEnergy Efficient Technologies in Electrical Systems

UNIT IV

Energy Performance Assessment for Equipment and Utility systems -BoilersFurnaces Cogeneration, Turbines (Gas, Steam)- Heat Exchangers-Electric Motors and Variable Speed Drives-Fans and Blowers-Water Pumps-Compressors

UNIT V

HVAC Systems-Lighting Systems-Performing Financial Analysis-Applications of Non Conventional and Renewable Energy Sources-Waste Minimization and Resource Conservation.

References

1. Guidebook for National Certification Examination for Energy Managers and Energy Auditors, Bureau of energy efficiencies, 2005.
2. Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington, 1980
3. Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington, 1988
4. Reay D.A, Industrial Energy Conservation, 1st edition, Pergamon Press, 1977.
5. Mehmet Kanoğlu, Yunus A. Çengel, Energy Efficiency and Management for Engineers, 1st Edition, McGraw-Hill Education, 2020.

Energy Storage Technology

Course Code: MECOEI606 **L:3 T:0 P:0**

Rationale:

- To understand the Need and Scope of Energy Storage Systems
- To analyse Thermal Energy Storage Systems.
- To evaluate Chemical Energy Storage Solutions
- To design and Optimize Battery Systems for Transportation.
- To master Electrochemical Storage Technologies

Course Outcomes:

CO1	Understand the necessity and various types of energy storage technologies, and effectively compare their applications and efficiency
CO2	Analyze and model thermal energy storage systems, including water, rock bed, and phase change storage units
CO3	Comprehend the fundamental concepts of batteries, including performance measurement, charging/discharging processes, and safety considerations
CO4	Explain the principles and types of fuel cells, assess their advantages and drawbacks, and conduct a detailed analysis of electrochemical storage systems
CO5	Understand the principles, methods, and applications of advanced energy storage technologies, including flywheels, super capacitors, and compressed air energy storage, as well as the concept and applications of hybrid storage systems

Course Contents:

UNIT I

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications

UNIT II

Thermal storage – Types – Modelling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system – Simple units, packed bed storage units - Modelling using porous medium approach, Use of Transys

UNIT III

Fundamental concept of batteries – measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel – Cadmium, Zinc Manganese dioxide and modern batteries for example (i) zinc - Air (ii) Nickel Hydride, (iii) Lithium Battery

UNIT IV

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantage and drawback of each type.

UNIT V

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications

References:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002
2. Fuel cell systems Explained, James Larminie and Andrew Dicks, Wiley publications, 2003.
3. Electrochemical technologies for energy storage and conversion, Ru-shiliu, Leizhang, Xueliang sun, Wiley publications, 2012
4. Charles R. Russell, Elements of Energy Conversion, Permagon Press, 1967.
5. Hart A.B. and Womack, G.J., Fuel Cells: Theory and Application, Prentice Hall, 1989.

Waste to Energy Conversion Techniques

Course Code: MECOEI607 **L:3 T:0 P:0**

Course Outcomes:

Low Temperature Technology

Course Code: MECOEI608 **L:3 T:0 P:0**

Rationale:

- To understand the fundamental principles of refrigeration, air conditioning and cryogenics.
- To select the right insulation for a particular cooling application
- To understand the behavior of properties of materials at different low temperatures
- To Select the cooling system for any given application and human comfort
- To Evaluate the merits of cooling systems and their usage

Course Outcomes:

CO1	Elucidate and implement the principles of refrigeration, air conditioning, and cryogenics.
CO2	Comprehend the characteristics of materials at reduced temperatures
CO3	Utilize various insulation and vacuum techniques for low-temperature systems.
CO4	Choose the appropriate cooling system for a specific application and human comfort.
CO5	Assess the advantages of various cooling systems and their applications.

Course Contents:

UNIT I

Basics of thermodynamic processes, Introduction to refrigeration, air conditioning and cryogenics.

UNIT II

Refrigeration, Vapor compression systems: Ideal and actual cycles, Vapor absorption systems: Refrigerant – absorbent combinations.

UNIT III

Psychrometry – Definitions for properties. Introduction to cooling load calculations. Comfort conditions. Air-conditioning systems.

UNIT IV

Cryogenic fluids, properties, behavior of cryogenics fluids, storage of cryogenic fluids,

UNIT V

Properties of materials at cryogenic temperatures, Insulation techniques, different types, vacuum techniques

References:

1. Arora, R.C., Refrigeration and Air Conditioning, PHI Pvt Ltd, 2010
2. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
3. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering, Plenum Press New York, 1989.
4. Herald Weinstock, Cryogenic Technology, 1969.
5. Roy.JDossat, Principles of Refrigeration, Pearson Education, 4th Edition , 2006

Non-Destructive Testing

Course Code: MECOEI609 **L:3 T:0 P:0**

Course Outcomes:

Welding Technology

Course Code: MECOEI610 L:3 T:0 P:0

Rationale:

- To study the different types of welding processes and understand the concept of weldability.
- To understand the principles of fusion welding processes.
- To acquire fundamental knowledge on principles of high energy density welding processes.
- To impart a sound understanding of principles of solid-state welding processes.
- To understand the effect of welding parameters on weld quality through modeling and optimization techniques.

Course Outcomes:

CO1	To learn basic principles and methods utilized for testing weldability.
CO2	To understand the impact of welding operations on environment and need for sustainable development
CO3	To select a suitable welding process for a particular application.
CO4	To acquire knowledge on modern developments in welding techniques
CO5	To get the knowledge about newly developed welding process and its parameters.

Course Contents:

UNIT I

Classification of welding processes: heat sources. Weld joint design - Weldability of steels and other materials - Weld defects.

UNIT II

Manual Metal Arc welding, TIG / A-TIG Welding, gas metal arc welding, Submerged arc welding.

UNIT III

Electron beam welding, Plasma arc welding, Laser beam welding - advantages and limitations, process variables and their effects.

UNIT IV

Friction welding and Friction stir welding processes – effects of speed and pressure – Explosive welding –Process Parameters – Resistance Welding – types and process capabilities.

UNIT V

Cold pressure welding - Ultrasonic welding - Recent Advances in welding - Modeling and optimization of welding process.

References:

1. Parmar, R.S., “Welding Engineering and Technology”, Khanna Publishers, 2013, ISBN-13-978-8174090287.
2. Lancaster J.F, ‘The Physics of Welding: International Institute of Welding’, Pergamon Press, 2013, ISBN-13- 978-0080340760
3. AWS, " Welding Handbook ", Vol. I to V. 1976
4. Weman, K., “Welding Processes Handbook”, Woodhead Publishing, 2011, ISBN-13- 978-0857095107
5. Nadkarni S.V., ‘Modern Arc Welding Technology’, Ador Welding Ltd., 2008. ISBN-13-978812041676

Elementary Continuum Mechanics

Course Code: MECOEI611 **L:3 T:0 P:0**

Rationale:

- To introduce indicial notation and summation convention for vectorial and tensorial operations
- To introduce basic tensorial calculus for understanding continuum behavior of matters in cartesian coordinates.
- To familiarize the kinematics of continuum body deformation
- To familiarize the configuration dependent stress measures
- To understand the fundamental balance principles of continuum objects

Course Outcomes:

CO1	To apply indicial notation and Einstein's summation convention for tensor operation
CO2	To represent physical parameters in tensorial notations and perform tensor calculus.
CO3	To understand the unified theory of continuum body such as fluids and solids undergoing deformation.
CO4	To differentiate stress and strain measures on a material and spatial point
CO5	To represent linear momentum balance in material and spatial configuration

Course Contents:

UNIT I: Tensor - Introduction

Scalar, Vector, Second order Tensors, Indicial notation and summation convention, Dot, cross and dyadic products, Linear Transformation, Spherical & deviatoric projectors, Coordinate Transformation.

UNIT II: Tensor - Calculus

Eigen values and eigen vectors, Transformation of Tensors, Tensor valued functions, gradient operators and Integral theorems.

UNIT III: Kinematics

Reference and deformed configurations, motion – velocity and acceleration in material & spatial representation, Deformation and displacement gradients, material and spatial stains measures, Line, area, and volume mappings, Nanson's formula, Polar decomposition - Rotation & stretch tensors, rate of deformation.

UNIT IV: Kinetics

Concept of stress, Cauchy's stress theorem, first and second PiolaKirchoff's& Cauchy's stress tensors, Normal and shear stress, Extremal stress values, stress states.

UNIT V: Balance Principles

Mass conservation, Reynold's transport theorem, Momentum and energy balances in references and current configuration, Weak and strong forms of balance equation, Continuum thermodynamics.

References:

1. Gerhard A. Holzapfel, Nonlinear solid mechanics: A Continuum approach for Engineering, Wiley, ISBN: 978-0-471-82319-3 ,2000.
2. W Michael Lai, David H. Rubin, Erhard Krempl, David Rubin, Introduction to Continuum Mechanics, Butterworth-Heinemann; 4th edition, ISBN: 978- 9380501581.
3. J.N. Reddy, An Introduction to Continuum Mechanics, Cambridge University Press; 2nd edition, ISBN: 978-1316614204.
4. George E. Mase, Schaum's Outline of Continuum Mechanics, McGraw Hill; First edition, ISBN: 978-9389691283
5. John W. Rudnick, Fundamentals of Continuum Mechanics, Wiley, ISBN: 978- 1-118-92767-0, 2014.

Modern Automotive Technology

Course Code: MECOEI612 **L:3 T:0 P:0**

Rationale:

- To impart knowledge on the constructions, functions and technological features of electric and hybrid vehicles.
- To imbibe the utilization of fuel cells and uses of alternative energy systems.
- To familiarize the various controls and safety features used in modern vehicles.
- To study the uses of modern peripheral systems and vehicle automated tracks used in automobiles.
- To understand the various modern features and developments in latest automobiles.

Course Outcomes:

CO1	To know the suitable control system for different electrical vehicles application.
CO2	To possess the knowledge about various alternative energy systems and fuel cells.
CO3	To identify various modern features for better functioning of vehicle
CO4	To demonstrate various safety features and equipment used in modern vehicle
CO5	To apply the fundamental knowledge in developing modern vehicle systems.

Course Contents:

UNIT I

Electric and Hybrid Vehicle Technology: Introduction, LEV, TLEV, ULV & ZEV, Basic components of Electric vehicles, Basic factors to be considered for converting automobiles to electric vehicle, electric hybrid vehicle, types - series and parallel hybrid, layouts, comparison, Power systems and control. Electric propulsion with cables – Magnetic track vehicles. Vehicle Operation and Control: Computer Control for fuel economy, pollution and noise.

UNIT II

Fuel Cells and Alternative energy systems: Proton exchange membrane fuel cells, alkaline electrolyte fuel cells, medium and high temperature fuel cells, fuel selection and processing, fuel cell stacks, fuel cell auxiliary systems. Recent Trends in Automotive Power Plants: Stratified charged / lean burn engines – Hydrogen Engines

UNIT III

Principle of Automobile Navigation and controls in the new generation cars. Capabilities of the navigation and control in future cars. Driver Assistance Systems in Automobiles: Vision in cars, A comprehensive driver assistance approach – Lane recognition, Traffic sign recognition, Stereo

vision, road recognition, Object recognition – Traffic lights and signals, Building intelligent systems in new generation cars.

UNIT IV

Vehicle Automated Tracks: Preparation and maintenance of proper road network-National highway network with automated roads and vehicles-Satellite control of vehicle operation for safe and fast travel. Introduction to electronic traction control and stability control. Brief introduction to driverless cars.

UNIT V

Modem electronic and micro control systems in automobiles: Electronically controlled concealed headlight systems, Electro chromic mirrors, automatic review mirrors, Day time running lamps (DRL), Head up display, Travel information systems, On board navigation system, Electronic climate control, Electronic cruise control, Antilock braking system, Electronically controlled sunroof, Anti-theft systems, Automatic door locks (ADL), engine management system, chassis control system, Integrated system. Modern Developments in Automobiles

References:

1. Chris Mi, M. Abul Masrur, Electric Vehicles, 2nd Edition, Wiley, 2017.
2. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, Modern electric, hybrid electric, and fuel cell vehicles: fundamentals, theory, and design, CRC Press, 2004.
3. Tom Denton, Automobile Electrical and Electronics System, Routledge, 2017.
4. Tom Denton, Electric and Hybrid Vehicles, Routledge, 2020.
5. Barry Hollembeak, Automotive Electricity, Electronics and Computer Controls, S.Chand (G/L) & Company Ltd , 1998.

Hydrogen – Production Handling and Storage

Course Code: MECOEI613 **L:3 T:0 P:0**

Rationale:

- To understand the various methods of hydrogen production, including conventional and renewable approaches.
- To explore the technologies and safety measures involved in the handling and storage of hydrogen.
- To analyze the economic, environmental, and technical challenges associated with hydrogen as an energy carrier.
- To evaluate the role of hydrogen in the context of sustainable energy systems and its potential in various applications.
- To develop strategies for the implementation and optimization of hydrogen technologies in various sectors.

Course Outcomes:

CO1	Understand and explain various hydrogen production technologies, including both conventional and renewable methods.
CO2	Demonstrate knowledge of the safety considerations, handling, and storage technologies for hydrogen.
CO3	Perform economic and environmental assessments of hydrogen as an energy carrier, considering its production, storage, and application
CO4	Critically evaluate the potential and challenges of hydrogen in future sustainable energy systems and its applications in industry, transportation, and power generation.
CO5	Formulate and propose practical solutions for the adoption and enhancement of hydrogen production, handling, and storage systems.

Course Contents:

UNIT I

Historical Perspective and Evolution of Hydrogen Use, Hydrogen's Role in the Energy Transition, Physical and Chemical Properties of Hydrogen, Hydrogen Handling and Safety: Hydrogen Properties and Hazard Identification, Safety Protocols for Handling Hydrogen, Hydrogen Leak Detection and Mitigation. Materials Compatibility and Hydrogen Embrittlement, Codes, Standards, and Regulations for Hydrogen Safety

UNIT II

Hydrogen Production Technologies- Conventional Methods: Steam Methane Reforming, Coal Gasification, Partial Oxidation of Hydrocarbons. Renewable Methods: Water Electrolysis (Alkaline, PEM, Solid Oxide), Biomass Gasification, Photoelectrochemical Water Splitting, Thermochemical Water Splitting, Biological Hydrogen Production. Emerging Technologies: Plasma-Assisted Hydrogen Production, Green Hydrogen via Wind and Solar Integration

UNIT III

Hydrogen Storage Technologies: Physical Storage: Compressed Gas Storage, Liquid Hydrogen Storage, Cryogenic Storage Systems. Material-Based Storage: Metal Hydrides, Chemical Hydrides, Carbon-Based and Novel Materials for Hydrogen Adsorption. Advanced Storage Solutions: Solid-State Storage Technologies, Challenges in Scaling Up Hydrogen Storage Solutions

UNIT IV

Hydrogen Transportation and Infrastructure: Hydrogen Pipelines and Distribution Networks, Road and Rail Transport of Hydrogen, Marine Transport of Liquid Hydrogen, Development of Hydrogen Refueling Infrastructure. Case Studies: Global

Hydrogen Infrastructure Projects, Economic and Environmental Aspects of Hydrogen, Cost Analysis of Hydrogen Production Methods, Life Cycle Assessment of Hydrogen Production and Use, Carbon Footprint and Environmental Impact, Hydrogen Economy: Opportunities and Barriers, Policy and Incentives for Hydrogen Deployment

UNIT V

Applications of Hydrogen, Hydrogen in Fuel Cells: PEMFC, SOFC, and MCFC. Hydrogen as a Fuel for Transportation, Industrial Applications of Hydrogen, Hydrogen in Power Generation and Grid Integration, Hydrogen for Energy Storage and Backup Power Systems. Research Directions: Advances in Hydrogen Production and Storage Technologies, Hydrogen Blending in Natural Gas Grids, Potential for Hydrogen in Decarbonizing Hard-to-Abate Sectors, Research and Development Priorities in Hydrogen Technology

References:

1. S.A. Sherif, D. Yogi Goswami, E.K. (Lee) Stefanakos, Aldo Steinfeld, “Handbook of Hydrogen Energy”, 1st Edition, 2014.
2. zimas, E., Filiou, C., Peteves, S.D., &Veyret, J.B. “Hydrogen storage: state-ofthe-art and future perspective. Netherlands”: European Communities, 2003.
3. Gupta, R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor & Francis Group, 2009.
4. Michael Hirscher, “Handbook of Hydrogen Storage”, Wiley-VCH, 2010.
5. Gupta, R. B., Hydrogen Fuel: Production, Transport and Storage, CRC Press, Taylor & Francis Group, 2009
6. Anand Ramanathan, Babu Dharmalingam, Vinoth Thangarasu, “Advances in Clean Energy Production and Application”, Taylor & Francis, CRC Press, 2020
7. Anand Ramanathan, Meera Begum, Amaro Pereira, Claude Cohen, “A Thermo-economic Approach to Energy from Waste”, Elsevier, 2021.

Alternative Sources of Energy

Course Code: MECOEI614 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Identify renewable energy sources and their utilization.
CO-2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilisation.
CO-3	Understand working of solar cells and its modern manufacturing technologies.
CO-4	Understand concepts of Fuel cells and their applications
CO-5	Identify methods of energy storage.
CO-6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Course Contents:

UNIT I:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

UNIT II:

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems

UNIT III:

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems

UNIT IV:

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

UNIT V:

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Text Books:

1. Sukhatme S.P. and J.K.Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Processes, John Wiley, 2001.

Other Suggested Readings:

1. NPTEL Courses

MIT Open Course Ware, etc.

3D Printing

Course Code: MECOEI615 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Develop preprocess data for the 3D Printing
CO-2	Identify properties of 3DP materials and their influence on final part quality
CO-3	Describe the working principles of each 3D Printing technology
CO-4	Apply suitable 3D Printing technology for any given industrial application
CO-5	Select the postprocessing and testing method for the given application
CO-6	Develop preprocess data for the 3D Printing

Course Contents:

UNIT I

Computer Aided Design (CAD) and Preprocessing Data for 3D Printing: Introduction to Geometric Modelling of Curves, Parametric Representation of Freeform Surfaces and Solids. CAD Data Exchange Formats, Input File Sources and Characteristics, 3D Printing Data File Formats and Software, STL File

Errors and Manipulation, 3D Printing Process Chain, Part Orientation and Support Generation, Model Slicing and Contour Data Organisation, Hatching Strategies, 3D Printing Toolpaths Generation and Process Plan, Build Preparation and 3D Printing Process Simulation.

UNIT II

3D Printing Materials and Characterisation: Nature of Thermoplastics and Thermosetting Polymers, Properties of Metal and Ceramics. *3DP Liquid Materials:* Rheology and Wetting Behaviour. *3DP Solid*

Materials: Filament Diameter Consistency, Density, Porosity, Moisture Content, Thermal Properties,

Microstructure of Composite Filament, Mechanical Properties of Filament. *3DP Powder Materials:* Powder Size Measurements, Morphology, Chemical Composition, Flow Characteristics, Density, Energy Absorption Characteristics of Powder.

UNIT III

3D Printing Processes: Classification of 3D Printing Processes. Description, Process Parameters, Material Selection and Characterisation, Applications, Strengths and Weaknesses of Vat Photopolymerization,

Material Jetting, Binder Jetting, Material Extrusion, Sheet Lamination, Powder Bed Fusion and Directed Energy Deposition Processes; *Other Processes:* Aerosol Printing and Bio-plotter. *Construction of DIY Printers:* Motion System, Frame/Chassis, Print Bed, Extruder, Electronics.

UNIT IV

3D Printing Applications: An Overview of 3D Printing Applications, *Aerospace:* Aerospace Materials and their Requirements, Qualification and Certification of Parts, Aerospace Case Studies. *Medical:* Medical Scanning Technologies, Biomaterials, Planning and Simulation of Complex Surgeries, Design and Fabrication of Customized Implants, Medical Case Studies. *Automobile:* Prototyping, Jigs and Fixtures, Components of Electric Vehicles, Formula 1, Cooling Ducts, Intake Manifolds, Automobile Case Studies. *Other Applications of 3DP:* Marine, Railway, Oil and Gas, Construction, Retail Industry, Arts and Architecture, Fashion and Textile, Jewellery, Cion and Tableware, Weapons, Food, Packaging, and Toy Industry.

UNIT V

Postprocessing and Testing of 3DP Parts: Need for Postprocessing in 3DP, *Surface Treatment Methods:* Subtractive Machining Methods, Thermal-based Methods, Abrasive-based Methods, Chemical Methods. *Surface Protection, Functionalization, and Decorative Methods.* Heat Treatment and Aging. Establish a

Relationship between Processing Parameters, Resulting Microstructure, Mechanical Properties, Fatigue,

Creep and Corrosion Resistance of 3DP Parts. *Testing of 3DP Parts:* Metrology Measurement Methods, Porosity and Density, Dimensions, Mechanical Measurement Methods, NDT Methods of 3DP Parts, 3DP Safety, 3DP Standards.

Text Books:

1. David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TataMcGrawHill, 2008.
2. DamirGodec, Joamin Gonzalez-Gutierrez, Axel Nordin, Eujin Pei, Julia Urena Alcazar, A Guide to Additive Manufacturing, Springer, 2022.
3. Ian Gibson, David Rosen, Brent Stucker, and Mahyar Khorasani, Additive Manufacturing Technologies, 3rd Edition, Springer, 2021.
4. Diegel, Olaf, Axel Nordin, and Damien Motte, A Practical Guide to Design for Additive Manufacturing, Springer, 2020.
5. Zafar Alam Faiz Iqbal, Dilshad Ahmad Khan, Post-processing Techniques for Additive Manufacturing, CRC Press, 2024.

Reference Books:

1. Michael E.Mortenson, Geometric Modeling, McGrawHill, 2013.

2. Patri K. Venuvinod and Weiyin Ma, Rapid Prototyping: Laser-based and Other Technologies, Springer, 2004.
3. Sanjay Joshi, Richard P. Martukanitz, Abdalla R. Nassar, Pan Michaleris, Additive Manufacturing with Metals: Design, Processes, Materials, Quality Assurance, and Applications, Springer, 2023.
4. L.Lu, J. Y. H. Fuh and Y.S.Wong, Laser-Induced Materials and Processes for Rapid Prototyping, Springer, 2001.
5. Chua Chee Kai, Leong Kah Fai, Rapid Prototyping: 3D Printing and Additive Manufacturing Principles & Applications, World Scientific, 5th Edition, 2019.
6. Gurminder Singh, Ranvijay Kumar, Kamalpreet Sandhu, Eujin Pei, and Sunpreet Singh, Handbook of Post-Processing in Additive Manufacturing: Requirements, Theories, and Methods, CRC Press, 2024.

Industrial Management

Course Code: MECOEI616 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO-1	Understand the evolutionary development of management thought and general principles of management
CO-2	Apply marketing concepts and tools for successful launch of a product
CO-3	Understand the role of productivity in streamlining a production system
CO-4	Apply the inventory management tools in managing inventory
CO-5	Apply quality engineering tools to the design of the products and process controls
CO-6	Apply project management tools to manage projects

Course Contents:

UNIT I:

General Management: Evolution of industry and professional management; functions of management; design of an organization structure, Hawthorn experiments, primary groups and informal organizational structures, leadership styles and characteristics of effective leadership, Mc Gregor's Theory X and Theory Y, Maslow's and Hertzberg's motivational theories, Japanese Management.

UNIT II:

Marketing Management: Marketing management process and the four Ps of marketing mix; market segmentation, targeting and positioning; product life cycle and marketing strategies in different stages of product life cycle.

UNIT III:

Productivity and Work Study: Productivity definition, its role in the economy, techniques for improving productivity, method study procedure, flow process chart and flow diagram, two handed process chart, principles of motion economy, work sampling, stop watch time study.

UNIT IV:

Quality Management: control charts - and R, p & c charts, Sampling plan –design of single sampling plan using OC curve, rectifying inspection and AOQL; Taguchi's method of total quality control, Quality function deployment, Introduction to TQM

UNIT V:

Inventory Management: Purposes of inventories, inventory costs, ABC classification, EOQ,P and Q systems of inventory control.

Project Management: Network diagrams, critical path method, total slack and free slack, crashing of activities and resource levelling, PERT.

Text Books:

1. Donald J clough. "Concepts in Management science", Prentice Hall of India.
2. Philip Kotler, "Marketing Management", Prentice Hall of India, New Delhi, 2020.
3. Koontz, H. et. al., "Essentials of Management" - Mc Graw Hill Book Co., New York, 2019.
4. Chase and Aquilano - Operations Management -Mc Graw Hill Pub. Books Co. New York, 2019.

Project Management

Course Code: MECOEI617 **L:3 T:0 P:0**

Rationale:

Course Outcomes:

CO1	Understand the importance of projects and its phases
CO2	Analyze projects from marketing, operational and financial perspectives
CO3	Evaluate projects based on discount and non-discount methods.
CO4	Develop network diagrams for planning and execution of a given project.
CO5	Apply crashing procedures for time and cost optimization

Course Contents:

UNIT I: Introduction

Introduction to Project Management, History of Project Management, Project Life Cycle.

UNIT II: Project Analysis

Facets of Project Analysis, Strategy and Resource Allocation, Market and Demand Analysis, Technical Analysis, Economic and Ecological Analysis.

UNIT III: Financial Analysis

Financial Estimates and Projections, Investment Criteria, Financing of Projects.

UNIT IV: Network Methods & Optimization in PM

Origin of Network Techniques, AON and AOA differentiation, CPM network, PERT network, other network models.Time and Cost trade-off in CPM, Crashing procedure, Scheduling when resources are limited.

UNIT V: Project Risk Management

Scope Management, Work Breakdown Structure, Earned Value Management, Project Risk Management.

Text Books:

1. Prasanna Chandra, Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, McGraw Hill Education, 9th Edition, 2019.
2. David I. Cleland and Lewis R. Ireland, Project Management: Strategic Design and Implementation, McGraw-Hill, 5th Edition, 2006.
3. Jack R. Meredith and Samuel J. Mantel, Jr., Project Management: A Managerial Approach, John Wiley & Sons, 10th Edition, 2017.

Reference Books:

1. Eliyahu M. Goldratt, The Critical Chain, North River Press, 2017.
2. Project Management Institute, A Guide to the Project Management Body of Knowledge, Seventh Edition,