



APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

(A State Government University)

B. Tech- 2024

**FIRST YEAR SYLLABUS
(GROUP C)**



SEMESTER 1

GROUP C

SEMESTER S1
MATHEMATICS FOR ELECTRICAL SCIENCE AND
PHYSICAL SCIENCE - 1

(Groups B & C)

Course Code	GYMAT101	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic knowledge in single variable calculus and matrix operations.	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding and basic techniques of matrix theory to analyze linear systems.
2. To offer advanced knowledge and practical skills in solving second-order ordinary differential equations, applying Laplace transforms, and understanding Fourier series, enabling students to analyze and model dynamic systems encountered in engineering disciplines effectively.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Linear systems of equations: Gauss elimination, Row echelon form, Linear Independence: rank of a matrix, Solutions of linear systems: Existence, Uniqueness (without proof), The matrix Eigen Value Problem, Determining Eigen values and Eigen vector, Diagonalization of matrices. (Text 1: Relevant topics from sections 7.3, 7.4, 7.5, 8.1, 8.4)	9

2	Homogeneous linear ODEs of second order, Superposition principle, General solution, Homogeneous linear ODEs of second order with constant coefficients (Method to find general solution, solution of linear Initial Value Problem). Non homogenous ODEs (with constant coefficients) - General solution, Particular solution by the method of undetermined coefficients (Particular solutions for the functions $ke^{\gamma x}$, kx^n, $k\cos\omega x$, $k\sin\omega x$, $ke^{\alpha x}\cos\omega x$, $ke^{\alpha x}\sin\omega x$), Initial value Problem for Non-Homogeneous Second order linear ODE(with constant coefficients), Solution by variation of parameters (Second Order). (Text 1: Relevant topics from sections 2.1, 2.2, 2.7, 2.10)	9
3	Laplace Transform, Inverse Laplace Transform, Linearity property, First shifting theorem, Transform of derivatives, Solution of Initial value problems by Laplace transform (Second order linear ODE with constant coefficients with initial conditions at $t=0$ only), Unit step function, Second shifting theorem, Dirac delta function and its transform (Initial value problems involving unit step function and Dirac delta function are excluded), Convolution theorem (without proof) and its application to finding inverse Laplace transform of products of functions. (Text 1: Relevant topics from sections 6.1, 6.2, 6.3, 6.4, 6.5)	9
4	Taylor series representation (without proof, assuming the possibility of power series expansion in appropriate domains), Maclaurin series representation, Fourier series, Euler formulas, Convergence of Fourier series (Dirichlet's conditions), Fourier series of 2π periodic functions, Fourier series of $2l$ periodic functions, Half range sine series expansion, Half range cosine series expansion. (Text 1: Relevant topics from sections 11.1, 11.2, Text 2: Relevant topics from section 10.8)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Solve systems of linear equations and diagonalize matrices.	K3
CO2	Solve homogeneous and non-homogeneous linear differential equation with constant coefficients.	K3
CO3	Compute Laplace transform and apply it to solve ODEs arising in engineering.	K3
CO4	Determine the Taylor series and evaluate Fourier series expansion for different periodic functions.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	-	-	-	-	-	-	2
CO2	3	3	-	2	-	-	-	-	-	-	-	2
CO3	3	3	-	2	-	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10 th edition, 2016
2	Calculus	H.Anton, I.Biven, S.Davis	Wiley	12 th edition, 2024

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Thomas' Calculus	Maurice D. Weir, Joel Hass, Christopher Heil, Przemyslaw Bogacki	Pearson	15 th edition, 2023
2	Essential Calculus	J. Stewart	Cengage	2 nd edition, 2017
3	Elementary Linear Algebra	Howard Anton, ChrisRorres	Wiley	11 th edition, 2019
4	Bird's Higher Engineering Mathematics	John Bird	Taylor & Francis	9 th edition, 2021
5	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39 th edition, 2023
6	Calculus	H. Anton, I. Biven, S.Davis	Wiley	12 th edition, 2024
7	Signals and Systems	Simon Haykin, Barry Van Veen	Wiley	2 nd edition, 2002

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/111/107/111107164/
2	https://archive.nptel.ac.in/courses/111/104/111104031/
3	https://archive.nptel.ac.in/courses/111/106/111106139/
4	https://archive.nptel.ac.in/courses/111/101/111101164/

SEMESTER S1/S2
PHYSICS FOR PHYSICAL SCIENCE AND LIFE SCIENCE
(Groups C & D)

Course Code	GZPHT121	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:2:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory + Lab

Course Objectives:

1. To provide students with a solid background in the fundamentals of Physics and impart this knowledge in Physical Science and Life Science disciplines.
2. To develop scientific attitudes and enable students to correlate Physics concepts with their core programs.
3. To equip students with practical knowledge that complements their theoretical studies and develop their ability to create practical applications and solutions in engineering based on their understanding of Physics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Laser & Fibre Optics Optical processes – Absorption-Spontaneous emission and stimulated emission, Principle of laser - conditions for sustained lasing – Population inversion- Pumping- Metastable states, Basic components of laser - Active medium - Optical resonant cavity, Construction and working of Ruby laser and CO2 laser, Construction and working Semiconductor laser (qualitative), Properties of laser, Applications of laser. Optic fibre-Principle of propagation of light, Types of fibres-Step index and Graded index fibres - Multimode and single mode fibers, Acceptance angle, Numerical aperture –Derivation, Applications of optical fibres - Fibre optic communication system (block diagram)	9
2	Interference and Diffraction Introduction, Principle of super position, Constructive and destructive interference, Optical path, Phase difference and path difference, Cosine law- reflected system- Condition for constructive and destructive interference, Colours in thin films, Newton's Rings-Determination of refractive index of transparent liquids and wavelength, Air wedge- Measurement of thickness of thin sheets. Diffraction-types of diffraction, Diffraction due to a single slit, Diffraction grating – Construction - grating equation, Dispersive and Resolving Power (qualitative).	9

3	Quantum Mechanics Introduction, Concept of uncertainty and conjugate observables (qualitative), Uncertainty principle (statement only), Application of uncertainty principle- Absence of electron inside nucleus - Natural line broadening, Wave function – properties - physical interpretation, Formulation of time dependent and time independent Schrodinger equations, Particle in a one- dimensional box - Derivation of energy eigen values and normalized wave function, Quantum Mechanical Tunnelling (qualitative)	9
4	Waves & Acoustics Waves- transverse and longitudinal waves, Concept of frequency, wavelength and time period (no derivation), Transverse vibrations in a stretched string- derivation of velocity and frequency - laws of transverse vibration. Acoustics- Reverberation and echo, Reverberation time and its significance - Sabine's Formula, Factors affecting acoustics of a building. Ultrasonics-Piezoelectric oscillator, Ultrasonic diffractometer, SONAR, NDT-Pulse echo method, medical application-Ultrasound scanning (qualitative)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Continuous Assessment	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Internal Examination- 3 (Lab Examination)	Total
5	10	10	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the basic principles and properties of laser and optic fibers.	K2
CO2	Describe the phenomena of interference and diffraction of light.	K2
CO3	Describe the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics.	K2
CO4	Apply the knowledge of waves and acoustics in non-destructive testing and in acoustic design of buildings.	K3
CO5	Apply basic knowledge of principles and theories in physics to conduct experiments.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3											3
CO3	3											3
CO4	3	3										3
CO5	3	3			3				2			3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Textbook of Engineering Physics	M N Avadhanulu, P G Kshirsagar & TVS Arun Murthy	S Chand & Co.	2 nd Edition, 2019
2	Engineering Physics	H K Malik , A.K. Singh,	McGraw Hill Education	2 nd Edition, 2017
3	Optics	Ajoy Ghatak	Mc Graw Hill Education	6 th Edition, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Physics	G Vijayakumari	Vikas Publications	8 th Edition, 2014
2	Concepts of Modern Physics	Arthur Beiser	Tata McGraw Hill Publications	6 th Edition 2003
3	Engineering Physics	Aruldas G.	PHI Pvt. Ltd	2 nd Edition, 2015
4	Fiber Optic Communications	Gerd Keiser	Springer	2021
5	A Text Book of Engineering physics	I. Dominic, A. Nahari	OWL Publications	2 nd Edition, 2016
6	Advanced Engineering Physics	Premlet B	Phasor Books	
7	Engineering Physics	Rakesh Dogra	Katson Books	1 st Edition, 2019

Video Links (NPTEL, SWAYAM...)	
Module No	Link ID
1	https://nptel.ac.in/courses/115102124 https://nptel.ac.in/courses/104104085
2	https://nptel.ac.in/courses/115105537
3	https://nptel.ac.in/courses/115102023 https://nptel.ac.in/courses/115101107
4	https://nptel.ac.in/courses/112104212 https://nptel.ac.in/courses/124105004

1. Continuous Assessment (10 Marks)

i. Preparation and Pre-Lab Work (2 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

ii. Conduct of Experiments (2 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

iii. Lab Reports and Record Keeping (3 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

iv. Viva Voce (3 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

2. Evaluation Pattern for Lab Examination (5 Marks)

1. Procedure/Preliminary Work/Conduct of Experiments (2 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Setup and Execution: Proper setup and accurate execution of the experiment or programming task

2. Result (2 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.

3. Viva Voce (1 Marks)

- Proficiency in answering questions related to theoretical and practical aspects of the subject.

Experiment List

Experiment No.	Experiments (Minimum 10 Experiments)
1	Optical fiber characteristics- Measurement of Numerical aperture.
2	Determination of wavelength of Laser using diffraction grating.
3	Measure the wavelength of Laser using a millimetre scale as a grating.
4	Determination of wavelength of a monochromatic light using Newton's Rings method.
5	Determination of diameter of wire or thickness of thin sheet using Air wedge method.
6	Determination of slit width (diffraction due to a single slit).
7	Measure wavelength of light source using diffraction grating.
8	Determination of resolving power and dispersive power of grating.
9	Characteristics of LED.
10	CRO basics-Measurement of frequency and amplitude of wave forms.
11	Solar Cell- I V and Intensity Characteristics.
12	Melde's experiment- Frequency calculation in Transverse and Longitudinal Mode.
13	LCR circuit –forced and damped harmonic oscillations.
14	Determination of wavelength and velocity of ultrasonic waves using ultrasonic diffractometer.
15	Determination of particle size of lycopodium powder.

SEMESTER S1/S2

CHEMISTRY FOR PHYSICAL SCIENCE

(Group C)

Course Code	GCCYT122	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:2:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory+ Lab

Course Objectives:

1. To equip students with a thorough understanding of chemistry concepts relevant to engineering applications.
2. To familiarize students with applied topics such as spectroscopy, electrochemistry, and instrumental methods.
3. To raise awareness among students about environmental issues, including climate change, pollution, and waste management, and their impact on quality of life.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Engineering Materials Fuels: Calorific value – HCV and LCV – Experimental determination of calorific value of solid fuels. Analysis of coal – Proximate analysis- Octane & Cetane Number. Biofuels- Biodiesel-Green Hydrogen. Lubricants: Classification - Solid, Semisolid and Liquid lubricants. Properties of lubricants - Viscosity Index, Flash point, Fire point, Cloud Point, Pour Point & Aniline Point. Cement: Manufacture of Portland cement – Theory of setting and hardening of cement. Nanomaterials: Classification based on Dimension & Materials- Synthesis – Sol gel & Chemical Reduction - Applications of nanomaterials – Supercapacitor Materials - Carbon Nanotubes, Fullerenes & Graphene – structure, properties & application. Polymers: ABS & Kevlar - Synthesis, properties and applications. Conducting Polymers- Classification – Application.	9
2	Electrochemistry and Corrosion Science Electrochemical Cell- Electrode potential- Nernst equation for single electrode and cell (Numerical problems)- Reference electrodes – SHE & Calomel electrode – Construction and Working - Electrochemical series - Applications – Glass Electrode & pH Measurement- Conductivity- Measurement using Digital conductivity meter. Li-ion battery & H₂-O₂ fuel cell (acid electrolyte only) construction and working. Corrosion – Electrochemical corrosion mechanism (acidic & alkaline medium). - Galvanic series - Corrosion control methods - Cathodic Protection - Sacrificial anodic protection and impressed current cathodic protection – Electroplating of copper - Electroless plating of Copper	9

3	Instrumental Methods of Analysis Molecular Spectroscopy: Types of spectra- Molecular energy levels - BeerLambert's law – Numerical problems - Electronic Spectroscopy – Principle, Types of electronic transitions –Role of Conjugation in absorption maxima - Instrumentation-Applications – Vibrational spectroscopy – Principle-Number of vibrational modes - Vibrational modes of CO₂ and H₂O –Applications Thermal analysis: –TGA- Principle, instrumentation (block diagram) and applications – TGA of CaC₂O₄.H₂O and polymers. DTA- Principle, instrumentation (block diagram) and applications - DTA of CaC₂O₄.H₂O. Chromatography-Gas Chromatography-Principle-Instrumentation- Application – Analysis of chemical composition of exhaust gases. Electron Microscopic Techniques: SEM - Principle, instrumentation and Applications.	9
4	Environmental Chemistry Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Degree of hardness (Numericals) Water softening methods-Ion exchange process- Principle, procedure and advantages. Reverse osmosis – principle, process and advantages. – Water disinfection methods – chlorination- Break point chlorination, ozone and UV irradiation. Dissolved oxygen (DO), BOD and COD- Definition & Significance Waste Management: Air Pollution- Sources & Effects- Greenhouse Gases- Ozone depletion. Control methods. Sewage water treatment- Primary, Secondary and Tertiary - Flow diagram -Trickling filter and UASB process. Solid waste-disposal methods- Composting, Landfill & Incineration.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Continuous Assessment	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Internal Examination- 3 (Lab Examination)	Total
5	10	10	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the use of various engineering materials in different industries.	K2
CO2	Explain the Basic Concepts of Electrochemistry and Corrosion to Explore the Possible Applications in Various Engineering Fields.	K2
CO3	Use appropriate analytical techniques for different engineering materials	K3
CO4	Outline various water treatment and waste management methods	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										2
CO2	3	3										2
CO3	3	3										2
CO4	3	3				2	3					2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Chemistry	B. L. Tembe, Kamaluddin, M. S. Krishnan	NPTEL Web-book	2018
2	Physical Chemistry	P. W. Atkins	Oxford University Press	International Edition- 2018
3	Instrumental Methods of Analysis	H. H. Willard, L. L. Merritt	CBS Publishers	7th Edition- 2005
4	Engineering Chemistry	Jain & Jain	Dhanpath Rai Publishing Company	17 th Edition - 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Molecular Spectroscopy	C. N. Banwell	McGraw-Hill	4 th edn., 1995
2	Principles of Physical Chemistry	B. R. Puri, L. R. Sharma, M. S. Pathania	Vishal Publishing Co	47th Edition, 2017
3	Introduction to Spectroscopy	Donald L. Pavia	Cengage Learning India Pvt. Ltd	2015
4	Polymer Chemistry: An Introduction	Raymond B. Seymour, Charles E. Carraher	Marcel Dekker Inc	4th Revised Edition, 1996
5	The Chemistry of Nanomaterials: Synthesis, Properties and Applications	Prof. Dr. C. N. R. Rao, Prof. Dr. h.c. mult. Achim Müller, Prof. Dr. A. K. Cheetham	Wiley-VCH Verlag GmbH & Co. KGaA	2014
6	Organic Electronics Materials and Devices	Shuichiro Ogawa	Springer Tokyo	2024
7	Principles and Applications of Thermal Analysis	Gabbot, P	Oxford: Blackwell Publishing	2008

Video Links (NPTEL, SWAYAM...)	
Sl No.	Link ID
1	https://archive.nptel.ac.in/courses/104/106/104106137/ https://archive.nptel.ac.in/courses/113/105/113105102/ https://archive.nptel.ac.in/courses/113/104/113104082/ https://www.youtube.com/watch?v=BeSxFLvk1h0
2	https://archive.nptel.ac.in/courses/113/104/113104102/ https://archive.nptel.ac.in/courses/104/105/104105124/ https://archive.nptel.ac.in/courses/105/104/105104157/

Continuous Assessment (10 Marks)

Continuous assessment evaluations are conducted based on laboratory associated with the theory.

Mark distribution

1. Preparation and Pre-Lab Work (2 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (2 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (3 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

2. Viva Voce (3 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for Lab Examination (5 Marks)

1. Procedure/Preliminary Work/Conduct of Experiments (2 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

2. Result (2 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.

3. Viva Voce (1 Marks)

- Proficiency in answering questions related to theoretical and practical aspects of the subject.

List of Experiments

***Minimum 10 Experiments**

Expt. Nos.	Experiment
1	Estimation of iron in iron ore
2	Estimation of copper in brass
3	Determination of cell constant and conductance of solutions
4	Calibration of pH meter and determination of pH of a solution
5	Synthesis of polymers (a) Urea-formaldehyde resin (b) Phenol-formaldehyde resin
6	Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} in solution
7	Determination of molar absorptivity of a compound (KMnO_4 or any water-soluble food colorant)
8	Analysis of IR spectra
9	Identification of drugs using TLC
10	Estimation of total hardness of water-EDTA method
11	Estimation of dissolved oxygen by Winkler's method
12	Determination of calorific value using Bomb calorimeter
13	Determination of saponification value of a given vegetable oil
14	Determination of acid value of a given vegetable oil
15	Verification of Nernst equation for electrochemical cell.

SEMESTER S1

ENGINEERING MECHANICS

Course Code	GCEST103	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. The course aims to enable students to analyse and solve fundamental mechanics problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to statics: introduction to branches of mechanics, concept of rigid body scalars and vectors, vector operations, forces in space. Support reactions of beams (point load and UDL only) Force systems: rectangular components in 2D and 3D, moment and couple, resultants Equilibrium: system isolation and the free-body diagram, equilibrium conditions 2D and 3D	10
2	Friction: -laws of friction – analysis of blocks and ladder Centroid of composite areas- – moment of inertia- parallel axis and perpendicular axis theorems. Polar moment of inertia, radius of gyration, mass moment of inertia-ring and disc	10
3	Dynamics – rectilinear translation - equations of motion in kinematics and kinetics – D'Alembert's principle. –motion on horizontal and inclined surfaces, motion of connected bodies	8
4	Curvilinear translation - equations of kinematics projectile motion (solution starting from differential equations) Rotation – kinematics of rotation- equation of motion for a rigid body rotating about a fixed axis –rotation under a constant moment	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination- 1(Written)	Internal Examination- 2 (Written)	Total
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End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the vector representation of forces and moments	K2
CO2	Identify and describe the components of system of forces acting on the rigid body	K3
CO3	Apply the conditions of equilibrium to different force system.	K3
CO4	Identify appropriate principles to solve problems of mechanics.	K3
CO5	Develop the understanding of fundamental principles of rigid body dynamics	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2	3	3										
CO3	3	3										
CO4	3	3										
CO5	3	2										

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Mechanics	Timoshenko and Young	McGraw Hill Publishers	5 th Edition 2017
2	Engineering Mechanics: Combined Statics and Dynamics	Russell C. Hibbeler	Pearson Education,	14 th Edition 2015
3	Engineering Mechanics - Statics and Dynamics,	Shames, I. H.	Prentice Hall of India.	4 th Edition 2008
4	Textbook of Engineering Mechanics	R. K. Bansal	Laxmi publications pvt ltd.	4 th Edition 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Mechanics Statics	J. L. Meriam, L. G.	Wiley	9 th Edition 2020
2	Engineering Mechanics	Kraige	PHI Learning	2011

Video Links (NPTEL, SWAYAM...)	
	Link ID
1	https://nptel.ac.in/courses/112106286

SEMESTER S1

INTRODUCTION TO MECHANICAL ENGINEERING & CIVIL ENGINEERING

Course Code	GCEST104	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	4-0-0-0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand thermodynamic cycles and working of IC engines.
2. Understand the refrigeration cycles and psychrometric concepts.
3. Understand the relevance of civil engineering and its various disciplines.
4. Describe the relevance of various building codes and types of buildings as per NBC.
5. Understand different building components and building materials.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	General introduction to Mechanical Engineering: Thermodynamic cycles -Carnot Cycle -Derivation of efficiency (problems on efficiency) Otto, Diesel cycles (no derivation of efficiency and problems). IC Engines: CI & SI Engines, working of 2-Stroke & 4-Stroke engines. Listing the parts of IC Engines. Concept of CRDI, MPFI and hybrid engines. Refrigeration: Unit of refrigeration, reversed Carnot cycle, COP, vapour compression cycle (only description and no problems); Definitions of dry, wet & dew point temperatures, specific humidity and relative humidity, Psychrometric chart, Cooling and dehumidification, Layout of central air conditioning systems.	9

2	Classification of pumps, Description about working with sketches of: Reciprocating pump, Centrifugal pump. Classification of Hydraulic Turbines. Different type of gears and its applications (spur, helical, bevel, worm and worm wheel), List types of clutches and their use, Bearings and their classification (Journal bearing and ball bearing) Manufacturing Process: Sand Casting, Forging, Rolling, Extrusion. Metal Joining Processes: List types of welding, Description with sketches of Arc Welding, SMAW, Soldering and Brazing and their applications. Machining processes: Description and operations performed on Lathe, Drilling machine, Milling machine, CNC machine, 3D printing.	9
3	General Introduction to Civil Engineering: Relevance of Civil Engineering in the overall infrastructural development of the country. Brief introduction to major disciplines of Civil Engineering like Structural Engineering, Geo-technical Engineering, Transportation Engineering, Water Resources Engineering and Environmental Engineering. Introduction to buildings: Types of buildings according to character of occupancy as per NBC, Load bearing and non-load bearing building structures, components of a residential building and their functions (conceptonly). Selection of site for a residential building. Building Area Definitions: Built up area, Plinth area, Floor area, Carpet area and Floor area ratio of a building as per KBR. Building rules and regulations: Relevance of NBC, KBR & CRZ norms (brief discussion of relevance only).	9
4	Conventional construction materials: Brick, stone, sand, cement and timber- Classifications, Qualities, Tests and Uses of construction materials. Cement concrete: Constituent materials, properties and types.	9

	Tests on fresh and hardened concrete - slump test, cube compressivestrength as per IS Codes. Steel: Structural steel sections and steel reinforcements – types and uses. Soil- Origin of soil-weathering of rocks, types of weathering	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the relevance of mechanical engineering and its various disciplines.	K2
CO2	Learn the applications of thermodynamics through IC engines and refrigeration systems.	K2
CO3	Understand the various manufacturing processes adapted by mechanical engineers.	K2
CO4	Understand the relevance of civil engineering and its various disciplines.	K2
CO5	Describe the relevance of various building codes and types of buildings as per NBC	K2
CO6	Understand different building components and building materials.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3											
CO3	3											2
CO4	3											
CO5	3							2				2
CO6	3											2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Basic Mechanical Engineering	Pravin Kumar	Pearson Education	1 st Edition, 2013
2	A Textbook of Basic Mechanical Engineering	R.K. Rajput	Laxmi Publications	3 rd Edition, 2017
3	Elements of Mechanical Engineering	K.P. Roy, S.K. Hajra Choudhury, A.K. Hajra Choudhury	Media Promoters & Publishers Pvt. Ltd.	Revised Edition, 2012
4	Fundamentals of Mechanical Engineering	G.S. Sawhney	PHI Learning Pvt. Ltd.	1 st Edition, 2013
5	Essentials of Civil Engineering	Dalal K R	Charotar Publishing house	1 st Edition 2012
6	Engineering Materials (Material Science)	Rangwala S C	Charotar Publishing House Pvt Limited	43 rd Edition 2019
7	Building Materials	Duggal S K	New Age International	5 th Edition 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives	Chris Mi and M. Abul Masrur	John Wiley & Sons	2nd Edition, 2017
2	Automotive Engineering Fundamentals	Richard Stone and Jeffrey K. Ball	SAE International	1 st Edition, 2004
3	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing	Ian Gibson, David W. Rosen, and Brent Stucker	Springer	2 nd Edition, 2015
4	Heating, Ventilating, and Air Conditioning Analysis and Design	Faye C. McQuiston, Jerald D. Parker, and Jeffrey D. Spitler	John Wiley & Sons	6 th Edition, 2005
5	Materials for Civil and Construction Engineering	Mamlouk, M.S., and Zaniewski, J.P	Pearson Publishers	4 th Edition, 2017
6	Building Construction	Rangwala, S.C and Dalal, KB	Charotar Publishing house	34 th Edition 2022
7	Construction Technology Vol.I to IV	Chudley, R	Longman group, England Course Plan	2 nd Edition 2014
8	Building Construction Volumes 1 to 4	Mckay, W.B. and Mckay, J.K	Pearson India Education Services	5 th Edition
9	Engineering Geology	Duggal S. K., Pandey H.K. and Rawat N,	Mcgraw Hill Education, New Delhi	1 st Edition 2017
10	Latest Building codes and related rules and regulations.			

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/112/105/112105123/ https://nptel.ac.in/courses/112/106/112106133/ https://nptel.ac.in/courses/112/105/112105129/
2	https://nptel.ac.in/courses/112/105/112105171/ https://nptel.ac.in/courses/112/105/112105268/ https://archive.nptel.ac.in/courses/112/107/112107145
3	https://archive.nptel.ac.in/courses/105/106/105106201/
4	https://archive.nptel.ac.in/courses/105/106/105106206/

SEMESTER S1
ALGORITHMIC THINKING WITH PYTHON
(Common to All Branches)

Course Code	UCEST105	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:2:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with a thorough understanding of algorithmic thinking and its practical applications in solving real-world problems.
2. To explore various algorithmic paradigms, including brute force, divide-and-conquer, dynamic programming, and heuristics, in addressing and solving complex problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	PROBLEM-SOLVING STRATEGIES:- Problem-solving strategies defined, Importance of understanding multiple problem-solving strategies, Trial and Error, Heuristics, Means-Ends Analysis, and Backtracking (Working backward). THE PROBLEM-SOLVING PROCESS:- Computer as a model of computation, Understanding the problem, Formulating a model, Developing an algorithm, Writing the program, Testing the program, and Evaluating the solution. ESSENTIALS OF PYTHON PROGRAMMING:- Creating and using variables in Python, Numeric and String data types in Python, Using the math module, Using the Python Standard Library for handling basic I/O - print, input, Python operators and their precedence.	7

2	ALGORITHM AND PSEUDOCODE REPRESENTATION:- Meaning and Definition of Pseudocode, Reasons for using pseudocode, The main constructs of pseudocode - Sequencing, selection (if-else structure, case structure) and repetition (for, while, repeat-until loops), Sample problems * FLOWCHARTS** :- Symbols used in creating a Flowchart - start and end, arithmetic calculations, input/output operation, decision (selection), module name (call), for loop (Hexagon), flow-lines, on-page connector, off-page connector. <i>* - Evaluate an expression, $d=a+b*c$, find simple interest, determine the larger of two numbers, determine the smallest of three numbers, determine the grade earned by a student based on KTU grade scale (using if-else and case structures), print the numbers from 1 to 50 in descending order, find the sum of n numbers input by the user (using all the three loop variants), factorial of a number, largest of n numbers (Not to be limited to these exercises. More can be worked out if time permits).</i> <i>** Only for visualizing the control flow of Algorithms. The use of tools like RAPTOR (https://raptor.martincarlisle.com/) is suggested. Flowcharts for the sample problems listed earlier may be discussed</i>	9
3	SELECTION AND ITERATION USING PYTHON:- if-else, elif, for loop, range, while loop. Sequence data types in Python - list, tuple, set, strings, dictionary, Creating and using Arrays in Python (using <i>Numpy</i> library). DECOMPOSITION AND MODULARIZATION* :- Problem decomposition as a strategy for solving complex problems, Modularization, Motivation for modularization, Defining and using functions in Python, Functions with multiple return values RECURSION:- Recursion Defined, Reasons for using Recursion, The Call Stack, Recursion and the Stack, Avoiding Circularity in Recursion, <i>Sample problems - Finding the nth Fibonacci number, greatest common divisor of two positive integers, the factorial of a positive integer, adding two positive integers, the sum of digits of a positive number **.</i>	10

	<i>* The idea should be introduced and demonstrated using Merge sort, the problem of returning the top three integers from a list of $n \geq 3$ integers as examples. (Not to be limited to these two exercises. More can be worked out if time permits).</i> ** Not to be limited to these exercises. More can be worked out if time permits.	
4	COMPUTATIONAL APPROACHES TO PROBLEM-SOLVING (Introductory diagrammatic/algorithmic explanations only. Analysis not required) :- Brute-force Approach - - Example: Padlock, Password guessing Divide-and-conquer Approach - - Example: The Merge Sort Algorithm - Advantages of Divide and Conquer Approach - Disadvantages of Divide and Conquer Approach Dynamic Programming Approach - Example: Fibonacci series - Recursion vs Dynamic Programming Greedy Algorithm Approach - Example: Given an array of positive integers each indicating the completion time for a task, find the maximum number of tasks that can be completed in the limited amount of time that you have. - Motivations for the Greedy Approach - Characteristics of the Greedy Algorithm - Greedy Algorithms vs Dynamic Programming Randomized Approach - Example 1: A company selling jeans gives a coupon for each pair of jeans. There are n different coupons. Collecting n different coupons would give you free jeans. How many jeans do you expect to buy before getting a free one? - Example 2: n people go to a party and drop off their hats to a hat-check person. When the party is over, a different hat-check person is on duty and returns the n hats randomly back to each person. What is the expected number of people who get back their hats - Motivations for the Randomized Approach	10

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Continuous Assessment (Accurate Execution of Programming Tasks)	Internal Examination-1 (Written Examination)	Internal Examination-2 (Written Examination)	Internal Examination- 3 (Lab Examination)	Total
5	5	10	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Utilize computing as a model for solving real-world problems.	K2
CO2	Articulate a problem before attempting to solve it and prepare a clear and accurate model to represent the problem.	K3
CO3	Use effective algorithms to solve the formulated models and translate algorithms into executable programs.	K3
CO4	Interpret the problem-solving strategies, a systematic approach to solving computational problems, and essential Python programming skills	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Problem solving & programming concepts	Maureen Sprankle, Jim Hubbard	Pearson	2012
2	How to Solve It: A New Aspect of Mathematical Method	George Pólya	Princeton University Press	2015
3	Creative Problem Solving: An Introduction	Donald Treffinger., Scott Isaksen, Brian Stead-Doval	Prufrock Press	2005
4	Psychology (Sec.. Problem Solving.)	Spielman, R. M., Dumper, K., Jenkins, W., Lacombe, A., Lovett, M., & Perlmutter, M	H5P Edition	2021
5	Computer Arithmetic Algorithms	Koren, Israel	AK Peters/CRC Press	2018
6	Introduction to Computation and Programming using Python	Gutttag John V	PHI	2/e., 2016
7	Python for Everyone	Cay S. Horstmann, Rance D. Nicaise	Wiley	3/e, 2024
8	Computational Thinking: A Primer for Programmers and Data Scientists	G Venkatesh Madhavan Mukund	Mylspot Education Services Pvt Ltd	2020

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://opentextbc.ca/h5pppsychology/chapter/problem-solving/
2	https://onlinecourses.nptel.ac.in/noc21_cs32/preview

1. Continuous Assessment (5 Marks)

Accurate Execution of Programming Tasks

- Correctness and completeness of the program
- Efficient use of programming constructs
- Handling of errors
- Proper testing and debugging

2. Evaluation Pattern for Lab Examination (10 Marks)

1. Algorithm (2 Marks)

Algorithm Development: Correctness and efficiency of the algorithm related to the question.

2. Programming (3 Marks)

Execution: Accurate execution of the programming task.

3. Result (3 Marks)

Accuracy of Results: Precision and correctness of the obtained results.

4. Viva Voce (2 Marks)

Proficiency in answering questions related to theoretical and practical aspects of the subject.

Sample Classroom Exercises:

1. Identify ill-defined problem and well-defined problems
2. How do you differentiate the methods for solving algorithmic problems: introspection, simulation, computer modelling, and experimentation?
3. Use cases for Trial and error, Algorithm, Heuristic and Means-ends analysis can be applied in proffering solution to problems
4. Use a diagram to describe the application of Tower of Hanoi in choosing and analysing an action at a series of smaller steps to move closer to the goal
5. What effect will be generated if the stage that involves program writing is not observed in the problem solving process?
6. What effect will be generated if the stage that involves program writing is not observed in the problem solving process?
7. Evaluate different algorithms based on their efficiency by counting the number of steps.
8. Recursive function that takes a number and returns the sum of all the numbers from zero to that number.
9. Recursive function that takes a number as an input and returns the factorial of that number.
10. Recursive function that takes a number 'n' and returns the nth number of the Fibonacci number.
11. Recursive function that takes an array of numbers as an input and returns the product of all the numbers in the list.

LAB Experiments:

1. Demonstrate about Basics of Python Programming
2. Demonstrate about fundamental Data types in Python Programming. (i.e., int, float, complex, bool and string types)
3. Demonstrate different Arithmetic Operations on numbers in Python.
4. Create, concatenate, and print a string and access a sub-string from a given string.
5. Familiarize time and date in various formats (Eg. "Sun May 29 02:26:23 IST 2017")
6. Write a program to create, append, and remove lists in Python using numPy.
7. Programs to find the largest of three numbers.
8. Convert temperatures to and from Celsius, and Fahrenheit. [Formula: $c/5 = f-32/9$]
9. Program to construct the stars(*) pattern, using a nested for loop
10. Program that prints prime numbers less than 20.

11. Program to find the factorial of a number using Recursion.
12. Recursive function to add two positive numbers.
13. Recursive function to multiply two positive numbers
14. Recursive function to the greatest common divisor of two positive numbers.
15. Program that accepts the lengths of three sides of a triangle as inputs. The program output should indicate whether or not the triangle is a right triangle (Recall from the Pythagorean Theorem that in a right triangle, the square of one side equals the sum of the squares of the other two sides). Implement using functions.
16. Program to define a module to find Fibonacci Numbers and import the module to another program.
17. Program to define a module and import a specific function in that module to another program.
18. Program to check whether the given number is a valid mobile number or not using functions?

Rules:

1. Every number should contain exactly 10 digits.
2. The first digit should be 7 or 8 or 9

SEMESTER S1

ENGINEERING WORKSHOP

Course Code	GCESL106	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0-0-2-0	ESE Marks (Internal only)	50
Credits	1	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To enable the student to familiarize various tools, measuring devices, practices and different methods employed in the industry.
2. To enable the students to apply this experience while developing product/project for the benefit of society.

Expt. No.	Experiments (Minimum 12 Exercises)
1	General: Introduction to workshop practice, Safety precautions, Shop floor ethics, and Basic First Aid knowledge. Study of mechanical and measurement tools, components and their applications: (a) Tools: screw drivers, spanners, Allen keys, cutting pliers etc. and accessories (b) bearings, seals, O-rings, circlips, keys etc. (c) Vernier Calipers, Height Gauge, Depth Gauge, Micrometers, Bevel Protractor etc.
2	Carpentry: Understanding carpentry tools and knowledge of at least one model 1. T –Lap joint 2. Cross lap joint 3. Dovetail joint 4. Mortise joints
3	Foundry: Understanding of foundry tools and knowledge of at least one model 1. Bench Moulding 2. Floor Moulding 3. Core making 4. Pattern making
4	Sheet Metal: Understanding sheet metal working tools and knowledge of at least one model 1. Cylindrical shape 2. Conical shape 3. Prismatic shaped job from sheet metal
5	Fitting: Understanding the tools used for fitting and knowledge of at least one model 1. Square Joint 2. V- Joint 3. Male and female fitting

6	Plumbing: - Understanding plumbing tools and pipe joints, along with practicing one exercise on joining pipes using a minimum of three types of pipe joints
7	Smithy: - Understanding the tools used in smithy. Demonstrating the forge-ability of different materials (MS, Al, alloy steel and cast steels) in both cold and hot states. Observing the qualitative difference in the hardness of these materials. One exercise on smithy (Square prism).
8	Welding: Understanding welding equipment and practicing at least one welding technique, such as making joints using electric arc welding. Bead formation in horizontal, vertical and overhead positions
9	Rolling: - Objective of rolling, rolling process, practical on two high rolling mill
10	Electroplating: -Electroplating a given job
11	Metrology: Common measuring instruments used in workshop, experiments to find the angle of a dovetail, angle of a taper and the radius of a circular surface. Introduction to instruments Vernier Bevel Protractor, Vernier Depth Gauge, Vernier Height Gauge.
12	Assembly: Demonstration only Disassembling and assembling of 1. Cylinder and piston assembly 2. Tail stock assembly 3. Bicycle 4. Pump or any other machine
13	Machines: Demonstration of the following machines: Shaping and slotting machine; Milling machine; Grinding Machine; Lathe; Drilling Machine.
14	Modern manufacturing methods (Fab lab/IDEA Lab - Demonstration only): Power tools, CNC machine tools, 3D printing, Soft Materials cutting using special machines
15	Use of proper Personal Protective Equipments. Measurements using Tape, Ruler, Vernier calipers, screw gauge
16	Measuring the area of a plot with an irregular boundary using a chain and cross staff
17	Measuring the area of a building using Distomat
18	Finding the level difference between two points using dumpy level
19	Onsite quality assessment of brick, and cement

20	Construct a 1 and 1 ½ thick brick wall with a height of 50 cm and a minimum length of 60 cm using English bond. Check the verticality of the wall
21	Construct a 1 and 1 ½ thick brick wall with a height of 50 cm and a minimum length of 60 cm using Flemish bond. Check the verticality of the wall
22	Estimate the number of different types of building blocks needed to construct the walls of a room measuring 2m x 3m, accounting for standard-sized doors and windows.
23	Setting out of a two roomed building using thread, tape and water tube levelling.
24	Conduct a market study to understand the types, prices, and general specifications of at least three materials available in the market (such as bricks, cement, aggregates, steel, plumbing items, fixtures, welding rods, fasteners etc.).
25	Studying the tools and testing instruments for electrical works. Wiring a light or a fan circuit using one way and two-way switch.
26	Familiarization/Application of testing instruments and commonly used tools in electronic works. [Multimeter, Soldering iron, De-soldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and desoldering station etc.]
Note: Minimum of 12 experiments from among the 26 experiments listed, is to be completed.	

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Total
5	45	50

End Semester Examination Marks (ESE): (Internal evaluation only)

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified Lab record.

Pass Criteria:

- A student must score a minimum of 50% overall, combining marks from both Continuous Internal Evaluation (CIE) and End Semester Examination (ESE).
- In addition, the student must secure at least 40% in the End Semester Examination (ESE).

The ESE shall be conducted internally, with evaluation carried out by a panel of faculty members. This panel must include at least one faculty member who was not involved in the Continuous Internal Evaluation (CIE) of the lab course.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify workshop operations and instruments in accordance with the material and objects.	K3
CO2	Understand appropriate tools and instruments with respect to the workshop specializations.	K2
CO3	Apply various tools, measuring devices, practices and different methods employed in the industry.	K3
CO4	Examine the quality of common materials used in the industry.	K3
CO5	Conduct market study of various engineering materials and consumables available in the market.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3									2		2
CO2	3									2		2
CO3	3				2					2		3
CO4	3									2		3
CO5	3								2	3		3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanical Workshop Practice	K C John	PHI Learning	Edition 2 2010
2	Engineering Materials	S C Rangwala	Charotar Publishing House Pvt Limited	Edition 43 2019
3	Building Materials	S K Duggal	New Age International	Edition 6 2025
4	Indian Practical Civil Engineering Handbook	Khanna P.N,	UBS Publishers Distributers (P) Ltd.	Year 2012
5	Building Construction	Arora S.P and Bindra S.P	Dhanpat Rai Publications	Edition 5 Year 2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Elements of Workshop Technology Vol-1- Manufacturing Processes	S K Hajra Choudhury A K Hajra Choudhury Nirjhar Roy	MPP Media Promoters and Publishers	2008

Video Links (NPTEL, SWAYAM...)	
Link ID	
https://archive.nptel.ac.in/courses/105/106/105106206/ https://archive.nptel.ac.in/courses/105/106/105106201/ https://archive.nptel.ac.in/courses/105/104/105104101/ https://archive.nptel.ac.in/courses/117/106/117106108/	

Continuous Assessment (45 Marks)

1. Preparation and Pre-Lab Work (10 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (15 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (10 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (10 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S1/S2
HEALTH AND WELLNESS
(Common to all Groups)

Course Code	UCHWT127	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	1:0:1:0	ESE Marks	0
Credits	1	Exam Hours	Nil
Prerequisites (if any)	None	Course Type	

Course Objectives:

1. To provide essential knowledge on physical activity, health, and wellness.
2. To ensure students understand body systems, exercise principles, nutrition, mental health, and disease management.
3. To educate students on the benefits of yoga, the risks of substance abuse and basic first aid skills.
4. To equip students with the ability to lead healthier lifestyles.
5. To enable students to design effective and personalized exercise programs.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Human Body Systems related to Physical activity and its functions:Respiratory System - Cardiovascular System. Musculoskeletal System and the Major Muscle groups of the Human Body. Quantifying Physical Activity Energy Expenditure and Metabolic equivalentof task (MET) Exercise Continuum: Light-intensity physical activity, Moderate - intensityphysical activity, Vigorous -intensity physical activity. Defining Physical Activity, Aerobic Physical Activity, Anaerobic PhysicalActivity, Exercise and Health-Related Physical Fitness. FITT principle to design an Exercise programme	4

	Components of Health-related Physical Fitness: - Cardiorespiratory Fitness- Muscular strength- Muscular endurance- Flexibility- Body composition.	
2	Concept of Health and Wellness: Health and wellness differentiation, Factors affecting health and wellness. Mental health and Factors affecting mental health. Sports and Socialization: Sports and character building - Leadership through Physical Activity and Sports Diet and nutrition: Exploring Micro and Macronutrients: Concept of Balanced diet Carbohydrate & the Glycemic Index Animal & Plant - based Proteins and their Effects on Human Health Dietary Fats & their Effects on Human Health Essential Vitamins and Minerals	2
3	Lifestyle management strategies to prevent / manage common hypokinetic diseases and disorders - Obesity - Cardiovascular diseases (e.g., coronary artery disease, hypertension) - Diabetes - Osteoporosis - Musculoskeletal disorders (e.g., osteoarthritis, Low back pain, Kyphosis, lordosis , flat foot, Knock knee) Meaning, Aims and objectives of yoga - Classification and importance of Yogic Asanas (Sitting, Standing, lying) Pranayama and Its Types - Active Lifestyle and Stress Management Through Yoga Understanding on substance abuse and addiction - Psychoactive substances & its ill effects- Alcohol- Opioids- Cannabis - Sedative -Cocaine -Other stimulants, including caffeine -Hallucinogens -Tobacco -Volatile solvents.	4

4	First aid and principles of First Aid: Primary survey: ABC (Airway,Breathing, Circulation). Qualities of a Good First Aider First aid measures for: - Cuts and scrapes - Bruises - Sprains - Strains -Fractures - Burns - Nosebleeds. First Aid Procedures: Cardiopulmonary Resuscitation (CPR) - HeimlichManeuver - Applying a sling Sports injuries: Classification (Soft Tissue Injuries - Abrasion, Contusion, Laceration, Incision, Sprain & Strain)	2
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Additional Topics

- Need and Importance of Physical Education and its relevance in interdisciplinary context. Understanding of the Endocrine System
- Developing a fitness profile
- Healthy foods habits for prevention and progression of Lifestyle Diseases. Processed foods and unhealthy eating habits.
- Depression - Anxiety - Stress
- Different ways of carrying an injured person. Usage of Automated external defibrillator

Course Assessment Method (CIE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Case Study/Micro project/Presentation	Activity evaluation	Total
10	20	20	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the different human body systems and describe various types of physical activities along with methods to measure and quantify these activities.	K2
CO2	Explain how to maintain or improve health and wellness through psychological practices, dietary habits, and sports activities.	K2
CO3	Discuss about common hypokinetic disorders and musculoskeletal disorders, and describe the importance of leading a healthy lifestyle through the practice of yoga and abstaining from addictive substances.	K2
CO4	Explain the basics of first aid and describe common sports injuries	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				2		3		3	3	2		2
CO2				2		3		2	2			2
CO3						3		3				2
CO4				2		3						2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Foundations of Nutrition	Bhavana Sabarwal	Commonwealth Publishers	1999
2	Anatomy and physiology in health and illness.	Ross and Wilson	Waugh, A., & Grant, A.	2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fit to be Well Essential Concept	Thygerson, A. L., Thygerson, S. M., & Thygerson, J. S.	Jones & Bartlett Learning.	2018
2	Introduction to physical education, fitness, and sport.	Siedentop, D., & Van der Mars, H.	Human kinetics.	2022
3	Substance Use Disorders. Manual for Physicians.	Lal, R., & Ambekar, A. (2005).	National Drug Dependence Treatment Centre, New Delhi	2005
4	The exercise health connection-how to reduce your risk of disease and other illnesses by making exercise your medicine.	Nieman, D. C., & White, J. A	Public Health	1998
5	ACSM's resource manual for guidelines for exercise testing and prescription.	Lippincott Williams & Wilkins.	American College of Sports Medicine.	2012
6	Exercise Physiology: energy, nutrition and human performance.	Katch, F. I., Katch, V. L., & McArdle, W. D.	Lippincott Williams & Wilkins	2010

Continuous Internal Evaluation Marks (CIE): for the Health and wellness course

Students will be evaluated as follows.

Title	Method of Evaluation
Attendance	Students must attend at least 75% of both theory and practical classes. They will receive 10 marks based on their class attendance. Students who do not meet the minimum attendance requirement for a course, as specified in the B. Tech regulations, will not be eligible to proceed to the next criteria.
Assignment / Presentation	Assignments will be given to students to assess their understanding of the subjects taught. Students will be required to make presentations on the subjects taught in class, and their understanding of the subjects will be assessed. Based on the Assignments and Presentations the students will be awarded marks out of 20
Activity Evaluation	The Assignment / Presentation faculty handling the class will use the tests from the Fitness Protocols and Guidelines for ages 18+ to 65 years, as set forth by FIT India. Measurements will be taken for all the tests of the FIT India Fitness Protocol and the evaluation will be based on the benchmark score received for the following tests: 1. V Sit Reach Test 2. Partial Curl Up - 30 seconds 3. Push Ups (Male) and Modified Push Up (Female) 4. Two (2) Km Run/Walk Students who achieve a total benchmark score of 8 across the aforementioned 4 tests will be awarded pass marks for activity evaluation. Students who score better will be awarded a maximum mark of 20.
Activity Evaluation - Special Circumstances	Physically challenged and medically unfit students can opt for an objective test to demonstrate their knowledge of the subjects taught. Based on their performance in the objective test, they will be awarded marks out of 20.

Activity Evaluation - Special Considerations - NCC	Students who enrolled themselves in the NCC during the course period (between the start and end dates of the program) and attended 5 college level parades will be awarded pass marks for activity evaluation. Students who attend more parades will be eligible for a maximum mark of 20 based on their parade attendance.
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Tests to evaluated as per Criterion - 2 and Benchmark Scores

V Sit Reach Test

How to Perform:

1. The subject removes their shoes and sits on the floor with the measuring line between their legs and the soles of their feet placed immediately behind the baseline, heels 8-12" apart.
2. The thumbs are clasped so that hands are together, palms facing down and placed on the measuring line.
3. With the legs held flat by a partner, the subject slowly reaches forward as far as possible, keeping the fingers on baseline and feet flexed.
4. After three tries, the student holds the fourth reach for three seconds while that distance is recorded.
5. Make sure there are no jerky movements, and that the fingertips remain level and the legs flat.

Infrastructure/Equipment Required:

1. A tape for marking the ground, marker pen, and ruler.
2. With the tape mark a straight line two feet long on the floor as the baseline, and a measurement line perpendicular to the midpoint of the baseline extending two feet on each side.
3. Use the marker pen to indicate every centimeter and millimeter along the measurement line. The point where the baseline and the measuring line intersect is the zero point.
4. Scoring: The score is recorded in centimeters and millimeters as the distance reached by the hand, which is the difference between the zero point (where the baseline and measuring line intersect) and the final position

Scoring for V Sit Reach Test for Males

Level	Benchmark Score	Measurement (cm)
1	2	<11
2	4	12-13
3	6	14-17
4	7	18-19
5	8	20-21
6	9	22
7	10	>22

Scoring for V Sit Reach Test for Females

Level	Benchmark Score	Measurement (cm)
1	2	<14
2	4	15-16
3	6	17-19
4	7	20-21
5	8	22
6	9	23
7	10	>23

Partial Curl Up - 30 seconds**How to Perform:**

1. The subject lies on a cushioned, flat, clean surface with knees flexed, usually at 90 degrees, with hands straight on the sides (palms facing downwards) closer to the ground, parallel to the body.
2. The subject raises the trunk in a smooth motion, keeping the arms in position, curling up the desired amount (at least 6 inches above/along the ground towards the parallel strip).
3. The trunk is lowered back to the floor so that the shoulder blades or upper back touch the floor.

Infrastructure/Equipment Required:

Flat clean cushioned surface with two parallel strips (6 inches apart), Stopwatch

Scoring: Record the maximum number of Curl ups in a certain time period 30 seconds.

Scoring for Partial Curl Up - 30 seconds Test for Males

Level	Benchmark Score	Numbers
1	2	<25
2	4	25-30
3	6	31-34
4	7	35-38
5	8	39-43
6	9	44-49
7	10	>49

Scoring for Partial Curl Up - 30 seconds Test for Females

Level	Benchmark Score	Numbers
1	2	<18
2	4	18-24
3	6	25-28
4	7	29-32
5	8	33-36
6	9	37-43
7	10	>43

Push Ups for Male/Modified Push Ups for Female**How to Perform:**

1. A standard push up begins with the hands and toes touching the floor, the body and legs in a straight line, feet slightly apart, the arms at shoulder width apart, extended and at a right angle to the body.
2. Keeping the back and knees straight, the subject lowers the body to a predetermined point, to touch some other object, or until there is a 90-degree angle at the elbows, then returns back to the starting position with the arms extended.
3. This action is repeated, and the test continues until exhaustion, or until they can do no

more in rhythm or have reached the target number of push-ups.

4. For Female: push-up technique is with the knees resting on the ground.

Infrastructure/Equipment Required:

Flat clean cushioned surface/Gym mat

Scoring: Record number of correctly completed pushups.

Scoring for Push Ups for Male

Level	Benchmark Score	Numbers
1	2	<4
2	4	04- 10
3	6	11 -18
4	7	19-34
5	8	35-46
6	9	47-56
7	10	>56

Scoring for Modified Push Ups for Female

Level	Benchmark Score	Numbers
1	2	0-1
2	4	2 - 5
3	6	6 -10
4	7	11 - 20
5	8	21-27
6	9	27-35
7	10	>35

2 Km Run/Walk

How to Perform:

1. Participants are instructed to run or walk 2 kms in the fastest possible pace.
2. The participants begin on signal (Starting point)- “ready, start”. As they cross the finish line, elapsed time should be announced to the participants.
3. Walking is permitted but the objective is to cover the distance in the shortest possible time.

Infrastructure/Equipment Required:

Stopwatch, whistle, marker cone, lime powder, measuring tape, 200 or 400 m with 1.22 m (minimum 1 m) width preferably on a flat and even playground with a marking of starting and finish line. You can also use any application on your mobile phone that tells you the distance.

Scoring: Time taken for completion (Run or Walk) in min, sec.

Scoring for 2Km Run/walk for Male

Level	Benchmark Score	Minutes : Seconds
1	2	> 11:50
2	4	10:42
3	6	09:44
4	7	08:59
5	8	08:33
6	9	07:37
7	10	>07:37

Scoring for 2Km Run/walk for Female

Level	Benchmark Score	Minutes : Seconds
1	2	>13:47
2	4	12:51
3	6	12:00
4	7	11:34
5	8	10:42
6	9	09:45
7	10	>09:45

SEMESTER - S1/S2
LIFE SKILLS AND PROFESSIONAL COMMUNICATION
(Common to all Branches)

Course Code	UCHUT128	CIE Marks	100
Teaching Hours/Week (L: T:P: R)	2:0:1:0	ESE Marks	0
Credits	1	Exam Hours	-
Prerequisites (if any)	None	Course Type	Activity-based learning

Course objectives:

1. To foster self-awareness and personal growth, enhance communication and interpersonal connection skills, promote effective participation in groups and teams, develop critical thinking, problem-solving, and decision-making skills, and cultivate the ability to exercise emotional intelligence.
2. To equip students with the necessary skills to listen, read, write & speak, to comprehend and successfully convey any idea, technical or otherwise.
3. To equip students to build their profile in line with the professional requirements and standards.

Continuous Internal Evaluation Marks (CIE):

- Continuous internal evaluation is based on the individual and group activities as detailed in the activity table given below.
- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. They should use online collaboration tools for group activities, report/presentation making and work management.
- Activities are to be distributed between 3 class hours (2L+1P) and 3.5 Self-study hours.
- Marks given against each activity should be awarded fully if the students successfully complete the activity.
- Students should maintain a portfolio file with all the reports and other textual materials generated from the activities. Students should also keep a journal related to the activities undertaken.
- Portfolio and journal are mandatory requirements for passing the course, in addition to the

minimum marks required.

- The portfolio and journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through the HMC courses and Mini project course.
- Self-reflection questionnaire shall be given at the beginning of the semester, in between and at the end of the semester based on the guidelines in the manual of the course.

Table 1. Activity Table

Sl. No.	Activity	Class room (L) / Self Study (SS)	Week of completion	Group / Individual (G/I)	Marks	Skills	CO
1.1	Group formation and self-introduction among the group members	L	1	G	-	• Connecting with group members • Time management - Gantt Chart	
1.2	Familiarizing the activities and preparation of the time plan for the activities	L	1	G	-		
1.3	Preparation of Gantt chart based on the time plan	SS	1	G	2		
2.1	Take an online personality development test, self-reflect and report	SS	1	I	2	• Self-awareness Writing	CO1
2.2	Role-storming exercise 1: Students assume 2 different roles given below and write about their • Strengths, • Areas for improvement, • Concerns, • Areas in which he/she hesitates to take advice, • Goals/Expectations, from the point of view of the following assumed roles i) their parent/guardian/mentor ii) their friend/sibling/cousin	L	1	I	2	• Goal setting - Identification of skills and setting goal • Self-awareness • Discussion in groups • Group work- Compiling of ideas • Mind mapping	CO1
2.3	Role-storming exercise 2: Students assume the role of their teacher						CO1

	and write about the • Skills required as a B. Tech graduate • Attitudes, habits, approaches required and activities to be practised during their B.Tech years, in order to achieve the set goals	SS	1	I	2		
2.4	Discuss the skills identified through role storming exercise by each one within their own group and improvise the list of skills	L	1	G	2		CO1
2.5	Prepare a mind map based on the role-storming exercise and exhibit/present it in class	SS	2	G	2		CO1
3	Prepare a presentation on instances of empathy they have observed in their own life or in other's life	L	2 to 4	I	2	• Empathy	CO2
4.1	Each student connects and networks with a minimum of 3 professionals from industry/public sector organizations/other agencies/NGOs /academia (at least 1 through LinkedIn)	SS	3	I	2	• Workplace awareness • Listening • Communication - interacting with people	
4.2	Interact with them to understand their workplace details including • workplace skills required • their work experience • activities they have done to enhance their employability during their B. Tech years • suggestions on the different activities to be done during B. Tech years Prepare a documentation of this	SS	3	I	4	• Networking through various media including LinkedIn • Discussion in groups • Report preparation • Creativity	CO2
4.3	Discuss the different workplace details & work readiness activities assimilated by each through the interactions within their group and compile the inputs collected by the individuals Prepare the Minutes of the discussions	SS	3	G	2	Goal setting - Preparation of action plan	CO2
4.4	Report preparation based on the	SS	4	G	3		CO4

	discussions						
4.5	Perform a role-play based on the workplace dynamics assimilated through interactions and group discussions	L	5	G	4		CO3
4.6	Identify their own goal and prepare an action plan for their undergraduate journey to achieve the goal	SS	5	I	2		CO1
5.1	Select a real-life problem that requires a technical solution and list the study materials needed	L	6	G	2		CO3
5.2	Listen to TED talks & video lectures from renowned Universities related to the problem and prepare a one-page summary (Each group member should select a different resource)	SS	6	I	2		CO4
5.3	Use any online tech forum to gather ideas for solving the problem chosen	SS	6	G	2		CO5
5.4	Arrive at a possible solution using six thinking hat exercise	L	7	G	3		CO3
5.5	Prepare a report based on the problem-solving experience	SS	7	G	2		CO4
6.1	Linkedin profile creation	SS	1	I	2		CO6
6.2	Resume preparation	SS	8	I	2	Profile-building	CO6
6.3	Self-introduction video	SS	8	I	3		CO6
7	Prepare a presentation on instances of demonstration of emotional intelligence	SS	9	I	2	Emotional intelligence	CO2
8	Prepare a short video presentation on diversity aspects observed in our society (3 to 5 minutes)	SS	10	G	3	Diversity	CO2, CO5
9	Take online Interview skills development sessions like robotic interviews; self-reflect and report	SS	10	I	2	• Interview skills	CO6
10	Take an online listening test, self-reflect and report	SS	11	I	2	Listening skills	CO6
11.1	Activities to improve English vocabulary of students	L	8	I/G	4	• English vocabulary	CO4

11.2	Activities to help students identify errors in English language usage	L	9	I/G	2	• English language skills • Writing • Presentation • Group work • Self-reflection	CO4
11.3	Activity to help students identify commonly misspelled words, commonly mispronounced words and confusing words	L	10	I/G	2		CO4
11.4	Write a self-reflection report on the improvement in English language communication through this course	SS	12	I	2		CO4
11.5	Presentation by groups on the experience of using online collaboration tools in various group activities and time management experience as per the Gantt chart prepared	L	11 to 12	G	2		CO4, CO5
12.1	Each group prepares video content for podcasts on innovative technological interventions/research work tried out in Kerala context by academicians/professionals/Govt. agencies/research institutions/private agencies/NGOs/other agencies	SS	12	G	4	• Audio-visual presentations creations with the use of technology tools • Effective use of social media platforms • Profile building	CO2, CO4, CO5
12.2	Upload the video content to podcasting platforms or YouTube	SS	12	G	1		CO5
12.3	Add the link of the podcast in their LinkedIn profile	SS	12	G	1		CO5

Table 2. Lab hour Activities (P): 24 Marks

Sl No	Activity	Marks	Skill	CO
1	Hands-on sessions on day-to-day engineering skills and a self-reflection report on the experience gained: 1. Drilling practice using electric hand drilling machines. 2. Cutting of MS rod and flat using electric hand cutters. 3. Filing, finishing and smoothening using electrically operated hand grinders. 4. MS rod cutting using Hack saw by holding the work in bench wise. 5. Study and handling different types of measuring instruments. 6. Welding of MS, SS work pieces. 7. Pipe bending practice (PVC and GI). 8. Water tap fitting. 9. Water tap rubber seal changing practice. 10. Union and valves connection practice in pipes. 11. Foot valve fitting practice. 12. Water pump seal and bearing changing practice.	24	Basic practical engineering skills	3
2	Language Lab sessions	-	Language Skills	4

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to know & understand oneself, show confidence in one's potential & capabilities, set goals and develop plans to accomplish tasks	K5
CO2	Develop the ability to communicate and connect with others, participate in groups/teams, empathise, respect diversity, be responsible and understand the need to exercise emotional intelligence	K5
CO3	Develop thinking skills, problem-solving and decision-making skills	K5
CO4	Develop listening, reading, writing & speaking skills, ability to comprehend & successfully convey any idea, and ability to analyze, interpret & effectively summarize textual, audio & visual content	K6
CO5	Develop the ability to create effective presentations through audio-visual mediums with the use of technology tools and initiate effective use of social media platforms & tech forums for content delivery and discussions	K6
CO6	Initiate profile-building exercises in line with the professional requirements, and start networking with professionals/academicians	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		3
CO2					1			3		3		3
CO3		1	1		1					1		1
CO4					1					1		2
CO5					1	1				1		2
CO6					1					1		

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Life Skills & Personality Development	Maithry Shinde et.al.	Cambridge University Press	First Edition, 2022
2	Emotional Intelligence: Why it can matter more than IQ	Daniel Goleman	Bloomsbury, Publishing PLC	25th Anniversary Edition December 2020
3	Think Faster, Talk Smarter: How to speak successfully when you are put on the spot	Matt Abrahams	Macmillan Business	September 2023
4	Deep Work: Rules for focused success in a distracted world	Cal Newport	PIATKUS	January 2016
5	Effective Technical Communication	Ashraf Rizvi	McGraw Hill Education	2nd Edition 2017
6	Interchange	Jack C. Richards, With Jonathan Hull, Susan Proctor	Cambridge publishers	5th Edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Life Skills for Engineers	Remesh S., Vishnu R.G.	Ridhima Publications	First Edition, 2016
2	Soft Skills & Employability Skills	Sabina Pillai and Agna Fernandez	Cambridge University Press	First Edition, 2018
3	Effective Technical Communication	Ashraf Rizvi	McGraw Hill Education	2nd Edition 2017
4	English Grammar in Use	Raymond Murphy,	Cambridge University Press India PVT LTD	5th Edition 2023
5	Guide to writing as an Engineer	David F. Beer and David McMurrey	John Wiley. New York	2004

SEMESTER 2

GROUP C

SEMESTER S2
MATHEMATICS FOR ELECTRICAL SCIENCE AND PHYSICAL
SCIENCE – 2

(Common to Groups B & C)

Course Code	GYMAT201	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic knowledge in single variable calculus.	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of partial derivatives, multiple integrals, and the differentiation and integration of vector-valued functions, emphasizing their applications in engineering contexts.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Limits and continuity, Partial derivatives, Partial derivatives of functions with two variables, Partial derivatives viewed as rate of change and slope, Partial derivatives of functions with more than two variables, Higher order partial derivatives, Local Linear approximations, Chain rule, Implicit differentiation, Maxima and minima of functions of two variables - relative maxima and minima (Text 1: Relevant topics from sections 13.2, 13.3, 13.4, 13.5, 13.8)	9

2	Double integrals, Reversing the order of integration in double integrals, change of coordinates in double integrals (Cartesian to polar), Evaluating areas using Double integrals, Finding volumes using double integration, Triple integrals, Volume calculated as triple integral, Triple integral in Cartesian and cylindrical coordinates. (Text 1: Relevant topics from section 14.1, 14.2, 14.3, 14.5, 14.6)	9
3	Vector valued function of single variable - derivative of vector valued function, Concept of scalar and vector fields, Gradient and its properties, Directional derivative, Divergent and curl, Line integrals of vector fields, Work done as line integral, Conservative vector field, independence of path, Potential function (results without proof). (Text 1: Relevant topics from section 12.1, 12.2, 13.6, 15.1, 15.2, 15.3)	9
4	Green's theorem (for simply connected domains, without proof) and applications to evaluating line integrals, finding areas using Greens theorem, Surface integrals over surfaces of the form $z=g(x, y)$, Flux integrals over surfaces of the form $z = g(x, y)$, Divergence theorem (without proof), Using Divergence theorem to find flux, Stokes theorem (without proof) (Text 1: Relevant topics from section 15.4, 15.5, 15.6, 15.7, 15.8)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Compute the partial and total derivatives and maxima and minima of multivariable functions and to apply in engineering problems.	K3
CO2	Understand theoretical idea of multiple integrals and to apply them to find areas and volumes of geometrical shapes.	K3
CO3	Compute the derivatives and line integrals of vector functions and to learn their applications.	K3
CO4	Apply the concepts of surface and volume integrals and to learn their inter-relations and applications.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	-	-	-	-	-	-	2
CO2	3	3	-	2	-	-	-	-	-	-	-	2
CO3	3	3	-	2	-	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Calculus	H. Anton, I. Biven, S.Davis	Wiley	12 th edition, 2024

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Thomas' Calculus	Maurice D. Weir, Joel Hass, Christopher Heil, Przemyslaw Bogacki	Pearson	15 th edition, 2023
2	Essential Calculus	J. Stewart	Cengage	2 nd edition, 2017
3	Advance Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10 th edition, 2016
4	Bird's Higher Engineering Mathematics	John Bird	Taylor & Francis	9 th edition, 2021
5	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39 th edition, 2023

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/111107108
2	https://nptel.ac.in/courses/111107108
3	https://nptel.ac.in/courses/111107108
4	https://nptel.ac.in/courses/111107108

SEMESTER S1/S2
PHYSICS FOR PHYSICAL SCIENCE AND LIFE SCIENCE
(Common to Group C & D)

Course Code	GZPHT121	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:2:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory + Lab

Course Objectives:

1. To provide students with a solid background in the fundamentals of Physics and impart this knowledge in Physical Science and Life Science disciplines.
2. To develop scientific attitudes and enable students to correlate Physics concepts with their core programs.
3. To equip students with practical knowledge that complements their theoretical studies and develop their ability to create practical applications and solutions in engineering based on their understanding of Physics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Laser & Fiber Optics Optical processes – Absorption-Spontaneous emission and stimulated emission, Principle of laser - conditions for sustained lasing – Population inversion- Pumping- Metastable states, Basic components of laser - Active medium - Optical resonant cavity, Construction and working of Ruby laser and CO₂ laser, Construction and working Semiconductor laser (qualitative), Properties of laser, Applications of laser. Optic fiber-Principle of propagation of light, Types of fibers-Step index and Graded index fibers - Multimode and single mode fibers, Acceptance angle, Numerical aperture –Derivation, Applications of optical fibers - Fiber optic communication system (block diagram)	9
2	Interference and Diffraction Introduction, Principle of super position, Constructive and destructive interference, Optical path, Phase difference and path difference, Cosine law- reflected system- Condition for constructive and destructive interference, Colours in thin films, Newton's Rings-Determination of refractive index of transparent liquids and wavelength, Air wedge- Measurement of thickness of thin sheets. Diffraction-types of diffraction, Diffraction due to a single slit, Diffraction grating – Construction - grating equation, Dispersive and Resolving Power(qualitative).	9

3	Quantum Mechanics Introduction, Concept of uncertainty and conjugate observables (qualitative), Uncertainty principle (statement only), Application of uncertainty principle- Absence of electron inside nucleus - Natural line broadening, Wave function – properties - physical interpretation, Formulation of time dependent and time independent Schrodinger equations, Particle in a one- dimensional box - Derivation of energy eigen values and normalized wave function, Quantum Mechanical Tunnelling (qualitative)	9
4	Waves & Acoustics Waves- transverse and longitudinal waves, Concept of frequency, wavelength and time period (no derivation), Transverse vibrations in a stretched string- derivation of velocity and frequency - laws of transverse vibration. Acoustics- Reverberation and echo, Reverberation time and its significance - Sabine's Formula, Factors affecting acoustics of a building. Ultrasonics- Piezoelectric oscillator, Ultrasonic diffractometer, SONAR, NDT-Pulse echo method, medical application- Ultrasound scanning (qualitative)	9

Course Assessment
Method (CIE: 40 marks , ESE:
60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Continuous Assessment	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Internal Examination- 3 (Lab Examination)	Total
5	10	10	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the basic principles and properties of laser and optic fibers.	K2
CO2	Describe the phenomena of interference and diffraction of light.	K2
CO3	Explain the behaviour of matter in the atomic and subatomic level through the principles of quantum mechanics.	K2
CO4	Apply the knowledge of waves and acoustics in non-destructive testing and in acoustic design of buildings.	K3
CO5	Apply basic knowledge of principles and theories in physics to conduct experiments.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											3
CO2	3											3
CO3	3											3
CO4	3	3										3
CO5	3	3			3				2			3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Textbook of Engineering Physics	M N Avadhanulu, P G Kshirsagar & TVS Arun Murthy	S Chand & Co.	2 nd Edition, 2019
2	Engineering Physics	H K Malik , A.K. Singh,	McGraw Hill Education	2 nd Edition, 2017
3	Optics	Ajoy Ghatak	Mc Graw Hill Education	6 th Edition, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Physics	G Vijayakumari	Vikas Publications	8 th Edition, 2014
2	Concepts of Modern Physics	Arthur Beiser	Tata McGraw Hill Publications	6 th Edition 2003
3	Engineering Physics	Aruldas G.	PHI Pvt. Ltd	2 nd Edition, 2015
4	Fiber Optic Communications	Gerd Keiser	Springer	2021
5	A Text Book of Engineering physics	I. Dominic, A. Nahari	OWL Publications	2 nd Edition, 2016
6	Advanced Engineering Physics	Premlet B	Phasor Books	
7	Engineering Physics	Rakesh Dogra	Katson Books	1 st Edition, 2019

Video Links (NPTEL, SWAYAM...)	
Module No	Link ID
1	https://nptel.ac.in/courses/115102124 https://nptel.ac.in/courses/104104085
2	https://nptel.ac.in/courses/115105537
3	https://nptel.ac.in/courses/115102023 https://nptel.ac.in/courses/115101107
4	https://nptel.ac.in/courses/112104212 https://nptel.ac.in/courses/124105004

1. Continuous Assessment (10 Marks)**i. Preparation and Pre-Lab Work (2 Marks)**

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

ii. Conduct of Experiments (2 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

iii. Lab Reports and Record Keeping (3 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

iv. Viva Voce (3 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

2. Evaluation Pattern for Lab Examination (5 Marks)

1. Procedure/Preliminary Work/Conduct of Experiments (2 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Setup and Execution: Proper setup and accurate execution of the experiment or programming task

2. Result (2 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.

3. Viva Voce (1 Marks)

- Proficiency in answering questions related to theoretical and practical aspects of the subject.

Experiment List

Experiment No.	Experiment (Minimum 10 Experiments)
1	Optical fiber characteristics- Measurement of Numerical aperture.
2	Determination of wavelength of Laser using diffraction grating.
3	Measure the wavelength of Laser using a millimetre scale as a grating.
4	Determination of wavelength of a monochromatic light using Newton's Rings method.
5	Determination of diameter of wire or thickness of thin sheet using Air wedge method.
6	Determination of slit width (diffraction due to a single slit).
7	Measure wavelength of light source using diffraction grating.

8	Determination of resolving power and dispersive power of grating.
9	Characteristics of LED.
10	CRO basics-Measurement of frequency and amplitude of wave forms.
11	Solar Cell- I V and Intensity Characteristics.
12	Melde's experiment- Frequency calculation in Transverse and Longitudinal Mode.
13	LCR circuit –forced and damped harmonic oscillations.
14	Determination of wavelength and velocity of ultrasonic waves using ultrasonic diffractometer.
15	Determination of particle size of lycopodium powder.

SEMESTER S1/S2
CHEMISTRY FOR PHYSICAL SCIENCE
(Group C)

Course Code	GCCYT122	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:2:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory + Lab

Course Objectives:

1. To equip students with a thorough understanding of chemistry concepts relevant to engineering applications.
2. To familiarize students with applied topics such as spectroscopy, electrochemistry, and instrumental methods.
3. To raise awareness among students about environmental issues, including climate change, pollution, and waste management, and their impact on quality of life.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Engineering Materials Fuels: Calorific value – HCV and LCV – Experimental determination of calorific value of solid fuels. Analysis of coal – Proximate analysis- Octane & Cetane Number. Biofuels- Biodiesel- Green Hydrogen. Lubricants: Classification - Solid, Semisolid and Liquid lubricants. Properties of lubricants - Viscosity Index, Flash point, Fire point, Cloud Point, Pour Point & Aniline Point. Cement: Manufacture of Portland cement – Theory of setting and hardening of cement.	9

	Nanomaterials: Classification based on Dimension & Materials- Synthesis – Sol gel & Chemical Reduction - Applications of nanomaterials –Supercapacitor Materials - Carbon Nanotubes, Fullerenes & Graphene – structure, properties & application. Polymers: ABS & Kevlar -Synthesis, properties and applications. Conducting Polymers- Classification – Application	
2	Electrochemistry and Corrosion Science Electrochemical Cell- Electrode potential- Nernst equation for single electrode and cell (Numerical problems)- Reference electrodes – SHE & Calomel electrode –Construction and Working - Electrochemical series - Applications – Glass Electrode & pH Measurement-Conductivity- Measurement using Digital conductivity meter. Li-ion battery & H₂-O₂ fuelcell (acid electrolyte only) construction and working. Corrosion –Electrochemical corrosion mechanism (acidic & alkaline medium). - Galvanic series - Corrosion control methods - Cathodic Protection - Sacrificial anodic protection and impressed current cathodic protection –Electroplating of copper - Electroless plating of copper	9
3	Instrumental Methods of Analysis Molecular Spectroscopy: Types of spectra- Molecular energy levels - Beer Lambert's law – Numerical problems - Electronic Spectroscopy – Principle, Types of electronic transitions –Role of Conjugation in absorption maxima - Instrumentation-Applications – Vibrational spectroscopy – Principle-Number of vibrational modes - Vibrational modes of CO₂ and H₂O –Applications Thermal analysis: –TGA- Principle, instrumentation (block diagram) and applications – TGA of CaC₂O₄.H₂O and polymers. DTA-Principle, instrumentation (block diagram) and applications - DTA of CaC₂O₄.H₂O. Chromatography- Gas Chromatography- Principle-Instrumentation- Application – Analysis of chemical composition of exhaust gases. Electron Microscopic Techniques: SEM - Principle, instrumentation and Applications.	9

4	Environmental Chemistry Water characteristics - Hardness - Types of hardness- Temporary and Permanent - Disadvantages of hard water -Degree of hardness (Numericals) Water softening methods-Ion exchange process- Principle, procedure and advantages. Reverse osmosis – principle, process and advantages. – Water disinfection methods – chlorination-Break point chlorination, ozone and UV irradiation. Dissolved oxygen (DO), BOD and COD- Definition & Significance Waste Management: Air Pollution- Sources & Effects- Greenhouse Gases-Ozone depletion. Control methods. Sewage water treatment- Primary, Secondary and Tertiary - Flow diagram -Trickling filter and UASB process. Solid waste-disposal methods- Composting, Landfill & Incineration.	9
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Course Assessment
Method (CIE: 40 marks, ESE:
60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Continuous Assessment	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Internal Examination- 3 (Lab Examination)	Total
5	10	10	10	5	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3=24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the use of various engineering materials in different industries.	K2
CO2	Explain the Basic Concepts of Electrochemistry and Corrosion to Explore the Possible Applications in Various Engineering Fields.	K2
CO3	Apply appropriate analytical techniques for different engineering materials	K3
CO4	Outline various water treatment and waste management methods	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										2
CO2	3	3										2
CO3	3	3										2
CO4	3	3				2	3					2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Chemistry	B. L. Tembe, Kamaluddin, M. S. Krishnan	NPTEL Web-book	2018
2	Physical Chemistry	P. W. Atkins	Oxford University Press	International Edition-2018
3	Instrumental Methods of Analysis	H. H. Willard, L. L. Merritt	CBS Publishers	7th Edition-2005
4	Engineering Chemistry	Jain & Jain	Dhanpath Rai Publishing Company	17 th Edition - 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Molecular Spectroscopy	C. N. Banwell	McGraw-Hill	4 th edn., 1995
2	Principles of Physical Chemistry	B. R. Puri, L. R. Sharma, M. S. Pathania	Vishal Publishing Co	47th Edition, 2017
3	Introduction to Spectroscopy	Donald L. Pavia	Cengage Learning India Pvt. Ltd	2015
4	Polymer Chemistry: An Introduction	Raymond B. Seymour, Charles E. Carraher	Marcel Dekker Inc	4th Revised Edition, 1996
5	The Chemistry of Nanomaterials: Synthesis, Properties and Applications	Prof. Dr. C. N. R. Rao, Prof. Dr. h.c. mult. Achim Müller, Prof. Dr. A. K. Cheetham	Wiley-VCH Verlag GmbH & Co. KGaA	2014
6	Organic Electronics Materials and Devices	Shuichiro Ogawa	Springer Tokyo	2024
7	Principles and Applications of Thermal Analysis	Gabbot, P	Oxford: Blackwell Publishing	2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/104/106/104106137/ https://archive.nptel.ac.in/courses/113/105/113105102/ https://archive.nptel.ac.in/courses/113/104/113104082/ https://www.youtube.com/watch?v=BeSxFLvk1h0
2	https://archive.nptel.ac.in/courses/113/104/113104102/ https://archive.nptel.ac.in/courses/104/105/104105124/ https://archive.nptel.ac.in/courses/105/104/105104157/

Continuous Assessment (10 Marks)

Continuous assessment evaluations are conducted based on laboratory associated with the theory.

Mark distribution

1. Preparation and Pre-Lab Work (2 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (2 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (3 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.

- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (3 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for Lab Examination (5 Marks)

1. Procedure/Preliminary Work/Conduct of Experiments (2 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

2. Result (2 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.

3. Viva Voce (1 Marks)

- Proficiency in answering questions related to theoretical and practical aspects of the subject.

List of Experiments

*Minimum 10 Experiments

Expt. Nos.	Experiment
1	Estimation of iron in iron ore
2	Estimation of copper in brass
3	Determination of cell constant and conductance of solutions
4	Calibration of pH meter and determination of pH of a solution
5	Synthesis of polymers (a) Urea-formaldehyde resin (b) Phenol-formaldehyde resin
6	Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} in solution
7	Determination of molar absorptivity of a compound (KMnO_4 or any water-soluble food colorant)
8	Analysis of IR spectra
9	Identification of drugs using TLC
10	Estimation of total hardness of water-EDTA method
11	Estimation of dissolved oxygen by Winkler's method
12	Determination of calorific value using Bomb calorimeter
13	Determination of saponification value of a given vegetable oil
14	Determination of acid value of a given vegetable oil
15	Verification of Nernst equation for electrochemical cell.

SEMESTER S2

ENGINEERING GRAPHICS AND COMPUTER AIDED DRAWING

Course Code	GCEST203	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	2-0-2-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	CourseType	Theory & Lab

Course Objectives:

1. To learn the principles and techniques of dimensioning and preparation of drawings
2. To develop the ability to accurately interpret engineering drawings
3. To learn the features of CAD software

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Relevance of technical drawing in engineering field. Types of lines, Dimensioning, BIS code of practice for technical drawing. (No questions for the end semester examination) Projection of points in different quadrants, Projection of straight lines inclined to one plane and inclined to both planes. Traces of a line. Inclination of lines with reference planes True length and true inclinations of line inclined to both the reference planes.	9
2	Projection of Simple solids such as Triangular, Rectangle, Square, Pentagonal and Hexagonal Prisms, Pyramids, Cone Cylinder and tetrahedron. Projection of solids in simple position including profile view. Projection of solids with axis inclined to one of the reference planes and with axis inclined to both reference planes.	9

3	Sections of Solids: Sections of tetrahedron, Prisms, Pyramids, Cone, Cylinder with axis in vertical position and cut by different section planes. True shape of the sections. (Exclude true shape given problems) Development of Surfaces: Development of surfaces of the solids and solids cut by different section planes. (Exclude problems with through holes)	9
4	Isometric Projection: Isometric scale- Isometric View and Projections of Prisms, Pyramids, Cone, Cylinder, Frustum of Pyramid, Frustum of Cone, Sphere, Hemisphere and their combinations. Computer Aided Drawing (CAD): Introduction, Role of CAD in design and development of new products, Advantages of CAD. Creating two-dimensional drawing with dimensions using suitable software. (CAD, only internal evaluation)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination -1(Written)	Internal Examination - 2(Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

Student can choose any one full question out of two questions from each module

2 Questions from one module. Total 8 Questions, each question carries 15 marks (15x4 =60marks)	Total
	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and plot the projection of points and lines located in different quadrants	K3
CO2	Prepare Multiview orthographic projections of objects by visualizing them in different positions	K3
CO3	Plot sectional views and develop surfaces of a given object	K3
CO4	Prepare pictorial drawings using the principles of isometric projection	K3
CO5	Sketch simple drawing using cad tools.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2										
CO4	3	2										
CO5	3	2	2		3							

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Graphics	Varghese, P. I.	V I P Publishers	Ist Edition 2012
2	Engineering Graphics,	Benjamin, J.	Pentex Publishers	5 th Edition 2017
3	Engineering Graphics for degree	John, K. C.	Prentice Hall India Publishers	Published in 2011
5	Engineering Graphics,	Anilkumar, K. N.	Adhyuth Narayan Publishers	10 th Edition 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Graphics with AutoCAD,	Kulkarni, D. M., Rastogi, A. P. and Sarkar, A. K.	Prentice Hall India Publishers	2009
2	Engineering Drawing & Graphics	Venugopal, K.	New Age International Publishers	4 th edition 2007
3	Engineering Drawing	Parthasarathy, N. S., and Murali, V.	Oxford University Press	2015

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/102/112102304/
2	https://archive.nptel.ac.in/courses/112/102/112102304/
3	https://archive.nptel.ac.in/courses/112/102/112102304/
4	https://archive.nptel.ac.in/courses/112/102/112102304/

SEMESTER S2
BASIC ELECTRICAL & ELECTRONICS ENGINEERING
(Common to Group C & D)

Course Code	GZEST204	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	4:0:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Apply fundamental concepts and circuit laws to solve simple DC/AC electric circuits
2. Develop an awareness on the fundamentals of electric power generation, transmission and distribution
3. Compare different types of DC and AC motors
4. Describe the fundamental concepts of electronic components and devices
5. Outline the basic principles of an electronic instrumentation system
6. Identify important applications of modern electronics in the contemporary world

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Generation of alternating voltages: - Faradays laws of Electromagnetic induction, Generation of Alternating Voltage, Elementary Generator, Representation of ac voltage and currents, sinusoidal waveforms: frequency, period average, RMS values and form factor of waveform; (Simple numerical problems) DC Circuits: Resistance in Series and Parallel, Ohms Law and Kirchhoff's laws, Voltage and current divider rule (Simple numerical problems)	11

	AC circuits: Purely resistive, inductive and capacitive circuits; Inductive and capacitive reactance, concept of impedance. (Simple numerical problems) Three phase AC systems: Representation of three phase voltages; star and delta connections (balanced only), relation between line and phase voltages, line and phase currents Power in AC circuits – Power factor; active, reactive and apparent power in single phase and three phase system. (Simple numerical problems)	
2	Generation of electrical energy: Conventional Sources: Hydro, thermal, nuclear plants (Block diagram description) Introduction to non-conventional energy sources: solar, wind, small hydroplants, PV system for domestic application. Transformers. Principle of operation, step-up and step-down transformers AC power supply scheme: Single phase and three phase system, Three phase 3 wire and 4 wire systems, Transmission System, Distribution system: Feeder, distributor, service mains Types of Motors – Principle of Operation: Block diagram showing power stages, losses and efficiency (electrical and mechanical and overall efficiency); Simple numerical efficiency Introduction to different types of DC and AC motors. Classification and different type of dc and ac motors, common applications: Principle of traction and applications Earthing: need for earthing, Types of earthing; pipe earthing, plate earthing; Principle of operation of MCB, ELCB/RCCB	11
3	Introduction to Semiconductor devices: Electronic components- Passive and active components - Resistors, Capacitors and Inductors (constructional features not required): types, specifications. Standard values, colour coding. PN Junction diode: - Principle of operation, V-I characteristics. Bipolar Junction Transistors: PNP and NPN structures, Principle of operation	11

	Digital Electronics: -Binary number system, Boolean algebra and Logic Gates, Universal gates. Basic electronic circuits: - Rectifiers and power supplies: Block diagram description of a dc power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple zener voltage regulator. Amplifiers: - Transistor as an amplifier, Block diagram of Public Address system	
4	Electronic Instrumentation: Quality of measurements -accuracy, precision, sensitivity and resolution, Working principle and applications of Sensors – pressure – strain gauge, Bourden gauge, temperature – RTD, thermocouple, proximity – capacitive sensor, ultrasonic sensor and accelerometer. Internet of things (IoT): Introduction, architecture of IoT, Implementation of smart city – street lighting, smart parking.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply fundamental concepts and circuit laws to solve simple DC/AC electric circuits	K2
CO2	Develop an awareness on the fundamentals of electric power generation, transmission and distribution	K3
CO3	Compare different types of DC and AC motors	K2
CO4	Describe the fundamental concepts of electronic components and devices	K2
CO5	Outline the basic principles of an electronic instrumentation system	K2
CO6	Identify important applications of modern electronics in the contemporary world	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										2
CO2	3		2			2	1					2
CO3	3					1						2
CO4	3	1										2
CO5	3		1									2
CO6	3					2	1					2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Basic Electrical Engineering	D P Kothari and I J Nagrath	Tata McGraw Hill	4/e 2019
2	Schaum's Outline of Basic Electrical Engineering	J.J.Cathey and Syed A Nasar	Tata McGraw Hill	
3	Basic Electronics: Principles and Applications	Chinmoy Saha, Arindham Halder and Debarati Ganguly	Cambridge University Press	1/e 2018
4	Basic Electrical and Electronics Engineering	D. P. Kothari and I. J. Nagrath	McGraw Hill	2/e 2020
5	The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World	Michael Miller	QUE	1/e 2015
6	Basic Electronics and Linear Circuits	N N Bhargava D C Kulshreshtha and S. C. Gupta	McGraw Hill	2/e 2017
7	Electronic Communication Systems	Kennedy and Davis	McGraw Hill	6/e 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Basic Electrical Engineering	D C Kulshreshtha	Tata McGraw Hill	2/e 2019
2	Electrical Engineering Fundamentals	Del Toro V	Pearson Education	2/e 2019
3	Basic Electrical Engineering	T. K. Nagsarkar, M. S. Sukhija	Oxford Higher Education	3/e 2017
4	Electronics: A Systems Approach	Neil Storey	Pearson	6e 2017
5	Electronic Devices and Circuit Theory	Robert L. Boylestad Louis Nashelsky	Pearson	11e 2015
6	Principles of Electronic Communication Systems	Frenzel, L. E	McGraw Hill	4e 2016
7	Internet of Things: Architecture and Design Principles	Raj Kamal	McGraw Hill	1/e 2017
8	Electronic Communication	Dennis Roddy and John Coolen	McGraw Hill	4/e 2008
9	Basic Electrical Engineering	D C Kulshreshtha	Tata McGraw Hill	2/e 2019

SEMESTER S2
ENGINEERING ENTREPRENEURSHIP AND IPR
(Common to all Branches)

Course Code	UCEST206	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	40
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Develop a framework for identifying, curating and validating engineering-based business ideas.
2. Learn essential tools for understanding product-market fit and customer needs.
3. Create a comprehensive business plan for a new venture.
4. Gain foundational knowledge of Intellectual Property Rights (IPR) and their importance for startups.
5. Develop skills for prototyping, stakeholder engagement, and team collaboration.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Ideation, Innovation & Entrepreneurship • What is Ideation? • Understanding Innovation • Frameworks for Innovation • The Entrepreneurial Mindset • Starting a Business, types formation statutory compliances. • Resources for Aspiring Entrepreneurs Introduction to Intellectual Property Rights (IPR) • Types of IPR: Patents, trademarks, copyrights, trade secrets • Strategies for protecting intellectual property based on the type of innovation	9

	• Role of IPR in securing funding and competitive advantage Importance of building a strong team • Identifying roles • Skill sets • Team dynamics Identifying Pain Points and problem statement • Idea Generation Techniques • Developing and Refining Ideas • Develop strategies for bringing your innovation to life	
2	Problem and solution canvas preparation • Orientation and canvas introduction • Customer needs assessment • Market segmentation • Value proposition • Competitive analysis • Market entry strategy • Market validation • Regulatory and legal considerations Customer profiling • Review of market research • Customer segmentation • Customer profiling • Persona development • Validation and feedback • Prioritisation and selection • Communication and messaging Competitor analysis • Identify competitors • Competitor profiling • SWOT analysis • Market positioning • Customer feedback and reviews • Pricing analysis • Differentiation strategy	9

	• Benchmarking and improvement	
3	Business plan preparation • Business plan framework • Market analysis • Product/ service description • Marketing and sales strategy • Operations plan • Financial projections • Risk management Prototype development plan preparation • Prototype requirements analysis • Technical specifications • Development approach • Development timeline • Resource allocation • Testing and quality assurance • Iterative development and feedback loop • Documentation and version control	9
4	Prototype development Stakeholder engagement strategies • Investors • Partners • Customers • Advisors & Mentors	9

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Micro Project	Internal Ex-1	Internal Ex-2	Total
5	35	10	10	60

Micro project / Comprehensive Business Plan:

The course will be evaluated based on a comprehensive Business Plan Report submitted and prototype development evaluation at the end of the course. The report should integrate learnings and activities from each module, demonstrating a deep understanding of the concepts and your ability to apply them to a chosen engineering venture.

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
- Minimum 1 and Maximum 2 Questions from each module. - Total of 6 Questions, each carrying 2 marks (6x2 =12 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 subdivisions. Each question carries 7 marks. (4x7 = 28 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Gain foundational knowledge of Innovation and Entrepreneurship, Intellectual Property Rights (IPR) and their importance for startups.	K2
CO2	Develop a framework for identifying, curating and validating engineering-based business ideas.	K3
CO3	Learn essential tools for understanding product-market fit and customer needs.	K3
CO4	Create a comprehensive business plan for a new venture.	K6
CO5	Develop skills for prototyping, stakeholder engagement, and team collaboration.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	3	3	3						
CO2	2	2	3	3	3	3	3	3	3			
CO3	2	2	2	2	2	3	3	3	3	2	2	2
CO4	3	3	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Engineering Handbook	Richard C.Dorf	CRC Press	2 nd edn, 2004
2	The Innovator's DNA	Clayton M. Christensen and Jeffrey H. Dyer	Harvard Business Review Press;	Revised edition (June 4, 2019)
3	Start with Why	Simon sinek	Portfolio	Reprint edition (December 27, 2011)
4	Business Model Generation	Alexander Osterwalder & Yves Pigneur	Wiley	2010
5	The Engineering Entrepreneur: A Practical Guide to Starting and Running a Successful Engineering Business in India	Saibal Gupta and Ashok Jhunhunwala	Sage Publications	2011
6	Innovation and Entrepreneurship for Engineers	Bharat Bhushan and Seema Bhushan	CRS Press	2016
7	Indian Patent Law	P. Narayanan	Eastern Book Company	2 nd edn/ 2020
8	The Law of Copyright and Designs	B.L. Wadehra	Universal Law	5 th edn/2010
9	Intellectual Property Rights (Including IPR in the Digital Age)	Prabuddha Ganguli	Tata McGraw-Hill Education	2001
10	The Startup India Manifesto: A Guide to the Indian Startup Ecosystem	Rashmi Bansal and Deepinder Goyal	Westland Publications	2020

SEMESTER S1/S2
HEALTH AND WELLNESS
(Common to all Groups)

Course Code	UCHWT127	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	1:0:1:0	ESE Marks	0
Credits	1	Exam Hours	Nil
Prerequisites (if any)	None	Course Type	

Course Objectives:

1. To provide essential knowledge on physical activity, health, and wellness.
2. To ensure students understand body systems, exercise principles, nutrition, mental health, and disease management.
3. To educate students on the benefits of yoga, the risks of substance abuse and basic first aid skills.
4. To equip students with the ability to lead healthier lifestyles.
5. To enable students to design effective and personalized exercise programs.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Human Body Systems related to Physical activity and its functions: Respiratory System - Cardiovascular System. Musculoskeletal System and the Major Muscle groups of the Human Body. Quantifying Physical Activity Energy Expenditure and Metabolic equivalent of task (MET) Exercise Continuum: Light-intensity physical activity, Moderate - intensity physical activity, Vigorous -intensity physical activity. Defining Physical Activity, Aerobic Physical Activity, Anaerobic Physical Activity, Exercise and Health-Related Physical Fitness. FITT principle to design an Exercise programme Components of Health-related Physical Fitness: - Cardiorespiratory Fitness- Muscular strength- Muscular endurance- Flexibility- Body composition.	4

2	Concept of Health and Wellness: Health and wellness differentiation, Factors affecting health and wellness. Mental health and Factors affecting mental health. Sports and Socialization: Sports and character building - Leadership through Physical Activity and Sports Diet and nutrition: Exploring Micro and Macronutrients: Concept of Balanced diet - Carbohydrate & the Glycemic Index Animal & Plant - based Proteins and their Effects on Human Health Dietary Fats & their Effects on Human Health Essential Vitamins and Minerals	2
3	Lifestyle management strategies to prevent / manage common hypokinetic diseases and disorders - Obesity - Cardiovascular diseases (e.g., coronary artery disease, hypertension) - Diabetes - Osteoporosis - Musculoskeletal disorders (e.g., osteoarthritis, Low back pain, Kyphosis, lordosis, flat foot, Knock knee) Meaning, Aims and objectives of yoga - Classification and importance of Yogic Asanas (Sitting, Standing, lying) Pranayama and Its Types - Active Lifestyle and Stress Management Through Yoga Understanding on substance abuse and addiction - Psychoactive substances & its ill effects- Alcohol- Opioids- Cannabis -Sedative -Cocaine -Other stimulants, including caffeine - Hallucinogens -Tobacco -Volatile solvents.	4
4	First aid and principles of First Aid: Primary survey: ABC (Airway, Breathing, Circulation). Qualities of a Good First Aider First aid measures for: - Cuts and scrapes - Bruises - Sprains - Strains -Fractures - Burns - Nosebleeds. First Aid Procedures: Cardiopulmonary Resuscitation (CPR) - Heimlich Maneuver - Applying a sling Sports injuries: Classification (Soft Tissue Injuries - Abrasion, Contusion, Laceration, Incision, Sprain & Strain)	2

Additional Topics

- Need and Importance of Physical Education and its relevance in interdisciplinary context. Understanding of the Endocrine System
- Developing a fitness profile
- Healthy foods habits for prevention and progression of Lifestyle Diseases. Processed foods and unhealthy eating habits.
- Depression - Anxiety - Stress
- Different ways of carrying an injured person. Usage of Automated external defibrillator

**Course Assessment Method
(CIE: 50 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Case Study/Micro project/Presentation	Activity evaluation	Total
10	20	20	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the different human body systems and describe various types of physical activities along with methods to measure and quantify these activities.	K2
CO2	Explain how to maintain or improve health and wellness through psychological practices, dietary habits, and sports activities.	K2
CO3	Discuss about common hypokinetic disorders and musculoskeletal disorders, and describe the importance of leading a healthy lifestyle through the practice of yoga and abstaining from addictive substances.	K2
CO4	Explain the basics of first aid and describe common sports injuries	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1				2		3		3	3	2		2
CO2				2		3		2	2			2
CO3						3		3				2
CO4				2		3						2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Foundations of Nutrition	Bhavana Sabarwal	Commonwealth Publishers	1999
2	Anatomy and physiology in health and illness.	Ross and Wilson	Waugh, A., & Grant, A.	2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fit to be Well Essential Concept	Thygerson, A. L., Thygerson, S. M., & Thygerson, J. S.	Jones & Bartlett Learning.	2018
2	Introduction to physical education, fitness, and sport.	Siedentop, D., & Van der Mars, H.	Human kinetics.	2022
3	Substance Use Disorders. Manual for Physicians.	Lal, R., & Ambekar, A.	National Drug Dependence Treatment Centre, New Delhi	2005
4	The exercise health connection-how to reduce your risk of disease and other illnesses by making exercise your medicine.	Nieman, D. C., & White, J. A	Public Health	1998
5	ACSM's resource manual for guidelines for exercise testing and prescription.	Lippincott Williams & Wilkins.	American College of Sports Medicine.	2012
6	Exercise Physiology: energy, nutrition and human performance.	Katch, F. I., Katch, V. L., & McArdle, W. D.	Lippincott Williams & Wilkins	2010

Continuous Internal Evaluation Marks (CIE): for the Health and wellness course

Students will be evaluated as follows.

Title	Method of Evaluation
Attendance	Students must attend at least 75% of both theory and practical classes. They will receive 10 marks based on their class attendance. Students who do not meet the minimum attendance requirement for a course, as specified in the B. Tech regulations, will not be eligible to proceed to the next criteria.
Assignment / Presentation	Assignments will be given to students to assess their understanding of the subjects taught. Students will be required to make presentations on the subjects taught in class, and their understanding of the subjects will be assessed. Based on the Assignments and Presentations the students will be awarded marks out of 20
Activity Evaluation	The Assignment / Presentation faculty handling the class will use the tests from the Fitness Protocols and Guidelines for ages 18+ to 65 years, as set forth by FIT India. Measurements will be taken for all the tests of the FIT India Fitness Protocol and the evaluation will be based on the benchmark score received for the following tests: 1. V Sit Reach Test 2. Partial Curl Up - 30 seconds 3. Push Ups (Male) and Modified Push Up (Female) 4. Two (2) Km Run/Walk Students who achieve a total benchmark score of 8 across the aforementioned 4 tests will be awarded pass marks for activity evaluation. Students who score better will be awarded a maximum mark of 20.
Activity Evaluation - Special Circumstances	Physically challenged and medically unfit students can opt for an objective test to demonstrate their knowledge of the subjects taught. Based on their performance in the objective test, they will be awarded marks out of 20.

Activity Evaluation - Special Considerations - NCC	Students who enrolled themselves in the NCC during the course period (between the start and end dates of the program) and attended 5 college level parades will be awarded pass marks for activity evaluation. Students who attend more parades will be eligible for a maximum mark of 20 based on their parade attendance.
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Tests to evaluated as per Criterion - 2 and Benchmark Scores

V Sit Reach Test

How to Perform:

1. The subject removes their shoes and sits on the floor with the measuring line between their legs and the soles of their feet placed immediately behind the baseline, heels 8-12" apart.
2. The thumbs are clasped so that hands are together, palms facing down and placed on the measuring line.
3. With the legs held flat by a partner, the subject slowly reaches forward as far as possible, keeping the fingers on baseline and feet flexed.
4. After three tries, the student holds the fourth reach for three seconds while that distance is recorded.
5. Make sure there are no jerky movements, and that the fingertips remain level and the legs flat.

Infrastructure/Equipment Required:

1. A tape for marking the ground, marker pen, and ruler.
2. With the tape mark a straight line two feet long on the floor as the baseline, and a measurement line perpendicular to the midpoint of the baseline extending two feet on each side.
3. Use the marker pen to indicate every centimeter and millimeter along the measurement line. The point where the baseline and the measuring line intersect is the zero point.

Scoring: The score is recorded in centimeters and millimeters as the distance reached by the hand, which is the difference between the zero point (where the baseline and measuring line intersect) and the final position.

Scoring for V Sit Reach Test for Males

Level	Benchmark Score	Measurement (cm)
1	2	<11
2	4	12-13
3	6	14-17
4	7	18-19
5	8	20-21
6	9	22
7	10	>22

Scoring for V Sit Reach Test for Females

Level	Benchmark Score	Measurement (cm)
1	2	<14
2	4	15-16
3	6	17-19
4	7	20-21
5	8	22
6	9	23
7	10	>23

Partial Curl Up - 30 seconds

How to Perform:

1. The subject lies on a cushioned, flat, clean surface with knees flexed, usually at 90 degrees, with hands straight on the sides (palms facing downwards) closer to the ground, parallel to the body.
2. The subject raises the trunk in a smooth motion, keeping the arms in position, curling up the desired amount (at least 6 inches above/along the ground towards the parallel strip).
3. The trunk is lowered back to the floor so that the shoulder blades or upper back touch the floor.

Infrastructure/Equipment Required:

Flat clean cushioned surface with two parallel strips (6 inches apart), Stopwatch

Scoring: Record the maximum number of Curl ups in a certain time period 30 seconds.

Scoring for Partial Curl Up - 30 seconds Test for Males

Level	Benchmark Score	Numbers
1	2	<25
2	4	25-30
3	6	31-34
4	7	35-38
5	8	39-43
6	9	44-49
7	10	>49

Scoring for Partial Curl Up - 30 seconds Test for Females

Level	Benchmark Score	Numbers
1	2	<18
2	4	18-24
3	6	25-28
4	7	29-32
5	8	33-36
6	9	37-43
7	10	>43

Push Ups for Male/Modified Push Ups for Female**How to Perform:**

1. A standard push up begins with the hands and toes touching the floor, the body and legs in a straight line, feet slightly apart, the arms at shoulder width apart, extended and at a right angle to the body.
2. Keeping the back and knees straight, the subject lowers the body to a predetermined point, to touch some other object, or until there is a 90-degree angle at the elbows, then returns back to the starting position with the arms extended.

3. This action is repeated, and the test continues until exhaustion, or until they can do no more in rhythm or have reached the target number of push-ups.

4. For Female: push-up technique is with the knees resting on the ground.

Infrastructure/Equipment Required:

Flat clean cushioned surface/Gym mat

Scoring: Record number of correctly completed pushups.

Scoring for Push Ups for Male

Level	Benchmark Score	Numbers
1	2	<4
2	4	04- 10
3	6	11 -18
4	7	19-34
5	8	35-46
6	9	47-56
7	10	>56

Scoring for Modified Push Ups for Female

Level	Benchmark Score	Numbers
1	2	0-1
2	4	2 - 5
3	6	6 -10
4	7	11 - 20
5	8	21-27
6	9	27-35
7	10	>35

2 Km Run/Walk

How to Perform:

1. Participants are instructed to run or walk 2 kms in the fastest possible pace.
2. The participants begin on signal (Starting point)- “ready, start”. As they cross the finish line, elapsed time should be announced to the participants.
3. Walking is permitted but the objective is to cover the distance in the shortest possible time.

Infrastructure/Equipment Required:

Stopwatch, whistle, marker cone, lime powder, measuring tape, 200 or 400 m with 1.22 m (minimum 1 m) width preferably on a flat and even playground with a marking of starting and finish line. You can also use any application on your mobile phone that tells you the distance.

Scoring: Time taken for completion (Run or Walk) in min, sec.

Scoring for 2Km Run/walk for Male

Level	Benchmark Score	Minutes : Seconds
1	2	> 11:50
2	4	10:42
3	6	09:44
4	7	08:59
5	8	08:33
6	9	07:37
7	10	>07:37

Scoring for 2Km Run/walk for Female

Level	Benchmark Score	Minutes: Seconds
1	2	>13:47
2	4	12:51
3	6	12:00
4	7	11:34
5	8	10:42
6	9	09:45
7	10	>09:45

SEMESTER - S1/S2
LIFE SKILLS AND PROFESSIONAL COMMUNICATION
(Common to all Branches)

Course Code	UCHUT128	CIE Marks	100
Teaching Hours/Week (L: T:P: R)	2:0:1:0	ESE Marks	0
Credits	1	Exam Hours	-
Prerequisites (if any)	None	Course Type	Activity-based learning

Course objectives:

1. To foster self-awareness and personal growth, enhance communication and interpersonal connection skills, promote effective participation in groups and teams, develop critical thinking, problem-solving, and decision-making skills, and cultivate the ability to exercise emotional intelligence.
2. To equip students with the necessary skills to listen, read, write & speak, to comprehend and successfully convey any idea, technical or otherwise.
3. To equip students to build their profile in line with the professional requirements and standards

Continuous Internal Evaluation Marks (CIE):

- Continuous internal evaluation is based on the individual and group activities as detailed in the activity table given below.
- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. They should use online collaboration tools for group activities, report/presentation making and work management.
- Activities are to be distributed between 3 class hours (2L+1P) and 3.5 Self-study hours.
- Marks given against each activity should be awarded fully if the students successfully complete the activity.
- Students should maintain a portfolio file with all the reports and other textual materials generated from the activities. Students should also keep a journal related to the activities undertaken.

- Portfolio and journal are mandatory requirements for passing the course, in addition to the minimum marks required.
- The portfolio and journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through the HMC courses and Mini project course.
- Self-reflection questionnaire shall be given at the beginning of the semester, in between and at the end of the semester based on the guidelines in the manual of the course.

Table 1: Activity Table

Sl. No.	Activity	Class room (L) / Self Study (SS)	Week of completion	Group / Individual (G/I)	Marks	Skills	CO
1.1	Group formation and self-introduction among the group members	L	1	G	-	• Connecting with group members • Time management - Gantt Chart	
1.2	Familiarizing the activities and preparation of the time plan for the activities	L	1	G	-		
1.3	Preparation of Gantt chart based on the time plan	SS	1	G	2		
2.1	Take an online personality development test, self reflect and report	SS	1	I	2	• Self-awareness Writing	CO1
2.2	Role-storming exercise 1: Students assume 2 different roles given below and write about their •Strengths, •Areas for improvement, •Concerns, •Areas in which he/she hesitates to take advice, •Goals/Expectations, from the point of view of the following assumed roles i) their parent/guardian/mentor ii) their friend/sibling/cousin	L	1	I	2	• Goal setting - Identification of skills and setting goal • Self-awareness • Discussion in groups • Group work- Compiling of ideas • Mind mapping	CO1
2.3	Role-storming exercise 2: Students assume the role of their teacher and write about the •Skills required as a B.Tech graduate •Attitudes, habits, approaches required and activities to be practised during their B.Tech years, in order to achieve the set goals	SS	1	I	2		CO1

2.4	Discuss the skills identified through rolestorming exercise by each one within their own group and improvise the list of skills	L	1	G	2		CO1
2.5	Prepare a mind map based on the rolestorming exercise and exhibit/present it in class	SS	2	G	2		CO1
3	Prepare a presentation on instances of empathy they have observed in their own life or in other's life	L	2 to 4	I	2	• Empathy	CO2
4.1	Each student connects and networks with a minimum of 3 professionals from industry/public sector organizations/other agencies/NGOs /academia (atleast 1 through LinkedIn)	SS	3	I	2	• Workplace awareness • Listening • Communication - interacting with people • Networking through various media including LinkedIn • Discussion in groups • Report preparation • Creativity	CO2
4.2	Interact with them to understand their workplace details including • workplace skills required • their work experience • activities they have done to enhance their employability during their B.Tech years • suggestions on the different activities to be done during B.Tech years Prepare a documentation of this	SS	3	I	4		
4.3	Discuss the different workplace details & work readiness activities assimilated by each through the interactions within their group and compile the inputs collected by the individuals Prepare the Minutes of the discussions	SS	3	G	2		CO2
4.4	Report preparation based on the discussions	SS	4	G	3		CO4
4.5	Perform a role-play based on the workplace dynamics assimilated through interactions and group discussions	L	5	G	4	Goal setting - Preparation of action plan	CO3
4.6	Identify their own goal and prepare an action plan for their undergraduate journey to achieve the goal	SS	5	I	2		CO1
5.1	Select a real-life problem that requires a technical solution and list the study materials needed	L	6	G	2		CO3
5.2	Listen to TED talks & video lectures from renowned Universities related to the problem and prepare a one-page summary (Each group member should select a different resource)	SS	6	I	2		CO4
5.3	Use any online tech forum to gather ideas for solving the problem chosen	SS	6	G	2		CO5
5.4	Arrive at a possible solution using six thinking hat exercise	L	7	G	3		CO3
5.5	Prepare a report based on the problem-	SS	7	G	2		CO4

	solving experience						
6.1	Linkedin profile creation	SS	1	I	2	Profile-building	CO6
6.2	Resume preparation	SS	8	I	2		CO6
6.3	Self-introduction video	SS	8	I	3		CO6
7	Prepare a presentation on instances of demonstration of emotional intelligence	SS	9	I	2	Emotional intelligence	CO2
8	Prepare a short video presentation on diversity aspects observed in our society (3 to 5 minutes)	SS	10	G	3	Diversity	CO2, CO5
9	Take online Interview skills development sessions like robotic interviews; self-reflect and report	SS	10	I	2	• Interview skills	CO6
10	Take an online listening test, self-reflect and report	SS	11	I	2	Listening skills	CO6
11.1	Activities to improve English vocabulary of students	L	8	I/G	4	• English vocabulary • English language skills • Writing • Presentation • Group work • Self-reflection	CO4
11.2	Activities to help students identify errors in English language usage	L	9	I/G	2		CO4
11.3	Activity to help students identify commonly misspelled words, commonly mispronounced words and confusing words	L	10	I/G	2		CO4
11.4	Write a self-reflection report on the improvement in English language communication through this course	SS	12	I	2		CO4
11.5	Presentation by groups on the experience of using online collaboration tools in various group activities and time management experience as per the Gantt chart prepared	L	11 to 12	G	2		CO4, CO5
12.1	Each group prepares video content for podcasts on innovative technological interventions/research work tried out in Kerala context by academicians/professionals/Govt. agencies/research institutions/private agencies/NGOs/other agencies	SS	12	G	4	• Audio-visual presentations creations with the use of technology tools • Effective use of social media platforms • Profile building	CO2, CO4, CO5
12.2	Upload the video content to podcasting platforms or YouTube	SS	12	G	1		CO5
12.3	Add the link of the podcast in their LinkedIn profile	SS	12	G	1		CO5

	i) their parent/guardian/mentor ii) their friend/sibling/cousin						
2.3	Role-storming exercise 2: Students assume the role of their teacher and write about the ● Skills required as a B.Tech graduate ● Attitudes, habits, approaches required and activities to be practiced during their B.Tech years, in order to achieve the set goals	SS	1	I	2		CO1
2.4	Discuss the skills identified through role storming exercise by each one within their own group and improvise the list of skills	L	1	G	2		CO1
2.5	Prepare a mind map based on the role-storming exercise and exhibit/present it in class	SS	2	G	2		CO1
3	Prepare a presentation on instances of empathy they have observed in their own life or in other's life	L	2 to 4	I	2	• Empathy	CO2
4.1	Each student connects and networks with a minimum of 3 professionals from industry/public sector organizations/other agencies/NGOs /academia (at least 1 through LinkedIn)	SS	3	I	2	• Workplace awareness • Listening • Communication - interacting with people	
4.2	Interact with them to understand their workplace details including • workplace skills required • their work experience • activities they have done to enhance their employability during their B. Tech years • suggestions on the different activities to be done during B. Tech years Prepare a documentation of this	SS	3	I	4	• Networking through various media including LinkedIn • Discussion in groups • Report preparation • Creativity • Goal setting - Preparation of action plan	CO2
4.3	Discuss the different workplace details & work readiness activities assimilated by each through the interactions within their group and compile the inputs collected by the individuals Prepare the Minutes of the discussions	SS	3	G	2		CO2
4.4	Report preparation based on the discussions	SS	4	G	3		CO4

4.5	Perform a role-play based on the workplace dynamics assimilated through interactions and group discussions	L	5	G	4		CO3
4.6	Identify their own goal and prepare an action plan for their undergraduate journey to achieve the goal	SS	5	I	2		CO1
5.1	Select a real-life problem that requires a technical solution and list the study materials needed	L	6	G	2		CO3
5.2	Listen to TED talks & video lectures from renowned Universities related to the problem and prepare a one-page summary (Each group member should select a different resource)	SS	6	I	2		CO4
5.3	Use any online tech forum to gather ideas for solving the problem chosen	SS	6	G	2		CO5
5.4	Arrive at a possible solution using six thinking hat exercise	L	7	G	3		CO3
5.5	Prepare a report based on the problem-solving experience	SS	7	G	2		CO4
6.1	Linkedin profile creation	SS	1	I	2		CO6
6.2	Resume preparation	SS	8	I	2		CO6
6.3	Self-introduction video	SS	8	I	3		CO6
7	Prepare a presentation on instances of demonstration of emotional intelligence	SS	9	I	2		CO2
8	Prepare a short video presentation on diversity aspects observed in our society (3 to 5 minutes)	SS	10	G	3		CO2, CO5
9	Take online Interview skills development sessions like robotic interviews; self-reflect and report	SS	10	I	2	• Interview skills	CO6
10	Take an online listening test, self-reflect and report	SS	11	I	2		CO6

11.1	Activities to improve English vocabulary of students	L	8	I/G	4	- English vocabulary - English language skills - Writing - Presentation - Group work - Self-reflection	CO4
11.2	Activities to help students identify errors in English language usage	L	9	I/G	2		CO4
11.3	Activity to help students identify commonly misspelled words, commonly mispronounced words and confusing words	L	10	I/G	2		CO4
11.4	Write a self-reflection report on the improvement in English language communication through this course	SS	12	I	2		CO4
11.5	Presentation by groups on the experience of using online collaboration tools in various group activities and time management experience as per the Gantt chart prepared	L	11 to 12	G	2		CO4, CO5
12.1	Each group prepares video content for podcasts on innovative technological interventions/research work tried out in Kerala context by academicians/professionals/Govt. agencies/research institutions/private agencies/NGOs/other agencies	SS	12	G	4	- Audio-visual presentations creations with the use of technology tools - Effective use of social media platforms - Profile building	CO2, CO4, CO5
12.2	Upload the video content to podcasting platforms or YouTube	SS	12	G	1		CO5
12.3	Add the link of the podcast in their LinkedIn profile	SS	12	G	1		CO5

Table 2: Lab hour Activities (P): 24 Marks

SI No	Activity	Marks	Skill	CO
1	Hands-on sessions on day-to-day engineering skills and a self-reflection report on the experience gained: 1. Drilling practice using electric hand drilling machines. 2. Cutting of MS rod and flat using electric hand cutters. 3. Filing, finishing and smoothening using electrically operated hand grinders. 4. MS rod cutting using Hack saw by holding the work in bench wise. 5. Study and handling different types of measuring instruments. 6. Welding of MS, SS work pieces. 7. Pipe bending practice (PVC and GI). 8. Water tap fitting. 9. Water tap rubber seal changing practice. 10. Union and valves connection practice in pipes. 11. Foot valve fitting practice. 12. Water pump seal and bearing changing practice.	24	Basic practical engineering skills	3
2	Language Lab sessions	-	Language Skills	4

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to know & understand oneself, show confidence in one's potential & capabilities, set goals and develop plans to accomplish tasks	K5
CO2	Develop the ability to communicate and connect with others, participate in groups/teams, empathise, respect diversity, be responsible and understand the need to exercise emotional intelligence	K5
CO3	Develop thinking skills, problem-solving and decision-making skills	K5
CO4	Develop listening, reading, writing & speaking skills, ability to comprehend & successfully convey any idea, and ability to analyze, interpret & effectively summarize textual, audio & visual content	K6
CO5	Develop the ability to create effective presentations through audio-visual mediums with the use of technology tools and initiate effective use of social media platforms & tech forums for content delivery and discussions	K6
CO6	Initiate profile-building exercises in line with the professional requirements, and start networking with professionals/academicians	K6

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										1		3
CO2					1			3		3		3
CO3		1	1		1					1		1
CO4					1					1		2
CO5					1	1				1		2
CO6					1					1		

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Life Skills & Personality Development	Maithry Shinde et.al.	Cambridge University Press	First Edition, 2022
2	Emotional Intelligence: Why it can matter more than IQ	Daniel Goleman	Bloomsbury, Publishing PLC	25th Anniversary Edition December 2020
3	Think Faster, Talk Smarter: How to speak successfully when you are put on the spot	Matt Abrahams	Macmillan Business	September 2023
4	Deep Work: Rules for focused success in a distracted world	Cal Newport	PIATKUS	January 2016
5	Effective Technical Communication	Ashraf Rizvi	McGraw Hill Education	2nd Edition 2017
6	Interchange	Jack C. Richards, With Jonathan Hull, Susan Proctor	Cambridge publishers	5th Edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Life Skills for Engineers	Remesh S., Vishnu R.G.	Ridhima Publications	First Edition, 2016
2	Soft Skills & Employability Skills	Sabina Pillai and Agna Fernandez	Cambridge University Press	First Edition, 2018
3	Effective Technical Communication	Ashraf Rizvi	McGraw Hill Education	2nd Edition 2017
4	English Grammar in Use	Raymond Murphy,	Cambridge University Press India PVT LTD	5th Edition 2023
5	Guide to writing as an Engineer	David F. Beer and David McMurrey	John Willey. New York	2004

SEMESTER S2

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING WORKSHOP

(Common to Group C & D except for Civil Engineering Branch)

Course Code	GZESL208	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:2:0	ESE Marks (Internal only)	50
Credits	1	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. Demonstrate safety measures against electrical shocks
2. Develop familiarity with transformers, rheostats, batteries and earthing schemes
3. Develop the connection diagram and identify the suitable accessories necessary for wiringsimple electric circuits
4. Identify various electronic components
5. Operate various measuring instruments
6. Design simple electronic circuits on breadboard and PCB
7. Build the ability to work in a team with good interpersonal skills.

Expt. No.	Experiments (Minimum of 7 Experiments to be done)
1	a) Demonstrate the precautionary steps adopted in case of Electrical shocks. b) Identify different types of cables, wires, switches, fuses, fuse carriers, MCB, ELCB andMCCB, familiarise the ratings.
2	Wiring of a simple light circuit for light/ fan point (PVC conduit wiring) and a 6A plug socket with individual control.
3	Wiring of light/fan circuit using two-way switches. (Staircase wiring)
4	Wiring of fluorescent lamp and a power plug (16 A) socket with a control switch.
5	Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch and Energy meter.

6	Familiarization of step up and step-down transformers, (use low voltage transformers) Measurement and representation of voltage and waveform to scale in graph sheet with the help of CRO
7	Familiarization of rheostats, measurement of potential across resistance elements and introducing the concept of relative potential using a DC circuit.
8	a) Identify battery specifications using different types of batteries. (Lead acid, Li Ion, NiCd etc.) b) Familiarize different types of earthing (Pipe, Plate Earthing, Mat Schemes) and ground enhancing materials (GEM).
ELECTRONICS WORKSHOP (Minimum of 7 Experiments to be done)	
1	Familiarization/Identification of electronic components with specification (Functionality, type, size, colour coding, package, symbol and cost of -Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink etc.)
2	Drawing of electronic circuit diagrams using BIS/IEEE symbols and Interpret data sheets of discrete components and IC's
3	Familiarization/Application of testing instruments and commonly used tools. - Multimeter, Function generator, Power supply, CRO, DSO. Soldering iron, Desoldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de- soldering station
4	Testing of electronic components using multimeter - Resistor, Capacitor, Diode, Transistor and JFET.
5	Printed circuit boards (PCB) - Types, Single sided, Double sided, PTH, Processing methods. Design and fabrication of a single sided PCB for a simple circuit.
6	Inter-connection methods and soldering practice. Bread board, Wrapping, Crimping, Soldering - types - selection of materials and safety precautions. Soldering practice in connectors and general-purpose PCB, Crimping.
7	Assembling of electronic circuit/system on general purpose PCB, test and show the functioning (Any two)- • Fixed voltage power supply with transformer • Rectifier diode

	• Capacitor filter • Zener/IC regulator • Square wave generation using IC 555 timer in IC base.
8	Assembling of electronic circuits using SMT (Surface Mount Technology) stations.
9	Introduction to EDA tools (such as KiCad or Xcircuit)

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Total
5	45	50

End Semester Examination Marks (ESE): (Internal evaluation only)

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified Lab record.*

Pass Criteria:

- *A student must score a minimum of 50% overall, combining marks from both Continuous Internal Evaluation (CIE) and End Semester Examination (ESE).*
- ***In addition, the student must secure at least 40% in the End Semester Examination (ESE).***

The ESE shall be conducted internally, with evaluation carried out by a panel of faculty members. This panel must include at least one faculty member who was not involved in the Continuous Internal Evaluation (CIE) of the lab course.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate safety measures against electrical shocks	K2
CO2	Familiarise with transformers, rheostats, batteries and earthing schemes	K2
CO3	Illustrate the connection diagram and identify the suitable accessories necessary for wiring simple electric circuits	K3
CO4	Identify various electronic components	K2
CO5	Select and Operate various measuring instruments	K3
CO6	Apply the design procedure of simple electronic circuits on breadboard and PCB	K3
CO7	Build the ability to work in a team with good interpersonal skills	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3						2
CO2	1					2	1					2
CO3	2					1						2
CO4	3					2						3
CO5	3				3	2			2			3
CO6	3		3	1	3	2	1		2			3
CO7									3	2		2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electrical Design Estimating and Costing	K B Raina and S K Bhattacharya	New Age International Publishers	2/e 2024
2	Electrical Systems Design	M K Giridharan	I K International Publishing House Pvt. Ltd	3/e 2022
3	Basic Electrical Engineering	D P Kothari and I J Nagrath	Tata McGraw Hill	4/e 2019
4	Basic Electronics and Linear Circuits	NN Bhargava, D C Kulshreshtha and S C Gupta	Mc Graw Hill	2/e 2017

Continuous Assessment with equal weightage for both specialisations (45 Marks)

1. Preparation and Pre-Lab Work (10 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (15 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (10 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (10 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Evaluation Pattern for End Semester Examination with equal weightage in both specializations (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S2
CIVIL ENGINEERING DRAFTING LAB
(Common to CE and CV)

Course Code	GCESL218	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:2:0	ESE Marks (Internal Only)	50
Credits	1	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GCEST104/ Equivalent	Course Type	Practical

Course Objectives:

1. To introduce the fundamentals of Civil Engineering Drawing and understand the principles of planning.
2. To enable students to learn the drafting of buildings manually and using drafting software.

Details of Experiment

Expt. No	Experiment
1	Introduction to Civil Engineering Drawing, Concept of Scale, Plan, Section and Elevation. Drawing tools and accessories, Manual and Computer Aided Drafting Draw the view of simple objects (books, shelves, benches, etc.) adopting appropriate scales
2	Draw sectional details and elevation of paneled doors.
3	Draw sectional details and elevation of wooden glazed window.
4	Draw elevation, section and detailing of connection between members for steel roof truss
5	Draw plan, section and elevation of dog legged staircase
6	Prepare a model of a single storied building with card board from given drawings (Not expected to complete in the lab hours)
7	Draw plan, section and elevation of single storied residential building from the given line sketch.

8	Draw plan, section and elevation of two-storied framed building from the given line sketch.
9	Draw plan, section and elevation of an industrial building.
10	Introduction to Auto CAD: Preparation of CAD drawing of any of the building components (Experiments 2-5)
11	Preparation of CAD drawing of plan, section and elevation of single storied residential building (Experiment 7).

Course Assessment Method (CIE: 50 Marks, ESE 50 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record. (Continuous Assessment)	Internal Exam	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

Mandatory requirements for ESE:

Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified Lab record.

Pass Criteria:

- A student must score a minimum of 50% overall, combining marks from both Continuous Internal Evaluation (CIE) and End Semester Examination (ESE).
- In addition, the student must secure at least 40% in the End Semester Examination (ESE).

The ESE shall be conducted internally, with evaluation carried out by a panel of faculty members. This panel must include at least one faculty member who was not involved in the Continuous Internal Evaluation (CIE) of the lab course.

Course Outcomes (COs)

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

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate ability to organize civil engineering drawings systematically and professionally	K2
CO2	Illustrate the detailing of building components like doors, windows, roof trusses etc.	K2
CO3	Develop the sketch of plan, front elevation and sectional elevation from line diagram.	K3
CO4	Draft the plan elevation and sectional views of the residential buildings, industrial buildings, and framed structures using software.	K3

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							3	3	1		2
CO2	3							3	3	1		2
CO3	3							3	3	1		2
CO4	3				2			3	3	1		2

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), : No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Building Drawing and Detailing	Dr. Balagopal T.S. Prabhu	Spades Publishers, Calicut	Revised Edition 2022
2	Building Drawing With An Integrated Approach to Built Environment	Shah, M.G., Kale, C. M. and Patki, S.Y.	Tata McGraw Hill Publishing Company Limited, New Delhi	5 th edition 2017
3	Building Planning and Drawing	M.V. Chitawadagi S.S. Bhavikatti	Dreamtech Press	2019

References	
Sl. No	Title of the Book
1	National Building Code of India (refer the latest updates)
2	Kerala panchayat building rules (refer the latest updates)
3	Kerala Municipality building rules (refer the latest updates)
4	IS962: 1989 (Reaffirmed 2022) Indian Standard Code of practice for architectural and building drawings

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

6. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

7. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

8. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

9. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

10. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

PROGRAMME CORE 1

SEMESTER S2

MECHANICS OF SOLIDS

(CIVIL ENGINEERING)

Course Code	PCCET205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GCEST103/ Equivalent	Course Type	Theory

Course Objectives:

1. To provide students with a fundamental understanding of the mechanics of deformable bodies and help them develop their analytical and problem-solving skills.
2. To introduce students to the various internal effects induced in structural members and their deformations due to different types of loading.
3. To enable students to determine the stress, strain, and deformation of loaded structural elements.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Concept of stress and strain – types, stress – strain relation - Hooke's law, Young's modulus of elasticity. Stress-strain diagram of mild steel. Factor of safety, working stress. Axially loaded bars with uniform and uniformly varying cross section–stress, strain and deformation. Temperature effects, temperature stress in composite bars. Shear stress and shear strain, Modulus of rigidity, simple shear, punching shear. Lateral strain, Poisson's ratio, volumetric strain. Bulk modulus of elasticity, relationships between elastic constants.	11

	Strain energy – concept. Strain energy due to normal stress. Strain energy in bars carrying axial loads. Strain energy due to shear stress.	
2	Beams – different types. Types of loading on beams. Concept of bending moment and shear force. Relationship between intensity of load, shear force and bending moment. Shear force and bending moment diagrams of cantilever beams, simply supported beams and overhanging beams for different type of loads. Point of contraflexure.	11
3	Theory of simple bending, assumptions and limitations. Calculation of normal stress in beams, moment of resistance. Shear stress in beams. Beams of uniform strength. Strain energy due to bending – calculation of strain energy in beams. Derivation of differential equation for calculating the deflection of beams – Macaulay's method.	10
4	Stresses on inclined planes for uniaxial and biaxial stress fields. Principal stresses and principal planes, maximum shear stress in 2D problems. Mohr's circle of stress for 2D problems. Short column – direct and bending stress. Kern of a section. Slender column – Euler's buckling load, slenderness ratio, limitation of Euler's formula. Rankine's formula. Torsion of circular and hollow circular shafts, Power transmitted by circular shafts and hollow circular shafts. Strain energy due to torsion.	12

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Recall the fundamental terms and theorems associated with mechanics of linear elastic deformable bodies.	K1
CO2	Explain the behavior and response of various structural elements under various loading conditions.	K2
CO3	Apply the principles of solid mechanics to calculate internal stresses/strains, stress resultants and strain energies in structural elements subjected to axial/transverse loads and bending/twisting moments.	K3
CO4	Choose appropriate principles or formula to find the elastic constants of materials making use of the information available.	K3
CO5	Perform stress transformations, identify principal planes/ stresses and maximum shear stress at a point in a structural member.	K3
CO6	Analyse the given structural member to calculate the safe load or proportion the cross section to carry the load safely.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-
CO6	3	3	2	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Structures	H. J. Shah and S. B. Junnarkar	Charotar Publishing House	32 nd Edition 2016
2	A Text book of Strength of Materials	R. K. Bansal	Laxmi Publications	6 th Edition 2018
3	Mechanics of Materials	B. C. Punmia, Ashok K. Jain, Arun Kumar Jain	Laxmi Publications	Revised Edition 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Mechanics of Solids	Egor P. Popov	Prentice Hall International Series	2 nd Edition 2015
2	Mechanics of Materials	James M Gere, S.P. Timoshenko	CBS Publishers and Distributors	2 nd Edition 2004
3	Mechanics of Materials	R.C. Hibbeler	Pearson	10 th Edition 2018
4	Strength of Materials	S. Ramamrutham and R. Narayanan	Dhanpat Rai Publishing Co	18 th Edition 2014
5	Strength of Materials	Rattan	McGraw Hill Education India	3 rd Edition 2016

Video Links (NPTEL, SWAYAM...)	
Sl No.	Link ID
1	https://archive.nptel.ac.in/courses/105/104/105104160/

SEMESTER S2

PROCESS CALCULATIONS

(CHEMICAL ENGINEERING)

Course Code	PCCHT205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To establish fundamental principles of Chemical Engineering in a simple and up-front manner and to provide the broad background for applying these principles to theoretical and industrial problems.
2. To introduce the basic concepts of composition calculations practiced in chemical processes, gas laws, material and energy balances etc. which are at the fundamental and core areas of Chemical Engineering course.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Concepts: Introduction to Chemical Engineering, Chemical process Industry, Unit Operations and Unit Processes. Units and Dimensions, Conversion of units, Conversion of equations- problems. Composition of solids, liquids and solutions - weight percent, mole percent, molarity, normality, molality, ppm Gaseous mixtures, Composition of gaseous mixtures, Average molecular weight and density, Ideal gas law, Dalton's Law, Amagat' Law, Vander Waals equation Vapour Pressure: Effect of temperature on vapour pressure – Antoine Equation, Clausius-Clapeyron equation.	11

	Problem solving in Equations of state, Vapor Pressure calculation using EXCEL /Matlab/ SCILAB/PYTHON etc. – only for self- study /microproject/assignment.	
2	Material Balance for unit operations- Introduction, key component Material balance for unit operations like mixing, distillation, drying, evaporation, absorption, crystallization, extraction, leaching.	11
3	Material Balance for unit processes - Definition of terms - limiting reactant, excess reactant, percentage yield, conversion, selectivity Orsat analysis, Material Balance for combustion, Recycle, bypass and purge operations. Problem solving in Material balance using EXCEL/ Matlab/ SCILAB/ PYTHON etc.- only for self-study/microproject/assignment.	11
4	Energy Balance: Heat capacity of solids, liquids and gaseous mixtures, Kopp's Rule, Latent Heats-Heat of fusion, heat of vaporization, Estimation of Heat of Vaporization - Kistyakowsky Equation, Trouton's rule, Watson equation. Heat effects accompanying chemical reactions - Standard heats of reaction, standard heat of combustion, and standard heat of formation, Hess's law of constant heat summation. Effect of temperature and pressure on heat of reaction, temperature of reaction, adiabatic reaction temperature.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain fundamentals of Chemical Engineering, units and dimensions and estimate chemical composition and other physical quantities of solids, liquids, solutions, gases and mixtures	K3
CO2	Develop and solve basic material balance equations for the unit operations employed in process industries.	K3
CO3	Develop and solve basic material balance equations for the unit processes employed in process industries.	K3
CO4	Develop and solve energy balance equations for various physical and chemical processes.	K3
CO5	Implement and run software programs for solving stoichiometric problems	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									3
CO2	3	3	3									3
CO3	3	3	3									3
CO4	3	3	3									3
CO5	3	3	3		3				1			3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Stoichiometry and Process Calculations	K.V. Narayanan, B. Lakshmikutty	Prentice-Hall of India Pvt. Ltd.	2 nd edition 2016
2	Stoichiometry	B.I. Bhatt, S.M. Vora	McGraw Hill Publishing Company Limited.	6 th edition 2021
3	Basic Principles & Calculations in Chemical Engineering	David M. Himmelblau, James B. Riggs	Prentice-Hall of India Pvt. Ltd.	8 th edition 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Chemical Process Principles Part-I: Material and Energy Balances	O.A.Hougen, K.M.Watson, R.A.Ragatz	CBS Publishers New Delhi	2 nd Edition 1962
2	Elementary Principles of Chemical Processes	Richard M. Felder, Ronald W. Rousseau	Wiley	4 th edition 2018

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/103/105/103105209/
2	https://archive.nptel.ac.in/courses/103/105/103105209/
3	https://archive.nptel.ac.in/courses/103/105/103105209/ ,
4	https://archive.nptel.ac.in/courses/103/105/103105209/

SEMESTER S2
MATERIAL SCIENCE AND ENGINEERING
(MECHANICAL ENGINEERING)

Course Code	PCMET205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To recognize the importance of the microstructures and physical properties of the materials to enable the material selection process.
2. To develop an understanding of the basic principles of phase transformations and apply those principles to engineering applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to material science: Classification of engineering materials, Structure of solids- Metallic, Ionic and covalent bonding. Properties based on atomic bonding. Crystallography: - SC, BCC, FCC, HCP structures, APF - theoretical density simple problems – Miller Indices: - crystal plane and direction - Modes of plastic deformation:- Slip and twinning	11
2	Crystal imperfections – - Point defects, Line defects, Surface defects, Volume defects. edge and screw dislocations – Burgers vector – interaction between dislocations. Polishing and etching, Metallographic characterisations of metallic	11

	materials. SEM, TEM- Grain size determination Wear, Roughness, Corrosion. Diffusion in solids, Fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems. Applications of Diffusion.	
3	Mechanical properties: Tensile properties, Hardness and hardness measurement, Impact properties, Fatigue, Creep, DBTT, Super plasticity. Types of steels- low, medium and high carbon steels, stainless steels, alloy steels and their applications. Properties and applications of composites, super-alloys, intermetallic- Stoichiometric and Non stoichiometric compounds- Applications. Maraging steel, Titanium- Ceramics:- structures, applications	11
4	Phase diagrams: - need of alloying - classification of alloys - Hume Rothery's rule – equilibrium diagram of common types of binary systems: isomorphous (Cu- Ni) eutectic (Pb- Sn), lever rule and Gibb's phase rule. Detailed discussion on Iron- Carbon equilibrium diagram with microstructure and properties -Heat treatment: - TTT, CCT diagram, applications - Tempering- Hardenability, Jominy end quench test, applications-Surface hardening methods.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the crystal structures (BCC, FCC, and HCP), and their relationship with the properties.	K2
CO2	Understand the crystallographic defects through metallography	K2
CO3	Compare the material properties among different materials for material selection.	K2
CO4	Define and differentiate the microstructure of metallic materials using phase diagrams.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3											
CO4	3	2										

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Material Science and Engineering, 2014	Callister William.D	John Wiley	2014
2	Engineering Metallurgy part-I	Higgins R.A	Arnold	6 th , 1998

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The science and engineering of materials	Donald R Askeland	Thomson	
2	Introduction to Physical Metallurgy	Avner H Sidney	Tata McGraw Hill	2009
3	Material Science and Engineering	Raghavan V	Prentice hall	2004

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/113/105/113105103/
2	https://archive.nptel.ac.in/courses/113/105/113105103/
3	https://archive.nptel.ac.in/courses/113/105/113105103/
4	https://archive.nptel.ac.in/courses/113/105/113105103/

SEMESTER S2 AUTOMOBILE POWER PLANT

(AUTOMOBILE ENGINEERING)

Course Code	PCAUT205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. Understand the functions of internal combustion engine components, valve actuating mechanisms, air-fuel systems, and Ignition systems.
2. Study the influence of fuel injection methods, ignition timing, and exhaust gas treatment on the performance of IC engines.
3. Understand the importance and components of cooling and lubrication systems in IC engines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	ENGINES: Basic engine nomenclature, Classification & Applications of IC Engines. Constructional details of engine components: Cylinders – types, Cylinder liners, Engine block, Cylinder head, Gasket, Piston, Piston rings, Piston pins, Connecting rod, Crank shaft, Flywheel, Cam shaft, Valve and valve mechanism systems - OHV, OHC, DOHC. Valve Timing Diagram & Port timing diagrams, Inlet and Exhaust manifold.	11

2	FUEL SUPPLY SYSTEM: Air fuel mixture requirements and types, Octane & Cetane Rating. Types of fuel feed systems, fuel tank, fuel pumps and fuel filters, air filter types. Carburetion, simple carburetor, Fuel injection system - GDi, MPFi. Fuel supply system in diesel engines: components of diesel fuel system, feed pump, injection pump, injection nozzles and types, Governors. Electronic Unit Injectors, CRDi system	11
3	IGNITION & EMISSION SYSTEM: Ignition system in IC engines: Ignition System Overview Battery ignition system, magneto ignition system, distributor less ignition – CDI & Coil on plug type of ignition system Pollutants in IC Engines. NOx, CO, unburned hydrocarbons, smoke and particulate. Non exhaust emissions and control methods, Exhaust gas treatment. - Catalytic converter – Thermal reactor - Particulate trap, Exhaust Gas Recirculation (EGR) Systems. Exhaust mufflers, Types of mufflers.	11
4	COOLING & LUBRICATION SYSTEM Need for cooling, types- air cooling system and liquid cooling systems- components- radiator, water pump and cooling fan. Properties of coolants and additives. Requirements of lubrication systems. Types of Lubrication system. SAE Ratings Multi grade lubricants, Pre-lubrication systems. Supercharging and Turbocharging in I C Engines.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand constructional details and working of various internal combustion engine	K2
CO2	Discuss the fuel system & air induction system for IC engines	K2
CO3	Explain the Ignition system & emission in IC engines	K2
CO4	Understand the Cooling and lubrication system for IC engines	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	2	2	1	-	-	-	-	-	-	-	-	-
CO3	2	2	1	-	-	-	-	-	-	-	-	-
CO4	3	3	1	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Internal Combustion Engines	Ganesan. V	Tata McGraw-Hill Publishing Co	4 th Edition 2017
2	Internal Combustion Engines	Ramalingam K.K	Sci-Tech Publications	3 rd Edition 2018
3	Internal Combustion Engines	R.K. Rajput	Laxmi Publications.	2 nd Edition 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A course in internal combustion engines	Mathur. M.L., Sharma. R.P	Dhanpatrai publication	2016
2	Internal Combustion Engines Fundamentals	John Heywood	McGraw Hill International Edition	2 nd Edition 2018
3	Fuels & Combustion	Smith, Marion L. And Karl W. Stinson	McGraw-Hill	

Video Links (NPTEL, SWAYAM...)	
Sl. No	Link ID
1	I C Engines and Gas Turbines https://archive.nptel.ac.in/courses/112/103/112103262/# Fundamentals of Automotive Systems https://archive.nptel.ac.in/courses/107/106/107106088

SEMESTER S2

TRANSDUCERS & MEASUREMENTS

(MECHATRONICS ENGINEERING)

Course Code	PCMRT205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with a comprehensive understanding of various types of transducers used in engineering applications, including their principles of operation and characteristics.
2. To familiarize students with different measurement techniques and instruments commonly used in engineering, enabling them to apply these techniques effectively for accurate measurement and analysis in practical scenarios

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to transducers and sensors Definition of sensors and transducers –Mechanical devices as Primary Detectors-Pressure Sensitive Primary Devices- Temperature Detectors- Hydro pneumatic Devices. Electric Transducers. Advantages of Electrical Transducers. Classification of Electrical Transducers- Primary and Secondary Transducers, Active and Passive Transducers, Analog and Digital Transducers. Electrical Phenomena Used in Transducers.	11

2	Resistive Transducers- Potentiometers, Strain gauges-gauge factor- Resistance Thermometers, Thermistors. Capacitance transducers - piezo electric transducers – Inductive transducers: LVDT characteristics-photoelectric sensors – Hall Effect transducers - measuring circuits-calibration- Optical transducers. Ionization transducers. Digital Transducer. Shaft Encoder.	11
3	Measurements and Measurement Systems Measurements- Significance of Measurements- Methods of Measurement: Direct & Indirect Methods-Instruments-Mechanical, Electrical and Electronic instruments- Classification of Instruments- Analog and Digital Modes of Operation-Functions of Instruments and Measurement Systems- Applications of Measurement Systems- Elements of a Generalized Measurement System- Characteristics of Instruments and Measurement Systems: Measurement system Performance- Static Calibration- Static Characteristics- Errors in Measurements-True Value-Static Error- Static Correction -Scale Range and Scale Span- Error Calibration Curve- Reproducibility and Drift- Accuracy and Precision, Linearity. Hysteresis-type of errors-classification of errors	11
4	DC bridges: introduction, sources and detectors-General Equation- Types of bridges: Wheatstone, Kelvin bridge- AC bridges: introduction, sources and detectors-General equation. Maxwell's inductance and Maxwell's inductance -capacitance bridge. Cathode ray oscilloscopes: principles, construction and limitations- Digital storage oscilloscopes: principles- Measurements using CRO s and DSOs- Recording instruments: Strip chart recorder, X-Y Plotter, LCD displays.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Summarize the concepts of sensors, transducers and classify various transducers.	K2
CO2	Apply the principles and functions of various types of Transducers in measuring systems.	K3
CO3	Illustrate the working principles of electronic measuring instruments and identify various types of errors in measuring systems and choose methods for minimization of the errors.	K3
CO4	Explain the concepts of CRO, DSO, various recording devices.	K2
CO5	Understand and utilize various measurement systems, enhancing their capability to apply theoretical knowledge in practical scenarios	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				1							3
CO2	3				1							3
CO3	3	2										3
CO4	2											3
CO5	3											3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Course in Electronic Measurements and Instrumentation	A. K. Sawhney	Dhanpat Rai & Co.	2015 Edition
2	Electronic Instrumentation and Measurements	David A Bell	Oxford University Press	3rd Edition 2013
3	Electronic Instrument Design	Kim R Fowler	Oxford reprint	2 nd Edition, 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Sensors and Transducers,	D .Patranabis	PHI	2nd edition, 2003
2	Electronic Instrumentation and Measurements	Kalsi HS	Mc Graw hill	4th edition, 2019.
3	Electrical Measurements and Measuring systems	Golding E W and Widdis F C	Wheeler&co	1993

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://www.youtube.com/watch?v=1uPTyJxZzyo
2	https://onlinecourses.nptel.ac.in/noc23_ee105/preview
3	https://nptel.ac.in/courses/112107242
4	https://onlinecourses.nptel.ac.in/noc23_ee112/preview https://www.youtube.com/watch?v=0FVzYLEdSA8

SEMESTER S2
FUNDAMENTALS OF MANUFACTURING SYSTEMS
AND PROCESSES

(PRODUCTION ENGINEERING)

Course Code	PCPET205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Summarize about Manufacturing Systems and Strategies
2. Identify the appropriate process for a given engineering material.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Manufacturing Systems, Classification of Manufacturing Systems; Discrete Manufacturing, Repetitive Manufacturing, Job Shop Manufacturing, Batch Manufacturing, Continuous manufacturing, Additive Manufacturing. Manufacturing Strategies; Lean Manufacturing, Mass Customization, Green Manufacturing, Total Quality Management, Agile Manufacturing, Just in Time. Original Equipment Manufacturer, Reconfigurable Manufacturing, Assembly Lines, Concept of Inventory. (Should cover basics concepts only)	11

2	Glass and Ceramic Manufacturing; Relevant Properties of glass and ceramics, Processing Steps; Mixing, melting, forming, cooling and finishing, equipment's used for processing: rotary kiln, tumbler, ball milling, hydraulic presses & jiggers. Plastic Manufacturing; Relevant Properties of Plastics, Processing Methods; Plastic Extrusion, Injection Moulding, Rotational Moulding, Plastic extrusion & injection blow moulding, Vacuum casting. Thermoforming & Vacuum forming, Compression moulding. Rubber Manufacturing; Relevant properties of Rubber, Processing Steps; mastication, mixing, shaping, , calendaring, curing. Textile Manufacturing: Weaving; Cutting. Spinning, Yarn production, Dyeing, Pattern making, Bleaching, Grading, Packing, Wet processing. (Should cover basics concepts only)	11
3	Metal industries –Ferrous Metals and Alloys- -raw materials for iron making, blast furnace and electric furnace operation, shaping and finishing, application of iron and steel. Non-Ferrous Metals, examples of nonferrous metals- extraction of ore, smelting & refining, shaping and finishing, alloying, application of nonferrous metals. (Should cover basics concepts only)	11
4	Wood based integrated Pulp and paper mill – Wood chips production, Batch digester, Pulp washing filters, bleaching, drying and calendaring. Cement manufacturing process- flow diagram, raw mill circuit, cement beneficiation, Manufacturing method and equipment used in Portland cement manufacture Petroleum refining process- flow diagram illustrating refining of crude oil well to saleable product. (Should cover basics concepts only)	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Summarize about Manufacturing Systems and Strategies	K2
CO2	Explain the manufacturing processes involved in polymer, ceramic and textile industries	K2
CO3	Classify the manufacturing processes involved in metal industries.	K2
CO4	Outline the manufacturing processes involved in cement paper and petroleum industries.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3				2				2	
CO2	3	3	3				2				2	
CO3	3	3	3				2				2	
CO4	3	3	3				2				2	

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Modern Manufacturing, Materials, Processes and Systems	Mikell P Groover	Wiley	7th Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ceramics, Glass and Glass-Ceramics	Francesco Baino (Editor), Massimo Tomalino (Editor), Dilshat Tulyaganov (Editor)	Springer.	Kindle edition 2021
2	Modern Plastic Handbook	Charles A. Harper	McGraw Hill	1999
3	The Complete Book on Rubber Processing and Compounding Technology	NIIR Board of Consultants and Engineers	NIIR Board of Consultants and Engineers	2011
4	Textbook of Fabric Science: Fundamentals to Finishing	Seema Sekhri	PHI.	Kindle edition 2011
5	Ironmaking and Steelmaking: Theory and Practice	Ahindra Ghosh	PHI.	1 st edition 2008
6	Manufacturing Technology of Non-Ferrous Metal Products	Brahmpal Bhardwaj	Engineers India Research Institute	1 st edition 2012
7	The chemical process industries	R . Norris Shreve	Mc Graw Hill	2 nd edition 1956
8	Energy performance assessment for equipment and utility systems	Bureau of energy efficiency	Bureau of energy efficiency	4 th edition 2015

SEMESTER S2

FUNDAMENTALS OF AERONAUTICS AND AIRCRAFT INSTRUMENTS

(AERONAUTICAL ENGINEERING)

Course Code	PCAOT205	CIE Marks	40
Teaching Hours/Week (L: T:P:R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. Introduce the basic concepts of aeronautics
2. Discuss about instruments, display and navigation systems employed in aircraft.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Atmospheric properties: Physical properties and structure of atmosphere-temperature, pressure and altitude relations. Basic concepts of Aeronautics: Laws of motion applied to aeronautics. Aerodynamic forces, Nomenclature and Classification of airfoil, mean aerodynamic chord, Centre of pressure and aerodynamic center, Types of drag - reduction techniques, Aerofoil characteristics: lift and drag curves, Speed of sound, Mach number, aspect ratio, wing loading. (Numericals)	11
2	Aircraft Classification and Components: Aircraft classifications. Airplane configurations based on wing, landing gear, engines attachments. Components of Wing, Fuselage-Fuselage Construction Truss, Monocoque, Semi-Monocoque. Control surfaces and maneuvers.	9

3	Basic Instruments: Pitot static system, Pitot static instruments: Altimeter, Vertical speed indicator, Airspeed indicator. Mach meter, Gyroscope, heading indicator, Turn coordinator, Engine instruments: Temperature gauges, Pressure gauges, Tachometer: Mechanical and Electrical. Modern control systems-Fly by wire systems and Auto pilot systems.	13
4	Cockpit Display systems: Head Up Display, Head Down Display, Helmet Mount Display, Multifunctional Keyboard, Multifunctional Display, DirectVoice Input, Hands on Throttle and Stick. Navigation systems: Distance Measuring Equipment, Very High Omnidirectional Range, Automatic Direction Finder, Instrument Landing System, Microwave Landing Systems, Inertial Navigation Systems, Global Positioning System.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the structure of atmosphere and basic concepts of aircraft	K2
CO2	Describe the classification, components, and maneuvers of airplane	K2
CO3	Explain the basic working principles of various aircraft instruments.	K2
CO4	Understand the principles and working of various cockpit display and aircraft navigation systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2
CO4	3	-	-	-	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Flight	J D Anderson Jr. and Mary L.Bowden	Mc Graw Hill	Ninth Edition 2021
2	Aircraft Instruments	EHJ Pallet	Pearson	Second Edition 2009
3	Mechanics of Flight	AC Kermode, RH Barnard, D R Philpott	Pearson	Eleventh Edition 2006
4	Flight Physics	E Torenbeek, H.Wittenberg	Springer	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flight without Formulae	A C Kermode	Pearson	
2	The Avionics Hand Book	Spitzer CR	CRC Press	Second Edition 2006
3	Avionics Training systems, Installation and troubleshooting	Len Buckwalter	Avionics Communication	Second Edition 2005
4	Fundamentals of Flight	Richard S Shevell	Pearson	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
Module - I	archive.nptel.ac.in/courses/101/104/101104061/
Module - II	archive.nptel.ac.in/courses/101/101/101101079/
Module - III & IV	archive.nptel.ac.in/courses/101/104/101104061/

SEMESTER S2

CROP PRODUCTION & PROTECTION TECHNOLOGIES

(AGRICULTURE ENGINEERING)

Course Code	PCAGT205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the principles of agricultural crop production and protection practices of different crops
2. To understand the role and importance of Agricultural Engineers in crop production
3. To equip the students with the basic principles of cropping and cultivation practices of important crops of Kerala.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to agriculture -Importance of agricultural science for crop production - Branches of agricultural science-National and international agricultural research Institutes - Basic elements of crop production - Agricultural seasons in India and Kerala. Classification of crops based on the intensity of cultivation, uses, life span, growth habit, and climatic response and/or habitat. Factors affecting crop growth and production: genetic (internal) and environmental (external) factors. Crop management through environmental modification and adaptation of crops to the existing	11

	environment through crop cultural practices. Competition among crop plants -Selection of crops- seed rate, seed treatment, raising of nursery and production of quality planting material. Field preparation for crops including systems of tillage; Spacing and arrangement of crop plants; Establishment of an adequate crop stand and ground cover. Types and methods of harvest	
2	Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping. Soil-water-plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation; Weeds and their management in crops; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Horticulture- Branches-Scope and importance; Seed rate and seed treatment for vegetable crops; Macro and micro propagation methods; Types of plant growing structures; Pruning and training; Orchard- site selection, layout and Management of orchard.	11
3	Definition of soil. Different functions of soil in our eco system namely as medium of plant growth, Regulator of water supply, Recycle of raw materials, Modifier of atmosphere, Habitat for organisms, Engineering medium etc. Soil profiles and horizons: O, A, B and C. Soil as an interface of solids, water and air and their percentage composition. Formation of soils: Weathering of rocks and minerals, Physical weathering, Biogeochemical weathering, Factors influencing soil formation, soil taxonomy orders. Important soil physical properties: texture, structure, density, porosity, consistency, temperature. The concepts of soil fertility and productivity. The essential elements and their functions in plants. Soil colloids – properties – nature - types and significance. Layer silicate clays - their genesis	11

	and sources of charges. Adsorption of ions - ion exchange - CEC and AEC - factors influencing ion exchange and its significance. Concept of pH - soil acidity - brief overview of saline, sodic and calcareous soils. Soil organic matter – composition – decomposability – humus.	
4	Organic and inorganic fertilizers- its Importance- soil reactions. Gypsum requirement for reclamation of sodic soils and neutralizing RSC; Liquid fertilizers and their solubility and compatibility. Major pests and diseases of field crops and horticultural crops and their management. Integrated methods of managing water, nutrients and plant protection. Crop production technology of field crops in Kerala: cereal crops, grain legumes, oil seed crops, sugarcane, and fibre crops. Cultivation practices of horticultural crops: vegetable crops, fruit crops, flower crops. Basic principles of natural farming, organic farming and sustainable agriculture	11

Course Assessment
Method (CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination-2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 = 24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the general crop production techniques of field crops and horticultural crops.	K2
CO2	Explain the factors affecting crop growth and explain environmental management for crop production.	K2
CO3	Identify different crops and understand the growing seasons of major crops of Kerala	K3
CO4	Describe crop water management, nutrition management and crop protection	K4
CO5	Explain cultivation practices of various field crops and horticultural crops commonly grown in Kerala	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							1					3
CO2		1			2		2					1
CO3	1	2	2		1		3					
CO4	2	1				2	2					
CO5		2					1		1			2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Textbook of Field Crops Production Vol 1: Foodgrain Crops (PB)	Dr. Rajendra Prasad	Indian Council of Agricultural Research, New Delhi	First Edition, 2006
2	Textbook of Field Crops Production: Commercial Crops Vol. II	Dr. Rajendra Prasad	Indian Council of Agricultural Research, New Delhi	First Edition, 2006
3	Principles of Agronomy	T. Yellamanda Reddy and G.H.Sankara Reddy	Kalyani Publishers, New Delhi	First Edition, 2005
4	Fundamentals of Agronomy	Amal Saxena and Lal Singh	Write And Print Publications, New Delhi	First Edition, 2008
5	Text Book of Soil Science.	Biswas, T.D. and Mukherjee, S.K.	Tata McGraw Hill Publishing Co., New Delhi	
6	Introductory Soil Science.	Das.D.K	Kalyani Publishers, New Delhi	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook of Agriculture.		ICAR Publications, New Delhi	6th Revised Edition, 2011.
2	Vegetable Crops of India.	Das P.C.	Kalayani Publishers, New Delhi	1993
3	Fundamentals of Agronomy.	De, G.C.	Oxford & IBH Publishing Co Pvt Ltd, New Delhi	1989
4	Introduction to Horticulture	Kumar N.	Rajalakshmi Publications, Nagarcoil	7 th Edition, 2015
5	Nature and Properties of Soils.	Brady, N.C	Pearson	

SEMESTER S2
MATERIALS AND MANUFACTURING ENGINEERING
(INDUSTRIAL ENGINEERING)

Course Code	PCIET205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Equip students with a comprehensive understanding of engineering materials, including crystal structures, phase diagrams, phase transformations, and heat treatment processes.
2. Provide fundamental knowledge of manufacturing processes and familiarize students with modern production methods and technologies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Materials and Types of Materials: Metals, polymers, ceramics, composites, advanced materials, biomaterials, nanomaterials, smart materials, energy materials, sustainable and green materials. Crystal Structure: Crystal lattices and the unit cell. Simple cubic, BCC, FCC, HCP crystal structures. Atomic packing factor. Crystallographic points, directions, and planes, Miller's indices. Crystal Imperfections: Point defects, line defects (dislocations), surface defects, volume defects. Microscopic Techniques: Polishing and etching techniques. Electron Microscopy, Transmission Electron Microscopy and Scanning Electron Microscopy. Grain size determination (ASTM). Elastic and Plastic Deformation: stress-strain diagram, true stress and true strain, flow stress. Schmidt's law. Slip and twinning.	11

2	Phase Diagram: Basic concepts: Solubility limit, solvent, solute, solid solutions, Hume Rothery's rule, phase and phase equilibrium, Gibb's phase rule. Alloys, need for alloying. Types of Phase diagrams, Invariant reactions, Iron-iron carbide equilibrium diagram, TTT diagram, CCT diagram, Formation of pearlite, bainite, and martensite. Heat Treatment: Basic principles of annealing, normalizing, hardening, spheroidizing, and tempering. Surface hardening techniques: Carburizing, nitriding, flame hardening, induction hardening, laser hardening Basics of fatigue and Creep: Fatigue, S-N curve, factors affecting fatigue life. Creep, factors affecting creep.	10
3	Rolling: Principles of rolling, types of rolling mills, Various rolling processes and applications: hot rolling, cold rolling, ring rolling, thread rolling, tube rolling, shape rolling, skew rolling, defects in rolling. Forging: Classification of forging, various forging operations: cogging, coining, heading, piercing, hubbing, swaging, forging defects. Extrusion: Process, types of extrusion: hot extrusion, cold extrusion, direct (forward) extrusion, indirect (backward) extrusion, hydrostatic extrusion, impact extrusion, applications and defects. Drawing: Process, applications and defects. Wire drawing process. Sheet-Metal Forming: Bending sheet, plate and tubes. springback, press brake forming, stretch forming, deep drawing, hydroforming, spinning, tube spinning.	11
4	Casting: cores, shell mold casting, plaster mold casting, ceramic mold casting, investment casting, permanent mold casting, pressure casting, die casting, centrifugal casting, casting defects. Welding: weldability, solidification of weld metal, heat affected zone, gas welding, arc welding (including GTAW, MIG, TIG, plasma arc welding, submerged arc welding), ultrasonic welding, friction welding, resistance welding (spot and seam), thermit welding, welding defects. Adhesive joints: Basic principles and applications. Additive Manufacturing (3D Printing): Basic principles, processes, materials used, applications, future trends. Sustainability in Manufacturing: Sustainable practices, recycling of materials, environmental impacts. Smart Manufacturing and Industry 4.0: Introduction to IoT, automation, and data analytics in manufacturing.	12

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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the types of engineering materials, their crystal structures, imperfections, and the principles of elastic and plastic deformation.	K2
CO2	Interpret phase diagrams, understand phase transformations, and analyse the principles and techniques of heat treatment, fatigue, and creep.	K3
CO3	Apply principles of various metal forming and shaping processes, including rolling, forging, extrusion, drawing, and sheet-metal forming, and identify associated defects.	K3
CO4	Understand and evaluate casting processes, welding techniques, adhesive joints, additive manufacturing, sustainability in manufacturing, and the implications of Industry 4.0 in smart manufacturing.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	2	-	2	-	-	-	-	2
CO2	3	3	2	2	2	-	2	-	-	-	-	2
CO3	3	3	3	2	2	-	2	-	-	-	2	2
CO4	3	3	3	2	3	2	2	-	-	-	2	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Materials Science and Engineering: An Introduction	William D. Callister Jr. and David G. Rethwisch	Wiley	10th Edition, 2018
2	Materials Science and Engineering: A First Course	V. Raghavan	Prentice Hall India	6th Edition, 2015
3	Manufacturing Engineering and Technology	Serope Kalpakjian, Steven Schmid	Pearson	8th Edition, 2020
4	Introduction to Manufacturing Processes	Mikell P. Groover	Wiley	12th Edition, 2020

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Materials Science and Engineering	William F. Smith	McGraw-Hill	4th Edition, 2005
2	The Science and Engineering of Materials	Donald R. Askeland, Wendelin J. Wright	Cengage Learning	7th Edition, 2015
3	Principles of Modern Manufacturing	Mikell P. Groover	Wiley	6th Edition, 2023
4	Manufacturing Engineering Handbook	Hwaiyu Geng	McGraw-Hill Education	2nd Edition, 2015
5	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing	Ian Gibson, David Rosen, Brent Stucker	Springer	3rd Edition, 2020
6	Sustainable Manufacturing	Kapil Gupta, Konstantinos Salonitis	Elsevier	2nd Edition, 2021

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/113/104/113104068/ https://nptel.ac.in/courses/113/106/113106034/ https://nptel.ac.in/courses/113/104/113104005/ https://archive.nptel.ac.in/courses/112/106/112106293/ https://onlinecourses.nptel.ac.in/noc22_mm25/preview
2	https://nptel.ac.in/courses/113/106/113106032/ https://nptel.ac.in/courses/113/104/113104006/ https://onlinecourses.nptel.ac.in/noc24_me74/preview
3	https://nptel.ac.in/courses/112/105/112105126/ https://nptel.ac.in/courses/112/107/112107080/ https://onlinecourses-archive.nptel.ac.in/noc18_me49/preview
4	https://onlinecourses.nptel.ac.in/noc23_me90/preview https://onlinecourses.nptel.ac.in/noc21_me23/preview https://elearn.nptel.ac.in/shop/iit-workshops/completed/additive-manufacturing-technologies-for-practicing-engineers/?v=c86ee0d9d7ed https://onlinecourses.nptel.ac.in/noc22_me130/preview https://onlinecourses.nptel.ac.in/noc21_ce47/preview https://onlinecourses.nptel.ac.in/noc20_cs69/preview

SEMESTER S 2

BASIC SHIP THEORY

(NAVAL AND SHIPPING ENGINEERING)

Course Code	PCNST205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	ExamHours	2 Hrs 30 Mins
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Explain various types of ships and fundamentals of Naval Architecture that would equip one to define hull forms geometrically, and develop them as lines plan drawings.
2. Apply the procedures of numerical integration to calculate hydrostatic properties, and plot sectional area curves, Bonjean curves, and hydrostatic curves.
3. Understand basic stability features of a ship using fundamental principles and hydrostatic curves
4. Explain the various types of shipbuilding materials and identify various major and minor structural components of a ship and identify the main and auxiliary machinery systems onboard.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Types of ships, terms and definitions, Archimedes principle, laws of floatation, weight and buoyancy. The ship's form, main dimensions, lines plan, coefficients and their meaning, Fairing process and table of offsets, Lines plan development and drawing	11
2	Integration rules: - Trapezoidal rule, Simpson's rules, Tchebycheff's rule, areas, volumes and moments, Bonjean calculations and curves, sectional area curves. Hydrostatic calculations and curves.	11

3	Potential energy and equilibrium, Stability of ships – stable and unstable conditions, Stability terms, Equal volume Inclinations shift of C.O.B. due to inclinations, C.O.B curve, metacentre, pro-metacentre and metacentric radius, metacentric height, metacentric curve, surface of flotation, curve of flotation, righting moment and righting lever	11
4	Frames, framing systems, primary and secondary members, shipbuilding materials, Bottom structure, shell structure, decks, bulkheads, superstructures, bulkheads, fore and aft structures. Main and auxiliary machinery, types of propulsion machinery, types of auxiliary machinery	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify various types of ships and understand fundamentals of Naval Architecture that would equip the student to define hull forms geometrically, and develop them as lines plan drawings.	K3
CO2	Understand and apply the procedures of numerical integration to calculate hydrostatic properties, and plot sectional area curves, Bonjean curves, and hydrostatic curves.	K2
CO3	Understand and explain basic stability features of a ship using fundamental principles and hydrostatic curves.	K2
CO4	Identify and explain the various types of shipbuilding materials and various major and minor structural components of a ship and identify the main and auxiliary machinery systems onboard.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2	2	2			1							
CO3	2	2			1							
CO4	2	2										

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Naval Architecture	Tupper, E.C.	Butterworth-Heinemann	Edition 5, 2013
2	Ship Stability for Masters & Mates	C.B. Barrass & D.R.Derrett	Elsevier	Edition 7, 2019
3	Ship Construction	Eyres D J	Elsevier	Edition 7, 2012
4	Introduction to Marine Engineering	Taylor D A	Elsevier	Edition 2, 1996

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Maritime Engineering Reference Book	Molland A F (Ed)	Elsevier	Edition1, 2008
2	Encyclopedia of Ship Technology	Jan Babicz	Wärtsilä Corporation	Edition 2, 2015
3	Ship Knowledge – A Modern Encyclopedia	Klaas van Dokkum	DOKMAR	2003
4	Lecture Notes in Basic Naval Architecture	Spyros Hirdaris	Aalto University Publication Series, Science & Technology 6/2021	Edition 1, 2021

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/114105003
2	https://nptel.ac.in/courses/114105003
3	https://nptel.ac.in/courses/114105003
4	https://nptel.ac.in/courses/114105031

SEMESTER S2
POLYMERS & POLYMERISATION PRINCIPLES
(POLYMER ENGINEERING)

Course Code	PCPOT205	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the basic terminologies associated with polymer materials
2. To analyse various techniques and methods for polymer conversion.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Monomers and Polymers: Definitions of monomer, repeat unit, oligomer, polymer, degree of polymerization, representation of polymer, functionality, bi-functional systems, poly-functional systems, advantages and disadvantages of polymers, classification of polymers. structure of monomer, repeat unit and polymer of the following- polyethylene, polypropylene, polystyrene, PVC, polyacrylonitrile, polycarbonate, PMMA, PF resin, MF resin, Nylon 6, Nylon 66 and PET, epoxy polymer, Kevlar, natural rubber, silicone rubber.	11
2	Molecular weight: High molecular weight of polymers, concept of averaging, different averages in polymer molecular weight, number average, weight average, viscosity average, z-average, MWD, polydispersity index, principles of osmotic pressure method and viscometry, Experimental methods to determine weight average and z-average molecular weight.	11

3	Types of Polymerisation : Linear step polymerisation, Carothers equation, non linear step polymerization, Addition polymerization- Free radical polymerisation, Cationic polymerization, anionic polymerization, Co-ordination polymerization, Co polymerisation, different types of copolymers, alternating, random, block and graft copolymer, copolymerization drift, derivation of copolymer equation.	11
4	Polymerisation techniques: Bulk polymerisation, Solution polymerisation, Suspension polymerization, Emulsion polymerisation, Interfacial polymerisation.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 = 24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the structural requirements of polymerisation	K2
CO2	Illustrate structural formula of simple plastic and rubber materials	K2
CO3	Explain the basic concepts of average molecular weights	K2
CO4	Explain the basic principles of addition polymerization, stereo-regularity, ionic polymerisation and co polymerisation.	K2
CO5	Compare and correlate various polymerisation techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	3	2									
CO3	3	3	3									
CO4	3	3	1									
CO5	3	3	1									

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Elements of Polymer Science and Engineering	A. Rudin, P. Choi,	Academic Press	Third edition, 2013
2	Textbook of Polymer Science	F W Billmeyer	John Wiley & Sons	Third Edition, 2007
3	Introduction to Physical Polymer Science,	L H. Sperling	Wiley & Sons	2015
4	Polymer Science	V. R. Gowariker, N. V. Viswanathan, Jayadev Sreedhar	New Age International	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Polymer Science for Engineers	S. Fakirov	John Wiley & Sons	2017
2	Polymer Chemistry	Charles E. Carraher Jr	CRC Press	2013
3	Introduction to Polymers	Robert J. Young	CRC Press	2011
4	Principles of Polymer Systems,	F. Rodrigues,	CRC Press	2014

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/content/mp4/105/106/105106205/MP4/mod01lec03.mp4
2	https://archive.nptel.ac.in/content/mp4/105/106/105106205/MP4/mod01lec05.mp4
3	https://archive.nptel.ac.in/content/mp4/105/106/105106205/MP4/mod09lec66.mp4
4	https://archive.nptel.ac.in/content/mp4/105/106/105106205/MP4/mod01lec06.mp4

SEMESTER S2
PRINCIPLES OF SAFETY MANAGEMENT
(SAFETY & FIRE ENGINEERING)

Course Code	PCSFT205	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To learn the various principles of safety management and enable the students to give safety training, perform safety audit, and accident investigation.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction-Safety -Goals of safety engineering. Need for safety. Safety and productivity. Definitions: Accident, Injury, Hazard, Risk, Unsafe act, Unsafe Condition, Near miss, Dangerous Occurrence, Reportable accidents, Loss Prevention. History of Safety Engineering. Industrialization and Accidents, Evolution of modern safety concepts. Theories of accident causation--Ten Axioms of Industrial Safety, Heinrich's theory, Frank Bird's Domino theory, Hepburn's theory, V.L Grose's Multiple Causation Theory, System Model theory, Ferrell's Human Factors theory. Safety organization objectives, types, functions, Role of management, supervisors, workmen, unions, government and voluntary agencies in safety. Safety policy - Safety department and size - Safety Officer- responsibilities, authority. Safety committee- Need, Types, Advantages.	11

2	Accident prevention Methods- Engineering, Education and Enforcement - Safety Education & Training -Importance, Various training methods, Effectiveness of training, Behaviour oriented training. Need and Reasons for Accident Prevention - 5E of Accident Prevention. Effective Communication-purpose, barrier to effective communication. Safety problems - employer's problem, employee's problem. Housekeeping: Responsibility of management and employees. Advantages of good housekeeping. 5S of housekeeping. Work permit system- objectives, hot work, cold work and other work permits. Safety psychology, Present Psychological Safety Problems General psychological factors- attitudes, aptitudes, frustration, conflict, morale, fatigue, boredom and monotony. Differences in factors affecting safety performance Motivation for safety- Need of motivation, Theories of motivation- Maslow's hierarchy of needs, Herzberg hygiene Theory, Mc Gregor X & Y Theory. Methods of Motivation.	11
3	Personal protection in the work environment, Types of PPEs, Personal protective equipment respiratory and non-respiratory equipment. Standards related to PPEs. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate, activity rate, safety "t" score, and safety activity rate – problems. Cost of accidents. Computation of Costs- Utility of Cost data. Plant safety inspection, types, and inspection Procedure, safety sampling techniques, Typical industrial models and methodology. Entry into confined spaces.	11
4	Code of Practice on Safety Audit-IS 14489-Goals, Objectives and Responsibilities, Audit Methodology, Executing the Audit, Job safety analysis (JSA), Safety surveys, Non conformity reporting (NCR). Safety Inventory Technique. The practice of safety management-the significance of risk acceptability. Risk Management-Introduction to ISO 31000 - Accident investigation –Why? When? Where? Who? & How? Basics- Man-Environment & Systems Process of Investigation–Tools-Data Collection-Handling witnesses- Case study. Accident analysis. Analytical Techniques-System Safety-Change Analysis- MORT-Multi Events Sequencing-TOR	11

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the concepts of safety, the theories of accident causation and duties of safety officer	K2
CO2	Explain functions safety organisation, accident prevention methods, concept of safety psychology and motivational theories	K2
CO3	Explain about personnel protective equipments and safety equipments, produce different types of work permits, and estimate safety performance using various indices	K2
CO4	Produce different types of accident investigation reports, and compliance check lists, Analyse job safety and accidents through JHA tools and accident models, estimate costs.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	3											
CO3	3				1							
CO4	3	1			1							

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of industrial safety and health	Dr. K.U.Misthri	Siddharth Prakashan Ahmadabad	2012 Edition Vol.I&II
2	Safety Management in Industry	N.V. Krishnan	Jaico Publishing House, New Delhi	1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial Accident Prevention	Heinrich H.W.	McGraw-Hill Company, New York,	1980.
2	Industrial Safety	Ronald P. Blake	Prentice Hall, New Delhi,	1973
3	Occupational Safety and health,	David L. Goetsch,	Prentice Hall	10 th edn 2023
4	Modern Accident Investigation and Analysis,	Ted S. Ferry	John Wiley & Sons	1988
5	Occupational Safety Management and Engineering,	Willie Hammer	Prentice Hall	
6	Safety Management System,	Alan Waring	Chapman & Hall	
7	Safety Management,	John V. Grimaldi and Rollin H.Simonds,	All India Traveller Book Seller, Delhi.	
8	Accident Prevention Manual for Industrial Operations		National Safety Council, Chicago	
9	Loss Prevention in process industries	Lees F.P	Butterworth publications, London,	2nd edition,1990.

SEMESTER 3

MECHANICAL ENGINEERING

SEMESTER S3
MATHEMATICS FOR ELECTRICAL SCIENCE AND PHYSICAL SCIENCE – 3
(Common to B & C Groups)

Course Code	GYMAT301	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic knowledge in complex numbers.	Course Type	Theory

Course Objectives:

1. To introduce the concept and applications of Fourier transforms in various engineering fields.
2. To introduce the basic theory of functions of a complex variable, including residue integration and conformal transformation, and their applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fourier Integral, From Fourier series to Fourier Integral, Fourier Cosine and Sine integrals, Fourier Cosine and Sine Transform, Linearity, Transforms of Derivatives, Fourier Transform and its inverse, Linearity, Transforms of Derivative. (Text 1: Relevant topics from sections 11.7, 11.8, 11.9)	9
2	Complex Function, Limit, Continuity, Derivative, Analytic functions, Cauchy-Riemann Equations (without proof), Laplace's Equations, Harmonic functions, Finding harmonic conjugate, Conformal mapping, Mappings of $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$. (Text 1: Relevant topics from sections 13.3, 13.4, 17.1, 17.2, 17.4)	9
3	Complex Integration: Line integrals in the complex plane (Definition & Basic properties), First evaluation method, Second evaluation method, Cauchy's integral theorem (without proof) on simply connected domain, Independence of path, Cauchy integral theorem on multiply connected domain (without proof), Cauchy Integral formula (without proof). (Text 1: Relevant topics from sections 14.1, 14.2, 14.3)	9

4	Taylor series and Maclaurin series, Laurent series (without proof), Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities, Zeros of Analytic functions – Poles and Zeros, Formulas for Residues, Residue theorem (without proof), Residue Integration- Integral of Rational Functions of $\cos\theta$ and $\sin\theta$. (Text 1: Relevant topics from sections 15.4, 16.1, 16.2, 16.3, 16.4)	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering.	K3
CO2	Understand the analyticity of complex functions and apply it in conformal mapping.	K3
CO3	Compute complex integrals using Cauchy's integral theorem and Cauchy's integral formula.	K3
CO4	Understand the series expansion of complex function about a singularity and apply residue theorem to compute real integrals.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	-	-	-	-	-	-	2
CO2	3	3	-	2	-	-	-	-	-	-	-	2
CO3	3	3	-	2	-	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10 th edition, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Complex Analysis	Dennis G. Zill, Patrick D. Shanahan	Jones & Bartlett	3 rd edition, 2015
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39 th edition, 2023
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44 th edition, 2018
4	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, Jae Jeong Hwang	Springer	1 st edition, 2011

SEMESTER S3
MECHANICS OF SOLIDS

Course Code	PCMET302	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To acquaint with the basic concepts of stress and deformation in solids.
2. To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to analysis of deformable bodies. Types of external loads - Normal, Shear, Bending and Bearing stress- Linear and Shear strains. Hooke's law - Stress-Strain diagrams - concepts of Isotropy, Orthotropy, Anisotropy. Young's Modulus, Bulk Modulus and Rigidity Modulus. Poisson's ratio - Relationship between elastic constants. Deformation in axially loaded bars –uniform cross section, varying cross section, dissimilar materials, principle of superposition. Thermal effects – simple, composite bars.	11
2	Torsion: Shafts - torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – shaft design for torsional load. Beams- Classification - Diagrammatic conventions for supports and loading Differential equations between load, Shear Force and Bending Moment- Shear Force and Bending Moment Diagrams of Cantilever and Simply supported beam with Point load/UDL. Point of Inflection.	11

3	Stresses in Beams: Pure Bending – Flexure formula for beams - assumptions and limitations – Section Modulus - Flexural Rigidity - derivation and problems for rectangular section only -assumptions and limitations Deflection of Beams: Moment-Curvature relation – assumptions and limitations - Double Integration method – Macaulay’s method	11
4	Stress on an inclined plane due to Uniaxial stress- Stress on an inclined plane due to Biaxial stress- Stress on an inclined plane due to two Normal Stresses accompanied by Shear stresses- principal planes and stresses. Mohr’s circle of stress. Buckling and stability of long columns-Euler’s buckling/crippling load for columns with different end conditions- Euler equation derivation for both ends hinged only- Rankine’s formula	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the stresses and strains in deformable bodies subjected to different types of external loads and thermal effects	K3
CO2	Analyse the torsion of circular bars and draw the shear force and bending moment diagrams for beams	K4
CO3	Determine the stresses and deflections in beams subjected to transverse loads	K3
CO4	Determine analytically and graphically the principal stresses and planes for structural members subjected to loads and analyse the strength of columns	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2									
CO2	3	3	2									
CO3	3	3	2									
CO4	3	3	2									

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Solids	R.K.Bansal	Laxmi Publications	2012
2	Mechanics of Solids	S. S. Bhavikatti	New Age International	2013
3	Strength of Materials	Surendra Singh	S. K. Kataria & Sons	2013
4	Strength of Materials	Rattan	McGraw Hills	2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of materials	R. C. Hibbeler	Pearson Higher Education	2018
2	Engineering Mechanics of Solids	Popov E	PHI	2002
3	Mechanics of Materials	Beer & Johnston	McGraw Hills	2017
4	Mechanics of Materials	Pytel A. and Kiusalaas J.	Cengage Learning India Private Limited,	2015

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_ce46/preview
2	https://onlinecourses.nptel.ac.in/noc22_ce46/preview
3	https://onlinecourses.nptel.ac.in/noc22_ce46/preview
4	https://onlinecourses.nptel.ac.in/noc22_ce46/preview

SEMESTER S3
FLUID MECHANICS AND MACHINERY

Course Code	PCMET303	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To establish fundamental knowledge of basic fluid mechanics and its simple applications.
2. To familiarize students with the relevance of turbo machines and find solutions to the associated engineering problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Prerequisite: Properties of fluid: Specific gravity, Specific Weight, Specific Volume, Dynamic and Kinematic Viscosity. Introduction to fluid mechanics - Types of fluids, Newton's law of viscosity. Pressure Measurement: Fluid pressure, Pressure head, types of pressures. Piezometer, Simple, differential Manometers. Fluid statics: Pressure, density, height relationship. Hydrostatic force and pressure on plane and inclined surfaces, Centre of pressure. Buoyancy and Metacentre. Stability of immersed and floating bodies.	8
2	Fluid kinematics: Description of fluid motion – Types of flows, Material derivative velocity and acceleration – Streamlines, path lines and streak lines, Stream function and velocity potential function, flow net . Fluid dynamics: Continuity equation, Euler's, and Bernoulli's equations. – Measuring instruments – Pitot tube, Orificemeter, Venturimeter, Rectangular and Triangular Notches-(notches Problems not required).	8

3	Pipe flow – laminar and turbulent flows, significance of Reynolds number, shear stress and velocity distribution in a pipe flow.– Hagen-Poiseuille equation, Darcy-Weisbach equation and Chezy's equation , Moody's chart for estimating frictional losses, Major and minor energy losses, hydraulic gradient, and total energy line. Navier-Stokes equation and explanation (without proof) . Dimensional analysis using Buckingham's π theorem. Boundary layer theory: Qualitative comparison between laminar and turbulent boundary layer. Boundary layer separation	12
4	Impact of jets: Impact of jet on fixed vertical, moving vertical flat plates. Impact of jet on curved vanes – fixed and moving. Velocity triangles. Classification of Turbines and pumps Comparison and examples. Pelton, Francis and Kaplan Turbines: Principle and working, head, work done, efficiencies (Problems using velocity triangles not required). Centrifugal Pumps: Principle and working, head, work required, efficiencies, Priming and cavitation.(Problems using velocity triangles not required) . Reciprocating Pump: Principle and working – slip,negative slip, work required and efficiency.	12

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify the fundamental fluid properties, their relationships and apply them to estimate the fluid pressure and hydrostatic forces on bodies	K3
CO2	Classify the fluid flow and apply the principles kinematic and dynamics using the conservation of mass and momentum equations.	K3
CO3	Analyse viscous flow through pipes and estimate the major and minor losses associated with piping network.	K3
CO4	Understand the basic concept of dimensional analysis.	K3
CO5	Select suitable turbo machine for specific application by identifying the pertinent parameters	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2	3	3	2									
CO3	3	3										
CO4	3	2										
CO5	2	2				2						

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics	Cengel Y. A. and J. M. Cimbala	Tata McGraw Hill	2013
2	Introduction to Fluid Mechanics and Fluid Machines	Som S.K.	McGraw Hill Education India	2011
3	Fluid Mechanics and Hydraulic Machines	Bansal R.K.	Laxmi Publications	2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics	White F.M.	Tata McGraw Hill	2003
2	Engineering applications of Fluid dynamics	Fisher and Henly	Willford Press	2023

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Fluid Statics https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfYY1O&index=4 Bouyancy, Metacentre and stability https://www.youtube.com/watch?v=gMuucNxc7eI&list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw&index=7&pp=iAQB
2	Fluid kinematics https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfYY1O&index=4
3	Internal Viscous Flow https://www.youtube.com/watch?v=qLx7ip0eBps&list=PLCoE5wxWtHFYiVGswvsWRaHjv18vxZzE2&index=17
4	Introduction to turbomachines https://www.youtube.com/watch?v=ocVzrn4DLj8&list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE&index=2

SEMESTER S3

MANUFACTURING PROCESSES

Course Code	PBMET304	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To gain theoretical and practical knowledge in manufacturing processes and to develop and understanding of the dependent and independent variables which control a production processes.
2. Provide a detailed discussion on the welding process and the physics of welding. Introduce students to different welding processes weld testing and advanced processes to be able to appreciate the practical applications of welding.
3. Generate solutions to problems that may arise in manufacturing engineering

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	General Classification of Manufacturing Processes. Casting-Characteristics of sand, design of patterns, cores, chaplets, solidification of metals and Chvorinov's rule, elements of gating system, risers, chills, numerical problems, defects in castings. Special casting process- Shell moulding, precision investment, die casting, centrifugal casting, continuous casting and squeeze casting. Powder Metallurgy- Powder Production, powder characteristics, mixing, compaction methods, sintering.	9
2	Welding: Classification, Fusion and Solid-state welding processes Gas Welding - Oxyacetylene welding-chemistry, types of flame and its applications	9

	Arc welding- applications, process parameters, numerical problems, consumable and non-consumable arc welding, SMAW; GTAW; GMAW; SAW; AHW; PAW. Thermit welding, friction welding, electro slag welding, ultrasonic welding, electron beam welding, laser beam welding Resistance welding-applications, process parameters, numerical problems Heat Affected Zone, weldability of ferrous and non-ferrous metals, residual stresses and distortion, defects in welding Brazing - soldering - adhesive bonding	
3	Metal Forming: Plastic deformation and yield criteria – hot and cold working processes Rolling- Flat-rolling process, rolling force and power, numerical problems, types of rolling mills, rolling defects, miscellaneous rolling processes. Sheet metal operations- Press tool operations-Shearing, Tension, Compression, Tension and compression operations, applications, numerical problems. Types of die-Progressive dies, Compound dies, and Combination dies	9
4	Forging-Forging load, numerical problems, Various methods, applications, defects in forging - Wire, Rod, and tube drawing - mechanics of rod and wire drawing, drawing force and power, numerical problems, drawing defects – Deep drawing. Bending – Details of bending, Determination of work load, estimation of spring back, numerical problems. Extrusion- Metal flow, mechanics of extrusion, numerical problems, miscellaneous processes, defects in extrusion, applications	9

**Course Assessment Method (CIE:
40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks (8x2 =16marks)	• Each question carries 6 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 2 sub divisions. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Classify different techniques of casting	K2
CO2	Summarize powder metallurgy processes	K2
CO3	Categorize welding processes according to welding principles and materials.	K2
CO4	Determine forming load associated with rolling, forging, drawing, extrusion, and sheet metal forming	K3
CO5	Develop products, processes or technologies for socially relevant applications.	K3, K4, K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	2										
CO3	3	2										
CO4	3	3										
CO5	3	3										

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Manufacturing Science	Amitabha Ghosh Asok Kumar Mallik	Affiliated East-West Private Limited	2 nd Edition 2010
2	Manufacturing Engineering and Technology	SeropeKalpakjian Steven R. Schmid	Pearson	
3	Manufacturing Technology Volume -1	P N Rao	Tata McGraw Hill	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	American Society for Metals - ASM Metals Handbook, Vol. 14	Joseph R. Davis, S. L. Semiatin,	Forming and Forging ASM International	1989
2	Tool design	Donalson cyril, LeCain, Goold, Ghose:-	McGraw Hill	
3	Cold and Hot Forging Fundamentals and Applications	Taylan Altan, Gracious Ngaile, Gangshu Shen	ASM International	2004
4	Foundry Technology	Peter Beeley	Butterworth- Heinemann	

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation / Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

Project Assessment and Evaluation criteria (30 Marks)

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches.

SEMESTER S3

INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Course Code	GNEST305	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Demonstrate a solid understanding of advanced linear algebra concepts, machine learning algorithms and statistical analysis techniques relevant to engineering applications, principles and algorithms.
2. Apply theoretical concepts to solve practical engineering problems, analyze data to extract meaningful insights, and implement appropriate mathematical and computational techniques for AI and data science applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to AI and Machine Learning: Basics of Machine Learning - types of Machine Learning systems-challenges in ML- Supervised learning model example- regression models- Classification model example- Logistic regression-unsupervised model example- K-means clustering. Artificial Neural Network- Perceptron- Universal Approximation Theorem (statement only)- Multi-Layer Perceptron- Deep Neural Network- demonstration of regression and classification problems using MLP.(Text-2)	11
2	Mathematical Foundations of AI and Data science: Role of linear algebra in Data representation and analysis – Matrix decomposition- Singular Value Decomposition (SVD)- Spectral decomposition- Dimensionality reduction technique-Principal Component Analysis (PCA). (Text-1)	11
3	Applied Probability and Statistics for AI and Data Science: Basics of probability-random variables and statistical measures - rules in probability- Bayes theorem and its applications- statistical estimation-Maximum	11

	Likelihood Estimator (MLE) - statistical summaries- Correlation analysis- linear correlation (direct problems only)- regression analysis- linear regression (using least square method) (Text book 4)	
4	Basics of Data Science: Benefits of data science-use of statistics and Machine Learning in Data Science- data science process - applications of Machine Learning in Data Science- modelling process- demonstration of ML applications in data science- Big Data and Data Science. (For visualization the software tools like Tableau, PowerBI, R or Python can be used. For Machine Learning implementation, Python, MATLAB or R can be used.)(Text book-5)	11

**Course Assessment Method (CIE:
40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the concept of machine learning algorithms including neural networks and supervised/unsupervised learning techniques for engineering applications.	K3
CO2	Apply advanced mathematical concepts such as matrix operations, singular values, and principal component analysis to analyze and solve engineering problems.	K3
CO3	Analyze and interpret data using statistical methods including descriptive statistics, correlation, and regression analysis to derive meaningful insights and make informed decisions.	K3
CO4	Integrate statistical approaches and machine learning techniques to ensure practically feasible solutions in engineering contexts.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								
CO2	3	3	3	3								
CO3	3	3	3	3								
CO4	3	3	3	3								
CO5	3	3	3	3								

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Linear Algebra	Gilbert Strang	Wellesley-Cambridge Press	6 th edition, 2023
2	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly Media, Inc.	2 nd edition, 2022
3	Mathematics for machine learning	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	1 st edition. 2020
4	Fundamentals of mathematical statistics	Gupta, S. C., and V. K. Kapoor	Sultan Chand & Sons	9 th edition, 2020
5	Introducing data science: big data, machine learning, and more, using Python tools	Cielen, Davy, and Arno Meysman	Simon and Schuster	1 st edition, 2016

Reference Books				
1	Data science: concepts and practice	Kotu, Vijay, and Bala Deshpande	Morgan Kaufmann	2 nd edition, 2018
2	Probability and Statistics for Data Science	Carlos Fernandez-Granda	Center for Data Science in NYU	1 st edition, 2017
3	Foundations of Data Science	Avrim Blum, John Hopcroft, and Ravi Kannan	Cambridge University Press	1 st edition, 2020
4	Statistics For Data Science	James D. Miller	Packt Publishing	1 st edition, 2019
5	Probability and Statistics - The Science of Uncertainty	Michael J. Evans and Jeffrey S. Rosenthal	University of Toronto	1 st edition, 2009
6	An Introduction to the Science of Statistics: From Theory to Implementation	Joseph C. Watkins	chrome-extension://efaidnbmnnnibpcajpegclclefindmkaj/https://www.math.arizo	Preliminary Edition.

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/106/106106198/
2	https://archive.nptel.ac.in/courses/106/106/106106198/ https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/resources/lecture-29-singular-value-decomposition/
3	https://ocw.mit.edu/courses/18-650-statistics-for-applications-fall-2016/resources/lecture-19-video/
4	https://archive.nptel.ac.in/courses/106/106/106106198/

SEMESTER S3
ECONOMICS FOR ENGINEERS
(Common to All Branches)

Course Code	UCHUT346	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function	6
2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	6

3	Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	6
4	Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	6

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
0	15	12.5	12.5	50

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
- Minimum 1 and Maximum 2 Questions from each module. - Total of 6 Questions, each carrying 3 marks (6x3 =18marks)	2 questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 2 sub divisions. - Each question carries 8 marks. (4x8 = 32 marks)	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	K2
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	K3
CO3	Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market.	K2
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7 TH Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	UCHUT347	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of ethics - Personal vs. professional ethics, Civic Virtue, Respect for others, Profession and Professionalism, Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, Technology and digital revolution-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, High technologies: connecting people and places-accessibility and social impacts, Managing conflict, Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Codes of Ethics. Basic concepts in Gender Studies - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, Gender disparity and discrimination in education, employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations, Ethical values and practices in connection with gender - equity, diversity & gender justice, Gender policy and women/transgender empowerment initiatives.	6

2	Introduction to Environmental Ethics: Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). Sustainable Engineering Principles: Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. Ecosystems and Biodiversity: Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. Landscape and Urban Ecology: Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	6
3	Hydrology and Water Management: Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. Zero Waste Concepts and Practices: Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. Circular Economy and Degrowth: Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. Mobility and Sustainable Transportation: Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	6
4	Renewable Energy and Sustainable Technologies: Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. Climate Change and Engineering Solutions: Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. Environmental Policies and Regulations: Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. Case Studies and Future Directions: Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	6

Course Assessment Method
(CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
Total Marks				50

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis:** Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts:** Ability to apply course concepts to real-world problems and local contexts.
- **Creativity:** Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills:** Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	K3
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	K4
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	K5
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	K4
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create
CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	2	3	3	2		2
CO2		1				3	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessment	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Pvt Ltd, Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER: S3

COMPUTER AIDED MACHINE DRAWING & MODELLING

Course Code	PCMEL307	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To introduce modern CAD packages for drafting and modelling of engineering components.
2. To create a digital mock up of engineering components

Expt. No.	Experiments
Part A	Understand the basics of machine drawing, including BIS code of practice, types of lines, dimensioning, scales of drawing, sectional views, geometric tolerances, and the importance of GD&T. Additionally, to practice, simple 2D sketches to familiarize with these concepts. Learn and practice drawing different types of rigid shaft couplings used for connecting shafts with collinear axes using 2D drafting software (Flange Coupling, Protected Flange Coupling etc). Understanding Basics of Assembly Drawings using 2D drafting software and creating a 2D Assembled Drawing with required Sectional Views (Universal coupling or Knuckle joint). Understanding Basics of Assembly Drawings using 2D drafting software and creating a 2D Assembled Drawing with required Sectional Views and prepare BOM (Stuffing Box). Use of geometrical dimensioning and tolerancing (GD & T) in drawing. (Minimum 5 Nos.)
Part B	Creating 3D machine components (Minimum 4 Nos). Creating 3D assembly models of Socket and spigot joint, Knuckle Joint, Rigid flange couplings, Bushed Pin flexible coupling, Plummer block, Screw jack etc. Modeling of surfaces of the given geometry like helmet, mouse, fender of automobiles etc. Parametric modeling of standard parts such as nuts, bolts, rivets, washers etc (Minimum 3 Nos).
<i>Out of 12 exercises, 5 should be from Part A and 7 should be from Part B</i>	

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Apply the knowledge of engineering drawings to interpret 2D drawings and model them using software.	K3
CO2	Prepare standard assembly models and drawings of machine components using part drawings	K1
CO3	Practice GD & T in models as well as drawings	K2
CO4	Apply parameterisation for the quick modeling of standard parts	K3
CO5	Model external surfaces of common objects	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		2		3					3		
CO2	3		2		3					3		
CO3	3		2		3					3		
CO4	3		2		3					3		
CO5	3		2		3					3		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Geometric Dimensioning and Tolerancing	James D. Meadows	James D. Meadows & Associates, Inc.	
2	Fundamentals of Geometric Dimensioning and Tolerancing	Alex Krulikowski	Delmar Cengage Learning	
3	CAD, 3D Modeling, Engineering Analysis, and Prototype Experimentation	Jeremy Zhang Li	Springer	2010 5th Edition

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Engineering Graphics and Design - Course (nptel.ac.in)

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S3

MATERIALS TESTING LAB

Course Code	PCMEL308	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. Characterize the mechanical behaviour of materials under various loading conditions.
2. Relate material properties and microstructure to engineering applications.

Expt. No.	Experiments (Minimum 10 experiments)
1	Evaluate the tensile properties of a ductile material (mild steel, high-strength steel, or tor-steel) using a Universal Testing Machine (UTM) equipped with an extensometer.
2	Conduct compressions test on a ductile material (mild steel, tor-steel, or high-strength steel) using a Universal Testing Machine (UTM) equipped with an extensometer.
3	Determine the tensile properties of cast iron (a brittle material) using a Universal Testing Machine (UTM) equipped with an extensometer.
4	Determine the shear strength of a mild steel rod using a shear test.
5	Perform Brinell/Vickers/Rockwell hardness tests on a given material
6	Determine the torsional rigidity of mild steel/copper/brass rods.
7	Evaluate the flexural stiffness (flexural rigidity) of mild steel/copper/brass specimens using a three-point bend test on a Universal Testing Machine (UTM)
8	Determine the notch toughness of the material at room temperature using Izod and Charpy impact testing.
9	Investigate the effect of coil type (close-coiled vs. open-coiled) and arrangement (series vs. parallel) on spring stiffness.
10	Microstructure of mild steel/copper/ brass/aluminium using opticalmicroscope, double disc polishing machine, emery papers and etchant.
11	Analyse the fracture surface morphology of a ductile or brittle material using an optical microscope for fractographic characterisation.
12	Evaluate the fracture toughness of a material with a Universal Testing Machine (UTM)
13	To study the procedure for plotting S-N curve using Fatigue testing machine

14	Perform stress analysis using photoelasticity.
15	Measure the deformation (strain) of an object using strain gauges.
16	Perform a bending test on a wooden beam to assess its load-carrying capacity.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- **Submission of Record:** Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- **Endorsement by External Examiner:** The external examiner shall endorse the record

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Evaluate the mechanical properties of different materials under various loading conditions.	K3
CO2	Relate material microstructure to its mechanical behaviour.	K4
CO3	Analyse the effect of design features on the performance of mechanical components.	K4
CO4	Utilize experimental techniques to determine material properties.	K3
CO5	Apply fundamental engineering principles to analyse the behaviour of structures under load.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			2								
CO2	3			2								
CO3	2		3									
CO4	2			3	2							
CO5	3	2			2							

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Callister's Materials Science and Engineering	D. Wayne Callister and David G. Rethwisch	Wiley	10th Ed (2018)
2	Mechanical Testing and Evaluation	Howard Kuhn; Dana Medlin	ASM International	Volume 8 (2000)

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Materials	James M. Gere and Barry J. Goodno	Cengage Learning	9th Ed (2022)
2	Introduction to Materials Science for Engineers	James F. Shackelford	Pearson	8th Ed (2022)

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc23_mm38/preview
2	https://archive.nptel.ac.in/courses/112/107/112107146/
3	https://archive.nptel.ac.in/courses/112/106/112106293/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the

procedure and understanding each step involved.

- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 4

MECHANICAL ENGINEERING

SEMESTER S4
MATHEMATICS FOR PHYSICAL SCIENCE – 4
(C Group)

Course Code	GCMAT401	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic calculus.	Course Type	Theory

Course Objectives:

1. To familiarize students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
2. To provide the students with the basics of various numerical methods to develop problem solving skills used in various engineering disciplines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Binomial distribution, Poisson distribution, Poisson distribution as a limit of the binomial distribution, Joint pmf of two discrete random variables, Marginal pmf, Independent random variables, Expected value of a function of two discrete variables. [Text 1: Relevant topics from sections 3.1 to 3.4, 3.6, 5.1, 5.2]	9
2	Continuous random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Uniform, Normal and Exponential distributions, Joint pdf of two Continuous random variables, Marginal pdf, Independent random variables, Expectation value of a function of two continuous variables. [Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2]	9

3	Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and t -distribution), Hypotheses and Test Procedures, Type I and Type II error, z Tests for Hypotheses about a Population Mean (for large sample), t Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples. [Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]	9
4	Newton-Raphson Method, Gauss Elimination Method, Gauss - Jordan Method, Numerical solution of ordinary differential equations-Euler's method, Modified Euler's method, Runge - Kutta method of 2 nd Order, Numerical solution of Laplace equation –Jacobi's Method, Curve Fitting by Method of Least Squares - Straight lines, Parabola. (Text 2: Relevant topics from sections 2.5, 4.2, 7.5, 8.4, 8.5, 9.4)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept, properties and important models of discrete random variables and to apply in suitable random phenomena.	K3
CO2	Understand the concept, properties and important models of continuous random variables and to apply in suitable random phenomena.	K3
CO3	Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using z -tests and the one-sample t -test.	K3
CO4	Apply numerical methods to find solutions of linear system of equations, ordinary differential equations and Laplace equations.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2
CO4	3	3	2	2	-	-	-	-	-	-	-	2

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probability and Statistics for Engineering and the Sciences	Devore J. L	Cengage Learning	9 th edition, 2016
2	Introductory Methods of Numerical Analysis	S S Sastry	PHI Learning Pvt Limited	5 th edition, 2012

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probability, Random Variables and Stochastic Processes,	Papoulis, A. & Pillai, S.U.,	McGraw Hill.	4 th edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Academic Press	6 th edition, 2020
3	Numerical methods for Engineers	Steven C. Chapra, Raymond P. Canale	McGraw Hill Education	8 th edition, 2021

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/117/105/117105085/
2	https://archive.nptel.ac.in/courses/117/105/117105085/
3	https://archive.nptel.ac.in/courses/117/105/117105085/
4	https://archive.nptel.ac.in/courses/111/107/111107105/

SEMESTER S4
MACHINE TOOLS AND METROLOGY

Course Code	PCMET402	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-1-0-0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To develop knowledge of appropriate process parameters to be used for various machining operations.
2. Understand the principles and operation of precision measurement tools and equipment used in modern manufacturing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, mechanics of chip formation: orthogonal and oblique cutting, shear angle, velocity relationship; merchant's analysis of cutting forces; cutting power estimation, tool life, and wear; economics of machining, numerical problems Lathe- Types, parts, specifications of lathe, lathe operations, accessories, process parameters, machining time calculations. Shaping, Planning, and Slotting machines – Classification, types of operations.	11
2	Drilling Machines –Operations, drill bit nomenclature, process parameters, machining time calculations and cutting forces. Milling machines – types, milling operations, types of milling cutters, milling cutter nomenclature, process parameters, machining time calculations and cutting forces. Indexing head and different indexing methods. Grinding- types of grinding machines, operations, cutting forces in grinding, grinding mechanisms, grinding wheels, honing, and lapping Broaching – different machines, cutter for broaching, internal and external broaching – applications. Gear generation -Gear hobbing. Work holding - jigs, and fixtures- functions and comparison	11

3	Metrology –Need for inspection, accuracy and precision, calibration, errors in measurement, standards of measurement. Limits, fits and tolerances-Principle of interchangeability, selective assembly approach, Tolerances-Classification of Tolerance, Types of fit, Allowances-Hole basis and Shaft basis systems, System of limits and fits, numerical problems. Limit gauging-classification of gauges, Taylor’s Principle, gauge tolerance – wear allowance.	11
4	Angular measurements-Autocollimator, Angle Dekkor. Comparators-Classification, Dial indicators, Electrical and electronic comparators, pneumatic comparators Interferometry- Principle of Interference, Optical Flats, NPL Flatness Interferometer, Pitter–NPL Gauge Interferometer and Laser Interferometers Gear measurement- Gear tooth terminology, errors in spur gears, measurement of gear elements. Screw Thread Measurement- Terminology, Measurement of major, minor, and effective diameters (2-wire and 3-wire methods). Surface Roughness Measurement- Components of surface texture, Analysis of surface traces, Specification of surface texture, Measurement of surface roughness-Stylus probe instruments Geometric Form Measurement: Straightness, Flatness, Roundness, Concepts of coordinate-measuring machine (CMM)	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe various machine tool operations	K2
CO2	Determine machining time and power consumption in various machining processes	K3
CO3	Explain limits, fits and tolerances	K2
CO4	Identify the uses of various advanced measuring instruments	K1

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	3										
CO3	3	2										
CO4	3	2										

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Elements of Workshop Technology Vol-II Machine Tools	S K Hajra Choudhury Nirjhar Roy	Media Promoters and Publishers Pvt Limited	
2	Manufacturing Science	Amitabha Ghosh Asok Kumar Mallik	Affiliated East-West Private Limited	2 nd Edition 2010
3	Engineering Metrology and Measurements	N.V. Raghavendra, I. Krishnamurthy	Oxford University Press	
4	Manufacturing Engineering and Technology	Serope Kalpakjian Steven R Schmid	Pearson	Edition 5

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Workshop Technology,	Chapman W. A. J.,	Viva books (P) Ltd	
2	Metrology for Engineers,	Galver J.F.W., Schotbolt C.R.,	ELBS.	
3	Machine Tools	Chernov	MIR Publication	
4	HMT, Production Technology		Tata McGraw-Hill	
5	Practical Engineering Metrology	Sharp K.W.B	Sir Isaac Pitman & Sons Ltd.	
6	Machine Tool Design Vol. 1 to 4	Acharkan. N	MIR Publication	
7	ASME, Hand book of Industrial Metrology.			
8	Engineering Metrology	Hume K. J	Macdonald &Co. Ltd.	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/105/112105233/
2	https://archive.nptel.ac.in/courses/112/105/112105233/
3	https://nptel.ac.in/courses/112106179
4	https://nptel.ac.in/courses/112106179

SEMESTER S4
ENGINEERING THERMODYNAMICS

Course Code	PCMET403	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Introduce the principles and laws of thermodynamics
2. Apply laws of thermodynamics to engineering systems
3. Identify systems where laws of thermodynamics are applicable

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction and basic concepts, application areas of thermodynamics, macroscopic and microscopic viewpoints, continuum, systems and control volumes, types of systems, properties of a system, state and equilibrium, the state postulate, processes and cycles Temperature and the Zeroth law of thermodynamics, temperature scales, forms of energy, physical insight to internal energy, energy transfer by heat and work, path function.	11
2	First law of thermodynamics, energy balance, (energy and exercise, dieting, mass gain and mass loss, etc. Can be discussed as examples), mechanisms of energy transfer, moving boundary work, boundary work for polytropic process, energy balance for closed systems, enthalpy and specific heats, flow work and the energy of a flowing fluid, mass and energy analysis of control volumes, SFEE, steady-flow devices: nozzles and diffusers, throttling valves, mixing chambers Thermal energy reservoirs, heat engines and thermal efficiency, refrigerators and heat pumps, COP, heat pumps	11

3	Second law: Kelvin–Planck statement, Second law: Clausius statement, equivalence of the two statements, perpetual-motion machines, reversible and irreversible processes, internally reversible processes Carnot and Reversed Carnot cycle, Carnot principles, thermodynamic temperature scale, entropy, internally reversible isothermal heat transfer, the increase of entropy principle, the Tds relations, isentropic efficiency, exergy, reversible work and irreversibility, second-law efficiency	11
4	Entropy generation, S_{gen} associated with a heat transfer process, entropy generation in daily life, isentropic process, Third law of thermodynamics Phase transformations of pure substance, saturated liquid, saturated vapor and superheated vapor, triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, Mollier charts, dryness fraction, property calculations using steam tables, isentropic efficiency of steam turbines and nozzles, ideal gas equation, gas constants, deviations from ideal gas model, compressibility, Van-der-Waals equation of state	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand basic concepts of thermodynamics	K1, K2
CO2	Understand the laws of thermodynamics	K1, K2
CO3	Conduct first law analysis of open and closed systems	K3
CO4	Determine entropy changes associated with different processes	K3
CO5	Determine the properties of pure substances	K2, K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										
CO2	2	3	2									
CO3	3	3	2	2								
CO4	2	3	2	2								
CO5	2	3	2	2								

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Thermodynamics: an engineering approach.	Cengel, Yunus A., Michael A. Boles, and Mehmet Kanoğlu.	McGraw-hill	2011
2	Engineering Thermodynamics	P.K. Nag	McGraw-Hill Education	6th Edition, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Engineering Thermodynamics,	Moran J. Shapiro N. M.	Wiley	2006
2	Fundamentals of Thermodynamics	Richard E. Sonntag, Claus Borgnakke, Gordon J. VanWynlen	Wiley	8th Edition, 2014
3	Thermodynamics: Principles and Applications	Jean-Philippe Ansermet, Sylvain D. Brechet	Cambridge University Press	1st Edition, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	1. Engineering Thermodynamics Prof. Suman Chakraborty, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/ 2. Chemical Engineering Thermodynamics Prof. Dr. Sandip Roy IIT Bombay https://nptel.ac.in/courses/103/101/103101004/
2	1. Engineering Thermodynamics Prof. Suman Chakraborty, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/ 2. Chemical Engineering Thermodynamics Prof. Dr. Sandip Roy IIT Bombay https://nptel.ac.in/courses/103/101/103101004/
3	1. Engineering Thermodynamics Prof. Suman Chakraborty, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/ 2. Chemical Engineering Thermodynamics Prof. Dr. Sandip Roy IIT Bombay https://nptel.ac.in/courses/103/101/103101004/
4	1. Engineering Thermodynamics Prof. Suman Chakraborty, IIT Kharagpur https://nptel.ac.in/courses/112/105/112105123/

SEMESTER S4
MECHANICS OF MACHINERY

Course Code	PBMET404	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3: 0: 0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To understand the kinematics of different mechanism
2. To understand the motion resulting from a specified set of linkages and to synthesis the mechanism.
3. To understand and to design of cam mechanisms for specified output motions.
4. To understand the basic concepts of toothed gearing and kinematics of gear trains

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Concepts of Kinematics and Dynamics, Mechanisms and Machines, Planar and Spatial Mechanisms, Degrees of Freedom, Mobility analysis - Kutzbach and Grubler's criterion, Grashof's criterion. Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Four bar chain, Slider Crank Mechanisms, Double slider crank Mechanisms and their Inversions. Exact Straight Line Motion Mechanisms- Peaucellier mechanism, Hart's Mechanism. Approximate Straight Line Motion Mechanisms- Watt's mechanism. Steering gear mechanism- Davis steering gear, Ackermann's steering gear	9

2	Velocity analysis of mechanisms (Up to six links)– relative motion - relative velocity. Instantaneous centre -Kennedy’s theorem-velocity analysis using instantaneous centre. (Up to six links) Acceleration analysis- Relative acceleration - Coriolis acceleration (Crank and slotted lever and Whitworth quick return mechanism)	9
3	Kinematic synthesis (planar mechanisms) - type, number and dimensional synthesis –Definitions of Motion, Path and Function generation, precision points, Chebychev spacing, Freudenstein’s equation. Cams - Types of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion- Graphical cam profile synthesis- knife edge and roller follower with and without offset	9
4	Gears – Classification- Terminology of spur, helical bevel, and worm gear – Law of gearing -tooth profiles-path of contact- arc of contact- contact ratio - interference- minimum number of teeth to avoid interference -undercut-backlash Gear trains - simple and compound gear trains - planetary gear trains. Tabulation method	9

Suggestion on Project Topics

- Students should be given projects which may include development of computer codes of analytical methods, computer models and computer aided simulations, and development of functioning proto type of various mechanisms.

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	2 questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 2 sub divisions. - Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Calculate degrees of freedom of mechanisms and Interpret their inversions.	K3
CO2	Perform velocity and acceleration analysis of various planar mechanisms	K4
CO3	Construct a mechanism for a specified output motion	K4
CO4	Solve the problem on cams and gear drives, including selection depending on requirement.	K3
CO5	Create prototype of various mechanisms.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2										
CO2	3	3										
CO3	3	3	2									
CO4	3	2										
CO5	3	3	3	2			2		2	2		2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Theory of Machines and Mechanisms	Ballaney P. L.	Khanna Publishers	2005
2	Theory of Machines	S. S. Rattan	Tata McGraw Hill	2009
3	Theory of Mechanisms and Machines	A Ghosh	East West	2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Kinematics and Dynamics of Machinery	C. E. Wilson, P. Sadler	Pearson Education	2005
2	Theory of Machines and Mechanisms	J. E. Shigley, J. J. Uicker	McGraw Hill	2010
3	Machines and Mechanisms Applied Kinematic Analysis	D. H. Myszka	Pearson Education	2013
4	Kinematics and Dynamics of Machinery	Norton	Tata McGraw Hill	2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	www.youtube.com for mechanism animations
2	https://archive.nptel.ac.in/courses/112/105/112105268/
3	https://archive.nptel.ac.in/courses/112/105/112105268/
4	https://archive.nptel.ac.in/courses/112/105/112105268/

- Students should be given projects which may include development of computer codes of analytical methods, computer models and computer aided simulations, and development of functioning proto type of various mechanisms.

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation

- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER S4

TURBO MACHINERY

Course Code	PEMET411	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fluid Mechanics and Machinery PCMET303	Course Type	Theory

Course Objectives:

1. To understand how to apply the fundamental principles of fluid mechanics and thermodynamics in the operation of different turbomachines
2. To give an insight in the general analysis of radial flow and axial flow turbomachines.
3. To familiarize and understand the working and the performance of different power generating turbomachines
4. To familiarize and understand the working and the performance of different power consuming turbomachines

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Definition of turbo machine, Classification: Axial flow, radial flow and mixed flow machines, parts of turbo machines, Comparison with positive displacement machines. Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines. Preheat factor in compressors, work and efficiency for compressors and turbines. Energy exchange in Turbo machines: Euler's equation, Alternate form of Euler's equation, components of energy transfer.	9
2	General Analysis of Turbo machines: Radial flow compressors– general analysis, degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance. Axial flow compressors-degree of reaction, velocity triangles.	9

3	Hydraulic Turbines: Classification Pelton Wheel – Principle of working, velocity triangles, efficiencies and losses. Reaction turbines – Francis turbine: Principle of working, velocity triangles, efficiencies and losses, draft tube, governing, cavitation. Kaplan and Propeller turbines - Principle of working, velocity triangles, efficiencies and losses. Selection turbines for power plants	9
4	Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Fans, Blowers and Compressors: Classification and working principles of fans, blowers and compressors. Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Use the fundamental principles of fluid mechanics and thermodynamics and find the efficiencies of power generating and power consuming turbomachines.	K3
CO2	Analyse the velocity triangles for radial flow and axial flow turbomachines and find the performance for parametrical changes.	K3
CO3	Select an appropriate power generating turbomachine for a particular application	K3
CO4	Select an appropriate power consuming turbomachine for a particular application	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	3	2	2	-	-		-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics and Thermodynamics of Turbomachinery	Dixon, S.I,	Pergamom Press	1999
2	Fundamentals of Turbo Machinery	B.K Venkanna	PHI Learning Pvt. Ltd	1 st Edition 2009
3	Turbines, Compressor and Fans	Yahya, S.H,	Tata Mc Graw Hill,	1996

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Turbomachinery – Fundamentals, Selection and Preliminary Design	Marco Gambini, Michela Vellini	Springer	1 st Edition, 2021
2	Fundamentals of Turbomachines	Erik Dick	Springer	2 nd Edition 2022

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://www.youtube.com/watch?v=ocVzrn4DLj8 (types and classification) https://youtu.be/DlkmkeENGwg (Euler's equation and fundamentals)
2	https://youtu.be/DlkmkeENGwg (Radial and Axial Flow, Velocity triangles)
3	https://youtu.be/hJA7jPiceTg (Pelton Wheel) https://youtu.be/utOHXJvqI9o https://youtu.be/MtueN0ByKIs (Francis Turbine) https://youtu.be/b7kTKdEISHc (Kaplan Turbine)
4	https://youtu.be/VQqiVYYuNks https://youtu.be/_-yk5GwFnKM (Centrifugal Pumps)

SEMESTER S4

NUCLEAR ENERGY

Course Code	PEMET412	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Mins.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To explore the motivations and basic physics for nuclear reactors
2. To understand the power plant and reactor fuel cycle
3. To understand the components of nuclear reactor.
4. To acquire nuclear waste management and Indian nuclear power program

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	MOTIVATION FOR NUCLEAR ENERGY SOURCE: Role of electricity; energy disparities among countries; energy sources; present source of energy; global resource estimates; issues associated with fossil fuels, potential role of nuclear energy; current status of nuclear energy & Indian energy resources. BASIC PHYSICS OF NUCLEAR REACTORS: Isotopes; binding energy; nuclear stability; α, β, γ and neutron interactions; concept of neutron cross section, radioactive decay law; units of radioactivity; Fission – fission energy, critical mass, Gabon – natural reactor, liquid drop model of fission cross section, prompt & delayed neutrons, neutron life cycle, infinite multiplication factor and 4 factor formula and 6 factor formula; effective multiplication factor; neutron moderation, moderator, slowing down; criticality, reactive power; reactor kinetics & control. (<i>Analytical treatment excluded</i>)	9

2	REACTOR FUEL CYCLE; fuel cycle material balance, uranium mining & milling; uranium conversion to uranium hexafluoride; enrichment – gaseous: diffusion & centrifuge; fuel fabrication; commuting radioactive materials; storage of spent fuel; reprocessing – solvent extraction: purex, urex, truex, pyro processing: electrolysis. <i>(Analytical treatment excluded)</i>	6
3	COMPONENTS OF NUCLEAR REACTOR: Fermi pile – control, safety, radiation monitoring; reactor core; fuel, control rods; moderator; essential core components; containment; core catcher; steam generator; turbine generator; steam water system; turbine generator; steam water system; fuel handling; cooling spent fuel; Nuclear reactor types- pressurized water reactor, boiling water reactor, Canada-deuterium reactor, solid cooled fast reactor, advanced gas cooled reactor. NEXT GENERATION REACTORS: basic knowledge and conceptual difference of next generation reactors only – Generation I, II, III, IV;- Fusion reaction- Lawson criterion, inertial and magnetic confinements <i>(Analytical treatment excluded)</i>	12
4	RADIATION SAFETY AND NUCLEAR WASTE MANAGEMENT;; Biological effects of radiation and shielding Radioactive waste type – exempted and low-level waste; classified low, intermediate and high level waste; treatment and conditioning of nuclear waste – incineration, compaction, cementation, vitrification; Waste disposal methods – near surface disposal, deep geological disposal, disposal at outer space, deep boreholes and disposal at sea. INDIAN POWER PROGRAM: installing a nuclear establishment; research reactor apsara, Canada-India research reactor, Indian 3 stage nuclear program – advanced heavy water reactor, accelerator driven sub-critical systems, compact temperature reactor. <i>(Analytical treatment excluded)</i>	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the key components of a nuclear reactor system and their functions	K2
CO2	Explain the principles of reactor control and safety mechanism	K2
CO3	Analyse the role of fuel cycle	K2
CO4	Discuss importance of containment structures & mitigation strategy for potential accidents	K2
CO5	Evaluate different options for fuel handling and spent fuel management	K3
CO6	Understand the regulatory framework for nuclear reactor safety	K2
CO7	Critically analyse the safety aspects of historic and future reactor design	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1									1
CO2	2	1										
CO3	2	2										2
CO4	1										1	1
CO5	2											2
CO6	1	1										1
CO7	1	2										1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Physics	R K Guptha & S L Gaur	Dhanpat Rai Publications	45 th Edition (2012)
2	Nuclear reactor engineering	Dr G Vaidyanathan	S Chand & co Pvt Ltd	1 st Edition (2013)

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Nuclear Reactor Engineering	S. Glasstone and A. Sesonske,	D. Van Nostrand Company, INC.	1967
2	Source book on atomic energy	S Glasstone	D. Van Nostrand Co, 196	1967

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/101/112101007/
2	https://www.youtube.com/watch?v=1U6Nzcv9Vws
3	https://www.youtube.com/watch?v=jpDRfaWYk3I
4	https://archive.nptel.ac.in/courses/112/101/112101007/

SEMESTER S4

COMPOSITE MATERIALS

Course Code	PEMET413	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Impart knowledge about the definition, benefits, and classification of composite materials.
2. The students will be able to understand the concept of various matrices and reinforcements used in composites.
3. The course also covers about types of fibers, polymer matrix composites, metal matrix composites, ceramic matrix composites and its manufacturing and applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Composite: Introduction, definition, characteristics, functions, classification of composites based on structure and matrix, smart composites, industrial applications. Interfaces: wettability and bonding interface in composites. Types of bonding at interface. Fibers : Introduction, types of fibers, natural fibers, glass fiber fabrication, structure, properties and applications, boron fiber fabrication, structure, properties and applications.	9
2	Polymer matrix composites (PMC): Thermoset, thermoplastic and elastomeric polymers, properties, characteristics and applications as matrix materials. Processing of polymer matrix composites: hand layup methods and spray layup method. Moulding methods: pressure bagging and bag moulding methods, Autoclave-based processing with prepregs, pultrusion and filament winding process.	9

3	Metal matrix composites (MMC): classification of metals, intermetallics, alloys and their potential role as matrices in composites, properties, characteristics and applications of metals as matrix materials, production techniques: powder metallurgy, diffusion bonding, melt stirring, squeeze casting, liquid infiltration under pressure, insitu process.	9
4	Ceramic matrix composites (CMC): classification of ceramics and their potential role as matrices, properties, characteristics and applications of CMC, conventional production techniques: cold pressing and sintering, hot pressing, reaction bonding, liquid infiltration, pultrusion. lanxide process, insitu chemical technique, sol-gel technique.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand about composites, various matrices and reinforcements used in composites, types of fibres	K1, K2
CO2	To know about polymer matrix composites, classification, properties, characteristics and applications, manufacturing methods.	K1, K2
CO3	To know about metal matrix composites, classification, properties, characteristics and applications, manufacturing methods.	K1, K2
CO4	To know about ceramic matrix composites, classification, properties, characteristics and applications, manufacturing methods.	K1, K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	-	-	3	2	2	-	-	-	1
CO2	3	-	1	-	-	3	2	1	-	-	-	2
CO3	3	-	1	-	-	3	2	2	-	-	-	1
CO4	3	-	1	-	-	3	2	2	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Composite Materials : Science and Engineering	K. K. Chawla	Springer	3rdEdn 2013
2	Fiber-reinforced composites,	P.K.Mallicak	MonalDeklar Inc., New York	1988
3	Mechanics of Composite Materials; Selected Works of Nicholas J. Pagano	Reddy J N	Springer	1994
4	Mechanics of Composite Materials	Robert M. Jones	CRC Press	1998

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Composite Materials, Engineering and Sciences	F.L.Matthews&R.D.Rawlings	Chapman & hall, London	1994
2	Stress Analysis of Fiber - Reinforced Composite Materials	MicaelHyar	Tata McGraw Hill	1998

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://www.youtube.com/watch?v=JBMVZpRD-Zk
2	https://www.youtube.com/watch?v=tP8JCX87DzI
3	https://www.youtube.com/watch?v=RihoVfzEfWI
4	https://www.youtube.com/watch?v=LGERbwD5S2g

SEMESTER S4
COMPONENTS OF INTELLIGENT SYSTEMS

Course Code	PEMET414	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. The students will have the ability to understand the working of various sensors and transducers.
2. The students will have the ability to develop systems for actuation of mechanical systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Sensors and Transducers: Internal Sensors: Position - Optical Encoders, Potentiometers, LVDT, Velocity - Encoders, Tachogenerators, Acceleration – Different types of accelerometers, Gyroscopes, IMU, Force transducers External Sensors: Contact Sensors, Inductive and Capacitive Proximity sensors, GPS, Ultrasonic transducers and SONAR, RADAR and Doppler effect, LIDAR Sensor Characteristics: Sensitivity, Linearity, Measurement /Dynamic range, Response Time, Accuracy, Repeatability and Precision, Resolution & Threshold, Bandwidth	9
2	Actuators: Hydraulic and Pneumatic Actuators: Working of Hydraulic and Pneumatic Actuators at block diagram level, advantages and disadvantages of each Electric Actuators: Electric motors - DC motors, Stepper motors, Servo motors, BLDC motors, Transmission Elements, advantages and disadvantages of Electric Actuators	9

3	Microcontrollers: Definitions of microprocessors and microcontrollers with basic block diagrams and differences between them Arduino Uno microcontroller: Board Study (Board level Block schematic) - Chip (Features only – Architecture not needed), GPIO, Memory, Programming Interface Programming: Arduino IDE, Sample Code for interfacing LED and Switch, DC motor and Stepper motor control, LCD Interfacing	9
4	Introduction to Embedded Systems and IoT: Embedded Systems: Applications of embedded systems-Consumer electronics, Robotics, Automobiles Embedded System Architecture: Hardware - Processor, Controller, Memory, Peripherals; Software - Application, Middleware, OS, Device Drivers, Tool chain- Assembler, Interpreter, Compiler, Linker, Loader, Debugger IoT: Definition, Impact of IoT in Manufacturing, Smart homes, Transportation and Cities Wired Communication: Basics of Serial communication (UART, SPI, I2C) Wireless Communication: Basics of Wi-Fi, Bluetooth, Zigbee, LoRa, and NFC Case Study: Design and implementation of a simple Embedded/IoT project	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the working of sensors and transducers	K2
CO2	Describe the operation of actuators for intelligent systems	K2
CO3	Develop the hardware and software for microcontroller based systems for actuation	K3
CO4	Outline the basic concepts of Embedded Systems and IoT	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	-	-	-	-	-	3
CO2	3	3	3	-	-	-	-	-	-	-	-	3
CO3	3	3	3	-	3	-	-		-	-	-	3
CO4	3	3	3	-	-	-	-	-	-	-	-	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Robotics	S K Saha	McGraw-Hill Education (India)	2008
2	Sensors, Actuators, and their Interfaces: A multidisciplinary introduction	SciTech Publishing Inc	SciTech Publishing Inc	2011
3	Beginning Arduino	Michael McRoberts	Apress	1 st Edition, 2011
4	Embedded Systems: An Integrated Approach	Lyla B Das	Pearson Education India	1 st Edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Sensors and Transducers	D. Patranabis	PHI Learning	2nd edition, 2003
2	Embedded Systems Architecture, programming and Design	Raj Kamal	Tata McGraw-Hil	3 rd edition, 2013

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.swayam2.ac.in/aic20_sp04/unit?unit=4&lesson=7

SEMESTER S4
ADVANCED METAL JOINING TECHNIQUES

Course Code	PEMET416	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	4/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To establish fundamental knowledge Advanced welding technologies
2. To enable the learner to select appropriate metal joining technique based on the application.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Solid State Welding: Principle and mechanism of solid-state welding, techniques, process parameters and applications of diffusion welding, cold pressure welding. Adhesive Bonding: Principle – types of adhesives, bonding methods – applications.	9
2	Explosive welding: principle and theory, equipment used, Process parameters and characteristics, weld joint design, Applications, advantages, and limitations. Friction and Friction stir welding: principle and theory – Process parameters and applications, Tools, and Metal flow. Ultrasonic Welding: principle, theory, and types – Welding environment, equipment used- Process parameters and characteristics, weld joint design and applications.	9

3	Electron Beam Welding (EBW) - principle and theory, Welding environment, equipment used- Process parameters and characteristics, weld joint design, Applications, advantages, and limitations. Laser Beam Welding (LBW) – Principle and theory, types of lasers, Process parameters and characteristics, Applications, advantages, and limitations. Plasma Arc Welding (PAW) –Theory – transferred arc and non-transferred arc techniques, equipment – applications.	9
4	Magnetically Impelled Arc Butt (MIAB)– principle and applications. Under water welding – wet land dry under water welding- set-up for underwater welding systems. Brazing – Principle – processes involved – torch brazing, furnace brazing, vacuum brazing, induction brazing – advantages and applications. Micro-joining and nano-joining: Introduction, theory, and applications.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Summarise the Solid-state welding techniques and outline the physics of adhesive bonding.	K2
CO2	Compare and select between explosive welding, friction welding and ultrasonic welding based on the applications.	K3
CO3	Understand radiant energy welding technologies and explain the principle and working of EBW, LBW and PAW.	K2
CO4	Outline the modern joining technologies and select appropriate brazing technique to resolve modern metal joining problem.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	2	-	-	-	-	-	2
CO2	2	2	2	-	-	2	-	-	-	-	-	2
CO3	2	2	-	-	-	-	-	-	-	-	-	2
CO4	2	3	2	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced welding Processes	J. Norrish	Woodhead publishing	2006
2	Welding Processes and Technology	Parmar R. S	Khanna Publishers	1998

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Welding	R. W. Messler	John Wiley and Sons	1999
2	Metal Joining Manual	Schwartz M. M	McGraw-Hill Inc.	1979
3	Micro-joining and Nano-joining	Y. N. Zhou	Woodhead publishing	2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/112103244
2	https://nptel.ac.in/courses/112103244
3	https://nptel.ac.in/courses/112103244
4	https://nptel.ac.in/courses/112103244

SEMESTER S4

TECHNOLOGY MANAGEMENT

Course Code	PEMET417	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. Develop a holistic understanding of management theory, covering management functions, system approaches, managerial tasks, the management process, and various domains including operations, human resources, marketing, corporate social responsibilities, finance, entrepreneurship, and intellectual property rights.
2. Explore the evolution of technology over the past two centuries, its impact on human needs, dimensions of technology management, and its role in business plans, competition, innovation, and research, with a focus on the Indian context and key aspects such as change, life cycle, diffusion, growth, transformation, and socio-economic planning.
3. Examine the implications of technological changes on production functions, innovation dynamics, service sectors, and macro-economic effects, focusing on technology absorption, terminology, government initiatives, and future strategies, with a specific emphasis on the Indian context.
4. Analyse the multifaceted impacts of technological changes, including production function dynamics, innovation paradigms, service sector evolution, and technology absorption processes, with a special focus on the Indian context and government initiatives for managing technological advancements

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Management theory: management definition & functions; system approaches to management; task & responsibilities of manager; management process; planning; organizing; decision making; management: operations; human resource; marketing; corporate & social responsibilities, financial; entrepreneurship; patent & Intellectual property rights.	9
2	Technology concept: significant technology changes during last 2 centuries; direct and indirect effect of technology on human need factors; dimensions of technology management; role & importance of technology management; business plan; technology & competition; new ventures; innovation; research; research infra structure; examples of speed of introducing technology development into social use; technology management in Indian context, Aspects and issues of technology management: technology – change, life cycle, diffusion & growth, transformation, alternatives, appropriateness, policy instruments, planning, development options & strategies	9
3	Implication in technology changes: production function and technology change, Nature of technology change – innovation: incremental, radical; new technology system: technology revolution: information technology revolution, Changes in service; personal service, process changes, macro-effects of technological change; knowledge intensity’ skill mismatch; erosion of competitive mismatch in developing countries. Technology absorption: technology – package & dependence, terminology and concepts in absorption, Technology import in India & Indian experience, managing technology absorption, government initiatives.	9
4	Technology environment: Science & Technology in India; policies, linkages at enterprise levels, Technology support systems: financing; information systems; organizing technology at enterprise level, Technology forecasting: innovation chain; necessity; role; classification forecasting approaches; methods; methodology comparison; pitfalls & mistakes. Digital Transformation and Industry 4.0: Concepts and significance of digital transformation. Industry 4.0 technologies: IoT, AI, ML, Big Data, Robotics, and Cyber-Physical Systems. Impact of digital transformation on business models and processes.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate a comprehensive understanding of management theories, including definitions, functions, and system approaches, to effectively fulfil managerial tasks and responsibilities.	K1
CO2	Analyse and apply various management processes such as planning, organizing, and decision-making across diverse domains including operations, human resources, marketing, and corporate social responsibilities.	K2
CO3	Evaluate the role and significance of entrepreneurship, financial management, and intellectual property rights within the broader context of management theory.	K5
CO4	Critically assess significant technological changes over the past two centuries and their direct and indirect effects on human needs, while exploring dimensions of technology management and its importance in business planning and competition.	K5
CO5	Synthesize the implications of technological changes, including production function dynamics, innovation paradigms, and the macro-effects of technology on service sectors and competitive landscapes, with a focus on technology absorption, policy instruments, and future strategies.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	1	1	1	1	1	1	1
CO2	1	1	1	1	1	1	1	1	1	1	1	1
CO3	1	1	1	1	1	1	1	1	1	1	1	1
CO4	1	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	1	1	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Management of Technology and Innovation: Competing Through Technological Excellence	P N Rastogi	SAGE Publications,	2009
2	Managing Strategic Innovation & Change	Tushman, M.L. and Anderson	Oxford University Press, New York,	2004
3	Management of Technology and Innovation,	Khurana, V. K.	Ane Books New Delhi,	2012
4	Managing Technology and Innovation for Competitive Advantage	Narayanan	Pearson Education,	2002

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	RobertA, Burgelman, Clayton.M.Christensen, Steven.C.Wheelright,	Strategic Management of Technology and Innovation	McGraw-Hill Education	5 th , 2009
2	Paul Trott,	Innovation Management and New Product Development	Pearson Education,	2009
3	Afuah, A	Innovation Management, Strategies, Implementation and Profits	Oxford University Press,2009	2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/110/106/110106157/
2	https://archive.nptel.ac.in/courses/110/106/110106157/
3	https://archive.nptel.ac.in/courses/110/106/110106157/
4	https://archive.nptel.ac.in/courses/110/106/110106157/

SEMESTER S4

SUPPLY CHAIN AND LOGISTICS MANAGEMENT

Course Code	PEMET418	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. Understand the complexity and key issues in supply chain management.
2. Describe logistics networks, distribution planning, routing design and scheduling models.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Understanding the Supply chain, Achieving strategic fit in a supply chain. Supply chain drivers and metrics. Analysing and designing the supply chain network, factors affecting distribution network design, role of network design, models for designing regional network configuration. Impact of globalisation on supply chain networks.	9
2	Demand forecasting in supply chain, role of forecasting, components of forecasting, forecasting methods. Aggregate planning in supply chain, basic trade-offs in aggregate planning, linear programming in aggregate planning. Coordination in supply chain, impact of lack of coordination in the chain, obstacles to coordination, managerial levers to improve coordination.	9
3	Managing economies of scale in a supply chain: Cycle inventory, Aggregating Multiple Products in a Single Order & Quantity Discounts. Managing uncertainty in a Supply chain – Safety inventory: Factors affecting the optimal level of product availability. Impact of supply uncertainty on safety inventory. Impact of aggregation on safety inventory. Factors affecting the optimal level of Product availability.	9

4	Logistics management and its components. Modes of transportation and their performance Characteristics & Transportation infrastructure policies. Design options for a transportation and logistics network. Trade-offs in transportation design, Tailored transportation. Role of sustainability in a supply chain. Sustainability connected supply chain drivers.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To analyse supply chains and design the supply chain network.	K4
CO2	To solve demand forecasting problems in the supply chain and enhance coordination in the network.	K4
CO3	To plan and manage inventories in the supply chain.	K4
CO4	To develop and plan transportation networks for supply chain considering sustainability also.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	2								
CO2	2	2		2						2		
CO3	2	2		2								
CO4	2	2	1	2								

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	SupplyChain Management:Strategy, planning & Operation	Sunil Chopra and Dharam Vir Kalra	Pearson	7th edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Designing and managing the supply chain concepts, strategies, and cases studies	David Simchi- Levi, Edith Simchi-Levi	McGraw Hill	4 th edition, 2022

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/110106045
2	https://nptel.ac.in/courses/110106045
3	https://nptel.ac.in/courses/110106045
4	https://nptel.ac.in/courses/110106045

SEMESTER S4
ADVANCED MECHANICS OF SOLIDS

Course Code	PEMET415	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET302 Mechanics of Solids	Course Type	Theory

Course Objectives:

1. To study the methodologies in theory of elasticity at a basic level.
2. To acquaint with the solution of advanced bending problems.
3. To study the methods for torsion in components with non-circular cross section and thin-walled structures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to theory of elasticity – 3D stress components in rectangular and cylindrical coordinate systems– strain-displacement relations (no derivation required) - constitutive equations (no derivation required)-stress transformation– octahedral shear stress-equations of equilibrium. Boundary value problems: Different boundary conditions-Examples for Displacement Formulation/ Force Formulation.	9
2	Equations in polar coordinates (2D) – equilibrium equations, strain displacement relations - Airy's stress function and equation – polynomial method of solution – solution for bending of a cantilever beam with end load Application of stress function to Lamé's problem and stress concentration problem of a small hole in a large plate (only Stress distribution)	9
3	Axisymmetric problems: thin cylinders pressurized from inside, and thick cylinders-pressurized from inside and outside - Rotating disks. Unsymmetrical bending of straight beams possessing two axes of symmetry-shear centre-Winkler Bach theory for Bending of curved beams (with rectangular cross-section).	9

4	Torsion of non-circular bars: St.Venant's and Prandtl's methods-solutions for elliptical cross-section. Membrane analogy. Torsion of thin-walled tubes, thin rectangular sections, rolled sections and multiply connected sections	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Formulate the field equations of Elasticity.	K1
CO2	Model engineering problems as two-dimensional, for solutions involving a Stress Function.	K2
CO3	Develop solutions for axi-symmetric problems for applications in thick pressure Vessels and in rotating circular discs.	K6
CO4	Extend the basic ideas related to theory of elastic flexure, for skewed loading and for beams which are curved.	K4
CO5	Apply solution methods for torsion in components with non-circular cross Sections and thin-walled structures.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	2	3	1									
CO3	2	3	1									
CO4	3	2	1									
CO5	2	3	1									

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Theory of Elasticity	S.P.Timoshenko and J.N. Goodier	McGrawHillEducation	ThirdEdition,2009
2	Advanced Mechanicsof Solids	LSSrinath	Tata McGraw Hill Publishing Company,	ThirdEdition,2008
3	Solid Mechanics	S.M.A. Kazimi	McGrawHill	2008
4	Advanced Mechanics of Materials	S. Jose	Pentagon Educational Services	2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	AdvancedStrength of Materials	J.P.Den Hartog	McGrawHill	1987
2	Engineering Solid Mechanics,Fundamentals and Applications	RagabA.R.and Bayoumi S. E.	CRCPress	FirstEdition,2018
3	Elasticity:Theory, Applications and Numerics	SaddM. H.	AcademicPress	SecondEdition,2012
4	An introduction the theory of elasticity	R.J.Atkin,andN.Fox	Longman	1980

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/101/112101095/
2	https://archive.nptel.ac.in/courses/112/101/112101095/
3	https://archive.nptel.ac.in/courses/112/101/112101095/
4	https://archive.nptel.ac.in/courses/112/101/112101095/

SEMESTER S4
ECONOMICS FOR ENGINEERS
(Common to All Branches)

Course Code	UCHUT346	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understanding of finance and costing for engineering operation, budgetary planning and control
2. Provide fundamental concept of micro and macroeconomics related to engineering industry
3. Deliver the basic concepts of Value Engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Economics Concepts - Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility – Law of Demand - Law of supply – Elasticity - measurement of elasticity and its applications – Equilibrium- Changes in demand and supply and its effects Production function - Law of variable proportion – Economies of Scale – Internal and External Economies – Cobb-Douglas Production Function	6
2	Cost concepts – Social cost, private cost – Explicit and implicit cost – Sunk cost - Opportunity cost - short run cost curves - Revenue concepts Firms and their objectives – Types of firms – Markets - Perfect Competition – Monopoly - Monopolistic Competition - Oligopoly (features and equilibrium of a firm)	6

3	Monetary System – Money – Functions - Central Banking –Inflation - Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Deflation Taxation – Direct and Indirect taxes (merits and demerits) - GST National income – Concepts - Circular Flow – Methods of Estimation and Difficulties - Stock Market – Functions- Problems faced by the Indian stock market-Demat Account and Trading Account – Stock market Indicators- SENSEX and NIFTY	6
4	Value Analysis and value Engineering - Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure - Break-even Analysis - Cost-Benefit Analysis - Capital Budgeting - Process planning	6

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	15	12.5	12.5	50

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
- Minimum 1 and Maximum 2 Questions from each module. - Total of 6 Questions, each carrying 3 marks (6x3 =18marks)	2 questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 2 sub divisions. - Each question carries 8 marks. (4x8 = 32 marks)	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	K2
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	K3
CO3	Outline the macroeconomic principles of monetary and fiscal systems, national income and stock market.	K2
CO4	Make use of the possibilities of value analysis and engineering, and solve simple business problems using break even analysis, cost benefit analysis and capital budgeting techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7 TH Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	UCHUT347	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of ethics - Personal vs. professional ethics, Civic Virtue, Respect for others, Profession and Professionalism, Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, Technology and digital revolution-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, High technologies: connecting people and places-accessibility and social impacts, Managing conflict, Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Codes of Ethics. Basic concepts in Gender Studies - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, Gender disparity and discrimination in education, employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations, Ethical values and practices in connection with gender - equity, diversity & gender justice, Gender policy	6

	and women/transgender empowerment initiatives.	
2	Introduction to Environmental Ethics: Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). Sustainable Engineering Principles: Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. Ecosystems and Biodiversity: Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. Landscape and Urban Ecology: Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	6
3	Hydrology and Water Management: Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. Zero Waste Concepts and Practices: Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. Circular Economy and Degrowth: Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. Mobility and Sustainable Transportation: Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	6
4	Renewable Energy and Sustainable Technologies: Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. Climate Change and Engineering Solutions: Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. Environmental Policies and Regulations: Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. Case Studies and Future Directions: Analysis of real-	6

	world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	
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**Course Assessment Method
(CIE: 50 marks , ESE: 50)**

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
Total Marks				50

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis:** Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts:** Ability to apply course concepts to real-world problems and local contexts.
- **Creativity:** Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills:** Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	K3
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	K4
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	K5
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	K4
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	2	3	3	2		2
CO2		1				3	2	3	3	2		2
CO3						3	3	2	3	2		2
CO4		1				3	3	2	3	2		2
CO5						3	3	2	3	2		2

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessment	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).

- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER S4

FLUID MECHANICS AND HYDRAULIC MACHINES LAB

Course Code	PCMEL407	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0-0-3-0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fluid Mechanics and Machinery (PCMET303)	Course Type	Lab

Course Objectives:

1. To familiarize the applications of fluid mechanics and dynamics.
2. To get acquainted with the practical implication of viscous flow and discharge measuring equipment in both closed & open channel flow.
3. To gain practical experience in handling various hydraulic machines.

Expt. No.	Experiments
1	Determination of coefficient of discharge and calibration of Notches.
2	Determination of coefficient of discharge and calibration of Orifice meter.
3	Determination of coefficient of discharge and calibration of Venturi meter.
4	Determination of hydraulic coefficients of orifices and mouthpieces with constant and varying head.
5	Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus.
6	Determination of the minor losses in pipe.
7	Experiments on hydraulic ram.
8	Reynolds experiment.
9	Bernoulli's experiment.
10	Determination of metacentric height and radius of gyration of floating bodies.
11	Performance test on Positive displacement pumps.
12	Performance test on Centrifugal pumps and determination of operating characteristics.
13	Performance test on Gear pump.
14	Performance test on Pelton turbine and determination of operating characteristics.

15	Performance test on reaction turbines (Francis and Kaplan Turbines) and determination of operating characteristics.
16	Speed variation test on Pelton turbine.

- Minimum 10 experiments should be completed

Course Assessment Method (CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the fundamental principles of fluid mechanics to understand the flow of fluid through pipes, notches, and associated losses.	K3
CO2	Select a pump/turbine based on the given operating conditions and determine the performance of a given Turbo machine under various operating conditions.	K4
CO3	Demonstrate the ability to work in groups and present results. Also, understand the ethical issues with decision making and professional conduct.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2												
CO3	3	3	2	2	-	2	-	-	-	-	-	2

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics	Cengel Y. A. and J. M. Cimbala	Tata McGraw Hill	2013
2	Introduction to fluid mechanics and fluid machines	Som S.K	McGraw Hill Education	2011
3	Fluid mechanics and hydraulic machines	Bansal R. K	Laxmi Publications	2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics	White F.M.	Tata McGraw Hill	2003
2	Engineering applications of fluid dynamics	Fisher & Henley	Willford Press	2023

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Fluid Statics – https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfYY1O&index=4 Bouyancy, Metacentre and stability https://www.youtube.com/watch?v=gMuucNxc7eI&list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw&index=7&pp=iAQB
2	Fluid kinematics – https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfYY1O&index=4
3	Internal viscous flow – https://www.youtube.com/watch?v=qLx7ip0eBps&list=PLCoE5wxWtHFYiVGswvsWRaHjv18vxZzE2&index=17
4	Introduction to turbomachines – https://www.youtube.com/watch?v=ocVzrn4DLj8&list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE&index=2

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.

- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER: S4

MANUFACTURING TECHNOLOGY LAB

Course Code	PCMEL408	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To understand the parts of various machine tools and impart hands-on experience on lathe, drilling, shaping, milling, grinding, tool and cutter grinding machines.
2. To study process parameters and practice arc and gas welding technologies.

Expt. No.	Experiments
1	Exercises on lathe: - Plain and step turning.
2	Exercises on lathe: - Ball & curve, and Taper turning.
3	Exercises on lathe: - Thread cutting.
4	Exercises on lathe: - Measurement of cutting forces in turning Process.
5	Exercises on shaping machine: - flat surfaces.
6	Exercises on shaping machine: - Grooves and key ways.
7	Exercises on drilling machine: - drilling, boring, reaming, tapping and counter sinking etc.
8	Exercises on drilling machine: - Measurement of cutting forces in drilling process.
9	Exercises on cylindrical grinding machine: - Grinding of a plain cylindrical surface.
10	Exercises on surface grinding machine: - Grinding of a flat surface.
11	Exercises on tool and cutter grinding machine: - Grinding of a single-point cutting tool.
12	Exercises on milling machine: - Plane and pocket milling operations.
13	Exercises on milling machine: - Spur gear cutting operation.
14	Exercises on milling machine: - Measurement of cutting forces in milling process.
15	Exercises on arc welding: - butt welding and lap welding of M.S. sheets.
16	Exercises on gas welding: - butt welding and lap welding of M.S. sheets.
17	Study and preparation of program, simulation and exercise on CNC lathe:-turning, step turning, taper turning, thread cutting, ball and cup turning etc.

18	Study and preparation of program, simulation and exercise on CNC milling machine: - surface milling, pocket milling, contour milling etc.
19	Metallurgy: - Specimen preparation, etching & microscopic study of Steel, Cast iron and Brass and grain size measurement.
20	Exercises on part quality inspection using machine vision systems.
21	Exercises on industrial robots- manual and programmed path planning

A minimum of 12 sets of experiments are mandatory but both experiments mentioned for programming and experiments on CNC machines are mandatory.

Course Assessment Method (CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	The students can operate different machine tools with understanding of work holders and operating principles to produce different part features to the desired quality.	K3
CO2	Apply cutting mechanics to metal machining based on cutting force and power consumption.	K3
CO3	Programming and manufacturing of complex profiles in CNC machines with high precision.	K3
CO4	Fabricate and assemble various metal components by welding and students will be able to visually examine their work and that of others for discontinuities and defects.	K3
CO5	Gain knowledge on the structure, properties, testing and applications of ferrous and non ferrous metals.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3			1								
CO2	3			3								
CO3	3			2	3							
CO4	3			1								
CO5	3			1								

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Production Technology	HMT	Tata McGraw Hill	2017
2	Workshop Technology Part I	W. A. J. Chapman	ELBS & Edward Arnold Publishers	1972
3	Numerical Control of Machine Tools	Yoram Koren	McGraw-Hill	2014
4	Production Technology	HMT	Tata McGraw Hill	2017

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 5

MECHANICAL ENGINEERING

SEMESTER S5

DYNAMICS OF MACHINERY

Course Code	PCMET501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3: 1: 0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Mechanics of Machinery (PBMET404)	Course Type	Theory

Course Objectives:

1. To understand the rigid- body dynamics of kinematically driven machine components and perform the force analysis
2. To understand the gyroscopic effect on stability of road vehicles, aeroplanes, ships; devise methods to control the fluctuation of power and speed of IC engines, perform balancing of masses to reduce vibrations in machines
3. To understand the theory of vibrations and perform analysis of single degree of freedom (SDOF) systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Static Force analysis: Static equilibrium conditions, Two & three force members, four bar and slider crank mechanisms (graphical and analytical), method of virtual work. Dynamic force analysis: Force & moment equilibrium, Inertial forces, D' Alembert's principle. Dynamic analysis of four-bar and slider-crank mechanisms.	11
2	Gyroscope - effect of gyroscopic couple on - bearings, the stability of - two wheel, four wheel vehicles, ships and aircrafts. Balancing of rotating masses- single mass, several masses in same and in different planes; Balancing of reciprocating masses, partial balancing of	11

	single cylinder and multi-cylinder inline engines	
3	Flywheels- turning moment diagrams-for four stroke IC engines; Coefficient of fluctuation of energy, speed; energy stored in a flywheel, design of flywheels, applications. Governor Mechanisms- types of governors, gravity controlled -Watt, Porter and Proell governors, Spring controlled- Hartnell governor; Isochronism, sensitivity, stability and hunting.	11
4	Vibration Analysis: Undamped free vibrations of SDOF systems - natural frequency of longitudinal, transverse and torsional vibrations by Newton's method and energy method; Damped systems and critical damping, logarithmic decrement. Forced harmonic vibration, response of reciprocating and rotating unbalance, magnification factor, resonance; whirling of rotating shafts, vibration isolation and transmissibility, accelerometer.	11

Course Assessment Method
(CIE: 40marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Perform the force analysis of four bar kinematic systems.	K2, K3, K4
CO2	Perform balancing of rotating and reciprocating masses in machines; understand the function and determine the gyroscopic effect on stability of automobiles, ships and aeroplanes.	K2, K3
CO3	Understand the principle of governors/ flywheel for the control of speed/energy fluctuation in engines or machines, and perform its analysis and design.	K2, K3
CO4	To determine the natural frequencies, perform the analysis of free or harmonically excited vibration response of damped and undamped vibratory SDOF systems	K2, K3, K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	-	-	-	-	-	2	-	-	3
CO2	3	2	3	-	-	-	-	-	2	-	-	3
CO3	3	2	3	-	-	2	-	-	2	-	-	3
CO4	3	2	3	-	3	2	-	-	2	-	-	3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Theory of Machines	S. S. Rattan	Tata McGraw-Hill Education	4th edition, 2017
2	Theory of Machines and Mechanisms	Ballaney P. L.	Khanna Publishers	21st edition, 2020
3	Theory of Machines	Thomas Bevan	Pearson Education Ltd.	3rd Edition, 2010
4	Textbook of Mechanical Vibrations	Dukkipati R.V., J Srinivas	Prentice Hall India	2nd Edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Theory of Mechanisms and Machines	Amithabha Ghosh, Asok Kumar Malik	East West Press	2011
2	Kinematics and dynamics of machinery	Robert L Norton	McGraw-Hill Education	1st edition in SI units 2009
3	Kinematics and Dynamics of Machinery	Charles E. Wilson, J. Peter Sadler	Pearson Education Ltd.	3rd Edition, 2008
4	Theory of Machines and Mechanisms	John J. Uicker, Gordon R. Pennock, Joseph E. Shigley	Oxford University Press	5th edition, 2017
5	Theory of vibration with applications	W. T Thomson	CBS Publishers	1st Indian edition, 1990
6	Mechanical vibrations and Industrial noise control	Lasithan L G	PHI Learning	1st edition, 2014

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/104/112104114/ (Dynamics of Machines, by Prof. Amitabha Ghosh, IIT Kanpur)
2	https://archive.nptel.ac.in/courses/112/104/112104114/
3	https://archive.nptel.ac.in/courses/112/104/112104114/
4	https://archive.nptel.ac.in/courses/112/107/112107212/ https://www.youtube.com/watch?v=9t9qZMhnRFE https://www.youtube.com/watch?v=R7pF2WC4hXQ

SEMESTER 5

ADVANCED MANUFACTURING ENGINEERING

Course Code	PCMET502	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Manufacturing Processes (PBMET304), Machine Tools and Metrology (PCMET402)	Course Type	Theory

Course Objectives:

1. Learn how to program CNC machines and control automated equipment with PLC.
2. To introduce machining principles and processes in the manufacturing of precision components and products that use non-conventional technologies.
3. To offer a basic understanding of machining capabilities, limitations, and productivity of advanced manufacturing techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	CNC: systems – Principle of operation, components of CNC system, coordinate systems, classification of CNC systems, point-to-point and contouring systems, incremental and absolute programming methods, open loop and closed loop systems, feedback devices. Interpolators: liner, circular and complete interpolator. Manual part programming - Computer aided part programming - APT. Programming exercises in turning, drilling and milling operations. <i>(At least one programming exercise must be included in the end-semester</i>	11

	<i>examination).</i>	
2	Programmable Logic Controllers (PLC) – input and output devices, ladder logic programming, simple problems only. Advanced Machining Processes: ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM), Plasma arc machining (PAM), Ion beam machining (IBM).	11
3	Advanced Metal Forming Processes: High velocity forming of metals - Sheet metal forming - explosive forming - Electro hydraulic forming - Electro Magnetic Forming. Stress waves and deformation in solids – types of elastic body waves- relation at free boundaries- relative particle velocity. Microfabrication process: CVD, PVD, LIGA process. Micromachining: Diamond turn mechanism.	11
4	Advanced finishing processes: - Abrasive Flow Machining, Magnetic Abrasive Finishing. - Magnetorheological Finishing, Magnetorheological Abrasive Flow Finishing, Magnetic Float Polishing, Elastic Emission Machining. Material addition processes: - stereo-lithography, selective laser sintering, fused deposition modeling, laminated object manufacturing, laser-engineered net-shaping.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub-divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course, students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	CNC programming, select appropriate tooling and parameters.	K3
CO2	To categorize the various non -traditional material removal processes based on energy sources and mechanisms employed.	K2
CO3	Analyze the processes and evaluate the role of each process parameter during the micromachining of various advanced material removal processes.	K3
CO4	Explain the processes used in additive manufacturing for a range of materials and applications.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2		2	-	-	-	-	-	-	2
CO2	3	-	-	-	2	-	-	-	-	-	-	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2
CO4	3	-	-	-	2	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer control of manufacturing systems	Yoram Koren	TMH	2017
2	Advanced Machining Processes	Jain V.K.	Narosa publishers	2014
3	Introduction to Micromachining	Jain V.K.	Narosa publishers	2014
4	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing	Ian Gibson, David Rosen, Brent Stucker	Springer Nature	2nd ed. 2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer-Aided Design and Manufacturing	M.P. Groover, E.M. Zimmers, Jr.	Prentice Hall of India	1987
2	Programmable logic controllers	PetruzellaFrank.D.	McGraw Hill	2016
3	Developments in high-speed metal forming	Davies K and Austin E.R	The Machinery Publishing Co	1970

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/112105211
2	https://nptel.ac.in/courses/112104028
3	https://nptel.ac.in/courses/102108078
4	https://nptel.ac.in/courses/112103306

SEMESTER S5

HEAT AND MASS TRANSFER

Course Code	PCMET503	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET403 Engineering Thermodynamics	Course Type	Theory

Course Objectives:

1. Apply heat transfer principles to solve engineering problems
2. Understand principles of various heat transfer equipments.
3. Apply mass transfer principles to solve engineering problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Conduction heat transfer Modes of heat transfer – Mechanisms and laws of heat transfer – thermal conductivity, convective heat transfer coefficient, overall heat transfer coefficient General heat conduction equation in three dimension through plane (derivation needed) cylindrical and spherical (only equation) walls –initial and boundary conditions - One Dimensional Steady state heat conduction - Thermal Conductivity – concept of thermal resistance – critical radius – conduction with heat generation. Transient heat conduction – Lumped system analysis – transient heat conduction analysis of bodies with non-negligible internal temperature	8

	gradient. Heat transfer through extended surfaces – classification of fins – heat transfer rate from a fin (rectangular fin, pin fin) – boundary conditions – fin effectiveness and fin efficiency. Introduction to finite difference method for steady state heat conduction analysis.	
2	Convection heat transfer Forced convection – concept of thermal and hydrodynamic boundary layers (internal and external flows) – thermal diffusivity – momentum diffusivity – fluid friction and heat transfer relationship – developing and developed flows (hydrodynamic and thermal). Non dimensional number in heat transfer. External heat convection from flat plate/cylinder/ sphere during laminar and turbulent flow. Internal heat transfer in a circular pipe during laminar and turbulent flow. Analogy between heat and momentum transfer. Natural convection – natural convection heat transfer from vertical plate, horizontal and vertical cylinder. Heat exchanger – classification – design considerations and parameters – compact heat exchangers – effect of fouling- heat exchanger analysis – LMTD and NTU methods. Introduction to heat pipes.	10
3	Radiation heat transfer Basic laws of radiation heat transfer – Black, gray, diffuse and real surfaces - emission characteristics and laws of black body radiation - solid angle and radiation intensity – radiation heat exchange between two infinite and finite back surfaces – shape factors- radiation heat exchange between two infinite parallel diffuse gray surfaces. Electrical network analogy for radiation heat exchange. Radiation shields. Conduction shape factor.	10
4	Mass Transfer Introduction to mass transfer – diffusion coefficient – Fick's law of	8

	diffusion- steady state diffusion in stationary medium- diffusion in moving medium- diffusion through a membrane. Convective mass transfer – non dimensional numbers – analogy between heat and mass transfer – correlations. Cooling of electronic equipments – need – various methods – influencing factors. Electric battery cooling – various methods - phase change material, fin cooling, air cooling, liquid cooling. (description only)	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To understand and apply the principles of heat conduction in engineering problems	K3
CO2	To analyse mechanisms of natural and forced heat convection and understand the factors influencing the design of heat transfer equipment.	K4
CO3	To understand the principles of thermal radiation and apply the principles for radiation shielding	K3
CO4	To understand the principles modern cooling techniques and solve mass transfer problems using correlations.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	1	-	-	2	-	-	-	2
CO2	3	3	3	-	-	-	1	2	-	-	-	2
CO3	3	3	2	-	-	-	1	2	-	-	-	2
CO4	3	3	2	-	-	-	-	2	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of engineering heat and mass transfer	R. C. Sachdeva	New Age International Publishers	6 th edition, 2022
2	Heat and Mass Transfer elements	P.K Nag	Tata McGraw Hill	3 th edition, 2011
3	Heat and Mass Transfer – Fundamental and Application	Yunus A. Cengel and Afshin J. Ghajar	McGraw Hill	6 th edition, 2020
4	A text book on heat transfer	S.P. Sukhatme	Universities Press	4 th edition, 2005

Data Books permitted for reference in the final examination:				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Heat and Mass Transfer Data Book	C P Kothandaraman	New Age International Publishers	10 th edition, 2022
2	Heat and Mass Transfer Data Book	Domkundwar	Dhanpatrai & Co.	2016
3	Heat Transfer Data Book	Mahesh M. Rathore	Laxmi Publications Pvt Ltd	1 st edition, 2020

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanical Engineering Design	J. E. Shigley	McGraw Hill	2003
2	Fundamentals of Machine Component Design,	Juvinall R.C, Marshek K.M.	John Wiley	5 th edition, 2011
3	Shigley's Mechanical Engineering Design	Richard G. Budynas, J. Keith Nisbett	McGraw Hill	11 th edition, 2020
4	Design of Machine Elements	M. F. Spotts, T. E. Shoup	Pearson Education	8 th edition, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/105/112105124/
2	https://archive.nptel.ac.in/courses/112/105/112105124/
3	https://archive.nptel.ac.in/courses/112/105/112105124/
4	https://archive.nptel.ac.in/courses/112/105/112105124/

SEMESTER S5

MANAGEMENT FOR ENGINEERS

Course Code	PBMET504	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	PBL

Course Objectives:

1. To develop ability to critically evaluate a variety of management practices in the contemporary context
2. To understand and apply a variety of management and organisational theories in practice
3. To create sustainable organisations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Management: Art and science perspectives – External environment – Classical, neo – classical and modern management theories – Levels of managers and skill required – Systems approach Planning – Types of plans – Mission, Goal, Strategy, Programme, Procedure Organizing - Organization levels and span of control – Delegation – Organization structures – line and staff concepts	9
2	Leading and Controlling: Leading Vs Managing - Dimensions of Leadership - Leadership Behaviour and styles - Transactional and Transformational Leadership -Basic control process Decision Making: Steps, Decision under certainty, risk and uncertainty: Decision trees, EMV method, EOL method, MaxiMin criterion, MiniMaxcriterion, MiniMax regret criterion.	9

3	Project Management: Network construction, AON, AOA diagrams – Redundancy – CPM and PERT networks – Scheduling computations – PERT time estimates – Probability of completion of project – crashing Human resource management: Manpower planning, recruitment, selection, placement, training, development, performance management - Motivation - mechanism and theories	9
4	Operations management – Introduction - Concept of Productivity and its measurement – Forecasting – moving average – weighted moving average Marketing management – Marketing mix – Market segmentation, Market targeting and product positioning – Product life cycle, Marketing strategies for different stages of product life cycle – Sales promotion and methods – Channels of distribution Corporate Social Responsibility	9

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 2 marks (8x2 =16marks)	2 questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 2 sub divisions. - Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop ability to critically analyse a variety of management practices in the contemporary context	K4
CO2	Examine the broad functions of management	K2
CO3	Demonstrate ability in decision making and productivity analysis	K3
CO4	Apply project management techniques to manage projects	K3
CO5	Understand the functional areas of management	K2
CO6	Introduce the concept of market, marketing and marketing strategies	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	-	2	-	-	2	2	-	-
CO2	3	-	-	-	-	2	-	-	-	-	-	-
CO3	2	3	2	-	-	-	-	-	-	-	-	-
CO4	2	2	2	-	-	-	-	-	-	-	3	-
CO5	3		2	-	-	-	-	-	-	-	-	-
CO6	3	2	2	-	-	-	-	-	2	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Essentials Of Management	Harold Koontz, Heinz Weihrich and Mark V. Cannice	McGraw Hill	11th Edition, 2020
2	Operations Management: Theory and Practice	B. Mahadevan	Pearson	3rd Edition, 2018
3	Principles of Management	P. C. Tripathi and P. N. Reddy	McGraw Hill	6th Edition, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Marketing Management	Philip Kotler, Kevin Keller, Alexander Chernev and Jagdish N. Sheth	Pearson	16th Edition, 2018
2	Human Resource Management: Text and Cases	K. Aswathappa and Sadhna Dash	McGraw Hill	10th Edition, 2023
3	Management: Principles and Practices	R. W. Griffin	Cengage	11th Edition. 2017

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER S5

COMPUTATIONAL FLUID DYNAMICS

Course Code	PEMET521	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. The finite difference methods and finite volume methods as a means of solving different types of differential equations that arise in fluid dynamics and heat transfer.
2. The fundamentals of numerical analysis, ordinary differential equations and partial differential equations related to fluid mechanics and heat transfer
3. The error control and stability considerations associated with numerical solutions.
4. A class of methods used in computational fluid dynamics for numerically solving the Navier-Stokes equations for 2D incompressible flows.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Computational Fluid Dynamics, Governing Equations of fluid flow and heat transfer, Conservative form of Navier-Stokes equation, General transport equation. Physical and mathematical classifications of partial differential equations. Elliptic, parabolic and hyperbolic equations, Comparison of experimental, theoretical and numerical approaches; applications of CFD.	9
2	Discretization-converting derivatives to their finite difference forms- Taylor's series approach and polynomial fitting approach. Central	9

	difference, backward difference, and forward difference of first and second order derivatives. Solution of partial differential equations using finite difference equations. Discretization error, truncation error, round off error. Consistency and numerical stability. Iterative convergence, condition for convergence, rate of convergence. Termination of iteration. Boundary and Initial conditions	
3	Introduction to finite volume method. Finite volume method for steady one-dimensional conduction problems. one-dimensional transient heat conduction problems -explicit, implicit, Crank- Nicholson schemes, under and over relaxations, handling of boundary conditions; dealing with Dirichlet, Neumann, and Robins type boundary conditions; two-dimensional steady state conduction problems; point-by-point and line-by-line method of solution; tri-diagonal matrix algorithm.	9
4	Finite volume method for steady-state diffusion and convection-diffusion problems; Central difference and Upwind schemes for convection and diffusion problems. Two dimensional incompressible viscous flows. Staggered grid. Pressure correction methods. Solution algorithm for pressure-velocity coupling in steady flows- SIMPLE algorithm to solve Navier - Stokes equations. Computer graphics techniques to present CFD results.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To understand the governing equations of fluid flow and heat transfer.	K2
CO2	To apply finite difference methods to simple partial differential equations	K3
CO3	To demonstrate the use of finite volume method for simple 1D/2D problems	K3
CO4	To understand different solution techniques for convection diffusion equations	K2
CO5	To apply the knowledge of CFD to interpret the graphical results	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	1	-	-	-	-	-	-	-	-
CO2	3	3	-	2	-	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-
CO4	2	2	-	2	-	-	-	-	-	-	-	-
CO5	3	3	-	3	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computational Fluid Dynamics	John D Anderson Jr	McGraw-Hill Book Company	2012
2	Numerical Heat Transfer and Fluid Flow	S V Patankar,	McGraw-Hill	2017
3	An Introduction to Computational Fluid Dynamics: The Finite Volume Method	H. Versteeg, W.Malalasekera	Pearson	2nd, 2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to computational fluid dynamics	Anil W. Date	Cambridge University Press	2005
2	Introduction to numerical methods to analysis	S SSastry	PHI Learning Private	2012
3	Heat transfer	S P Venkatesh	Ane books Pvt Ltd	2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/112105045
2	https://onlinecourses.nptel.ac.in/noc20_me64/preview
3	https://nptel.ac.in/courses/112105045 https://onlinecourses.nptel.ac.in/noc21_me126/preview
4	https://onlinecourses.nptel.ac.in/noc21_me126/preview https://onlinecourses.nptel.ac.in/noc20_me64/preview

SEMESTER S5

DESIGN FOR MANUFACTURE AND ASSEMBLY

Course Code	PEMET522	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Manufacturing Process PBMET304	Course Type	Theory

Course Objectives:

1. To introduce the basic guidelines of different manufacturing processes.
2. To understand concepts of design for assembly to reduce number of parts and to optimize design.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to DFMA: History of DFMA, Steps for applying DFMA, Advantages of applying DFMA, Reasons for not implementing DFMA. Introduction to Manufacturing Process: Classification of manufacturing process, Basic manufacturing processes, Mechanical properties of materials, Introduction to materials and material selection, Classification of engineering materials, Material selection for product design, Process capability analysis.	9
2	Introduction to Assembly: The assembly process, Characteristics and applications, Economic significance of assembly, General taxonomies of assembly operation and systems, assembling a product. Design for Assembly: Introduction, Design consideration, DFA methodology, General Design Guidelines for Manual Assembly for Part Handling and for Insertion and Fastening, General Rules for Product Design for Automation, Design for Fasteners: Introduction, Design recommendation for fasteners. Design for disassembly.	9

3	Design for machining: Introduction to machining, Recommended materials for machinability, Machining Using Single-Point Cutting Tools, Machining Using Multipoint Tools. Design for tuning operation: Process description, typical characteristics and applications, Suitable materials, Design recommendations. Design for machining round holes: Introduction, Suitable materials, Design recommendations. Design for milling: Process description, Characteristics and applications of parts produced on milling machines, Design recommendations.	9
4	Sand casting: Introduction to sand casting, typical characteristics of sand cast part, Design recommendations. Die casting: Introduction, Applications, Suitable material consideration, Design recommendations. Injection moulding: Introduction, Typical characteristics of injection moulded parts, Effect of shrinkage, Suitable materials, Design recommendations. Welding process: Different types of welding processes, Design recommendations.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the knowledge of Design Guidelines for Manual Assembly.	K3
CO2	Apply the knowledge of General design principles for manufacturability.	K3
CO3	Design and improve parts for better machinability.	K3
CO4	Design and improve parts for better casting and injection moulding.	K3
CO5	Design and improve parts for better welded joints.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	CO1	3	-	2	-	-	2	-	-	-	-	-
CO2	CO2	3	-	2	-	-	2	-	-	-	-	-
CO3	CO3	2	-	2	-	-	-	-	-	-	-	-
CO4	CO4	2	-	2	-	-	-	-	-	-	-	-
CO5	CO5	2	-	2	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Product Design for Manufacture and Assembly	Geoffrey Boothroyd, Peter Dewhurst, Winston Knight	CRC press	Third Edition, 2010
2	Product design and Manufacturing	A.K. Chitale and R.C. Gupta	Prentice Hall of India	Fifth Edition, 2011
3	Engineering Design: A Materials and processing Approach	Dieter, G.E.	McGraw Hill Co. Ltd	2000
4	Design for Manufacturing and assembly	O. Molloy, S. Tilley and E.A. Warman	Chapman &Hall, London, UK	First Edition, 1998

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Design for Manufacturability Handbook	James G. Bralla	McGraw-Hill companies, New York	Second Edition, 1998
2	Assembly Automation and Product Design	Geoffrey Boothroyd	CRC press	Second Edition, 2005
3	Mechanical Assemblies: Their Design, Manufacture, and Role in Product Development	D. E. Whitney	Oxford University Press, New York	2004
4	Industrial Design, Materials and Manufacture Guide	J. Lesko	John Willy and Sons, Inc	1999

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/107103012
2	https://nptel.ac.in/courses/107103012
3	https://nptel.ac.in/courses/107103012
4	https://nptel.ac.in/courses/107103012

SEMESTER S5

COMPUTER AIDED DESIGN AND ANALYSIS

Course Code	PEMET523	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide a foundational understanding of CAD, including its historical evolution, industrial applications, and key components such as geometric and solid modeling, CAD/CAM/CAE/CAPP packages, hardware, and software developments.
2. To develop proficiency in 2D and 3D computer graphics, focusing on transformations, drawing algorithms, solid modeling techniques, and coordinate systems, alongside foundational knowledge in finite element method (FEM) and finite volume method (FVM).

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to CAD, historical developments, industrial look at CAD, comparison of CAD with traditional designing, application of computers in design, basics of geometric and solid modeling, packages for CAD/CAM/CAE/CAPP, hardware in CAD components, user interaction devices, design database, graphic standards, data exchange formats, raster scan, random scan, various display systems, CAD software, latest developments in the area, PDM, PLM and CAD	9
2	Transformation of points and lines, 2-D rotation, reflection, scaling, combined transformation, homogeneous coordinates, shearing, orthographic and perspective projections, simple problems, line drawing algorithms, DDA algorithm, Bresenham's line algorithm, circle drawing	9

	algorithms, Bresenham's circle algorithm, curve drawing algorithms.	
3	3D graphics, algebraic and geometric forms, tangents and normals, blending functions, straight lines, conics, cubic splines, Bezier curves, B-spline curves, solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration, coordinate systems for solid modelling.	10
4	Introduction to finite element analysis, steps involved in FEM, pre-processing phase, discretization, types of elements, stiffness matrix Fundamentals of Finite volume methods, different types of finite volume grids, approximation of surface and volume integrals; interpolation methods, Review of governing equations	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the historical developments and industrial applications of CAD, including key components and latest software developments.	K1, K2
CO2	Apply 2D transformation techniques, including rotation, reflection, scaling, and line and curve drawing algorithms in CAD software.	K3
CO3	Apply 3D graphics and solid modeling techniques, such as Bezier and B-spline curves, and their application in creating complex geometric forms.	K3
CO4	Understand finite element analysis (FEA) and finite volume methods (FVM) including discretization, formulation, and boundary condition implementation for simple structural and fluid flow problems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	1	-	-	-	-	-	-	-
CO2	3	2	-	-	1	-	-	-	-	-	-	-
CO3	3	2	-	-	1	-	-	-	-	-	-	-
CO4	3	2	-	-	1	-	-	-	-	-	-	-
CO5	3	2	-	-	1	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	CAD/CAM Computer Aided Design and Manufacturing	M.P. Groover, E.M. Zimmers, Jr.	Prentice Hall of India	2014
2	CAD/CAM : Theory and Practice	Ibrahim Zeid, R Sivasubramanian	McGraw Hill Education	2 nd , 2009
3	Product Design and Development	Karl T. Ulrich, Steven D. Eppinger	McGraw Hill Education	7 th 2020
4	Introduction to Finite Elements in Engineering,	T. R. Chandrupatla and A. D. Belagundu	Pearson Education	2001

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	CAD/CAM – Principle Practice and Manufacturing Management,	Chris McMahon and Jimmie Browne	Addision Wesley England,	1998
2	Mathematical Elements in Computer Graphics,	D. F. Rogers and J. A. Adams	McGraw-Hill	1990
3	A First course in Finite Element Method	Daryl Logan	Thomson Learning	2007
4	Computer Graphics with open GL,	Donald Hearn, M. Pauline Baker and Warren Carithers	Pearson Education	2001

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/102/112102101/
2	https://archive.nptel.ac.in/courses/112/102/112102101/
3	https://archive.nptel.ac.in/courses/112/102/112102101/
4	https://archive.nptel.ac.in/courses/112/102/112102101/ https://archive.nptel.ac.in/courses/101/104/101104074/

SEMESTER S5

ADDITIVE MANUFACTURING

Course Code	PEMET524	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To demonstrate appropriate level of understanding on principles of additive manufacturing
2. To understand the different additive manufacturing technologies.
3. To choose appropriate materials for additive manufacturing processes
4. To design prototypes by identifying suitable process with optimum process parameters

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Additive Manufacturing (AM) –Basic principle of AM- Procedure of product development in AM process chain. Classification of additive manufacturing processes, Basic concept, Digitization techniques, Benefits and challenges in AM. Data processing for AM- CAD model preparation, Part orientation and support generation, Slicing methods, Tool path generation, STL Formats. Demonstration of slicing software packages.	8
2	Common AM technologies: Principle, materials, process parameters, advantages and applications of: Stereo Lithography (SLA), Digital Light Processing (DLP), Continuous Liquid Interface Production (CLIP), Laminated Object Manufacturing (LOM), Ultrasonic AM (UAM), 3D printing, Binder Jetting, Material Jetting, Fused Deposition Modelling	10

	(FDM), Direct Ink Writing (DIW).	
3	Common AM technologies: Principle, materials, process parameters, advantages and applications of: Selective Laser Sintering (SLS), Selection Laser Melting (SLM), Electron Beam Melting (EBM), Wire Arc Additive Manufacturing (WAAM), Laser Engineering Net Shaping(LENS).	10
4	Design for AM (DFAM) AM unique capabilities, DFAM concepts and objectives, Design freedom and synthesis methods. Applications for AM Applications: Prototyping, Industrial tooling, Aerospace, Automobile, Medical etc.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept of AM from conventional manufacturing systems.	K2
CO2	Understand the data processing techniques in AM process	K2
CO3	Understand the principles of AM processes.	K2
CO4	Create components using AM process.	K6
CO5	Understand the key aspects in design a product using AM.	K2
CO6	Understand the application of AM in industries	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	2	2		3	-	-	-	-	-	-	-
CO3	2		2	-	-	-	-	-	-	-	-	-
CO4	2	-	3	-	3	-	-	-	-	-	-	-
CO5	2	2	2	2	2	3	3	-	-	-	-	-
	2	-	-	-	2	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Additive Manufacturing Technologies-3D Printing, Rapid Prototyping, and Direct Digital Manufacturing.	Gibson I D. W. Rosen I and B. Stucker	Springer	Second Edition, 2015
2	Rapid prototyping: Principles and applications	Chua, C.K., Leong K.F. and Lim C.S.	World Scientific Publishers	Third edition, 2010.

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Rapid Manufacturing The Technologies and Applications of Rapid Prototyping and Rapid Tooling	D.T. Pham and S.S. Dimov	Springer London Ltd	Softcover reprint of the original 1st ed. 2001, 2011
2	Additive Manufacturing: Principles, technologies and Application	C.P. Paul, A.N. Jinoop	McGraw Hill	First Edition, 2021
3	Additive Manufacturing Technologies	S. Shiva, Anuj K. Shukla	Wiley	First Edition, 2024
4	Additive Manufacturing: Fundamentals and Advancements	Manu Srivastava, Sandeep Rathee, Sachin Maheshwari	CRC Press	First Edition, 2019

Video Links (NPTEL, SWAYAM...)	
NPTEL	NOC: Fundamentals of Additive Manufacturing Technologies, IIT Guwahati by Prof. Sajan Kapil Link: https://nptel.ac.in/courses/112103306

SEMESTER S5

ENERGY ECONOMICS AND POLICY

Course Code	PEMET526	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To learn and understand the set of policies that has developed to regulate energy-related behaviour, as well as the economic concepts that direct the actions of energy producers and consumers.
2. To understand different facets of energy supply and demand, with an emphasis on policies that support sustainable energy supply, learn the relationship between energy, the environment, and emission reduction strategies

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Energy as a resource and its accounting, Government role in innovation. Introduction, Energy as a system, What is the System of Economic Accounting for Energy, Government's role in mobilising investment and innovation in energy, The importance of the investment environment. Energy Efficiency Characteristics, energy supply and demand analysis. A review of energy efficiency measures (EEM) characteristics, Adoption and measures of EEM, Supply and Demand Analyses, Energy demand science for a decarbonized society. Energy statistics influence on energy consumption for oil rich countries. Global Influence of Oil-Rich Countries, Oil-Rich Countries Statistics, Geo-	9

	Political Influence, Energy Transitions, Energy Policy Shifts.	
2	Behaviour Change Approach to Promote and Sustain Energy Efficiency. Behaviour gaps, Biases, design thinking methodology, Ripple effect. Drivers of human behaviour to meet UN SDGs in relation with Energy. Role of individuals in attaining SDGs, Behavioural aspects in energy modelling, Behaviour changes for sustainable development. Energy efficiency and emission abatement relations. Abatement of emissions through energy efficiency, Sector wise analysis, Harnessing Renewable Energy Potential (Some country case studies).	9
3	Energy Market Analysis, Regulations by Government of India. Scenario analyses, feasible options for developing an energy future, the impacts, costs, and financial risks of the various scenarios for transitioning to the energy future, market penetration pathways. The Economics of Depleting Resources & The Oil Sector Examples. Resource depletion and overuse, combating resource depletion and Misuse and pollution, The Prospects for Greener Growth-Policies and Politics of Low-Carbon Growth. Unregulated Markets and Technological Change: oil and natural gas sector examples. The Emergence of Markets, Natural Gas Market, Transportation Market, Markets in Other Segments of the Gas Industry, Trading Models in the Deregulated Natural Gas Industry, Under development and unregulated markets: Reasons why unregulated markets reproduce underdevelopment.	9
4	Carbon Emission: Recent Trends and Shift in Policies in India, case studies of different countries. Sector wise emission trends in India, electricity, industry, transportation, buildings, agriculture, policies, case study of other countries. Hydrogen: A Pathway to Carbon Neutral Economy, possibilities and approaches. Hydrogen production and potential utilization, technical challenges, codes and standards development-Public awareness and social	

	acceptance. Energy efficient policies to achieve SDGs for countries, Importance of Conference of parties (COP). Energy Policy: A Foundation for Transition- Energy Transition: A Paradigm Shift, Future Prospects and Emerging Trends, The Link Between Energy Policy, Energy Transition, and Sustainability in Oil-Rich Countries, Energy Policy Research A Pathway to Achieve UN (SDGs).The Role of COP in Emission Abatement, COP Goals, Agenda, Major Outcomes of COP	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To enhance the vision while making any energy related decision on supply and demand.	K2
CO2	To understand the energy efficiency and behaviour change approaches.	K3
CO3	To understand the energy market and energy economics pertaining to oil rich economies	K3
CO4	To know the energy policies and emission abatement strategies	K3
CO5	To understand UN SDGs and COP	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	3	3	3	-	-	-
CO2	3	-	-	-	-	-	3	3	3	-	-	-
CO3	2	-	-	-	-	-	2	3	3	-	-	-
CO4	3	-	-	-	-	-	3	2	3	-	-	-
CO5	2	-	-	-	-	-	3	3	3	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Energy Economics: Concepts, Issues, Markets and Governance. (Selected chapters)	Bhattacharyya, Subhes. C.	Springer. London, UK.	2011
2	Energy Policy: Perspectives, Challenges and Future Directions (Selected chapters)	K J Sreekanth	Nova Publishers USA	2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Energy Efficiency Improvements with Emission Abatement for Energy Sustainability	K J Sreekanth	Springer Nature Singapore Pte Ltd.	2024
2	“The Economics of Exhaustible Resources,”	Hotelling, Harold,	Journal of Political Economy,	Vol. 39, No. 2 (April 1931), pp. 137-175
3	An Introduction to Energy Economics. In Stevens, P.(ed.)	Stevens, P.	The Economics of Energy, Vol.1, Edward Elgar, Cheltenham, UK.	2000

SEMESTER S5

HUMAN RESOURCES MANAGEMENT

Course Code	PEMET527	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the HRM Concepts in organisation.
2. To familiarise the Recruitment & selection process
3. To familiarize the Career Development ways in an organization.
4. Acquire the knowledge about Employee safety measures and Labour activities

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	HUMAN RESOURCE MANAGEMENT: Concept of Human Management in a system-Organisation and Function of the HR. Objectives and Characteristics of HRM. Role of HR manager-Responsibility-Competitiveness- HR policies -HRM Concepts. JOB ANALYSIS & JOB DESIGN: Job Analysis- Job title- duties & essential functions- job specification -Techniques & Approaches in Job Analysis .Job design -considerations in job design-Types of Job design approaches.	9
2	HR PLANNING: Definition-HR planning system- HR forecasting— Importance of HR Planning- Human resource information system. RECRUITMENT & SELECTION: Concept of Recruitment- objectives- Sources of Recruitment- Internal & External sources-Recruitment process-	9

	Common constraints in recruitment. Selection- Selection Process-Screening-Employment Test-Interview- Physical Examination-Job offer, Various Approaches in Hiring Decisions.	
3	TRAINING: Training- Need for training- Induction training-Effective training Programme process-Structural issues in Training. CAREER DEVELOPMENT: Employee development methods-performance management -Components of effective performance management -performance appraisal- purposes of appraisal – methods of performance appraisal- promotion -transfers.-Incentive systems- Employee Benefits.-Types of Benefit schemes.	9
4	LABOUR RELATIONS: Relation between management and labours-Labour unions -objectives- Collective Bargaining -Negotiations-Strikes-Grievance Handling-Grievance redressal methods. EMPLOYEE SAFETY AND HEALTH: Employee safety- awareness – Accident prevention -creating safe environment -employee health problems and preventive measures-job stress – employee assistance programmes.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To familiarise with the basic concepts in HR Management	K1
CO2	Evaluate the Job design & analysis methods.	K2
CO3	Identify the Recruitment and selection methods.	K1
CO4	Understand the training process of Employees	K1
CO5	Understand various career development procedures.	K1
CO6	Analyse the various employee issues in an organisation	K3
CO7	Identify various safety issues and stress faced by employees	K1

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	-	1	-	-	-	-	1
CO2	2	-	-	-	-	-	-	-	-	-	1	1
CO3	1	-	-	-	-	1	1	-	-	-	-	1
CO4	1	1	-	-	-	-	-	-	-	-	1	1
CO5	1	1	-	-	-	1	-	-	-	-	-	1
CO6	2	1	-	-	-	-	1	-	-	-	1	2
CO7	2	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Human Resource Management	Gary Dessler	Pearson Publication	15th Edition (2016)
2	International Human Resource Management	Srinivas R Kandula	SAGE publication	2nd Edition (2018)
3	Human Resource management -Text and Cases	K. Aswathappa, Sadhna Dash	McGrawhill	10th Edition (2023)
4	Human Resource Management	Dr.TRaju, Dr. S Jayabharathi	Biztantra publications	1 ST Edition (2014)

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Human Resource Management and Digitalization	Franca cantoni, Gianlugi Mangia	Routledge publication	1 st Edition 2020
2	Human Resource Management	Jacquina Gilbert	Vibrant publishers	1st Edition 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/110/105/110105069/
2	https://archive.nptel.ac.in/courses/110/105/110105069/
3	https://archive.nptel.ac.in/courses/110/105/110105069/
4	https://archive.nptel.ac.in/courses/110/105/110105069/

SEMESTER S5

OPERATIONS RESEARCH

Course Code	PEMET528	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3: 0: 0: 0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the role of Operations Research (OR) in decision making
2. To apply different OR techniques for solving managerial problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Operations Research (OR) and Linear Programming: Basics of OR, Modelling approach, Linear Programming (LP), Formulation of LP models, Graphical method, Simplex method, Big-M Method. Transportation Problem: Mathematical Formulation, Initial Basic Feasible Solution, North West Corner method, Least Cost method, Vogel's Approximation Method, Optimality test by MODI method, Assignment problem, Hungarian method.	9
2	Sequencing Problem: Basic terminologies, Processing of n Jobs through 2 machines, Processing of n Jobs through 3 machines, Processing n Jobs, through m machines. Game Theory: Games with saddle points, Games without saddle points – 2 x 2 games, Graphical method for m x 2 & 2 x n games	9

3	Non-traditional Optimization Techniques: Genetic Algorithm (GA) – Working principles, GA Operators, Parameters setting, Constraints handling, Solving simple problems using GA. Simulated Annealing and Particle Swarm Optimization (Theory only) - Introduction, Key concepts, Algorithm.	9
4	Scope of queuing theory, Importance and applications, Kendall's Notations, Characteristics of Queuing Systems, Performance Measures in Queuing Systems, Classic Queuing Models, Single-server exponential arrival and service times, Two-server exponential arrival and service times.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To formulate and solve linear programming problems and transportation problems	K2, K3
CO2	To apply basic sequencing techniques for processing jobs through machines	K2, K3
CO3	To solve simple problems in game theory	K2, K3
CO4	To apply evolutionary algorithms for optimization problems	K2, K3
CO5	To solve problems using classical queuing theory models	K2, K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	2	-	-	-	-	-	-	-
CO2	2	2	-	-	2	-	-	-	-	-	-	-
CO3	2	2	-	-	2	-	-	-	-	-	-	-
CO4	2	2	-	-	3	-	-	-	-	-	-	-
CO5	2	2	-	-	2	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Operations Research-Principles and Applications	Srinivasan, G.	PHI Pvt. Ltd.	Third Edition, 2017
2	Operations Research	Prem Kumar Gupta & D. S. Hira,	S Chand publication	Third Edition, 2008
3	Quantitative Techniques in Management	N. D Vohra. Hitesh Arora	McGraw Hill.	Sixth Edition, 2021
4	Soft Computing Fundamentals and Applications	Dilip K. Pratikar	Alpha Science	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Optimization: Theory and Applications	Rao, S.S.	Wiley eastern.	Second edition,
2	Introduction to Operations Research,	F. S. Hillier& G. J. Leiberman:	McGraw Hill	Eleventh Edition
3	Operations Research Principles and Practice	Ravindran, Phillips and Solberg,	Wiley & Sons	1987
4	Operations Research,	Goel, B. S. and Mittal, S. K.,	Pragati Prakashan, Meerut	1999

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc24_ma55
2	https://onlinecourses.swayam2.ac.in/cec24_ma05
3	https://onlinecourses.swayam2.ac.in/cec24_ma05
4	https://onlinecourses.swayam2.ac.in/cec24_ma05

SEMESTER S5

INSTRUMENTATION AND CONTROL SYSTEMS

Course Code	PEMET525	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the basic principles of instrumentation.
2. Familiarize with various types of sensors and transducers used for measuring physical quantities
3. Gain knowledge of the fundamental concepts of control systems including open-loop and closed-loop systems.
4. Learn about system dynamics, mathematical modelling of physical systems and stability analysis of LTI systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Industrial measurement systems – different types of industrial variables and measurement systems elements. Sensors– Sensor components - Resistive sensors - Inductive sensors - Capacitive sensors - Thermoelectric sensors - Piezoelectric sensors. Transducers - Definition and classification. LVDT, Electromagnetic and Ultrasonic flow meters, Piezoelectric transducers-modes of operation-force transducer, Load cell, Strain gauge etc.	9
2	Industrial signal conditioning systems- Operational amplifiers - Amplifier circuits with ideal operational amplifiers - Current-to voltage converters - Inverting voltage amplifiers - Non-inverting voltage amplifiers - Differential amplifiers -Instrumentation amplifiers . Filters – Passive filters - First and second order RC-filters - Low-pass first-order RC-filter – High pass first-	9

	order RC-filter – Band pass filters , A/D converters for industrial measurements systems. Data Acquisition Systems(DAS) –Objectives of DAS.	
3	System Modeling- Open loop and closed loop control systems ,Transfer function of LTI systems- Electrical, translational and rotational systems – Force voltage and force current analogy Block diagram representation - block diagram reduction, Signal flow graph - Mason's gain formula. Control system components: Transfer functions of DC and AC servo motors– Control applications of Tacho generator and Stepper motor. Characteristic equation of Closed loop systems. Controllers- P, PI, and PID controllers.	9
4	Time domain analysis of control systems: Time domain specifications, Impulse and Step responses of first order and second order systems. Error analysis: Steady state error analysis - static error coefficients of type 0,1,2 systems. Stability Analysis: Concept of stability— Routh's stability criterion, Root locus method. Frequency Domain Analysis: Frequency Domain Specifications, Stability in Frequency Domain, Gain Margin, Phase Margin, Bode Plot, Polar Plot, Nyquist Plot.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To get basic knowledge about industrial measurement system and different elements involved in it.	K2
CO2	Acquire knowledge about sensors and transducers for different industrial variables	K4
CO3	Acquire knowledge about signal conditional circuits like amplifiers, filters, ADC, etc. for working industrial measurement systems	K4
CO4	To describe the role of various control blocks and components in feedback systems	K3
CO5	To analyse the time domain responses of the linear systems and apply Root locus technique to assess the performance.	K4
CO6	Analyse the stability of the given LTI system	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	C	1	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	3
CO5	3	3	3	-	2	-	-	-	-	-	-	3
CO6	3	3	3	-	-	-	-	-	-	-	-	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial Instrumentation	K Krishnaswamy	New Age International Publishers, New Delhi	2003
2	Measurement systems applications and design	Ernest O. Doebelin	McGraw- Hill Publishing Company	1990
3	Control Systems Engineering	Nise N.S.	Wiley Eastern	6/e
4	Modern Control Engineering	Ogata K	Prentice Hall of India.	5/e
5	Control Systems	K R Varmah	Tata McGrawHill Tata McGrawHill	2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Industrial Instrumentation	Patranabis D	McGraw-Hill Education	3rd Edition, 2017
2	Industrial Instrumentation and Control	Singh, S.K	Tata McGraw-Hill Education	2009
3	Control Systems Principles and Design	Gopal M	Tata McGraw Hill	, 4/e
4	Automatic Control Systems	Kuo B. C	Prentice Hall of India	7/e

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108105064
2	https://nptel.ac.in/courses/108105062
3	https://nptel.ac.in/courses/107106081
4	https://nptel.ac.in/courses/107106081

SEMESTER S5

THERMAL ENGINEERING LAB-1

Course Code	PCMEL507	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET403 Engineering Thermodynamics	Course Type	Lab

Course Objectives:

1. To conduct experiment for measuring viscosity, flash and fire point and Calorific value of petroleum products
2. To conduct the various heat transfer experiments

Expt. No.	Experiments
1	Determination of viscosity of lubricating oils and fuels and its variation with Temperature
2	Determination of flash and fire points of petroleum fuels and oils
3	Determination of calorific value of solid and liquid fuels- Bomb Calorimeter
4	Determination of calorific value of gaseous fuels –Gas Calorimeter
5	Calibration of Thermocouples
6	Determination of LMTD and effectiveness of parallel flow, Counter flow and cross flow heat exchangers
7	Performance studies on a shell and tube heat exchanger
8	Development of heat transfer correlation for heat exchangers/condenser using modified Wilson Plot Method

9	Determination of heat transfer coefficients in free convection
10	Determination of heat transfer coefficients in forced convection
11	Determination of thermal conductivity of solids (composite wall/metal rod)
12	Determination of thermal conductivity of powder
13	Determination of thermal conductivity of liquids
14	Measurement of unsteady state conduction heat transfer
15	Determination of emissivity of a specimen
16	Determination of Stefan Boltzman constant
17	Measurement of solar radiation
18	Experimental study of dropwise and filmwise condensation
19	Experiments on boiling heat transfer
20	Performance study on heat pipe
	Note : 10 Experiments are mandatory

**Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Measure thermo-physical properties of solid, liquid and gaseous fuels	K4
CO2	Evaluate thermal properties of materials in conduction, convection and radiation	K4
CO3	Analyse the performance of heat exchangers and heat pipes	K4
CO4	Measure solar radiation	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	-	-	-	-	3	3	-	-
CO2	3	-	-	2	-	-	-	-	3	3	-	-
CO3	3	-	-	2	-	-	-	-	3	3	-	-
CO4	3	-	-	2	-	-	-	-	3	3	-	-

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Heat Transfer a Practical Approach	Yunus A. Cengel	Tata McGraw-Hill Education	4th Edition, 2012.
2	Fundamentals of Engineering, Heat and Mass Transfer	R. C. Sachdeva	New Age publication,	3 rd Edition, 2012.
3	Heat transfer	Holman J.P	Mc Graw-Hill	10th. Ed., 2009
4	Heat and Mass Transfer	Frank P. Incropera and David P. Dewitt	John Wiley and sons	2011
5	Fundamentals of Heat and Mass Transfer	Kothandaraman C.P	New Age International, New Delhi.	2006

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.

- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S5

MECHANICAL ENGINEERING LAB

Course Code	PCMEL508	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET402	Course Type	Lab

Course Objectives:

1. To get an idea of the dimensional & form accuracy of products
2. To get exposure to equipment and exercises related to machine dynamics, basics of hydraulic and pneumatic devices, basic concepts of stepper motors, basic ideas of data acquisition systems and automation

Expt. No.	Experiments
PART 1 (Any six experiments)	
1	Calibration of vernier caliper, micrometer, LVDT and dial gauge. Determine the class of fits between the given shaft and hole. etc Study and analysis of repeatability and reproducibility
2	Angular measurements using sine bar, bevel protractor, combination sets, clinometers, angle dekkor etc.
3	Measurement of straightness, flatness, squareness and roundness error using autocollimator, Laser interferometer, spirit level, dial gauge etc.
4	Measurement of displacement, velocity and acceleration of vibration.
5	Measurement of surface roughness of turned, milled, grounded, lapped surfaces and glass etc.
6	Measurement of strain using strain gauges and strain indicators using various bridge arrangements
7	Measurement of screw thread parameters

8	Measurement of gear profile error and other parameters
9	Bore diameter measurement
10	Use of Tool maker's microscope
11	Analysis of automobile exhaust gas and flue gas.
12	Demonstration of Coordinate Measuring Machine for the evaluation of form errors
	PART 2 (Any six experiments)
1	Experiment on Whirling of shaft
2	Experiment on Gyroscope
3	Experiment on Universal governor apparatus
4	Experiment on Free and forced vibration analysis
5	Experiment on any Non-destructive testing.
6	Exercises on hydraulic and pneumatic circuits using trainer units
7	Exercises on electro-pneumatic and electro-hydraulic circuits using trainer units
8	Exercises on Motion controller using AC/DC motor, servo motors and stepper motors with encoders to determine the operating characteristics.
9	Exercises on PC-based data acquisition systems with any software.
10	Study of PLC programming, Controlling variable speed drive through PLC
11	Exercises on the robotic trainer units
12	Exercises on 3-D printing

A minimum of 12 sets of experiments are mandatory

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Choose the appropriate instruments for different measurements	K3
CO2	Determine dimensional and form accuracies of various components	K3
CO3	Develop knowledge of designing and analyzing mechanisms in machinery	K3
CO4	Demonstrate the functions and control of various devices used for industrial automation	K3
CO5	Demonstrate 3D printing technique	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	-	-	-	2	2	-	-	2
CO2	3	2	-	2	2	-	-	2	2	2	-	-
CO3	3	2	-	2	-	-	-	-	2	2	-	-
CO4	3	-	-	-	-	-	-	-	2	2	-	-
CO5	3	-	-	-	2	-	-	-	2	2	-	-

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Metrology for Engineers, 5th edition	Shotbolt C.R. and Gayler J.F.W,	ELBS, London	
2	Practical Engineering Metrology	Sharp K.W.B. and Hume	Sir Isaac Pitman and sons Ltd, London	
3	Kinematics and Dynamics of Machinery	C.E.Wilson, P. Sadler	Pearson Education	2005
4	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	W.Bolton	Person Education Limited, New Delhi	2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Measurements	Collett, C.V. and Hope, A.D	Second edition, ELBS/Longman	
2	Machines and Mechanisms Applied Kinematic Analysis	D.H.Myskza	Pearson Education	2013
3	Mechatronics: Integrated Mechanical Electronic Systems	K.P.Ramachandran, G.K.Vijayaraghavan, M.S.Balasundaram	Wiley India Pvt. Ltd., New Delhi	2008

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.

- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity,

SEMESTER 6

MECHANICAL ENGINEERING

SEMESTER S6

INDUSTRIAL AND SYSTEMS ENGINEERING

Course Code	PCMET601	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3: 0: 0: 0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart knowledge about various tools and techniques of Industrial Engineering.
2. To facilitate students to acquire knowledge about inventory management, lean manufacturing, agile manufacturing, enterprise resource planning and thus inculcate the skills needed to apply these principles in an organization.
3. To get acquainted with quality management practices

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Scope and functions of Industrial Engineering - Types of production (batch, flow and unit), Roles of line supervisors and production managers. Product Development and Design: Objectives - Quality and cost considerations - Human factors in design - Detailed design & prototyping - Functionality & manufacturability - Standardization, simplification and variety reduction - Concurrent engineering. Plant layout and Material handling: Types of plant layout - Principles of material handling - Material handling equipment – Types, selection and application.	9
2	Production Planning and Control: Aggregate production planning, materials requirement planning - Inventory Management: EOQ models, discount models,	9

	P system, Q system, reorder level – Selective inventory control techniques - JIT - Supply chain and management. Break down, preventive and predictive maintenance.	
3	Lean Manufacturing (LM): Basic elements – Tools - Concept of wastes - stages of 5S and waste elimination - Need for LM. Agile manufacturing: Definition, business need, conceptual frame work, characteristics and generic features - Approaches to enhance agility in manufacturing - Managing people in agile organization. Enterprise resource planning (ERP): Concept of Enterprise, ERP Overview - Integrated information system - ERP implementation – Benefits, challenges, success and failure factors - Business Process Reengineering (BPR), Customer relationship management (CRM).	9
4	Quality Management: Quality, quality planning, quality control, quality assurance, quality management – TQM, ISO, Six Sigma and Quality circle (Brief description only). Statistical Quality Control - Process capability - Causes of variation in quality- Control charts for $\bar{x}$ and R – Acceptance sampling. Reliability Engineering - Causes of failures - Bath tub curve - System reliability - Life testing.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Implement various tools and techniques in industrial engineering	K3
CO2	Apply inventory control techniques for materials management	K3
CO3	Identify the framework of lean and agile manufacturing	K2
CO4	Identify core and extended modules of enterprise resource planning	K2
CO5	To be conversant with important terms for quality management in organizations	K2
CO6	Implement different quality control techniques	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-
CO4	3	2	2	-	2	-	-	-	-	-	-	-
CO5	3	2	2	-		-	-	-	-	-	-	-
CO6	2	2	3	-	2	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial Engineering & Production Management	M. T. Telsang	S Chand	3rd Edition, 2018
2	Production and operations management	R. Paneerselvam	PHI	3rd Edition, 2012
3	Operations Management: Theory and Practice	B. Mahadevan	Pearson	3rd Edition, 2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial Engineering and Management – A new perspective	Philips E. Hicks	McGraw Hill	2nd Edition, 1994
2	Statistical Quality Control	Montgomery	Wiley Eastern	6th Edition, 2010
3	Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities	S. R. Devadasan, V. M. Sivakumar, R. Muruges and P. R. Shalij	PHI Learning	1st Edition, 2012
4	Operations Management: Processes and Supply Chains	L. J. Krajewski, M. K. Malhotra, S. K. Srivastava and L. P. Ritzman	Pearson Education	12th Edition, 2019

SEMESTER S6
MACHINE DESIGN

Course Code	PCMET602	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET302 Mechanics of Solids	Course Type	Theory

Course Objectives:

1. To review concepts of statics and strength of materials.
2. To introduce fundamental approaches to failure prevention of components.
3. To provide knowledge in the design of common machine elements such as fasteners, springs, belts and pressure vessels.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Design- Definition, steps in design process, preferred numbers, standards and codes in design. Materials and their properties- Elastic and plastic behaviour of metals, ductile and brittle behaviour, shear, bending and torsional stresses, Factor of safety, stress concentration, combined stresses, stress concentration factor. Notch sensitivity, Shock and impact loads, fatigue loading, endurance limit stress, factors affecting endurance limit, Design for fatigue loading; Combined steady and variable stress- Gerber, Goodman and Soderberg method	10
2	Design of riveted joints- Material for rivets, modes of failure, efficiency of joint, design of boiler and tank joints, structural joints Design of welded joints- welding symbols, stresses in fillet and butt welds, Butt joint in tension, fillet weld in tension, fillet joint under torsion, fillet weld under	9

	bending, eccentrically loaded welds.	
3	Springs- classification, spring materials, stresses and deflection of helical springs, axial loading, curvature effect, resilience, static and fatigue loading, surging, critical frequency, concentric springs, end construction. Leaf springs- Flat springs, semi elliptical laminated leaf springs, design of leaf springs, nipping	9
4	Design of flat belt- materials for belts, slip of the belts, creep, centrifugal tension. Design of V-belt drives, Advantages and limitations of V-belt drive Cylinders and Pressure vessels, thin cylinders, thick cylinders, Open and closed vessels, Lamé's, Clavarino's and Birnie's equations. Dilation.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 = 24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Interpret component behavior subjected to static and fatigue loads and identify the failure criteria	K3
CO2	Analyze the load carrying capacity of riveted joints, and welded joints	K4
CO3	Analyze stress carrying capacity and deformation of helical and leaf springs	K4
CO4	Analyze the load carrying capacity of belts and pressure vessels	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	2	2	-	-	-	2
CO2	3	3	3	-	-	-	2	2	-	-	-	2
CO3	3	3	3	-	-	-	2	2	-	-	-	2
CO4	3	3	3	-	-	-	2	2	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Machine Design – An Integrated Approach	RobertL. Norton	Pearson Education	5 th edition, 2018
2	Design of Machine elements	V.B.Bhandari	Tata McGraw Hill	5 th edition, 2020
3	Design of Machine elements,	Jalaludeen	Anuradha Publications, Chennai	2014
4	A Text book of Machine Design	Dr. P. C. Sharma, Dr. D. K. Aggarwal	S.K. Kataria & Sons	2017

Data Books permitted for reference in the final examination:			
Design Data Hand Book	K. Mahadevan, K.Balaveera Reddy	CBS Publishers & Distributors	4 th edition, 2019
PSG Design DataHand book	PSG Tech	DPV Printers, Coimbatore	2022
Machine Design Data Handbook	NarayanaIyengar B.R, Lingaiah K	Tata McGraw Hill/Suma Publications	1984

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanical Engineering Design	J. E. Shigley	McGraw Hill	2003
2	Fundamentals of Machine Component Design,	Juvinall R.C, Marshak K.M.	John Wiley	5 th edition, 2011
3	Shigley's Mechanical Engineering Design	Richard G. Budynas, J. Keith Nisbett	McGraw Hill	11 th edition, 2020
4	Design of Machine Elements	M. F. Spotts, T. E. Shoup	Pearson Education	8 th edition, 2019
5	MachineElements: Life and Design	Boris M Klebanov, David M. Barlam, Frederic E. Nystrom	CRC Press	2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/105/112105124/
2	https://archive.nptel.ac.in/courses/112/105/112105124/
3	https://archive.nptel.ac.in/courses/112/105/112105124/
4	https://archive.nptel.ac.in/courses/112/105/112105124/

SEMESTER S6

POWER PLANT ENGINEERING

Course Code	PEMET631	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course Objectives:

1. To develop a comprehensive understanding of steam, gas, hydro and nuclear power plants and various energy storage systems.
2. To familiarise various terms related to power plant economics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Analysis of Steam Cycle Steam engineering-temperature entropy diagram- mollier diagram-Rankine cycle-steam power plant, internally irreversible and externally irreversible Rankine cycle-Mean temperature of heat addition-Effect of superheat and inlet pressure-Reheating of steam, Regeneration-Regenerative feed water heating-Feed water heaters-Efficiencies in a steam power plant-binary vapor cycle	9
2	Steam generator classifications Cochran boiler-Lancashire boiler-Cornish boiler-locomotive boiler-Babcock and Wilcox boiler Stirling boiler-high pressure boilers-boiler mountings and accessories Steam nozzles Flow through steam nozzles-throat pressure for maximum discharge-effect of friction-super saturated flow	9

	Steam turbines Impulse and reaction turbines-velocity diagram-condition for maximum efficiency-compounding-reheat factor-blade height-governing of steam turbines-cogeneration and combined cycle power generation	
3	Thermal power plants General layout-site selection-fuel handling, storage and burning systems-dust and ash handling system-chimney draught Nuclear power plants Classification-components-safety measures-effects of nuclear radiation-nuclear waste disposal. Gas turbine power plants Classification-closed open and other systems Hydro Electric Power Plants Classification- Typical Layout and associated components	9
4	Energy Storage Pumped hydro, Compressed air energy storage, flywheel energy storage, Electrochemical energy storage, magnetic energy storage, Thermal energy storage, Chemical energy storage Economics of power generation Estimation of load-load curve-load factor-diversity factor-capacity factor-use factor-economics in plant selection-economics of generation and distribution of power-useful life-tariff for electrical energy. Environmental pollution and its control Pollutants from power plants-control of pollutants-control of particulate matter -Control of SO ₂ - control of wastewater from steam power plants-pollution from nuclear power plants-noise pollution and noise control	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the layout, components and working of steam, gas, hydro, and nuclear power plants.	K2
CO2	Calculate the performance parameters of simple and modified Rankine cycles.	K3
CO3	Calculate the performance parameters of steam turbines and steam nozzles.	K3
CO4	Explain the working of various energy storage systems	K2
CO5	Discuss the economics of power generation and pollution from power plants and their effect on the environment	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2
CO4	3	2	2	-	-	-		-	-	-	-	2
CO5	3	2	2	-	-	-	3	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Power Plant Technology	M. M. El Wakil	McGraw Hill Education	1, 2017
2	Power Plant Engineering	P. K. Nag	McGraw Hill Education	4, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Power Plant Engineering	G. R. Nagpal, S. C. Sharma	KHANNA Publishers	16, 2012
2	Power Plant Engineering	Manoj Kumar Gupta	PHI Learning Pvt. Ltd	1, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/107/112107291/
2	https://archive.nptel.ac.in/courses/112/107/112107291/
3	https://archive.nptel.ac.in/courses/112/107/112107291/
4	https://archive.nptel.ac.in/courses/112/107/112107291/

SEMESTER S6

COMPRESSIBLE FLUID FLOW

Course Code	PEMET632	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET303	Course Type	Theory

Course Objectives:

1. To provide a foundation in compressible fluid mechanics, focusing on steady, one-dimensional flow problems.
2. To familiarise property variations across normal and oblique shock waves

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of compressible flow: Various regimes of flow, Reynolds transport theorem-Governing equations for compressible flows. Mach number, Mach waves, Mach cone and Mach angle, Sonic boom. Concept of stagnation state, stagnation properties. Adiabatic energy equation, various regions of flow, adiabatic ellipse One Dimensional isentropic flow: adiabatic and isentropic flow of a perfect gas, isentropic flow in ducts of varying cross-sections, nozzles, mass flow rate, critical properties, choking, impulse function, operation of nozzle under varying pressure ratios–Use of gas tables.	10
2	Flow in constant area duct with friction: Assumptions, Governing equations, Fanno curve on h-s and P-v diagram, Fanno flow relations for a perfect gas, variation of Mach number with duct length, choking due to friction, Use of gas tables for Fanno flow. Isothermal flow (elementary idea only)	8

3	Flow through constant area duct with heat transfer (Rayleigh Flow): Assumptions, Governing equations, Rayleigh line on h-s and P-v diagram, Rayleigh relation for perfect gas, maximum possible heat addition, location of maximum enthalpy and entropy points, thermal choking, Use of gas tables for Rayleigh flow.	9
4	Irreversible discontinuity in supersonic flow: Development of shock wave, types of shock waves, governing equations, strength of shock waves, normal Shock on T-S diagram, Prandtl-Mayer relation, Rankine-Huguenot relation, Mach number downstream of normal shock, variation of flow parameters across the normal shock, normal shock in Fanno and Rayleigh flows, Use of gas tables for normal shocks. Oblique shock waves - supersonic flow over compression and expansion corners (elementary idea only). Wind tunnel types, measurement of velocity, pressure, and temperature.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination- 1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic concepts of compressible fluid mechanics and	K3
CO2	Analyze problems in one dimensional isentropic compressible flow.	K4
CO3	Analyze problems of flow in constant area duct with friction.	K4
CO4	Analyze problems of flow in constant area duct with heat transfer.	K4
CO5	Determine the variation in flow properties across normal and oblique shock waves.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	2
CO2	3	2	2	2	-	-	-	-	-	-	-	1
CO3	3	2	2	2	-	-	-	-	-	-	-	1
CO4	3	2	2	2	-	-	-	-	-	-	-	
CO5	3	3	-	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Dynamics and Thermodynamics of Compressible Fluid Flow. Vol I	Shapiro A.H	John Wiley & Sons	1977
2	Fundamental of Compressible flow	S. M. Yahya	New age international Publication	7 th edition,2023
3	Gas Dynamics	E. Rathakrishnan	PHI Learning Pvt. Ltd.	7 th edition,2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Compressible Flow: With Historical Perspective.	John D. Anderson	McGraw-Hill, Inc	4 th edition,2021
2	Fundamentals of compressible fluid dynamics	P. Balachandran	PHI Learning Pvt. Ltd.	2006
3	Elements of Gas Dynamics	Liepmann and Roshako	Dover Publications Inc.	2002

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/BYqZPwQPU_4 https://youtu.be/TYqxQS6ZPC4
2	https://youtu.be/C2JIBOmEZ4k https://youtu.be/7EKaOXZrEq4
3	https://youtu.be/3npd-kOS2FQ
4	https://youtu.be/Jrdm7Pwssto https://youtu.be/Llc1_XWPyIQ

SEMESTER S6

INDUSTRIAL TRIBOLOGY

Course Code	PEMET633	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fluid Mechanics and Machinery	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of the fundamental concepts of tribology.
2. To prepare students to integrate tribological knowledge into the design and analysis of engineering systems.
3. To equip students with the analytical skills necessary to assess and solve tribological problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Tribology: Definition and Scope, Historical development and significance in engineering. Contact Mechanics:Types of contact: point, line, and surface contacts,Hertzian contact theory,Deformation of solid bodies under load Friction: Laws of friction, Types of friction: static, kinetic, and rolling friction Factors affecting friction. Theories of friction: adhesion, deformation, and plowing.	9
2	Wear: Types of wear: adhesive, abrasive, corrosive, and surface fatigue wear. Surface Topography: Statistical Parameters (Ra,Rz,RMS) Techniques of Surface Examination: Optical Microscopy, Electron Microscopy, Atomic Force Microscopy , Profilometry. Wear measurement techniques: Pin-on-	9

	disk Tester and the Four Ball Tester.	
3	Principles of Lubrication: Hydrodynamic lubrication, Boundary lubrication, Elasto-hydrodynamic lubrication (EHL) Lubrication Regimes: Thick film and thin film lubrication, Mixed lubrication, Stribeck curve and its significance Lubricant Properties and Classification: Physical and chemical properties of lubricants, Types of lubricants: oils, greases, and solid lubricants, Additives and their functions Criteria for selecting lubricants	9
4	Surface Treatments and Coatings: Heat treatments, surface hardening, and nitriding, Coatings: PVD, CVD, thermal spray coatings, and electroplating Tribology in Industries: Tribological challenges in engines, transmissions, and braking systems, Role of tribology in machining, forming, and finishing processes, Tribological issues in tool wear and lubrication in manufacturing Recent Advances and Future Trends: Emerging materials and technologies in tribology, Smart lubricants and self-lubricating materials, Sustainable tribology practices, Micro and Nano Tribology (Applications in MEMS/NEMS devices).	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain fundamental principles of Tribology	K2
CO2	Understand Surface characterisation techniques for tribological investigations	K2
CO3	Explain Wear Measurement Techniques:	K2
CO4	Select and Evaluate Lubricants and Surface Treatments:	K2
CO5	Apply tribological knowledge in industrial applications	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	2	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	2	2	-	-	-	-	2
CO5	3	2	1	-	-	2	2	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Tribology	G. W. Stachowiak and A. W. Batchelor	Butterworth-Heinemann,	Second , 2000.
2	Introduction to Tribology	BharathBhushan	Wiley-Blackwell	First , 2013
3	Engineering Tribology	John Williams	Cambridge University Press,	First,2005
4	Tribology: Friction and Wear of Engineering Materials	I. M. Hutchings	Butterworth-Heinemann	Second,2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Surface Engineering for Corrosion and Wear Resistance	J.R. Davis	ASM International	First,2001
2	Lubrication and Lubricant Selection: A Practical Guide	A. R. Lansdown	ASME	Third,2003
3	Tribology for Scientists and Engineers	Pradeep L. Menezes, Siddhartha Ghosh, and BijoyBhushan	Springer	First,2013
4	Advanced Tribology: Proceedings of CIST2008 & ITS-IFTtoMM2008	JianbinLuo, YonggangMeng, Tianmin Shao, and Qian Zhao	Springer	2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/102/112102014/
2	https://archive.nptel.ac.in/courses/112/102/112102014/
3	https://archive.nptel.ac.in/courses/112/102/112102014/
4	https://nptel.ac.in/courses/113108083

SEMESTER S6

FINITE ELEMENT METHODS

Course Code	PEMET634	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET302 Mechanics of Solids	Course Type	Theory

Course Objectives:

1. To study the basic procedure of FEM and stiffness formulation of simple element using direct method.
2. To study the formulations of shape functions, strain displacement matrix and stress matrix.
3. To study the energy method and Galerkin weight residual formulations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction FEM, Mathematical Modelling of field problems in Engineering, Governing Equations – Discrete and continuous models, discretization-convergence behavior. General procedure of Finite Element analysis, Types of elements, Formulation of stiffness matrix- one dimensional spring, bar element assembly and solution procedure.	9
2	Types of coordinate system in FEM, coordinate transformation Plane truss stiffness formulation and its assembly. Shape functions, Derivation of shape functions using polynomial of One-Dimensional bar, 2-Dimensional CST and 1- Dimensional beam element. Convergence requirement of shape functions, Pascal triangle. Shape functions using Langrange polynomial.	10
3	Derivation of strain -displacement relation- B matrix- bar, CST and beam element. Potential energy and equilibrium, principle of minimum potential	

	energy, Variational formulation in FEM.Element stiffness-bar, beam and CST element, consistent loads.	9
4	Strong and Weak form, Galerkin's weighted residual FEM formulation; One dimensional axially loaded bar, heat flow in a bar, natural coordinate system, Iso parametric elements, Quadrilateral elements- Serendipity elements Isoparametric formulations, Jacobian matrix, stiffness matrices, Numerical integration: Gaussian quadrature.	10

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To understand the governing equations of various physical phenomena and basic procedure of FEM.	K2
CO2	To apply the coordinate transformation and formulation of shape functions of various element.	K3
CO3	Formulate shape functions and element strain displacement matrix of various element	K4
CO4	Evaluate element stress using energy method and study Galerkin weight residual formulations	K5
CO5	Study the concept of iso parametric elements and analyze iso parametric formulations	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	-	-	-	-	-	-	-	-
CO3	3	3	1	-	-	-	-	-	-	-	-	-
CO4	3	3	1	-	-	-	-	-	-	-	-	-
CO5	3	3	1	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	An introduction to Finite Element Method	J N Reddy	McGrawHill Education	Third Edition, 2009
2	Concept and application of Finite Element method	Robert D Cook	Wiley	Third Edition, 2008
3	Finite Element Analysis,	S SBhavikatti,	New Age Publisher	Third edition,2008
4	A First Course in Finite Elements	Jacob Fish Rensselaer ,Ted Belytschko	John Wiley & Sons, Ltd	Second edition,2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Applied Finite Element Analysis	Larry J Segerlind	Johny Wiley and sons	Second Edition,2010
2	Applied Finite element Analysis	G Ramamurthi	I K International Publishing House Pvt. Ltd	Second Edition
3	Fundamentals of Finite Element Methods	David V Hutton	McGrawHillEducation	Third Edition,2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/112106135
2	https://nptel.ac.in/courses/112106135
3	https://nptel.ac.in/courses/112106135
4	https://nptel.ac.in/courses/112106135

SEMESTER S6

NON – DESTRUCTIVE TESTING

Course Code	PEMET636	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To comprehend the fundamental ideas, methodologies, tools, applications and constraints of NDT approach.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Visual Inspection: Fundamentals of visual testing, tools, applications and limitations. Vision, lighting, material attributes, environmental factors. Visual perception, direct and indirect methods, mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources special lighting, a systems, computer enhanced system. Liquid penetrant Testing: properties required for a good penetrants and developers - Types of penetrants and developers. LPI technique/ test procedure interpretation and evaluation of penetrant test indications, false indication and safety precaution required in LPI.	9
2	Magnetic Particle Testing: Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique, central conductor testing, and magnetization using yokes. Direct and indirect method of magnetization, continuous testing of MPI, residual technique of	9

	MPI, system sensitivity, checking devices in MPI. Eddy Current Testing: physics aspects of ECT. Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT. Equipment and accessories, Various application of ECT such as conductivity measurement, hardness measurement, defect detection coating thickness measurement.	
3	Ultrasonic Testing: UT testing methods, contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques, resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used. Reference blocks with artificially created defects, calibration of equipments. Radiography Testing (RT): Electromagnetic radiation sources. Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real-time radiography, films used in industrial radiography, types of film, speed of films, qualities of film screens used in radiography, quality of a good radiograph, film processing, interpretation, evaluation of test results, safety aspects required in radiography.	11
4	Advanced NDI Techniques: Principle and Procedure of Digital Signal and image Processing & Digital Image correlation, Acoustic emission Inspection, Thermography, Computed Tomography	7

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Have a basic knowledge of NDT Techniques which enables to carry out various inspections in accordance with the established procedures.	K2
CO2	Familiarize with basic principles of electromagnetic NDT methods	K2
CO3	Apply the principles of signal processing of ultrasonic signals and image processing of radiographic images.	K3
CO4	Have a better knowledge in the field of advanced techniques in NDT	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Practical Non- destructive testing	Baldev Raj	Alpha Science International	2008
2	Non - destructive testing	Hull V and V John	McMillan	2012
3	Non Destructive testing Techniques	Ravi Prakash	New Academic Science	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Recent developments in the field of non-destructive testing, safety and material science	Elena Lysenko, Alexander Rogachev, Oldrich Stary	Springer	2022
2	New Technologies in electromagnetic non-destructive Testing	Songling Huang & Shen Wang	Springer	2016
3	Recent Advances in Non - Destructive Inspection	Carosena Meola	Nova Science publishers	2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
I to IV	https://archive.nptel.ac.in/courses/113/106/113106070/

SEMESTER S6

INDUSTRIAL SAFETY ENGINEERING

Course Code	PEMET637	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

To provide on concept of safety in industry, principle of accident prevention, major hazards and consequences.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Industrial Safety: Concept of Safety, Goals of safety engineering, Need for safety engineering, definitions of Accident, injury, unsafe actions & Conditions. Accident causing mechanisms, Heinrich's Law of accident prevention. Responsibility of Safety - Society, Govt., Management, Union & employees. Duties of safety officer. Safety Committee - Functions & Scope, Safety Awareness and Training, Safety audit and mock drill.	9
2	Hazard and hazard identification: Hazard and risk, Types of Chemical hazards and its control. Fire safety. Factors contributing towards fire, Classification of Fire and Fire extinguishers. Explosion-Toxic gas release - precautions. Consequence assessment and mitigation measures. – Effect model-vulnerability model Electrical Hazards – controls- Safe limits of amperages, Voltages Safe distance from lines. Means of cutting of power overload and short circuit	9

	protection. Hazard identification and risk assessment: Inventory analysis, Hazard rating of process plants- The Dow Fire and Explosion Hazard Index, Hazard analysis -Preliminary hazard analysis, HAZOP, FMEA.	
3	Occupational Health and Safety: Safety and Health training, Stress and Safety. Ergonomics - Introduction, Advantages. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders. Human factors contributing to accidents. Personal protection in the work environment, Types of PPEs, Respiratory and non-respiratory equipment. Standards related to PPEs. Hearing Conservation Program in Production industries.	9
4	Safety issues in Machines: Machinery safeguard, Principle of machine guarding -types of guards and devices. Safety in machining, welding and cutting. Material Handling-Classification-safety consideration- manual and mechanical handling-Maintenance of common elements-wire rope, chains slings, hooks, clamps. Monitoring Safety Performance: Frequency rate, severity rate, incidence rate Housekeeping, Work permits system. Entry into confined spaces.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the theories of accident causation and preventive measures of industrial accidents.	K2
CO2	Describe the different types of hazards and apply hazard identification tools.	K3
CO3	Understand the occupational health hazards and human factors contributing to industrial accidents.	K2
CO4	Explain about personal protective equipment, its selection, safety performance & indicators.	K2
CO5	Describe various hazards associated with different machines and mechanical material handling.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	2	2	2	-	-	-	-
CO2	2	2	2	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	2	2	2	-	-	-	-
CO4	2	2	2	-	-	-	-	-	-	-	-	-
CO5	2	2	2	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial Safety, Health and Environment management systems	R.K Jain	Khanna Publications	2000
2	Safety Management	Grimaldi and Simonds	AITBS Publishers, New Delhi	2001
3	Occupational Safety and Health Management	Thomas J. Anton	McGraw Hill	1989
4	Safety management System and Documentation training Programme handbook	Paul S V	CBS Publication	2000

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Safety management in Industry	Krishnan, N.V.	Jaico Publishing House, New Delhi	1997
2	Industrial safety	Ronald P. Blake.	Prentice Hall, New Delhi	1973
3	Safety management system	Alan Waring	Chapman & Hall, England	1996
4	Guidelines for Hazard Evaluation Procedures	AICHE/CCPS	Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York	Second edition, 1992

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/110105094
2	https://nptel.ac.in/courses/110105094
3	https://nptel.ac.in/courses/110105094
4	https://nptel.ac.in/courses/110105094

SEMESTER S6

MARKETING MANAGEMENT

Course Code	PEMET638	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course Objectives:

1. To evaluate the Marketing concepts and ideas.
2. To analyse the consumer behaviour in the market.
3. To interpret the ideas in pricing of products.
4. To identify modern day advertisement and marketing methods.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION: Definition of Marketing- Evolution-Marketing concept-Marketing mix- 4 Ps Frame work-Marketing orientation and philosophies.: Types of Markets-Different Market segmentation- Non segmented markets-Benefits- Limitations MARKETING RESEARCH & ENVIRONMENT. Stages in Marketing research- Types of Research Methods- Exploratory- Descriptive- Experimental -Survey Methods Marketing Environment- Micro& Macro environment -Factors affecting-Economic-Technological- political -Competitive Environment-Green Marketing concept.	9
2	CONSUMER BEHAVIOUR:- Consumer Psychology- Choice criteria-	

	order management cycle – Buying situation- Personal and social influence . PRODUCT DECISION: Concept of a Product – Types of Products- Business, Consumer , Service product-Commodity- Technology and Customised product .New product development- Product idea-Product Life Cycle. Brand- Brand attributes- Building a brand name -strategies of corporate Branding.	9
3	PRICING STRATEGIES: setting the price of a product-pricing policies and constraints-factors influencing pricing decision-Methods of pricing- cost oriented -competitor oriented- marketing oriented pricing -tactics of price adjustment. price wars- price sensitivity CHANNEL DECISION- Nature of Marketing Channels –. Types of Channel flows –Consumer- Industrial-Service channels. Functions of Distribution Channel – Structure and Design of Marketing Channels - Channel co-operation, conflict and competition – Channel Intermediaries- Franchising Retailers and wholesalers-Theory of retailing.	10
4	ADVERTISEMENTS: Advertisements- Identifying audience - Types of Advertisements-Impact of advertisements. Role of Media in advertisements- Advertisement restrictions & legal actions. DIRECT & INTERNET MARKETING: Direct marketing Techniques- Direct mail-Tele marketing- catalogues- direct response. Internet Marketing- Types of Networks- e business practices in post covid era. B2B-B2C-C2C-C2B exchanges.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To familiarise with the basic terms of marketing.	K1
CO2	Evaluate the marketing concepts and ideas	K2
CO3	Identify the consumer concepts in buying	K1
CO4	Understand the method of channelling the product	K1
CO5	Analysis of various pricing strategies in the market	K3
CO6	Analyse the modern day advertising methods	K3
CO7	Understand the digital marketing methods	K1

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	1	1	-	-	-	-	1
CO2	2	-	-	-	-	-	-	-	-	-	-	1
CO3	2	-	-	-	-	1	1	-	-	-	-	1
CO4	1	1	1	1	-	-	-	-	-	-	-	2
CO5	2	1	-	-	-	-	-	-	-	-	-	2
CO6	2	-	-	-	-	-	1	-	-	-	-	1
CO7	2	1	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Marketing Management	Phillip Kotler, Kevin Lane Keller	Pearson Publication	15th Edition (2018)
2	Marketing Management	Arun Kumar, N Meenakshi	Vikas Publishing house	2nd Edition (2013)
3	Research for Marketing decisions	Paul E Green, Donald S Tull, Gerald Albaum	PHI learning	5th Edition (2010)
4	Managing Marketing	Noel Capon, Sidharth Shekhar Singh	Wiley Publications	1 st Edition (2014)

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Marketing Analytics	Wayne L Winston	Wiley publication	2nd Edition 2018
2	Strategic Market Management-Global perspective	David A Aaker, Damien McLoughlin	Wiley Publications	3rd Edition 2016

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/110/104/110104068/
2	https://archive.nptel.ac.in/courses/110/104/110104068/
3	https://archive.nptel.ac.in/courses/110/104/110104068/
4	https://archive.nptel.ac.in/courses/110/104/110104068/

SEMESTER S6
ADVANCED MATERIALS

Course Code	PEMET635	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET205	Course Type	Theory

Course Objectives:

1. Develop the understanding of materials
2. Apply materials science and engineering solutions to enhance existing technology

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to advanced materials, Advanced materials and alloys, Super alloy: Metallurgy and strengthening mechanisms, Types of super alloy and application. Bulk metallic glasses: Mechanism of formation, properties, and application. High Entropy Alloys (HEA): Thermodynamics, applications, Core effects of HEA, Phase selection in HEA. Self-healing materials: different self-healing processes. Materials for self-healing process.	9
2	Shape-Memory Materials: Shape memory effect and phase transformation effect, Superelasticity or Pseudoelasticity, Shape Memory Polymer (SMP), Thermo-Stimulated SMP, Electric-Stimulated SMP, Light-Stimulated SMP, Shape Memory Ceramic, Shape Memory Hybrids. Piezoelectric Materials: Direct and inverse Piezoelectric Effect, Materials used for piezoresistivity (Ceramics, Polymer and Composites), Single Crystal	9

	Piezoelectric. Smart Fluids: Electro-Rheological Fluids, Magneto -Rheological Fluid, Ferro Fluids, Photo-Rheological fluids, Materials used for ER, MR and PR fluids.	
3	Nanomaterials: Size effect, synthesis and properties of Nanomaterials. Application of Nanomaterials. Carbon based nanomaterials- Graphene, CNT, Carbon dots, Fullerene. Pyrolyzed nanocarbon materials, properties and applications Emerging 2D materials (Hexagonal boron nitride (h-BN), metal chalcogenides, metal oxides, metal halides, metal carbides/nitrides (MXenes), and organic semiconductors (OSCs)), properties and applications. Emerging photovoltaic materials	9
4	Ultralight materials: Aerogels, metallic and ceramic foams Biomaterials: Biocompatibility, Classification of biomaterials and applications. Surface modification of biomaterials-biocompatible coating, surface treatment, Advanced plastic materials, High temperature and conducting plastics, Biodegradable and Biorenewable Polymers/Plastics, Applications	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Get introduction to different types of advanced materials	K4
CO2	Understand properties of alloys and self healing materials	K4
CO3	Understand and identify the applications of smart materials	K4
CO4	Learn the application and scope of nano-materials	K4
CO5	Identify the importance of biomaterials	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	2	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Materials An Introduction to Modern Materials Science	Ajit Behera	Springer	2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Biomaterials Principles and Practices	Donald R. Peterson, Joseph D. Bronzino, Joyce Y. Wong	Taylor & Francis	2012
2	Carbon Nanomaterials	Volker Presser, Yury Gogotsi	CRC Press	2006
3	Advanced Materials	Ivan A. Parinov, Shun- Hsyung Chang, Vitaly Yu. Topolov	De Gruyter	2020

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc19_mm13/preview
2	https://onlinecourses.nptel.ac.in/noc19_mm13/preview
3	https://onlinecourses.nptel.ac.in/noc19_mm13/preview
4	https://nptel.ac.in/courses/113104009

SEMESTER S6

THERMAL ENGINEERING

Course Code	PBMET604	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET403 Engineering Thermodynamics	Course Type	Theory

Course Objectives:

1. To become proficient with steam turbines and steam power systems.
2. To comprehend and evaluate the performance of internal combustion engines and examine their combustion processes

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Steam Power Cycle: Simple Rankine cycle, Improvements in Rankine cycles-Reheat and Regenerative cycles – Numerical problems. Steam Boilers: Types of boilers, Fire tube boiler - Cochran boiler, Water tube boiler - Babcock and Wilcox, Boiler Mountings and Accessories. Steam nozzles: -Types of nozzles, Velocity, Effect of friction, nozzle efficiency and its effects - Simple numerical problems, Super saturated flow.	9
2	Steam turbines: Classification, compounding of turbines-pressure velocity variation. Velocity diagrams, work done, efficiency, Condition for maximum efficiency (Derivation not required). Graphical Method for solving velocity triangle problems on impulse and reaction turbines. Multistage turbines -Condition line, stage efficiency, reheat factor and degree of reaction. Governing of turbines – Centrifugal governing and Nozzle governing.	9

3	Fundamentals of IC Engines: Air standard cycles, their analysis, and applications - Otto cycle, Diesel cycle, Dual cycle, Atkinson cycle (No numerical problems and derivations) Reciprocating type SI and CI engines: Ideal and Actual cycle for IC engines– Deviation from ideal cycle and associated factors. Super charging, and turbo charging. Engine Testing and Performance of SI and CI engines: Torque, Engine power- BHP, IHP, Efficiencies of IC engines, Specific fuel consumption, Mean effective pressure. Morse test, Heat balance test and Retardation test – Simple Numerical problems.	9
4	Combustion in IC Engines: Fuels for IC engines, Ignition limits, air-fuel ratio, equivalence ratio. S.I. engines: Stages of combustion in S.I. Engines, Ignition lag, Auto ignition and Detonation, Effects of engine variables on detonation and Octane rating of fuels. C.I. Engines: Stages of combustion in C.I engines, Delay period, variables affecting delay period; knocking, Cetane rating of fuels. Major pollutants from S.I. and C.I. Engines, Measurement of exhaust emissions, Emission Control techniques – Catalytic convertors, Particulate traps Thermal reactor, Exhaust Gas Recirculation	9

Suggestion on Project Topics

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	2 questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 2 sub divisions. - Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the basic thermodynamic principles and analyse the operation of steam power cycles	K4
CO2	Analyse the performance of steam turbines and identify methods to improve their efficiency.	K3
CO3	Identify the performance parameters of IC engines and evaluate their performance.	K3
CO4	Explain the combustion phenomenon and pollution in IC engines.	K2
CO5	Conduct case studies, carry out simulation/testing, and prototyping.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	2	2	-	-	-	-	2	-	-	-	2	2
CO5	3	3	2	2	2	2	2	2	3	3	2	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Thermal Engineering	Rudra Moorthy	McGraw Hill Education India	2003
2	Thermal Engineering	R.K Rajput	Laxmi publications	2010
3	Fundamentals of IC engines	V. Ganesan	Tata McGraw-Hill	2002
4	Fundamentals of IC engines	H N Gupta	PHI	Second Edition, 2018
5	Internal Combustion Engines	V Sajith and Shijo Thomas	Oxford University Press	2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	I.C engine fundamentals	J.B.Heywood	McGraw-Hill	2011
2	Thermal Engineering	Mahesh Rathore	McGraw Hill Education India	2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptelvideos.com/video.php?id=1181
2	https://nptelvideos.com/video.php?id=1181
3	https://archive.nptel.ac.in/courses/112/103/112103262/
4	https://archive.nptel.ac.in/courses/112/103/112103262/

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER S6

INTRODUCTION TO BUSINESS ANALYTICS

Course Code	OEMET611	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic Knowledge of Statistics	Course Type	Theory – Open elective

Course Objectives:

1. Understand the Importance of Analytics in Decision making and Problem solving.
2. Understand the basic concepts in different levels of Analytics and how it is used in data-driven decision making.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Business Analytics: Why Analytics- Business Analytics: The Science of Data Driven Decision Making - Components of Business Analytics- Levels of Analytics – Descriptive Analytics, Predictive Analytics and Prescriptive Analytics- Framework for Data Driven Decision Making- Challenges in Data Driven Decision Making and Future. Introduction to Big data Analytics –Characteristics- Sources of Big Data.	9
2	Data: Definition and its Importance- How Data Add Value to the Business- Data Analytics vs Data Analysis Introduction to Descriptive Analytics: Data Types - Structured and Unstructured data - Types of Data Measurement Scales. Measures of Central Tendency: Arithmetic Mean-Mean of Grouped Data -Weighted Mean – Median- Median of Grouped Data- Mode- Mode of Grouped Data- Percentiles.	9

	Measures of Dispersion: Range - Inter QuartileRange -Standard Deviation - Variance and Coefficient of Variation. Measures of Shape- Skewness and Kurtosis.	
3	Data Visualization: Histogram- Bar Chart-Pie Chart-Scatter Plot-Coxcomb Chart-Box and Whisker Plot. Correlation Analysis: Pearson Correlation Coefficient-Spearman Rank Correlation. Predictive Analytics: Simple Linear Regression-Simple Linear Regression Model-Least Squares Method -Coefficient of Determination -Model Assumptions.	9
4	Prescriptive Analytics: Introduction Business Performance Management: Business Performance Management cycle-Performance management system-Key Performance Indicators. Analytics in Business support functions: Sales and Marketing - Human Resources-Financial Analytics-Production and Operations Analytics.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of business analytics and how it is becoming competitive strategy for many organisations.	K2
CO2	Understand the Importance of analytics in decision making and problem solving.	K2
CO3	Understand the application of descriptive analytics in decision making.	K2
CO4	Learn data visualization and various types of visual charts.	K2
CO5	Apply simple linear regression model in predictive analytics problems.	K3
CO6	Understand the basic concepts in prescriptive analytics.	K2
CO7	Understand the essence of business performance management and analytics in business support functions.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	2	-	-	-	-	2	-	-	-
CO2	2	2	2	3	3	-	-	-	-	-	-	-
CO3	2	2	3	3	3	-	-	-	-	-	-	-
CO4	2	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	3	3	3	-	-	-	-	-	-	-
CO6	2	2	2	1	2	-	-	-	-	-	-	-
CO7	-	-	-	-	-	2	-	2	2	3	2	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Business Analytics-The Science of Data Driven Decision Making	U Dinesh Kumar	Wiley	First Edition:2017
2	Fundamentals of Business Analytics	R. N. Prasad & Seema Acharya	Wiley	Second Edition:2016
3	Business Intelligence. Analytics and Data Science: A Managerial Perspective	R. Sharda, D. Delen & E. Turban	Pearson	Fourth Edition:2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Analytics	A. Maheshwari	McGraw Hill Education	First Edition:2017
2	Business Analytics for Managers: Taking Business Intelligence Beyond Reporting	Gert H. N. Laursen & Jesper Thorlund	Wiley	First Edition:2017
3	Business Analytics	J. R. Evans	Pearson	Third Edition:2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/YZf5q-ICf8Y
2	https://youtu.be/1MiT06JFNo4 and https://youtu.be/6lQn1hdG43o
3	https://youtu.be/eY55ocm-VgM and https://youtu.be/xXDoZLVjfs

SEMESTER S6

QUANTITATIVE TECHNIQUES FOR ENGINEERS

Course Code	OEMET612	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3: 0: 0: 0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory – Open elective

Course Objectives:

1. This course will equip the student with the expertise to mathematically model real life optimization problems and subsequently educate the student to solve these models with the help of the available methods. The mathematical concepts and models deal with solving engineering problems using minimum available resources.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Quantitative Techniques: Basics of Operations Research – Applications - Linear Programming - Problem Formulation, Graphical method, Simplex method, Big-M Method. Decision Making: Decision under certainty, risk and uncertainty: Decision trees, EMV method, EOL method, MaxiMin criterion, MiniMax criterion.	9
2	Transportation Problem: Mathematical Formulation, Balanced and unbalanced problems, Initial Basic Feasible Solution, North West Corner method, Least Cost method, Vogel's Approximation Method, Optimality test by MODI method, Assignment problem, Hungarian method. Sequencing Problem: Basic terminologies, Processing of n Jobs through 2, 3 and m machines.	9

3	Network analysis – Basic terms – Network construction, time analysis, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT). Game Theory: Games with saddle points, Games without saddle points – 2 x 2 games, Graphical method for m x 2 and 2 x n games	9
4	Queuing theory: Scope, terminology, classification Importance and applications, Performance Measures in Queuing Systems, Single-server exponential arrival and service times. Multi - server problems. Simulation: Monte Carlo simulation – Queuing simulation model- Generation of random numbers	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To formulate and solve linear programming and transportation problems	K4
CO2	To apply decision theory under various conditions of certainty, risk, and uncertainty.	K3
CO3	To sequence and schedule jobs and projects	K3
CO4	To solve Game Theory problems	K3
CO5	To solve problems using classical queuing theory models	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	2	3	-	-	-	-	-	-	-	-	-
CO4	2	2	3	-	-	-	-	-	-	-	-	-
CO5	2	3	2	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Operations Research	Paneerselvam R.	PHI	Third edition, 2023
2	Operations Research	Taha	Pearson	Tenth edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Operations Research	F. S. Hillier and G. J. Lieberman	McGraw Hill	Tenth edition, 2017
2	Discrete Event System Simulation	Banks, Carson, Nelson and Nicol	Pearson	Fifth edition, 2013

SEMESTER S6

AUTOMOTIVE TECHNOLOGY

Course Code	OEMET613	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory – Open elective

Course Objectives:

1. To understand the fundamental principles and technologies of automotive propulsion systems, including electric, hybrid, and internal combustion engines, along with their classifications and basic dynamics.
2. To understand automotive components and systems such as power plants, fuel supply, ignition, transmission, chassis, steering, braking, suspension and Electrical/Electronic architecture.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: History of automobiles: Electric, Hybrid and Internal Combustion Engines (ICE) vehicles – classification of automobile L, M and N category. Sub division according to body style (hatchback to station wagon). Basic vehicle dynamics: Rolling, Air and Grade resistance, Power and Torque for propulsion (basic equations). Different ICEs – SI & CI, Single and multicylinder with arrangements, Bi fuel & dual fuel, latest technologies in ICEs – Flex fuel vehicles, H ₂ -ICE, Hybrid types – Mild & strong hybrids, series, parallel, and series parallel types.	9

2	Power plant: Components in an IC engine – head, block & sump, cylinder, piston, piston pin, crank, connecting rod, valve train and types, combustion process – A/F ratio, self-ignition temperature, Octane and cetane number. Fuel, Air and ignition systems: Carburettors(simple), MPFI, CRDI & GDI systems with components (line diagram). Working of solenoid and piezo injectors. Naturally aspirated and forced induction systems (turbo and super charger). Spark ignition systems –components, ignition timing, Single coil ignition system & coil over plug ignitions system.	9
3	Lubrication, Cooling and exhaust system: Lubrication system – basic circuitry, oil grade and viscosity. Cooling system – basic circuit including thermostat valve. Exhaust system – 3-way catalytic converter, DPF and SCR basics. Transmission & Chassis: Gear ratio, manual transmission: synchromesh, Automated and Automatic transmission basics, Friction and Fluid clutches basics. Different types chassis – tubular to integrated, duties of a chassis.	9
4	Steering, Braking and Suspension: Working of manual, electric and hydraulic steering system. Working of brake system – hydraulic, pneumatic and ABS. Suspension system – rigid & independent, coil & leaf, shock absorber basics. E & E architecture –ECUs, sensors and actuators other than ECM, distributed and zonal electrical architecture. Basics of communication protocols – CAN, LIN and ethernet. Electric vehicle components and energy flow, On-board diagnostic basics – DTC code, basics of ADAS – sensors, levels of automation, examples – LDWS to Lane change assist, Adaptive cruise control, Automatic emergency braking, Driver monitoring system, Autonomous Vehicles.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the efficiency and performance of different automotive propulsion systems (electric, hybrid, internal combustion)	K2
CO2	Apply knowledge of automotive components to diagnose and troubleshoot issues in propulsion, transmission, and chassis systems.	K3
CO3	Describe the operation and integration of advanced automotive technologies such as fuel injection systems and electronic control units (ECUs) in vehicle design and performance enhancement.	K2
CO4	Understand basics of E & E architecture and principles behind vehicle handling and safety through analysis of steering, braking and suspension systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

[illegible]

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automobile Engineering, Vol.1 & Vol.2	Kirpal Singh	Standard Publishers	13 th edition,2020.
2	A Textbook of Automobile Engineering	S K Gupta	S Chand	January 2020
3	Fundamentals of motor vehicle technology.	Hillier and Peter Coobes	New Age International Private Limited	6th edition (1 January 2006)
4	Vehicle and engine technology	Heinz Heisler	Society of Automotive Engineers	2nd edition (1 September 1998)
5	Automobile mechanical and electrical systems	Tom Denton & <u>Hayley Pells</u>	Routledge Publishers	3 rd edition, 2022
6	Automobile Electrical and Electronic systems	Tom Denton	Routledge Publishers	5 th edition, 2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Mechanics	Heitner J	East-West Press	2 nd edition, 1999
2	Automobile Engineering	Jain K.K. and Asthana R. B	Tata McGraw Hill	New Delhi, 2002
3	Electric and Hybrid Vehicles	Tom Denton	Routledge Publishers	2nd edition, 2020
4	Fundamentals of modern vehicle technology	V.A.W. Hillier	Butterworth-Heinemann	2nd edition,1998

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/107/106/107106088/
2	https://archive.nptel.ac.in/courses/107/106/107106088/
3	https://archive.nptel.ac.in/courses/107/106/107106088/
4	https://archive.nptel.ac.in/courses/107/106/107106088/

SEMESTER S6

RENEWABLE ENERGY ENGINEERING

Course Code	OEMET614	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory – Open elective

Course Objectives:

1. The course is aimed at imparting basic knowledge on the different types of renewable energy resources and utilization of these energy effectively so as to minimize the consumption of non-renewable energy to a greater extend.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	The Energy Scenario- Commercial energy sources -World's production and reserves- India' Production and reserves. Solar Energy collectors: Solar thermal collectors -Flat plate collectors –Solar concentrators (parabolic trough, parabolic dish, Central Tower Collector) – Solar Air Heaters. Solar thermal electric power generation -Thermal Energy storage, sensible heat storage, latent heat storage , Thermo chemical storage , photovoltaic system for power generation , Solar pond -Solar Cells-Types of solar cells , principle of working and performance characteristics, Production process- Block diagram only Applications- Solar space heating and cooling of buildings, solar pumping, solar cooker, solar still, solar drier, solar refrigeration and air-conditioning, heliostat, solar furnace.	11

2	Wind Energy- classification of wind turbines and power performance curve, Energy in wind, calculation of energy content, Power coefficients, Betz limit theory, tip speed ratio, solidity of turbine' power control strategies, Basic principles of Wind Energy Conversion Systems (WECS), Classification of WECS, Parts of WECS	7
3	Ocean Energy – Devices for Wave Energy conversion, Ocean Thermal Energy Conversion (OTEC): Principle of OTEC system, Methods of OTEC power generation – Open Cycle (Claude cycle), Closed Cycle (Anderson cycle) and Hybrid cycle (block diagram description of OTEC); Geothermal energy: Introduction, hot dry rock resources, magma resources, vapour and liquid dominated systems, binary cycle, advantages and disadvantages	10
4	Bio Mass Energy- Biomass conversion technologies –Bio Gasification, Bio ethanol, Bio Diesel, Biogas production from waste biomass, factors affecting biogas generation Bio Gas -KVIC and Janata model. Hydrogen Energy – various routes for production of Hydrogen energy.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain solar energy collectors, storages, solar cell characteristics and applications	K2
CO2	Explain the different types of wind power machines and control strategies of wind turbines	K2
CO3	Explain the ocean energy and conversion devices and different Geothermal sources	K2
CO4	Explain biomass energy conversion devices. Calculate the Net Present value and payback period	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Solar Energy: Principles of Thermal Collection and Storage	S P Sukhatme , J K Nayak	Mc Graw Hill	2015
2	Fundamentals of renewable energy sources	Tiwari G N, Ghosal M K	Alpha Science International Ltd	2007
3	Sustainable Energy Choosing among options	Jefferson W Tester et.al	PHI	2006

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Renewable energy resources and emerging technologies	D.P. Kothari	Prentice Hall of India Pvt. Ltd	2011
2	Fundamentals and Applications of Renewable Energy	Mehmet KanoğluYunus A. Çengel John M. Cimbala	Mc Graw Hill	2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1 to 4	https://nptel.ac.in/courses/103103206

SEMESTER S6

QUALITY ENGINEERING AND MANAGEMENT

Course Code	OEMET615	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory – Open Elective

Course Objectives:

1. To impart knowledge on principles and practices of quality engineering and management.
2. To enable use of various tools and techniques for continuous quality improvement.
3. To provide ideas on implementation of quality standards

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Quality Management - Definitions of quality, Dimensions of Quality, Concepts of Product and Service Quality, Evolution of Quality Management, quality control, quality assurance, quality planning, quality management, Total Quality Management (TQM)-the TQM axioms - Consequences of total quality- Barriers to TQM, Deming approach, Juran's quality trilogy, Crosby's fourteen steps for quality improvement, Quality circles.	9
2	Human dimensions of TQM – Top management commitment- Leadership for TQM- Change management- resources for quality activities - Training for quality –Employee involvement, motivation, empowerment- teamwork- self managing teams - Role of the quality director-Quality System: ISO 9000 family of standards. Quality auditing- types and benefits.	9
3	Tools and Techniques in TQM: Affinity diagram -brainstorming - cause and effect analysis - process flow chart – check sheets- Scatter diagram -	9

	Pareto chart- Histogram. Quality control and Inspection, Fundamentals of statistics, accuracy and precision, causes of variation in quality, Statistical Process Control, control charts, $\bar{x}$ and R chart problems, process capability, Acceptance sampling.	
4	Strategic Quality Management: Integrating quality into strategic management - obstacles to achieving successful strategic quality management-Cost of Quality-Customer satisfaction. Quality Function Deployment (QFD), Failure Mode and Effect Analysis, Analysis of Variance (ANOVA), Design and Analysis of Experiments (DOE), Concepts of 5S, Kaizen, Six Sigma, Total Productive Maintenance. Reliability Engineering - types and causes of failures - Bath tub curve - System reliability - Life testing.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop knowledge of quality management and contributions of quality gurus.	K2
CO2	Identify various human dimensions of TQM	K2
CO3	Implement different tools and techniques in TQM	K3
CO4	Implement different statistical quality control techniques	K3
CO5	Demonstrate knowledge of the underlying principles of strategic quality management	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	-	-	-	-	-	-
CO2	3	-	-	-	-	2	-	-	2	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-
CO4	2	3	2	-	-	-	-	-	-	-	-	-
CO5	2	3	2	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Total Quality Management(TQM)	B esterfield D. H. , BesterfieldC, Besterfield G. H., Besterfield M, U. Hemant, U.Rashmi	Pearson Education	Fifth Edition, 2018
2	Total Quality Management	SubburajRamasamy	Tata McGraw Hill Education	First Edition, 2017
3	Introduction to Statistical Quality Control	D. C. Montgomery	John Wiley & Sons	Third Edition
4	Fundamentals of Quality Control and Improvement	Mitra A.	PHI	Second Edition, 1998

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Design and Analysis of Experiments	D. C. Montgomery	John Wiley & Sons	6thEdition ,2004
2	Quality Planning and Analysis - From Product Development through Use	Juran J M and Gryna, F M	Tata McGraw Hill Publishing Limited, New Delhi	Third Edition, 2004
3	Quality is Free	Crosby P B	McGraw Hill	New York, 1979

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/110105088
2	https://nptel.ac.in/courses/110101010
3	https://nptel.ac.in/courses/110101010
4	https://nptel.ac.in/courses/110101010

SEMESTER S6
ADDITIVE MANUFACTURING

Course Code	OEMET616	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory – Open elective

Course Objectives:

1. To demonstrate appropriate level of understanding on principles of additive manufacturing
2. To understand the different additive manufacturing technologies.
3. To choose appropriate materials for additive manufacturing processes
4. To design prototypes by identifying suitable process with optimum process parameters

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Additive Manufacturing (AM) –Basic principle of AM- Procedure of product development in AM process chain. Classification of additive manufacturing processes, Basic concept, Digitization techniques, Benefits and challenges in AM. Data processing for AM- CAD model preparation, Part orientation and support generation, Slicing methods, Tool path generation, STL Formats. Demonstration of slicing software packages.	8
2	Common AM technologies: Principle, materials, process parameters, advantages and applications of: Stereo Lithography (SLA), Digital Light Processing (DLP), Continuous Liquid Interface Production (CLIP), Laminated Object Manufacturing (LOM), Ultrasonic AM (UAM), 3D printing, Binder Jetting, Material Jetting, Fused Deposition Modelling	10

	(FDM), Direct Ink Writing (DIW).	
3	Common AM technologies: Principle, materials, process parameters, advantages and applications of: Selective Laser Sintering (SLS), Selection Laser Melting (SLM), Electron Beam Melting (EBM), Wire Arc Additive Manufacturing (WAAM), Laser Engineering Net Shaping (LENS).	10
4	Design for AM (DFAM) AM unique capabilities, DFAM concepts and objectives, Design freedom and synthesis methods. Applications for AM Applications: Prototyping, Industrial tooling, Aerospace, Automobile, Medical etc.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept of AM from conventional manufacturing systems.	K2
CO2	Understand the data processing techniques in AM process	K2
CO3	Understand the principles of AM processes.	K2
CO4	Understand the application of AM in industries	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	1
CO2	3	2	-	-	-	-	-	-	-	-	-	1
CO3	3	2	-	-	-	-	-	-	-	-	-	1
CO4	3	2	-	-	-	-	-	-	-	-	-	1

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Additive Manufacturing Technologies-3D Printing, Rapid Prototyping, and Direct Digital Manufacturing.	Gibson I D. W. Rosen I and B. Stucker	Springer	Second Edition, 2015
2	Rapid prototyping: Principles and applications	Chua, C.K., Leong K.F. and Lim C.S.	World Scientific Publishers	Third edition, 2010.

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Rapid Manufacturing The Technologies and Applications of Rapid Prototyping and Rapid Tooling	D.T. Pham and S.S. Dimov	Springer London Ltd	Softcover reprint of the original 1st ed. 2001, 2011
2	Additive Manufacturing: Principles, technologies and Application	C.P. Paul , A.N. Jinoop	McGraw Hill	First Edition, 2021
3	Additive Manufacturing Technologies	S. Shiva , Anuj K. Shukla	Wiley	First Edition, 2024
4	Additive Manufacturing: Fundamentals and Advancements	Manu Srivastava, Sandeep Rathee, Sachin Maheshwari	CRC Press	First Edition, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1 - 4	NOC: Fundamentals of Additive Manufacturing Technologies, IIT Guwahati by Prof. Sajan Kapil Link: https://nptel.ac.in/courses/112103306

SEMESTER S6

SOLAR ENERGY CONSERVATION SYSTEMS

Course Code	OEMET617	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	OEMET 617	Course Type	Theory – Open elective

Course Objectives:

1. To equip students with a thorough understanding of solar radiation, the sun-earth relationship, and the atmosphere's impact, and to provide detailed knowledge of different solar collectors, their thermal analysis, tracking mechanisms, and storage solutions.
2. To enable students to understand PV systems' principles and performance, including design and components of standalone and grid-connected systems, and to introduce methods of economic evaluation of solar energy technologies, such as cost analysis, payback period calculation, and financial feasibility in the context of energy policy.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Energy Scenario: India and world, Basic concepts related to solar radiation, the sun, spectral distribution, sun- earth relationship, extraterrestrial radiation, revolution of earth, seasons, position of sun in the sky, position of sun with respect to the centre of the earth. Role of atmosphere on solar radiation, air mass, terrestrial spectrum, prediction of solar radiation. Sign conventions, angle of incidence on a tilted plane, shading, sun-path diagram, overhangs, parallel rows of solar collectors. Diffuse and direct radiation. Solar energy measuring instruments.	9

2	Solar collectors: Flat plate collector, thermal analysis, heat removal factor. Overview of other thermal collectors. Concentrating collectors, theoretical limit, classifications of concentrators. Parabolic trough collector, thermal analysis, compound parabolic concentrators, Linear Fresnel Reflector, parabolic dish collector, central receiver tower. Tracking of solar concentrators. Solar ponds. Storage of heat in solar thermal power plants, storage media and heat transfer fluids.	9
3	Non-thermal routes for solar energy conversion, Basics of photovoltaic effect, Fundamentals of PV: Principles and performance analysis, Photovoltaic materials, Modules, Array, Maximum Power Point Tracking (MPPT) etc.; standalone PV system: Components and design of standalone system, fundamentals of battery system; grid connected PV system: components and design of grid connected PV systems.	9
4	Methods of fixing power tariff - Simple Methods to Calculate the Plant Economy - Life Cycle Cost - Payback Period – Relevance of financial and economic feasibility evaluation of energy technologies and systems, Energy-economy interaction, Energy Policy related acts and regulation. Economic Analysis for the Selection of Alternative Decisions and the future of the Power Plants.	9

Course Assessment Method
(CIE: 40marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic concepts of solar radiation, the sun-earth relationship, and the effects of the atmosphere on solar energy.	K2
CO2	Able to recall the various types of solar collectors and their theoretical principles, including flat plate collectors and concentrating collectors.	K1
CO3	Apply thermal analysis techniques to different solar collectors and implement design principles for both standalone and grid-connected PV systems.	K3
CO4	Understand the methods for calculating plant economy, including life cycle cost, payback period, and the relevance of economic feasibility evaluations for energy technologies.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	3	-	-	-	-	-	-
CO2	3	2	-	-	-	2	-	-	-	-	-	-
CO3	3	2	-	-	-	2	-	-	-	-	-	-
CO4	3	2	-	-	-	2	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Solar Energy	S P Sukhatme	McGraw Hill Education (India) Private Limited	Fourth edition (1 January 2017)
2	Principles of Solar Engineering	D. Yogi Goswami, Frank Kreith, and Jan F. Kreider	CRC Press	3rd Edition (2015)
3	Handbook of Solar Energy: Theory, Analysis and Applications	G. N. Tiwari	Publisher Springer	1st ed. 2016
4	Photovoltaic Systems Engineering	Roger A. Messenger and Jerry Ventre	CRC Press	4th Edition (2012)

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Renewable Energy: Power for a Sustainable Future	Godfrey Boyle	Oxford University Press	3rd Edition (2012)
2	Solar Photovoltaic Technology and Systems: A Manual for Technicians, Trainers and Engineers	Chetan Singh Solanki	PHI Learning Pvt. Ltd.	1st Edition (2013)
3	Handbook of Photovoltaic Science and Engineering	Antonio Luque and Steven Hegedus	John Wiley & Sons	2nd Edition (2011)
4	Solar Electricity Handbook: A Simple, Practical Guide to Solar Energy - Designing and Installing Solar Photovoltaic Systems	Michael Boxwell	Greenstream Publishing	2020 Edition

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/104/112104300/
2	https://archive.nptel.ac.in/courses/112/104/112104300/
3	https://archive.nptel.ac.in/courses/115/103/115103123/
4	https://archive.nptel.ac.in/courses/115/103/115103123/

SEMESTER S6

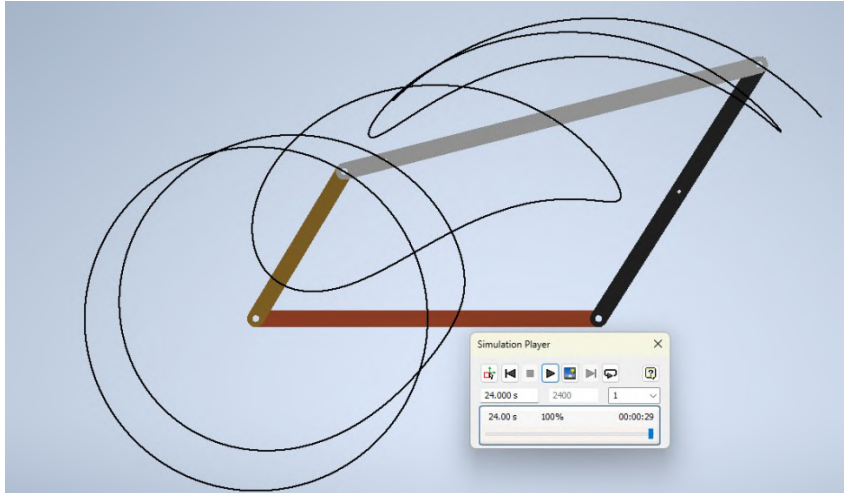
COMPUTER AIDED DESIGN AND ANALYSIS LAB

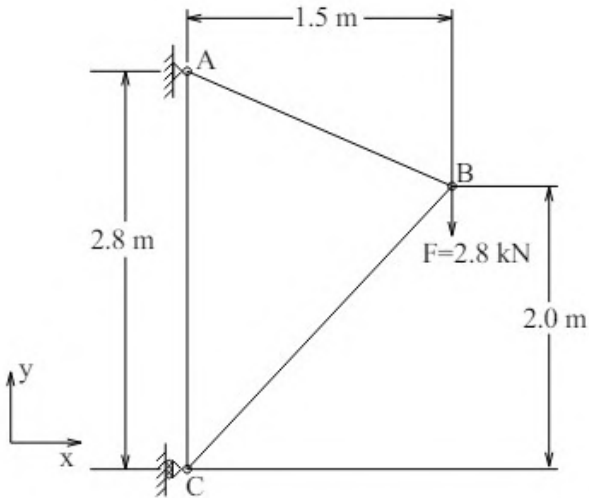
Course Code	PCMEL607	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Computer Aided Machine Drawing (Course code - PCMEL307)	Course Type	Lab

Course Objectives:

1. Teach students to design and simulate mechanical systems using CAD and FEA software. This includes creating mechanisms like the Whitworth quick return and four-bar linkage, and analyzing structural elements such as bars and trusses.
2. Enable students to perform dynamic simulations and analyze mechanical systems under various loads. This includes studying mechanism kinematics, fatigue, and heat transfer in steady-state and transient conditions.
3. Introduce students to fluid dynamics principles and computational tools for analyzing fluid flow. This includes performing flow analysis on airfoils and improving designs by analyzing flow separations and recirculation zones.

Expt. No.	Experiments
1	Perform a dynamic simulation of a four-bar mechanism. Example Problem Description. Perform a dynamic simulation of a four-bar mechanism using dynamic simulation. The dimensions of the mechanism are as follows: Crank = 100 mm, Coupler = 275 mm, Follower = 150 mm, and Fixed Link = 200 mm. Your objectives are to find the coupler curve at the center point of the coupler, 100 mm towards the crank, and 100 mm towards the follower. Additionally, determine the velocity and acceleration curves of the follower with respect to the fixed link, and specifically find the acceleration and velocity of the

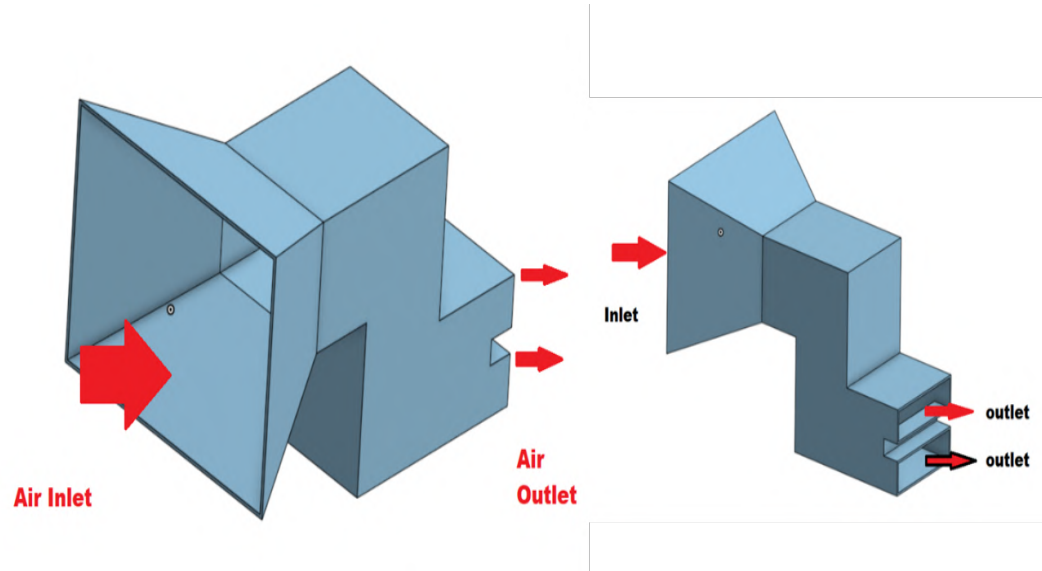
	follower at crank angles of 30°, 60°, and 90°. Begin by modeling the four-bar mechanism, setting up the simulation with appropriate joints, and running the simulation over a complete cycle of the crank. Trace and document the specified coupler curves, plot the velocity and acceleration curves of the follower, and tabulate the velocity and acceleration values at the specified crank angles. Submit a comprehensive report including the 3D model, plots, and a brief discussion on the findings. 
2	Design and Simulation of a Whitworth Quick Return Mechanism Design and simulate a Whitworth quick return mechanism with a specified quick return ratio. Analyze and plot the Coriolis component of acceleration, as well as the position of the slider in the slotted lever, acceleration and position of the tool ram throughout the mechanism's cycle.
3	Perform a structural analysis of an axial bar with varying cross-sectional areas under axial load using FEA software to determine the stress distribution, strain distribution, and total deformation. Example Problem Description: An axial bar of length $L=1\text{m}$ is subjected to an axial tensile load $P=10\text{kN}$. The bar has three different cross-sectional areas along its length: Section 1: From $x=0$ to 0.3m, the cross-sectional area is $A_1=50\text{mm}^2$, Section 2: From $x=0.3\text{m}$ to $x=0.7\text{m}$, the cross-sectional area is $A_2=75\text{mm}^2$, Section 3: From $x=0.7\text{m}$ to $x=1.0\text{m}$, the cross-sectional area is $A_3=100\text{mm}^2$. The bar is fixed at the end with the smallest cross-sectional area (Section 1).
4	Perform a structural analysis of a truss using FEA software to determine the force in each member, identify if the members are in tension or compression, and calculate the

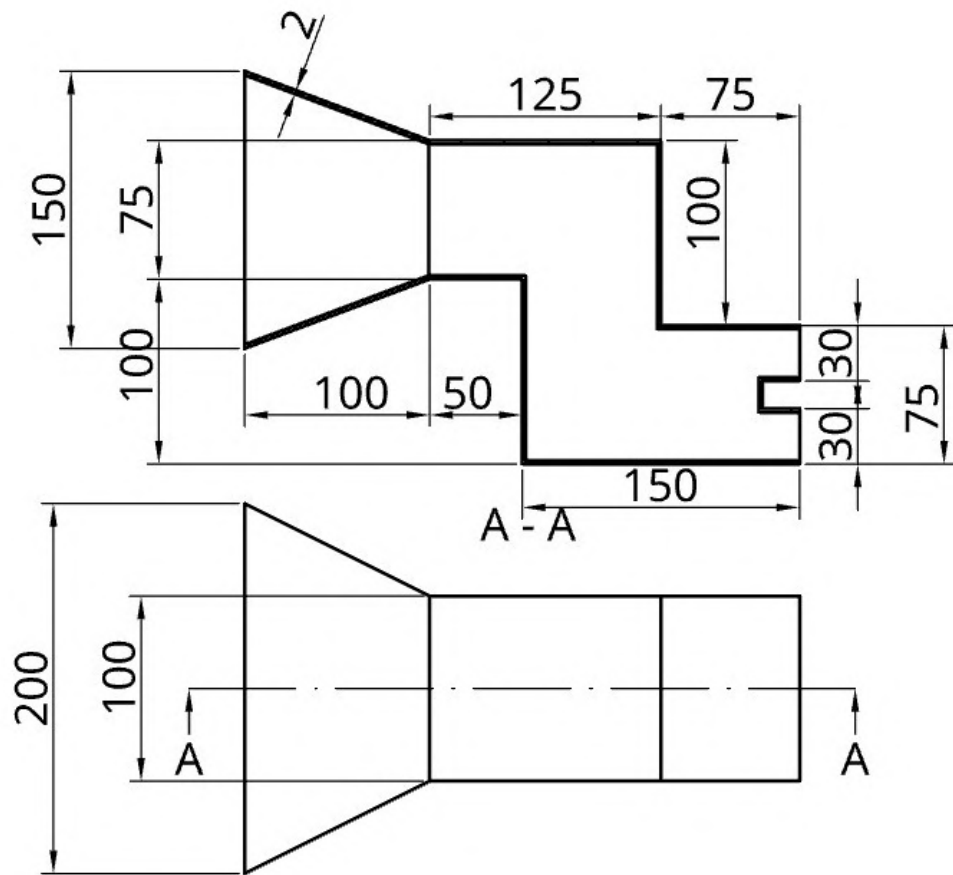
	support reactions. Example Problem Description: Analyze the given truss structure. The cross-sectional area of each truss member is 0.01m^2, the material of the truss members is steel with a Young's Modulus $E = 2.1 \times 10^5 \text{ MPa}$.  Figure 1: Geometry of the truss.
5	Perform the structural analysis of a thin plate (plane stress case) subjected to in plane loads
6	Perform the modal analysis of a cantilever beam
7	Perform the harmonic analysis of a cantilever beam
8	Perform an Eigen-buckling analysis using FEA software. Example Problem Description: Conduct an Eigenbuckling Analysis of a column with I-section using a FEM software to determine the shape numbers and load multipliers for the column. Compare the results obtained with Euler's critical buckling load formula. Additionally, provide the following results: the critical buckling load, the mode shapes, the corresponding displacements, and the stress distribution for each mode.
9	Perform a fatigue analysis using FEA software. Example Problem Description: Perform a fatigue analysis on a Formula SAE hub subjected to a torque of 300 N-m and a dead load of 700 N per wheel. Determine the number of cycles to fatigue failure for the

	hub under these specified loading conditions.
10	Solve a steady-state heat conduction problem using FEA software to determine the temperature distribution within a solid material. Example Problem Description: Consider a rectangular solid plate with dimensions $L = 200$ mm (length), $W = 100$ mm (width), and $t = 10$ mm (thickness). Material Properties given, Thermal conductivity, $k = 50$ W /mK, Density, $\rho = 7800$ kg/m³, Specific heat capacity, $C = 500$ J/kgK. Boundary Conditions: Left edge ($x = 0$ mm): Maintained at a constant temperature $T_1 = 100$ C. Right edge ($x = 200$ mm): Maintained at a constant temperature $T_2 = 50$ C. Top and bottom surfaces ($y = 0$ mm and $y = 100$ mm): Insulated (no heat flux). Front and back surfaces ($z = 0$ mm and $z = 10$ mm): Insulated (no heat flux).
11	Perform a transient heat transfer analysis of a solid fin subjected to natural convection using FEA software to determine the temperature distribution and heat transfer over time. Example Problem Description: Consider a rectangular solid fin made of aluminum with dimensions: length $L = 100$ mm, width $W = 50$ mm, and thickness $t = 5$ mm. The fin is made of aluminum, having a thermal conductivity of $k = 237$ W /mK, density of $\rho = 2700$ kg/m³, and a specific heat capacity of $C = 900$ J/kgK. Initially, the fin is at a uniform temperature of $T_o = 25^\circ\text{C}$. One end of the fin ($x = 0$ mm) is subjected to a constant heat flux of $q = 2000$ W /m², while the surrounding air temperature is $T_{\text{sur}} = 25^\circ\text{C}$ with a convective heat transfer coefficient $h = 10$ W/m² K on all other surfaces. Perform a transient thermal analysis for a duration of $t = 3600$ s (1 hour) with appropriate time steps. The analysis aims to determine the temperature distribution and heat transfer in the fin at various time intervals, including contour plots showing the temperature distribution at different intervals and values of temperature at key points, the base (near 0 mm), the tip ($x = 100$ mm), and the midpoint ($x = 50$ mm). The results should include the total heat transfer rate from the fin to the surrounding air and heat flux distribution plots at the specified time intervals.
12	Perform the 2D flow analysis of an airfoil

13

Perform a flow analysis to improve the design of an air intake manifold for a pneumatic device by analyzing flow separations and recirculation zones using flow analysis software





- Out of 12 exercises, 8 should be given as exercises in the lab sessions. The rest of the exercises are optional

Course Assessment Method (CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply CAD and FEA tools to design and simulate mechanical systems. .	K3
CO2	Perform dynamic simulations of mechanical systems and analyze their kinematic behavior	K4
CO3	Conduct thermal and stress analysis on mechanical components under different loading conditions.	K5
CO4	Design optimized mechanical components and airflow systems using Computational Fluid Dynamics (CFD) software.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	3	1	2	1	2	2	2	3
CO2	3	3	3	3	3	1	1	1	3	2	2	2
CO3	3	3	3	3	3	2	2	1	2	2	2	3
CO4	3	3	3	3	3	2	3	1	3	2	2	3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Design with SolidWorks 2019	David C. Planchard and Marie P. Planchard	SDC Publication	
2	Creo Parametric 6.0 for Engineers and Designers	Prof. Sham Tickoo	BPB Publications	
3	Finite Element Analysis: Theory and Application with ANSYS	Saeed Moaveni	Pearson	
4	Fundamentals of Heat and Mass Transfer	Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, and David P. DeWitt	John Wiley & Sons	
5	Introduction to Computational Fluid Dynamics	Anil W Date	Cambridge University Press	
6	Manuals of software such as CatiaV and UG NX		Respective OEM	

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.

- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER S6

THERMAL ENGINEERING LAB-2

Course Code	PCMEL609	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:2:0	ESE Marks	50
Credits	1	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET403 Engineering Thermodynamics	Course Type	Lab

Course Objectives:

1. To familiarize the various systems and subsystems of IC engines
2. To conduct the performance test on IC engines, compressors /blowers
3. To conduct the performance test on air conditioning and refrigeration systems

Expt. No.	Experiments
Study	a) Familiarisation of various systems and subsystems of petrol engine / MPFI engine b) Familiarisation of various systems and subsystems of Diesel engine / Turbocharged engine
1	Performance test on petrol engines / MPFI engine
2	Performance test on Diesel engines / Turbocharged engine
3	Heat Balance test on petrol/Diesel engines
4	Determination volumetric efficiency and Air-fuel ratio of IC engines
5	Cooling curve of IC engines
6	Valve timing diagram of IC engines
7	Economic speed test on IC engines
8	Retardation test on IC engines
9	Morse test on petrol engine
10	Analysis of automobile exhaust gas and flue gas using exhaust gas analyser
11	Performance test on reciprocating compressor

12	Performance test on rotary compressor/blower
13	Study and performance test on refrigeration (Refrigeration Test rig)
14	Study and performance test on air conditioning equipment (Air Conditioning test rig)
	Note : 8 Experiments are mandatory

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify various systems and subsystems of Diesel and petrol engines	K1
CO2	Analyse the performance characteristics of internal combustion engines	K4
CO3	Investigate the emission characteristics of exhaust gases from IC Engines	K4
CO4	Interpret the performance characteristics of air compressors / blowers	K4
CO5	Interpret the performance characteristics of air conditioning and refrigeration systems	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	2	-	-	-	-	3	3	-	-
CO2	3	-	-	2	-	-	-	-	3	3	-	-
CO3	3	-	-	2	-	-	-	-	3	3	-	-
CO4	3	-	-	2	-	-	-	-	3	3	-	-
CO5	3	-	-	2	-	-	-	-	3	3	-	-

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of IC engines,	V. Ganesan	Tata McGraw-Hill	4, 2017
2	I.C engine fundamentals,	J.B.Heywood	McGraw-Hill	2, 2018
3	An Introduction to Combustion: Concepts and Applications,	Stephen R Turns	McGraw-Hill	3,2011

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.

- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 7

MECHANICAL ENGINEERING

SEMESTER S7

GAS TURBINE AND JET PROPULSION

Course Code	PEMET741	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fluid Dynamics	Course Type	Theory

Course Objectives:

1. To be able to perform fluid dynamic and thermodynamic analysis of gas turbine engines
2. To understand the principles of various jet and rocket propulsion engines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Gas Turbines – Introduction, fluid dynamics analysis of rotating machines, classification, energy equation, thermodynamic analysis, efficiency, basics of airfoil theory. Gas turbine cycles – open cycle, closed cycle, ideal cycle, simple cycle, heat exchange cycle and reheat cycle, intercooled cycle, intercooled with reheat and heat exchange. Cycle Analysis - Characteristics and properties of working medium, stagnation properties, compressor and turbine efficiencies, pressure losses, cycle efficiency.	9
2	Axial flow compressor – Working principle, velocity triangle, Work done, stage efficiency, degree of reaction, flow through blade rows, Losses, performance characteristics, comparison with centrifugal compressor Reaction turbines – single reaction stage, velocity triangle, work output, blade and stage efficiencies, multistage reaction turbines, blade to gas speed ratio, losses and efficiencies	9

3	Combustion – Theory of Combustion, factors affecting combustion chamber design and performance, process of combustion, combustion chamber geometry and arrangements, mixing and dilution. Inlet and nozzles – Subsonic inlets, diffuser, supersonic inlets, exhaust nozzles. Turbine blades: blade materials, manufacturing techniques, blade cooling, Applications of gas turbines, trends and future development, micro gas turbines – smart energy system.	9
4	Jet propulsion – Cycles and analysis – Gas turbine engines, Turboprop, Turbojet, Ramjet, Pulsejet, Thrust equation, Specific thrust of turbojet engine, efficiencies, factors affecting flight performance, Thrust augmentation Rocket propulsion – Classification, principle of rocket propulsion, optimum expansion ratio, solid propellant rocket and liquid propellant rocket, Nuclear propulsion, electro dynamic propulsion, photon propulsion, multistage rocket, propulsive efficiency.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To apply the principles of thermodynamics and fluid dynamics to understand the performance and efficiency of various gas turbine cycles.	K3
CO2	To analyze the performance characteristics and efficiencies of axial flow compressors and reaction turbines	K4
CO3	To analyse the performance of gas turbine systems by understanding the characteristics of various components.	K4
CO4	To understand the principles and characteristics of jet and rocket propulsion systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	2	2	1	-	-	-	-	-	-	-	-	1

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Gas Turbines	V Ganesan	McGraw Hill Education	Third, 2017
2	Turbines, Compressors and Fans	S M Yahya	McGraw Hill	Fourth, 2011
3	Gas Turbine & Jet Rocket Propulsion	Mathur M L	Standard Publishers Distributors	First, 2010

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Jet Engine	Rolls Royce	Wiley	First, 2015
2	Gas Turbine Theory	H. Cohen	Pearson Education	Seventh, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc24_ae19/preview
2	https://onlinecourses.nptel.ac.in/noc24_ae19/preview
3	https://onlinecourses.nptel.ac.in/noc24_ae19/preview
4	https://onlinecourses.nptel.ac.in/noc24_me96/preview

SEMESTER S7

AUTOMOBILE ENGINEERING

Course Code	PEMET742	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. To provide a comprehensive overview of the automotive industry and the historical evolution of automobiles, focusing on internal combustion engine (ICE) vehicles and their classifications.
2. To introduce and elaborate on the various systems and technologies used in modern automobiles, including fuel, ignition, lubrication, cooling, exhaust, power trains, suspension, brakes, and electronic systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Overview of the automotive industry, History and evolution of automobiles, Combustion Engines (ICE) vehicles – classification of automobile L, M and N category (an overview). Sub division according to body style (hatchback to station wagon) I C Engine components: Head, block & sump, cylinder, piston, piston pin, crank, connecting rod, valve train and types, combustion process – A/F ratio, self-ignition temperature, Octane and cetane number.	9
2	Fuel, Air and ignition systems: Carburetors, MPFI, CRDI & GDI systems with components (with neat diagrams). Working of solenoid and piezo injectors. Naturally aspirated and forced induction systems (turbo and super charger). Spark ignition systems –components, ignition timing, Single coil ignition system & coil over plug ignitions system. Lubrication, Cooling and exhaust system: Lubrication system – basic	9

	circuitry, oil grade and viscosity. Cooling system – basic circuit including thermostat valve. Exhaust system – 3-way catalytic converter, DPF and SCR basics.	
3	Power Trains: General arrangement of clutch, Principle of friction clutches, Constructional details, Single plate and multi-plate. Numerical calculations for torque transmission by clutches. Gear box: Necessity for gear ratios in transmission, synchromesh gear boxes, planetary gears, over drives, principle of automatic transmission (AMT, CVT, DCT, TC – an overview). Drive to Wheels: Propeller shaft and universal joints, differential, rear axle, Ackerman Steering Mechanism, steering geometry, camber, king pin inclination, included angle, castor, toe in & toe out, steering gears, power steering, general arrangements of links and stub axle, types of chassis frames.	9
4	Suspension, Springs and Brakes: Requirements, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system. Types of brakes, mechanical, hydraulic and air braking systems, brake shoe arrangements, Disk brakes, drum brakes, Antilock –Braking systems, purpose and operation of antilock-braking system. Electronics: ECUs, sensors and actuators other than ECM, distributed and zonal electrical architecture. Basics of communication protocols – CAN, LIN and ethernet. Electric vehicle components and energy flow, On-board diagnostic basics – DTC code, basics of ADAS – sensors, levels of automation, examples – LDWS to Lane change assist, Adaptive cruise control, Automatic emergency braking, Driver monitoring system, Autonomous Vehicles.	9

Course Assessment Method
(CIE: 40marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and classify various types of automobiles and their evolution.	K2
CO2	Identify and explain the components and functioning of Internal Combustion Engines (ICE)	K3
CO3	Describe and analyse the various fuel, air, ignition, lubrication, cooling, and exhaust systems in vehicle.	K4
CO4	Explain the power train, drive to wheels, suspension, springs, and braking systems.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	1	-	-	-	-	-	-
CO2	3	2	-	-	-	1	-	-	-	-	-	-
CO3	3	2	-	-	-	1	-	-	-	-	-	-
CO4	3	2	-	-	-	1	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automobile Engineering, Vol.1 & Vol.2	Kirpal Singh	Standard Publishers	13 th edition, 2020
2	A Textbook of Automobile Engineering	S K Gupta	S Chand	January 2020
3	Fundamentals of motor vehicle technology.	Hillier and Peter Coobes	New Age International Private Limited	6th edition (1 January 2006)
4	Vehicle and engine technology	Heinz Heisler	Society of Automotive Engineers	2nd edition (1 September 1998)
5	Automobile mechanical and electrical systems	Tom Denton & <u>Hayley Pells</u>	Routledge Publishers	3 rd edition, 2022
6	Automotive Electrics and Automotive Electronics	Robert Bosch GmbH	John Wiley & Sons	5th (2014)
7	Automotive Control Systems: For Engine, Driveline, and Vehicle	Uwe Kiencke and Lars Nielsen	Springer	2nd (2005)

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Automotive Technology: Principles, Diagnosis, and Service	James D. Halderman	Pearson	5th (2019)
2	Automotive Engineering: Powertrain, Chassis System and Vehicle Body	David Crolla	Butterworth-Heinemann	1st (2009)
3	The Internal Combustion Engine in Theory and Practice	Charles Fayette Taylor	MIT Press	2nd (1985)
4	Costs and Productivity in Automobile Production	Melvyn A. Fuss, Leonard Waverman,	Cambridge University Press	1, 2006
5	Automotive Lubricants Reference Book	Arthur J. Caines	SAE International	2nd (2004)
6	Automotive Transmissions and Transaxles	Thomas W. Birch	Pearson	5th (2018)
7	Automotive Suspension and Steering Systems	Thomas W. Birch	Pearson	5th (2018)
8	Understanding Automotive Electronics	William B. Ribbens	Butterworth-Heinemann	8th (2017)

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/107/106/107106088/ https://archive.nptel.ac.in/courses/112/103/112103262/
2	https://archive.nptel.ac.in/courses/107/106/107106088/ https://archive.nptel.ac.in/courses/112/102/112102014/
3	https://archive.nptel.ac.in/courses/107/106/107106088/ https://onlinecourses.nptel.ac.in/noc22_me96/preview
4	https://nptel.ac.in/courses/107106080 https://nptel.ac.in/courses/108102045

SEMESTER S7
DESIGN OF MACHINE ELEMENTS

Course Code	PEMET743	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PBMET604 Machine Design	Course Type	Theory

Course Objectives:

1. To develop a comprehensive understanding of the fundamental principles and theories involved in design.
2. To familiarize students with international standards and codes.
3. To teach the systematic approach to design.
4. To enable students to select appropriate materials based on mechanical properties.
5. To analyze and predict potential failure modes.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Design of Shafts: Design of Shafts Based on Bending Moment, Twisting Moment, Combined Bending & Twisting Moments, Axial Loads in Addition to Combined Torsional and Bending Loads, Rigidity and Stiffness.	7
2	Design of IC Engine parts: General design considerations, Design of cylinder and cylinder head, Design of piston and its parts, Design of connecting rod, Design of crankshaft. Design of Clutches: Design considerations, Friction clutches, Multiple disc clutches, Cone clutch, Centrifugal clutch. Design of Brakes: Block brake, band brake, band and block brake, internal expanding shoe brake.	9
3	Bearings and Lubrication: Introduction to lubrication, types of lubrication and lubricants viscosity, Design of journal bearings, Sommerfield Number, bearing materials, heat balance, bearing housing and mountings. Rolling contact bearings: Bearing types, Ball& roller bearings, Static and	8

	Dynamic load capacity, Equivalent dynamic load, Bearing life, Stribeck's equations, selection of bearings.	
4	Design of gears: Nomenclature: spur, helical, bevel and worm gears, gear materials, tooth loads, design stresses, basic tooth stresses, stress concentration, service factor, velocity factor, bending strength of gear tooth, Lewis equation and Lewis form factor. Working stress in gear teeth, Dynamic load and wear load on gear teeth, Buckingham's equation for dynamic load, surface strength and durability, design for strength and wear, Design of spur gear, Helical gear, bevel gear and worm gear.	12

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Model suitable transmission system for the stated conditions	K3
CO2	Make use of the design procedure for I C engine components	K3
CO3	Develop of Sliding contact bearing for industrial applications.	K3
CO4	Choose a suitable Rolling contact bearing from manufacturer's Catalogue for a specific application	K3
CO5	Model suitable spur or helical gear drive based on the industrial requirements.	K3
CO6	Apply the design procedure for bevel and worm gear drives for specific application.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	2	-	-	-	-	-	1
CO2	3	3	3	-	-	2	-	-	-	-	-	1
CO3	3	3	3	-	-	2	-	-	-	-	-	1
CO4	3	3	3	-	-	2	-	-	-	-	-	1
CO5	3	3	3	-	-	2	-	-	-	-	-	1
CO6	3	3	3	-	-	2	-	-	-	-	-	1

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Design of Machine Elements	V B Bhandari	McGraw Hill Education (India)	5th Edition, 2020
2	Machine Design – An Integrated Approach	R. L. Norton	Pearson Education	5th Edition, 2018
3	Design of Machine Elements II	Raghavendra K	CBS Publishers and Distributors Pvt Ltd	1 st Edition 2019
4	Machine Design	Dr P.C. Sharma Dr D.K. Agarwal	S.K. Kataria & Sons	2017
5	Machine Design Data Book	V B Bhandari	McGraw Hill Education (India) Private Limited	2 nd edition 2019
6	Design Data Hand Book	K. Mahadevan, K. Balaveera Reddy	CBS Publishers & Distributors	4 th Edition, 2019
7	PSG Design Data	PSG Tech	DPV Printers, Coimbatore	2022

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanical Engineering Design	J. E. Shigley	McGraw Hill	2003
2	Fundamentals of Machine Design, Volume 1, 2	Ajeet Singh	Cambridge University Press	1, 2022
3	Fundamentals of Machine Component Design	Juvinall R.C, Marshek K.M.	John Wiley	5th Edition 2011
4	Design of Machine Elements	M. F. Spotts, T. E. Shoup	Pearson Education	8th Edition 2019
5	Machine Elements: Life and Design	Boris M. Klebanov, David M. Barlam, Frederic E. Nystrom	CRC Press	2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/105/112105124/
2	https://archive.nptel.ac.in/courses/112/105/112105124/
3	https://archive.nptel.ac.in/courses/112/105/112105124/
4	https://archive.nptel.ac.in/courses/112/105/112105234/

SEMESTER S7
FAILURE ANALYSIS AND DESIGN

Course Code	PEMET744	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course Type	Theory

Course Objectives:

1. **Understand** the fundamental theories and modes of failure to prevent catastrophic failures in engineering materials.
2. **Apply** principles of fatigue loading, life prediction, and fracture mechanics to design against material failure under various conditions.
3. **Analyse** advanced failure mechanisms such as contact fatigue, high-temperature effects, and corrosion, integrating fracture mechanics principles for complex loading conditions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Failure Modes and Theories of Failure Identification of failure modes, Combined stresses, Theories of failure, Maximum Stress Theory, Maximum Strain Theory, von Mises Stress Theory, Material behaviour under different loading conditions, Failure mechanisms, Preventing catastrophic failures	9
2	Fatigue Loading and Life Prediction Fatigue loading, High cycle fatigue, Fatigue testing, S-N-P curves, Factors affecting S-N-P curves, Endurance diagrams, Cumulative damage, Life prediction, Fracture control, Fatigue design for combined stress.	9
3	Low Cycle Fatigue and Fracture Mechanics Low cycle fatigue, Cumulative damage in low cycle fatigue, Stress concentration factors, Notch sensitivity, Principles of fracture mechanics, Crack initiation, Crack propagation, Designing against fatigue and fracture,	9

	Application of fracture mechanics in design practice.	
4	Advanced Topics in Failure Analysis Contact fatigue, High-temperature effects, Corrosion, Shock and impact loading, designing for contact fatigue, Influence of high temperatures on material properties, Mechanisms of corrosion and prevention, Integration of fracture mechanics principles, Designing for complex loading conditions.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the different theories of failure and material behaviour under various loading conditions.	K2
CO2	Remember the factors affecting fatigue loading, S-N-P curves, and endurance diagrams for life prediction.	K1
CO3	Apply principles of fracture mechanics to analyse and design against crack initiation and propagation.	K3
CO4	Understand advanced failure mechanisms, including contact fatigue, high-temperature effects, and corrosion, and their impact on material properties and design.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	2	2	-	-	-	-	3
CO2	3	3	2	1	-	2	2	-	-	-	-	2
CO3	3	3	3	2	3	3	3	1	2	2	2	3
CO4	3	3	2	2	2	3	3	1	1	1	2	3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Materials 3– Materials Failure Analysis: Case Studies and Design Implications	Jones D. R. H	Pergamon Press	1993.
2	“Failure Analysis and Prevention”	ASM Handbook, Vol. 11	Edited by, ASM Publications	2002
3	Failure of Materials in Mechanical Design	Jack A. Collins	Wiley Inter science Publishers	2013., 2nd Edition
4	Elements of Fracture Mechanics	Prashant Kumar	Wheeler Publishing,	1999.

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/107/112107241/
2	https://archive.nptel.ac.in/content/storage2/courses/105108072/mod01/hyperlink-4.pdf
3	https://archive.nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_08_m.pdf
4	https://archive.nptel.ac.in/content/storage2/courses/113108051/module1/lecture1.pdf https://www.digimat.in/nptel/courses/video/113104082/L01.html

SEMESTER S7

LEAN MANUFACTURING

Course Code	PEMET746	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Students will be able to learn about lean manufacturing, types of industrial wastes associated and tools for eliminating the wastes.
2. Students will understand about the lean elements and identify those within industries.
3. Students can understand the concept of six sigma and agile manufacturing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction - History of Lean – Toyota Production System (TPS)- Ford Production System (FPS)- Principle of Lean Manufacturing- Seven Wastes, their causes and the effects- Conventional Manufacturing versus Lean Manufacturing	8
2	Tools of Lean manufacturing: 5-S, Workplace organization, Total Productive Maintenance, Process mapping/ Value stream mapping, Work cell, Cause and Effect diagram, Pareto chart, Spider chart, Poka yoke, Kanban, Automation, Single minute exchange of die (SMED), Just in time (JIT), Visual workplace, OEE	10
3	Lean elements: Introduction to Lean Concepts like In-Built Quality, Concept of Right Part at the Right Time, Lead Time reduction, Optimum utilization of Capital, Optimum utilization of People. Understanding the Zero-defect concept and Metrics, Focus on Human Resources, Quality and Delivery Cost. Building Zero defect capabilities, Cultural and Organizational aspects	8

4	Six Sigma Fundamentals: Introduction to six sigma- basic tools of six sigma like problem solving approach, standard deviation, normal distribution. DMAIV and DMADV. Agile Manufacturing: Agile manufacturing - Definition, business need, conceptual frame work, characteristics, and generic features -Approaches to enhance ability in manufacturing - Managing people in agile organization	10
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Course Assessment Method
(CIE: 40marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identify and understand the key concepts in lean manufacturing.	K1, K2
CO2	Select the lean manufacturing tools to find and eliminate wastes	K3
CO3	Identify and improve a manufacturing system by applying lean manufacturing principles and tools	K3
CO4	Understanding the key concepts of six sigma	K2
CO5	Identify the framework of agile manufacturing	K1, K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	3	3	3	3	3	2	3
CO2	1	-	-	-	-	2	3	2	3	3	2	3
CO3	1	-	-	-	-	3	3	2	3	3	2	3
CO4	1	-	-	-	-	3	3	2	3	3	2	3
CO5	1	-	-	-	-	3	3	2	3	3	2	3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Machine that Changed the World: The Story of Lean Production	James P. Womack, Daniel T. Jones, and Daniel Roos	Simon & Schuster	1996
2	Becoming Lean	Jeffrey K. Liker	Industrial Engineering and Management Press	1997
3	Demystifying six sigma: a company-wide approach to continuous improvement	Larson, Alan	Jaico, Mumbai	2007
4	Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities	S.R. Devadasan, V. Mohan Sivakumar, R. Muruges and PR Shalij	PHI Learning private Limited, New Delhi	2012
5	The Cambridge International Handbook of Lean Production	Thomas Janoski, Darina	Cambridge University Press	1, 2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Lean Thinking	James P. Womack and Daniel T. Jones	Free Press-Business and Economics	2003
2	Learning to See	Rother M. and Shook J	The Lean Enterprise Institute, Brookline	2003
3	Lean six sigma: combining six sigma quality with lean speed	George, Michael. L.	Tata McGraw Hill Education, New Delhi	2002
4	Lean Evolution	Nick Rich, Nicola Bateman,	Cambridge University Press	1, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/104/112104188/
2	https://archive.nptel.ac.in/courses/112/104/112104188/
3	https://archive.nptel.ac.in/courses/112/104/112104188/
4	https://archive.nptel.ac.in/courses/112/104/112104188/

SEMESTER S7
RELIABILITY ENGINEERING

Course Code	PEMET747	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3: 0: 0: 0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To induce an attitude towards reliability engineering in students which will ensure that they can identify steps to avoid failures in their future assignments.
2. To understand the basic principles of reliability engineering and its applications to various systems in engineering

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Reliability Concepts: Definition of reliability, Reliability vs. Quality, Reliability function, MTTF and MTBF, Hazard rate function, Bathtub curve, Derivation of the reliability function, Failure and Failure modes, Causes of Failures and Unreliability. Hazard Models: Constant hazard model, Linearly increasing hazard models, Weibull model. System Reliability: Series and parallel configurations, Combined series parallel systems, k-out-of-m systems, standby systems.	9
2	Redundancy Techniques in System design: Component and Unit redundancy, Weakest-link Technique, Mixed redundancy, Redundancy optimization. State - Dependant Systems: Markov analysis, Single and two independent components, Load sharing systems, Standby system, Degraded systems. Reliability Allocation: Equal, ARINC, and Proportional apportionments,	9

	AGREE method.	
3	System Analysis and Reliability Estimation: Fault tree analysis, Event tree analysis, FMEA and FMECA, Tie - set and Cut - set methods. Design for reliability: Load -Strength Interference and safety Margin Software reliability: Software errors; Fault Tolerance; Data Reliability; Hardware and Software Interfaces. Reliability prediction Standards: MIL 217 and NSWC Standards. Human reliability: Methods for Human Reliability Analysis. Economics of Reliability: Optimizing Reliability Cost`	9
4	Availability: Definitions and Basic Concepts; Inherent availability; Achieved availability; Operational availability; Availability of Series and Parallel Systems. Maintenance: Preventive, predictive and reliability cantered maintenances, Maintainability - Instantaneous Repair Rate and Maintainability Function, MTTR. Life Testing: Objectives and Types, Censoring; Accelerated Life Testing, HALT, HASS.	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain various modes of failure and basic concepts of reliability	K2
CO2	Identify methods for reliability prediction according to system characteristics	K3
CO3	Develop ability in formulating suitable strategies to enhance reliability of a manufacturing system.	K3
CO4	Explain relation between reliability, availability and maintainability	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

[illegible]

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Reliability Engineering	Balagurusamy	McGraw Hill Education	17th Reprint, 2017
2	Quality and Reliability in Engineering	<u>Tirupathi R. Chandrupatla</u>	Cambridge University Press	1, 2009
3	Concepts of Reliability Engineering	L.S. Srinath,	Affiliated East-West Press	4th Edition, 2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	An introduction to Reliability and Maintainability Engineering	Ebling C. E.	Tata McGraw Hill	12th Edition, 2004.
2	Reliability Engineering and Life Testing	Naikan V. N. A.	PHI	1st Edition, 2008
3	Introduction to Reliability Engineering	Lewis E. E.	Wiley India	2nd Edition, 2012
4	Engineering Reliability	Richard E. Barlow	Cambridge University Press	1, 1998

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/127/105/127105234/
2	https://archive.nptel.ac.in/courses/127/105/127105234/
3	https://archive.nptel.ac.in/courses/127/105/127105234/
4	https://archive.nptel.ac.in/courses/127/105/127105234/

SEMESTER S7

ROBOTICS

Course Code	PEMET748	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. This course helps the student to the basic idea of Robots. Students are introduced to the basic design considerations of robots.
2. Concepts like trajectory planning and obstacle avoidance and kinematics of robots are introduced.
3. Discussion on various mobile robots and robotic manipulators are also included as part of the course to get an overall idea on robotics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Definitions- Robots, Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom; Robot configurations-PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots. Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in the robot.	9
2	Direct Kinematics- Rotations-Fundamental and composite Rotations, Homogeneous coordinates, Translations and rotations, Composite homogeneous transformations, Screw transformations, Kinematic parameters, The Denavit-Hartenberg (D-H) representation, The arm equation, direct kinematics problems (up to 3DOF). Inverse kinematics-general properties of solutions and problems (up to 3DOF).	10

	Inverse kinematics of 3DOF manipulator with concurrent wrist (demo/assignment only). Tool configuration Jacobian, relation between joint and end effector velocities.	
3	Manipulator Dynamics: Lagrange's formulation – Kinetic Energy expression, velocity Jacobian and Potential Energy expression, Generalised force, Euler-Lagrange equation, Dynamic model of planar and spatial serial robots up to 2 DOF, modelling including motor and gearbox.	8
4	Trajectory Planning. Joint space trajectory planning- cubic polynomial, linear trajectory with parabolic blends, trajectory planning with via points; Cartesian space planning, point-to-point vs. continuous path planning. Obstacle avoidance methods- Artificial Potential field, A* algorithms. Robot Control: The control problem, Single axis PID control-its disadvantages, PD gravity control, computed torque control	9

**Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Robotics – Analysis and Control	Robert. J. Schilling	Prentice Hall of India	1996
2	Introduction to Robotics (Mechanics and Control)	John. J. Craig	Pearson Education Asia	2002
3	Introduction to Robotics	S K Saha,	McGraw Hill Education	
4	Robotics and Control	R K Mittal	Tata McGraw Hill, New Delhi	2003
5	Robotics-Fundamental concepts and analysis	Ashitava Ghosal	Oxford University Press	
6	Modern Robotics Mechanics Planning and Control	Kevin M. Lynch, Frank.C.Park	Cambridge University Press	1, 2017
7	Statics and Kinematics with Application to Robotics	Joseph Duffy	Cambridge University Press	1, 2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook of Robotics	Siciliano, Khatib	Springer	
2	, Introduction to Robotics – Mechanics and Control	John J. Craig		
3	Modern Robotics Mechanics, Planning and Control	. Kevin M. Lynch, Frank C. Park,		
4	Robotics Modelling, Planning and Control	Bruno Siciliano, Lorenzo Sciacivico, Luigi Villani, Giuseppe Oriolo	Springer	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/105/112105249/
2	https://archive.nptel.ac.in/courses/112/105/112105249/
3	https://archive.nptel.ac.in/courses/112/105/112105249/
4	https://archive.nptel.ac.in/courses/112/105/112105249/

SEMESTER S7
MECHATRONICS

Course Code	PEMET745	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course Type	Theory

Course Objectives:

1. To introduce the students to the concepts of mechatronics
2. To understand behaviour of sensors and actuators.
3. To understand different controllers for mechatronic systems and program them.
4. To review typical case studies involving mechatronics and appreciate the mechatronic system design process.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Sensors and signal conditioning: Introduction to Mechatronics: Structure of Mechatronics system. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute, gray coded encoder. Piezoelectric sensors. Acoustic Emission sensors. Principle and types of vibration sensors. Signalconditioning, need and methods. Op amp configurations. Current/Resistance/reactance to voltage circuits, bridge circuits applications. ADC and DAC circuits. Basics of sampling theorem.	9
2	Actuators: Mechanical actuators, Electrical actuators, Hydraulic and Pneumatic actuators. Basic mechanical elements: guide ways, drives. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws, pre-loading methods. Re-circulating roller screws. Pneumatics and hydraulics. Directional control valves, pressure control valves, process control valves. Rotary actuators.	9

	Development of simple hydraulic and pneumatic circuits using standard Symbols. Electric motors, ac, dc, bldc and stepper motors, torque-speed characteristics	
3	Control of mechanical systems: System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Microcontrollers and architecture. Use of microcontrollers for mechatronic applications Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of ladder programs for specific purposes.	9
4	Modern mechatronic systems: Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope. MEMs devices for biomedical applications. Mechatronics in automobiles. Sensors ECU, ABS, Cruise control. Mechatronics in robotics, sensors and drives for robots.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the characteristics and working of sensors and choose the optimal one based on the application	K2
CO2	Understand the characteristics and working of actuators and choose the optimal one based on the application	K2
CO3	Understand the basics of mathematical modelling of the given real systems and to predicts its behaviour	K2
CO4	Understand the use of PLC for industrial and product automation and to create ladder programs for applications	K3
CO5	Understand the use and characteristics of microcontrollers and choose the appropriate one based on the given application	K3
CO6	Understand the characteristics of MEMs devices and incorporate them in mechatronic applications	K2
CO7	Understand the use of mechatronic concepts in modern applications.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	-	-	-	-	-	-	-	-	1
CO2	2	1	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	-	-	-	-	-	-	-	2
CO4	1	-	-	-	-	-	-	-	-	-	1	1
CO5	2	-	-	-	-	-	-	-	-	-	-	2
CO6	1	1	-	-	-	-	-	-	-	-	-	1
CO7	1	2	-	-	-	-	-	-	-	-	-	1

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering	W. Bolton	Pearson	7th
2	Mechatronics: Principles and Applications	Godfrey C. Onwubolu	Elsevier	
3	Mechatronics System Design	DevdasShetty, Richard Kolk	PWS Pub	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Text Book of Mechatronics	R.K. Rajput	S. Chanth	First edition 2007

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/107/112107298/
2	https://archive.nptel.ac.in/courses/112/107/112107298/
3	https://archive.nptel.ac.in/courses/112/107/112107298/
4	https://archive.nptel.ac.in/courses/112/107/112107298/

SEMESTER S7

REFRIGERATION AND AIRCONDITIONING

Course Code	PEMET751	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET403 Engineering Thermodynamics	Course Type	Theory

Course Objectives:

1. To master fundamental principles and applications of Refrigeration and Air Conditioning
2. To develop proficiency in thermodynamic analysis and understanding of components:

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to refrigeration and air conditioning, ideal refrigeration cycles, Aircraft refrigeration cycles. Definition of refrigeration and air conditioning, Relationship of refrigeration and air-conditioning fields, Applications of refrigeration and air-conditioning, unit of refrigeration. Ideal refrigeration cycle- Reversed Carnot cycle, refrigerator and heat pump, coefficient of performance (COP) , Gas and Vapour as refrigerant in reversed Carnot cycle, Revisions of the reversed Carnot cycle- reversed Brayton cycle and simple vapour compression refrigeration cycle. Simple aircraft refrigeration system with ram compression, Boot strap refrigeration system, Regenerative and Reduced ambient systems	9

2	Thermodynamic analysis of vapour compression and vapour absorption refrigeration systems. Simple vapour compression refrigeration system, representation of the cycle on T-s and P-h diagram, Use of refrigerant tables and charts, Effect of operating on COP suction line heat exchanger, actual vapour compression refrigeration system. Limitation of single stage refrigeration systems in achieving ultra-low temperature. Cascade refrigeration system and Trans-critical refrigeration system (Numerical Problems to be limited to Refrigerants R134a, R32, R1234yf, R410A, R744, R718, R744) Principle of vapour absorption system, desirable properties of refrigerant and absorbent pairs, Working of continuous vapour absorption system, ideal COP of absorption system, LiBr-Water absorption system, NH₃-Water absorption system, Use of charts to calculate the performance of vapour absorption refrigeration system (Numerical problem limited to LiBr-Water absorption system), Comparison of vapour absorption and vapour compression system. Three fluid absorption system.	9
3	Refrigerants and refrigeration system components Types of refrigerants, designation of refrigerants, Ozone depletion and Global warming, commonly used refrigerants- HFC, HC,HFO and mixed refrigerants, desirable physical, chemical and thermodynamic properties of refrigerants. Types of expansion devices – Constant pressure valve-Thermostatic expansion valve and capillary tube, Electronic Expansion valves. Types of compressors in refrigeration systems, Types of evaporators and condensers, Cooling towers.	9
4	Psychrometry and applied psychrometry Properties of moist air- specific humidity. Dew point temperature, Relative humidity, Enthalpy of moist air, wet bulb and thermodynamic wet bulb temperatures, Psychrometric chart, Typical air conditioning processes, Air washer, sensible heat factor, grand sensible heat factor, effective sensible heat factor, Simple air conditioning system, Summer air-conditioning system, Winter air-conditioning system, year round air-conditioning systems – Representation on the Psychrometric chart and estimation of quantities.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Define and describe the basic concepts and applications of refrigeration and air conditioning and analyse performance of ideal refrigeration cycles	K2, K4
CO2	Explain the principles and evaluate the efficiency of aircraft refrigeration systems,	K2, K5
CO3	Perform Thermodynamic Analysis of Vapour Compression and Absorption Systems.	K3, K4
CO4	Explain and Select Appropriate Refrigerants and System Components	K2. K3
CO5	Analyse properties of moist air using psychrometric principles and chart and explain the working principles and applications of air washers and air-conditioning systems.	K2, K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	-	-	-	-	-	-	-	2
CO2	3	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2
CO4	3	2	1	-	-	-	2	-	-	-	-	2
CO5	3	3	2	-	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Refrigeration and Air Conditioning	Arora C.P	Tata McGraw hill	4 th edition/2021
2	Refrigeration and Air Conditioning	Ramesh Cahndra Arora	PHI	4 th Printing/2015
3	A Course in Refrigeration and Air Conditioning	Arora S. C. and S. Domkundwar	Dhanpat Rai and Company.	2018
4	Refrigeration and air conditioning -	Ahamadul Ameen.	Eastern economy addition	2020
5	Air Conditioning Engineering	W P Jones	Spon Press	5 th edition/ 2001
6	Data book- Refrigeration tables and charts including air conditioning data	C P Kothandaraman	New Age International.	2023

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	ASHRAE Handbook	The American Society of Heating, Refrigerating and Air-Conditioning Engineers		
2	Basic Refrigeration and Air Conditioning	P NAnanthanarayanan	McGraw Hill	4 th Edition 2013
3	Refrigeration & Air-conditioning	Stoecker & Jons	McGraw Hill	2 nd edition

Video Links (NPTEL, SWAYAM...)		
Module No.	Link ID	
1	Refrigeration and Air-conditioning By Prof. Ravi Kumar	IIT Roorkee
2	Refrigeration and Air-conditioning By Prof. Ravi Kumar	IIT Roorkee
3	Refrigeration and Air-conditioning By Prof. Ravi Kumar	IIT Roorkee
4	Refrigeration and Air-conditioning By Prof. Ravi Kumar	IIT Roorkee

SEMESTER S7

ACOUSTICS AND NOISE CONTROL

Course Code	PEMET752	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the acoustics principle
2. To give awareness about different acoustic measurement devices
3. To bring importance to noise control

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Acoustics, sound and noise, generation of sound, Acoustic pressure, Puretone and rms values, speed of sound, frequency, wavelength, period, relation between them; Particle velocity; Acoustic impedance; Acoustic power and intensity, Inverse square law; Acoustic energy density; Spectrum, frequency bands and octave. Development of Acoustic wave equation, plane wave equation and D-Alembert's solution, Helmholtz equation(frequency-domain); plane waves and spherical waves Levels, decibel, sound pressure level, sound power level, and sound intensity level. Addition, subtraction, and averaging of decibel.	10
2	Point source, spherical source, Line source, Monopole, dipole; Lateral and longitudinal quadrupole; Array of N sources and continuous line array of sources; baffled piston, Near-and far-field spectrum; Directivity: Directivity pattern; Beam width; Directivity factor and directivity index. Sound transmission: Transmission through two media-Normal and oblique incidence; Transmission and reflection coefficients (pressure, intensity and power), transmission loss; Absorption coefficient Sound propagation in open or a closed tube; Standing waves	10
3	Ear its structure and function; Subjective and objective assessment of	10

	sound; Hearing threshold ; Octave band analysis ; Sound level frequency weightings; Equivalent sound level ; Loudness; Equal loudness contours ; Phones and sones ; Hearing loss; Masking Speech interference level; Perceived noise level; Noise and number index; Need for noise criteria, regulations and standards; NC, PNC, and NCB curves; Noise dose; Industrial noise criteria (OSHA standards). Microphones-principle and types; Sound level meters; Sound intensity probes; Dosimeters; Sound measurement in anechoic and reverberation chambers; Measurement of directivity factor.	
4	Noise control at source; Control during transmission; Control at Receiver; Causes of noise and noise control in pumps, compressors, fans, Electric motor, Cooling towers. Acoustical closures; Barriers; and absorbers-porous, fibrous, foams, resonance; Acoustic filters; Helmholtz resonator; Plenum chamber. Mufflers- active and passive-reactive and dissipative; Transmission loss and design procedure for Expansion Chamber Mufflers.	6

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To define various acoustic terminologies and understand the physics behind acoustic wave propagation	K2
CO2	To analyse the transmission of sound through different media and tubes	K4
CO3	To understand the mechanism of hearing, noise regulations and noise measuring devices	K2
CO4	To explain various noise reducing measures	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					3				3		3
CO2	3	3		3		3				3		3
CO3	3		3			3	3			3		3
CO4	3	3	3	3		3	3			3		3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Noise and vibration control engineering	Istvan L. Ver and Leo L. Beranek	Wiley	Second edition, 2006
2	Fundamentals of Acoustics	Lawrence E Kinsler, Austin R Frey, Alan B Coppers, James V Sanders	Wiley	Fourth edition, 2000

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Noise and Vibration Control	M L Munjal	World Scientific publishing	2013
2	Handbook of Noise and Vibration Control	Malcom J Crocker	Wiley	2007
3	Industrial Noise Control and Acoustics	Randall F. Barron	Marcel Dekker, Inc., New York.	2001
4	Mechanical Vibrations and Industrial Noise Control	Lasithan L G	PHI Learning	2014

SEMESTER S7

AEROSPACE ENGINEERING

Course Code	PEMET753	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understanding Atmospheric and Aerodynamic Fundamentals
2. Analysing 3D Aerofoils and Wing Performance
3. Evaluating Aircraft Performance and Flight Dynamics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	The atmosphere - characteristics of troposphere, stratosphere, thermosphere, and ionosphere - pressure, temperature and density variations in the atmosphere.	9
2	2D aero foils -Nomenclature and classification- pressure distribution in inviscid and real flows- momentum and circulation theory of aero foil- characteristics	9
3	3D or finite aero foils — effect of releasing the wingtips- wing tip vortices- replacement of finite wing by horseshoe vortex system, lifting line theory- wing load distribution — aspect ratio, induced drag calculation of induced drag from momentum considerations. Skin friction and from drag- changes in finite wing plan shape	9
4	Propellers — momentum and blade element theories —propeller coefficients and charts. Aircraft performance-straight and level flight —power required and power available graphs for propeller and jet aircraft. Gliding and climbing —rate of climb-service and absolute ceilings-gliding angle and speed of flattest glide, take-off and landing performance — length of runway required- aircraft ground run- circling flight — radius of tightest turn-jet and rocket assisted take —off, high lift devices-range and endurance of airplanes-charts for piston and jet engine aircrafts	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the characteristics of the atmosphere and understand the Theory of 2D Aerofoils.	K2
CO2	Evaluate the effects of wingtip vortices on 3D Aerofoils, calculate induced drag using lifting line theory, and understand the impact of finite wing plan shapes on aerodynamic performance.	K2
CO3	Assess aircraft performance metrics such as power requirements, rate of climb, service ceilings, and gliding angles, and apply this knowledge to both propeller and jet aircraft.	K3
CO4	Explain the principles and functions of essential flight instruments, including airspeed indicators, altimeters, and gyroscopic instruments, and perform basic calculations such as true airspeed.	K2
CO5	Gain a qualitative understanding of aircraft stability and control, including static and dynamic stability, and the aerodynamic and mass balancing of control surfaces.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	-
CO3	3	2	-	-	1	-	-	-	-	-	-	-
CO4	3	-	-	-	1	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics Of Flight	A. C. Kermode, Revised By R.H. Barnard & D.R. Philpott	Pearson Prentice Hall	11th Edition, 2006
2	Fundamentals Of Aerodynamics	John D. Anderson	McGraw-Hill	6th Edition, 2017
3	Aircraft Instruments and Integrated Systems	E. H. J. Pallett	Pearson Prentice Hall	3rd Edition, 1992
4	Introduction to Flight	John D. Anderson	McGraw-Hill	6th Edition, 2008
5	Fundamentals of Aerospace Navigation and Guidance	Pierre T. Kabamba	Cambridge University Press	1, 2014

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aerodynamics for Engineering Students	E.L. Houghton, P.W. Carpenter, Steven H. Collicott, Daniel T. Valentine	Elsevier Science	6th Edition, 2012
2	Plasma Dynamics for Aerospace Engineering	Joseph J. S. Shang	Cambridge University Press	1, 2028

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod01lec02.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod01lec03.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod05lec22.mp4
2	https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod05lec24.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod05lec26.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod05lec28.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod06lec33.mp4
3	https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod08lec41.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod09lec45.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod09lec46.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod09lec47.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod09lec48.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod11lec61.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod11lec62.mp4 https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod11lec63.mp4
4	https://archive.nptel.ac.in/content/storage2/101/101/101101079/MP4/mod10lec51.mp4

SEMESTER S7

RENEWABLE ENERGY ENGINEERING

Course Code	PEMET754	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understanding commercial energy sources and alternatives
2. Applying the fundamentals of heat transfer in solar energy systems
3. Obtaining knowledge about energy from wind, small hydroelectric projects, ocean, biomass, hydrogen and hybrid systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Commercial energy sources -World's production and reserves-India' Production and reserves, Energy Alternatives Principles of solar radiation: Solar radiation outside the earth's atmosphere and at the earth's surface Solar Constant, Basic Sun-Earth Angles, Instruments for measuring solar radiation and sunshine	9
2	Solar Energy collectors: Solar thermal collectors -Flat plate collectors – Solar concentrators (Tracking concentrators and Non-tracking concentrators) Solar Energy Storage Systems –Solar thermal power plant - Principle and operation of Solar Pond Applications – Solar Photovoltaic system, Solar water heating, Solar Air heating, Solar crop drying, Solar distillation	9
3	Wind Energy –Classification of wind turbines – Types of rotors – Land for wind energy (regions, areas and khals) – Modes of wind power generation (Standalone mode, backup mode and Grid connected wind turbine generators)	9

	Small Hydel power plants – classification and advantages	
4	Energy from ocean – Tidal power generation – Wave power generation Bio Mass Energy- Biomass conversion technologies –Bio Gasification, Bio ethanol, Bio Diesel, Biogas production from waste biomass, factors affecting biogas generation Hydrogen Energy – various routes for production of Hydrogen energy Hybrid Energy Systems – PV hybrid with diesel generator – Wind – diesel hybrid system –Biomass – Solar thermal hybrid system	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Differentiate between commercial energy systems and alternatives	K2
CO2	Obtain a detailed knowledge in solar energy implementation for collection, conversion and storage	K2
CO3	Understand the possibilities of wind energy and small hydel power plants	K2
CO4	Gain knowledge about tidal and wave energy, energy from biomass and hydrogen	K2
CO5	Understand about the energy alternatives by hybrid system	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	--	--	--	--	--	--	--	--	2
CO2	3	2	2	2	--	--	--	--	--	--	--	--
CO3	3	2	--	--	2	--	--	--	--	--	--	--
CO4	3	--	--	--	2	--	--	--	--	--	--	--
CO5	3	2	2	--	--	--	--	--	--	--	--	--

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Renewable Energy Resources	John Twidell, Tony Weir	Taylor and Francis	3rd Edn, 2015
2	Renewable Energy Sources and Emerging Technologies	D P Kothari, K C Singal, Rakesh Ranjan	PHI Learning Pvt. Ltd.	2nd Edn, 2014
3	Non-conventional Energy Sources	G D Rai	Khanna Publishers	2004
4	Solar Energy: Principles of Thermal Collection and			

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Sustainable Energy Choosing among options	Jefferson W Tester	PHI Learning Pvt. Ltd.	2006
2	Fundamentals and Applications of Renewable EnergyMc Graw Hill ,2019	Mehmet KanoğluYunus A. Çengel John M. Cimbala	Mc Graw Hill	2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	NOC Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems (nptel.ac.in)
2	NOC Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems (nptel.ac.in)
3	NOC Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems (nptel.ac.in)
4	NOC Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems (nptel.ac.in)

SEMESTER S7

MOBILE ROBOTICS

Course Code	PEMET756	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course Type	Theory

Course Objectives:

1. Providing a foundation to the theory behind numerical computation and optimization techniques used in robotic systems
2. This course will equip the students with mathematical framework for the robotic systems and optimization techniques necessary for mobile robotic systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Wheeled Mobile Robots, Wheeled locomotion: The design space, wheeled locomotion: Case studies. Mobile manipulators, Legged Mobile Robots- Leg configurations and stability, Examples of legged robot locomotion, aerial robots, underwater robots and surface water robots	8
2	Kinematic model: of a differential drive and a steered mobile robot, degree of freedom and maneuverability, Degree of steerability, different wheel configurations, holonomic and non-holonomic robots. Dynamics of mobile robot: Lagrange-Euler method, Newton-Euler methods, Differential-Drive WMR, Dynamics of WMR with Slip, Car-Like WMR Dynamic Model, Three-Wheel Omnidirectional Mobile Robot	10
3	Sensors for mobile robot navigation: Sensor classification, Characterizing sensor performance, Wheel /motor sensors, Heading sensors, Accelerometers, IMUs, Ground-based beacons, Active ranging, Motion/speed sensors, and Vision-based sensors. Robot navigation: Localization, Error propagation model, Probabilistic map-	9

	based localisation-Kalman method, Autonomous map building, Simultaneous localization and mapping (SLAM).	
4	Path Planning: local vs global path planning, Graph search, Potential field-based path planning; Map based path planning- Dijkstra's algorithm, A*, D* algorithms. Obstacle avoidance- Bug algorithm, Vector field histogram, Dynamic window approach. Control of mobile robots: Control of differential drive robot and steered robot based on its kinematic model, Case study- design and implementation of a differential drive robot capable of moving to a point, following a line and following a path.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Familiarise types of locomotion for mobile Robots	K2
CO2	Derive the kinematic model of mobile robots	K4
CO3	Derive dynamic model of mobile robots	K4
CO4	Choose appropriate Sensors for mobile robot navigation	K3
CO5	Perform navigation and path planning mobile robots	K3
CO6	Control the mobile robots to follow different paths	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	3	3	2	-	-	-	-	-	3
CO2	3	-	3	3	3	2	-	-	-	-	-	3
CO3	3	-	3	3	3	2	-	-	-	-	-	3
CO4	3	-	3	3	3	2	-	-	-	-	-	3
CO5	3	-	3	3	3	2	-	-	-	-	-	3
CO6	3	-	3	3	3	2	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Autonomous Mobile Robots	R. Siegwart, I. R. Nourbakhsh,	The MIT Press,	2011
2	Robotics, Vision and Control: Fundamental Algorithms in MATLAB,	Peter Corke,	Springer Tracts in Advanced Robotics	2011
3	Introduction to Mobile Robot Control,	Spyros G. Tzafestas	Elsevier.	
4	Planning Algorithms	S. M. La Valle	Cambridge University Press	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probabilistic Robotics.	Thrun, S., Burgard, W., and Fox, D.,	MIT Press, Cambridge, MA,	2005
2	Arduino and Kinect Projects: Design, Build	Melgar, E. R., Diez, C. C	Blow Their Minds,.	2012
3	Introduction to Autonomous Mobile Robots	Siegwart, Roland,	Cambridge, Mass.: MIT Press,	Second Edition,

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/106/112106298/
2	https://archive.nptel.ac.in/courses/112/106/112106298/
3	https://archive.nptel.ac.in/courses/112/106/112106298/
4	https://archive.nptel.ac.in/courses/112/106/112106298/

SEMESTER S7

FLEXIBLE MANUFACTURING SYSTEMS

Course Code	PEMET757	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course Type	Theory

Course Objectives:

1. Understand the basic components, layout configurations, and functions of Flexible Manufacturing Systems (FMS).

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Evolution of FMS, Basic Components of FMS, Types of FMS Layouts, -Inline layout, loop layout, loader layout, open field layout, robot configured layout, general FMS considerations, functions of FMS, FMS Justification, Cell/FMS Justification Flow chart.	9
2	Manufacturing cells: Introduction, Classification of manufacturing Cells- FMS Unattended Machining- Features and Requirement, Toyota Production System (TPS), Group technology- Part Classification and Coding, Production Flow Analysis. Machining Center- Types, Axes and Format Information, Automated Features and Capabilities of Machining Center, Cellular Vs Flexible manufacturing.	9
3	Computer aided programme generation & Product Manufacturing, Automated Material Movement and Storage System- Automated Storage and Retrieval Systems (AS/RS), Industrial Robots, Cutting Tools and Tool Management- Tool Preset, Identification and Data Transfer.	9
4	FMS Planning: CAD Considerations FMS planning, CAM Considerations for FMS planning. FMS Software Structure- General Structure and Requirements, Types of FMS Software Modules, FMS installation and	9

	implementation- System Installation, acceptance testing.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic components, layout configurations, and functions of Flexible Manufacturing Systems (FMS).	K2
CO2	Remember the classification of manufacturing cells, features and requirements of unattended machining, and principles of the Toyota Production System (TPS).	K1
CO3	Apply the knowledge of CAD and CAM considerations in planning and implementing FMS.	K3
CO4	Understand the automated material movement, storage systems, and tool management in FMS operations.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	2	1	1	-	-	-	-	2
CO2	3	3	2	2	-	2	1	-	-	-	-	2
CO3	3	3	3	2	3	2	2	1	2	2	2	3
CO4	3	2	2	2	3	2	2	1	2	2	2	3

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flexible Manufacturing System	Shivanand H.K., Benal MM, Koti V	New age international (P) Limited, New Delhi	2006
2	Flexible Manufacturing Cells and System	William W Luggen	Prentice Hall of Inc New Jersey	1991
3	Flexible Manufacturing system	Reza A Maleki	Prentice Hall of Inc New Jersey	1991
4	Flexible Manufacturing	. John E Lenz D. Eppinger	marcel Dekker Inc New York	1989

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Manufacturing Engineering and Technology	Kalpakjin	Addison Wesley Publishing	1995
2	Automation, Production Systems and Computer Integrated Manufacturing"	Mikell P. Groover	PHI,	2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/110/106/110106044/
2	https://archive.nptel.ac.in/courses/110/106/110106044/
3	https://archive.nptel.ac.in/courses/110/106/110106044/
4	https://archive.nptel.ac.in/courses/110/106/110106044/

SEMESTER S7

QUALITY ENGINEERING AND MANAGEMENT

Course Code	PEMET758	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To impart knowledge on principles and practices of quality engineering and management.
2. To enable use of various tools and techniques for continuous quality improvement.
3. To provide ideas on implementation of quality standards

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Quality Management - Definitions of quality, Dimensions of Quality, Concepts of Product and Service Quality, Evolution of Quality Management, quality control, quality assurance, quality planning, quality management, Total Quality Management (TQM)- he TQM axioms - Consequences of total quality- Barriers to TQM, Deming approach, Juran's quality trilogy, Crosby's fourteen steps for quality improvement.	9
2	Human dimensions of TQM – Top management commitment- Leadership for TQM- Change management- resources for quality activities - Training for quality –Employee involvement, motivation, empowerment- teamwork- self managing teams - Role of the quality director-Quality System: ISO 9000 family of standards. Quality auditing- types and benefits.	9
3	Tools and Techniques in TQM: Affinity diagram -brainstorming - cause and effect analysis - process flow chart – check sheets- Scatter diagram - Pareto chart- Histogram. Quality control and Inspection, Fundamentals of statistics, accuracy and precision, causes of variation in quality, Statistical Process Control, control charts, $\bar{x}$ and R chart problems, process capability, Acceptance sampling.	9

4	Strategic Quality Management: Integrating quality into strategic management - obstacles to achieving successful strategic quality management-Cost of Quality-Customer satisfaction. Quality Function Deployment (QFD), Failure Mode and Effect Analysis, Analysis of Variance (ANOVA), Design and Analysis of Experiments (DOE), Concepts of 5S, Kaizen, Six Sigma, Total Productive Maintenance.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop knowledge of quality management and contributions of quality gurus.	K2
CO2	Identify various human dimensions of TQM	K2
CO3	Implement different tools and techniques in TQM	K3
CO4	Implement different statistical quality control techniques	K3
CO5	Demonstrate knowledge of the underlying principles of strategic quality management	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	2	-	-	-	-	-	-
CO2	3	-	-	-	-	2	-	-	2	-	-	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-
CO4	2	3	2	-	-	-	-	-	-	-	-	-
CO5	2	3	2	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Total Quality Management(TQM)	B esterfield D. H. , BesterfieldC, Besterfield G. H., Besterfield M, U. Hemant, U.Rashmi	Pearson Education	Fifth Edition, 2018
2	Total Quality Management	SubburajRamasamy	Tata McGraw Hill Education	First Edition, 2017
3	Introduction to Statistical Quality Control	D. C. Montgomery	John Wiley & Sons	Third Edition
4	Fundamentals of Quality Control and Improvement	Mitra A.	PHI	Second Edition, 1998

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Design and Analysis of Experiments	D. C. Montgomery	John Wiley & Sons	6thEdition,2004
2	Quality Planning and Analysis - From Product Development through Use	Juran J M and Gryna, F M	Tata McGraw Hill Publishing Limited, New Delhi	Third Edition, 2004
3	Quality is Free	Crosby P B	McGraw Hill	New York, 1979

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/110105088
2	https://nptel.ac.in/courses/110101010
3	https://nptel.ac.in/courses/110101010
4	https://nptel.ac.in/courses/110101010

SEMESTER S7

OPTIMIZATION TECHNIQUES

Course Code	PEMET755	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Formulate and classify different optimization problems.
2. Apply classical, numerical and modern methods for solving optimization problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Engineering applications of optimization, Formulation of design problems as mathematical programming problems. Classification of optimization problems/techniques. Classical optimization: unconstrained single and multivariate optimization, Constrained optimization. Linear, Mathematical formulation of LP Problems, Solving using Simplex method and Graphical method.	9
2	Game Theory: Introduction, 2- person zero – sum game -Saddle point; Mini-Max and Maxi-Min Theorems (statement only)- Graphical solution (2x n, m x 2 game), dominance property. Introduction to network tree - Minimal Spanning Tree - Prim's Algorithm. Shortest path problems- Solution methods – Dijkstra's Method.	9
3	Single variable optimization methods- Fibonacci search method, Newton Raphson method Multi-variable methods- Hook-Jeeves pattern search method, Cauchy's	9

	(steepest descent) method	
4	Introduction to Genetic algorithm, Basic GA framework, GA operators: Encoding, Crossover, Selection, Mutation Introduction to Fuzzy logic. Fuzzy sets and membership functions. Operations on Fuzzy sets. Optimization of Fuzzy Systems.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Formulate the real world problem as Linear Programming Problem	K4
CO2	Apply different methods of Game Theory, Network Tree and Shortest Path.	K3
CO3	Find solutions for Nonlinear unconstrained optimization problems	K3
CO4	Apply modern methods of optimization for solving optimization problems.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Optimization : Theory and Practice	S.S.Rao	New Age International Publishers, New Delhi	Revised 3rd Edition 2011
2	Operations Research	H.A. Taha	Pearson	Eight Edition 2006

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Operations Research	Kanti Swarup, P.K.Gupta and Man Mohan	Sultan Chand and Sons	20 th Revised Edition 2022
2	Optimization for Engineering Design- Algorithms and Examples	Kalynamoy Deb.	Prentice-Hall of India Pvt. Ltd., New Delhi	2 nd Edition 2012
3	Operations Research – Principles andPractice	A. Ravindran, D. T. Phillips, J. J. Solberg	John Wiley and Sons.	2 nd Edition 2007

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1-4	https://archive.nptel.ac.in/courses/111/105/111105039/

SEMESTER S7

ENGINEERING MATERIALS

Course Code	OEMET721	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NA	Course Type	Theory

Course Objectives:

1. To provide a comprehensive understanding of the classification, structure, and properties of different engineering materials, including metals, ceramics, polymers, and composites.
2. To develop the ability to select metals and their alloys for specific engineering applications based on their properties and performance requirements.
3. To introduce polymeric, ceramic, and composite materials, and discuss their unique properties, synthesis methods, and applications in modern engineering.
4. To develop the ability to select appropriate materials for specific engineering applications based on their properties and performance requirements.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Engineering Materials: Overview of Engineering Materials: Definition and Classification, Importance in Engineering Design. Material Properties; Mechanical Properties: Strength, Toughness, Ductility, Hardness. Thermal Properties: Conductivity, Expansion, Heat Capacity, Electrical and Magnetic Properties. Material Selection Criteria: Factors Influencing Material Selection, Case Studies in Material Selection Material Testing and Standards: Overview of Material Testing Methods, Introduction to ASTM, ISO, and other relevant standards Material Processing: Basic Processing Techniques: Casting, Forging, Machining, Introduction to Manufacturing Processes: Additive Manufacturing, Powder Metallurgy.	11

2	Introduction to Metals: Types of Metals: Ferrous and Non-Ferrous, Crystal Structures and Properties. Steel and Its Alloys: Composition and Heat Treatment, Types of Steel: Carbon Steel, Alloy Steel, Stainless Steel. Non-Ferrous Metals and Alloys: Aluminum, Copper, Titanium, Nickel Alloys. Applications and Properties, Corrosion and Protection: Mechanisms of Corrosion, Methods of Corrosion Control and Prevention	9
3	Polymers and Composites Introduction to Polymers: Types of Polymers: Thermoplastics, Thermosets, Elastomers, polymerization Methods. Properties and Applications of Polymers: Mechanical and Thermal Properties, Case Studies in Polymer Applications Composite Materials: Definition and Types of Composites, Fiber-Reinforced Composites: Properties and Applications, Manufacturing Techniques Ceramics and Glasses Introduction to Ceramics: Types of Ceramics: Traditional and Advanced Ceramics. Properties: Hardness, Brittleness, Wear Resistance Processing of Ceramics. Methods of Shaping and Sintering, Glazing and Surface Treatments Glasses: Types of Glasses: Soda-Lime, Borosilicate, Specialty Glasses, Properties and Applications, Applications in Engineering Structural Ceramics Electronic and Optical Ceramics	10
4	Material Testing and Characterization Mechanical Testing Methods: Tensile, Compression, Impact, and Fatigue Testing, Microscopy and Surface Analysis, Optical Microscopy, Scanning Electron Microscopy (SEM), Surface Profiling Techniques Non-Destructive Testing (NDT) Techniques: Ultrasonic Testing, Radiographic Testing, Magnetic Particle Testing Material Behavior and Failure Analysis Fracture Mechanics and Failure Analysis Case Studies in Material Failures	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To provide a comprehensive understanding of the classification, structure, and properties of different engineering materials, including metals, ceramics, polymers, and composites.	K1, K2
CO2	To develop the ability to select metals and their alloys for specific engineering applications based on their properties and performance requirements.	K1, K2
CO3	To introduce polymeric, ceramic, and composite materials, and discuss their unique properties, synthesis methods, and applications in modern engineering.	K3, K4
CO4	To develop the ability to select appropriate materials for specific engineering applications based on their properties and performance requirements.	K3, K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Materials Science and Engineering: An Introduction	William D. Callister Jr. and David G. Rethwisch	John Wiley	10 th edition, 2020
2	Engineering Materials: Properties and Selection	Kenneth G. Budinski and Michael K. Budinski	Pearson India	9 th edition, 2017
3	Introduction to Materials Science for Engineers,	James F. Shackelford	Pearson India	9 th edition, 2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Science and Engineering of Materials	Donald R. Askeland	Chapman & Hall	1996
2	Materials Science and Engineering: A First Course	V. Raghavan	PHI Learning	6 th edition 2015

SEMESTER S7

ROBOTICS

Course Code	OEMET722	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. This course helps the student to the basic idea of Robots. Students are introduced to the basic design considerations of robots.
2. Concepts like trajectory planning and obstacle avoidance and kinematics of robots are introduced.
3. Discussion on various mobile robots and robotic manipulators are also included as part of the course to get an overall idea on robotics

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Definitions- Robots, Robotics; Types of Robots- Manipulators, Mobile Robots-wheeled & Legged Robots, Aerial Robots; Anatomy of a robotic manipulator-links, joints, actuators, sensors, controller; open kinematic vs closed kinematic chain; degrees of freedom; Robot configurations-PPP, RPP, RRP, RRR; features of SCARA, PUMA Robots. Classification of End effectors - mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers.	9
2	Direct Kinematics- Rotations-Fundamental and composite Rotations, Homogeneous coordinates, Translations and rotations, Composite homogeneous transformations, Screw transformations, Kinematic parameters, The Denavit-Hartenberg (D-H) representation, The arm equation, direct kinematics problems (up to 3DOF). Inverse kinematics- general properties of solutions and problems (up to	10

	3DOF).	
3	Manipulator Dynamics: Lagrange's formulation – Kinetic Energy expression, velocity Jacobian and Potential Energy expression, Generalised force, Euler-Lagrange equation, Dynamic model of planar and spatial serial robots up to 2 DOF, modelling including motor and gearbox.	8
4	Trajectory Planning. Joint space trajectory planning- cubic polynomial, linear trajectory with parabolic blends, trajectory planning with via points; Cartesian space planning, point-to-point vs. continuous path planning. Obstacle avoidance methods- Artificial Potential field, A* algorithms. Robot Control: The control problem, Single axis PID control-its disadvantages, PD gravity control, computed torque control	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Familiarise with anatomy, specifications and types of Robots	K2
CO2	Obtain forward and inverse kinematic models of robotic manipulators	K3
CO3	Plan trajectories in joint space & Cartesian space and avoid obstacles while robots are in motion	K4, K5
CO4	Develop a dynamic model and design the controller for robotic manipulators	K4, K6
CO5	Choose the appropriate Robotic configuration and list the technical specifications for robots used in different application	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	-	-	-	-	-	-	3
CO2	2	1	-	-	-	-	-	-	-	-	-	3
CO3	2	1	-	-	-	-	-	-	-	-	-	3
CO4	3	2	2	-	-	-	-	-	-	-	-	3
CO5	3	2	2	-	-	-	-	-	-	-	-	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Robotics – Analysis and Control	Robert. J. Schilling	Prentice Hall of India	1996
2	Introduction to Robotics (Mechanics and Control)	John. J. Craig	Pearson Education Asia	2002
3	Introduction to Robotics	S K Saha,	McGraw Hill Education	
4	Robotics and Control	R K Mittal	Tata McGraw Hill, New Delhi	2003
5	Robotics-Fundamental concepts and analysis	AshitavaGhosal	Oxford University Press	
6	Robotics Technology and Flexible Automation,	S. R. Deb		Second Edition,
7	Introduction to Autonomous Mobile Robots	Siegwart, Roland,	Cambridge, Mass.: MIT Press,	Second Edition,

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbook of Robotics	Siciliano, Khatib	Springer	
2	Introduction to Robotics – Mechanics and Control	John J. Craig		
3	Modern Robotics Mechanics, Planning and Control	. Kevin M. Lynch, Frank C. Park,		
4	Robotics Modelling, Planning and Control	Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, Giuseppe Oriolo	Springer	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/105/112105249/
2	https://archive.nptel.ac.in/courses/112/105/112105249/
3	https://archive.nptel.ac.in/courses/112/105/112105249/
4	https://archive.nptel.ac.in/courses/112/105/112105249/

SEMESTER S7

FINITE ELEMENT METHODS

Course Code	OEMET723	CIE Marks	40
Teaching Hours/Week(L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites(if any)	None	Course Type	Theory

Course Objectives:

1. To study the basic procedure of FEM and stiffness formulation of simple element using direct method.
2. To study the formulations of shape functions, strain displacement matrix and stress matrix.
3. To study the energy method and Galerkin weight residual formulations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction FEM, Mathematical Modelling of field problems in Engineering, Governing Equations – Discrete and continuous models, discretization-convergence behavior. General procedure of Finite Element analysis, Types of elements, Formulation of stiffness matrix-one dimensional spring, bar element assembly and solution procedure.	9
2	Types of coordinate system in FEM, coordinate transformation Plane truss stiffness formulation and its assembly. Shape functions, Derivation of shape functions using polynomial of One-Dimensional bar, 2-Dimensional CST. Convergence requirement of shape functions, Pascal triangle.	9
3	Derivation of strain -displacement relation- B matrix- bar, CST and beam element. Potential energy and equilibrium, principle of minimum potential energy, Variational formulation in FEM . Element stiffness-bar,and CST element, consistent loads.	9

4	Strong and Weak form , , Galerkin's weighted residual FEM formulation ; One dimensional axially loaded bar, heat flow in a bar, natural coordinate system, Iso parametric elements, Quadrilateral elements- Serendipity elements Isoparametric formulations, Jacobian matrix, stiffness matrices.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To understand the governing equations of various physical phenomena and basic procedure of FEM.	K2
CO2	To apply the coordinate transformation and formulation of shape functions of various element.	K3
CO3	Formulate shape functions and element strain displacement matrix of various element	K4
CO4	Evaluate element stress using energy method and study Galekin weight residual formulations	K5
CO5	Study the concept of iso parametric elements and analyze iso parametric formulations	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1									
CO2	3	3	1									
CO3	3	3	1									
CO4	3	3	1									
CO5	3	3	1									

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	An introduction to Finite Element Method	J N Reddy	McGrawHillEducation	ThirdEdition,2009
2	Concept and application of Finite Element method	Robert D Cook	Wiley	ThirdEdition,2008
3	Finite Element Analysis,	S SBhavikatti,	New Age Publisher	Third edition,2008
4	A First Course in Finite Elements	Jacob Fish Rensselaer ,Ted Belytschko	John Wiley & Sons, Ltd	Second edition,2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Applied Finite Element Analysis	Larry J Segerlind	Johny Wiley and sons	Second Edition,2010
2	Applied Finite element Analysis	G Ramamurthi	I K International Publishing House Pvt. Ltd	Second Edition
3	Fundamentals of Finite Element Methods	David V Hutton	McGrawHillEducation	ThirdEdition,2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/112106135
2	https://nptel.ac.in/courses/112106135
3	https://nptel.ac.in/courses/112106135
4	https://nptel.ac.in/courses/112106135

SEMESTER S7
NON – DESTRUCTIVE TESTING

Course Code	OEMET724	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To comprehend the fundamental ideas, methodologies, tools, applications and constraints of NDT approach.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Visual Inspection: Fundamentals of visual testing, tools, applications and limitations. Vision, lighting, material attributes, environmental factors. Visual perception, direct and indirect methods, mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources special lighting. Liquid penetrant Testing: properties required for a good penetrants and developers - Types of penetrants and developers. LPI technique/ test procedure interpretation and evaluation of penetrant test indications, false indication and safety precaution required in LPI.	9
2	Magnetic Particle Testing: Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique, central conductor testing, and magnetization using yokes. Direct and indirect method of magnetization, continuous testing of MPI, residual technique of MPI, system sensitivity, checking devices in MPI. Eddy Current Testing: physics aspects of ECT. Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT. Equipment and accessories, Various	9

	application of ECT such as conductivity measurement, hardness measurement, defect detection coating thickness measurement.	
3	Ultrasonic Testing: UT testing methods, contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques, resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used. Radiography Testing (RT): Electromagnetic radiation sources. Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real-time radiography, films used in industrial radiography, types of film, speed of films, qualities of film screens used in radiography, quality of a good radiograph, film processing, interpretation, evaluation of test results.	11
4	Advanced NDT Techniques: Principle and Procedure of Digital Signal and image Processing & Digital Image correlation, Acoustic emission Inspection ,Thermography, Computed Tomography	7

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Have a basic knowledge of NDT Techniques which enables to carry out various inspections in accordance with the established procedures.	K2
CO2	Familiarize with basic principles of electromagnetic NDT methods	K2
CO3	Apply the principles of signal processing of ultrasonic signals and image processing of radiographic images.	K3
CO4	Have a better knowledge in the field of advanced techniques in NDT	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

[illegible]

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Practical Non- destructive testing	Baldev Raj	Alpha Science International	2008
2	Non - destructive testing	Hull V and V John	McMillan	2012
3	Non Destructive testing Techniques	Ravi Prakash	New Academic Science	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Recent developments in the field of non-destructive testing, safety and material science	Elena Lysenko, Alexander Rogachev, Oldrich Stary	Springer	2022
2	New Technologies in electromagnetic non-destructive Testing	Songling Huang & Shen Wang	Springer	2016
3	Recent Advances in Non - Destructive Inspection	Carosena Meola	Nova Science publishers	2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
I to IV	https://archive.nptel.ac.in/courses/113/106/113106070/

SEMESTER S7

ENGINEERING INSTRUMENTS AND MEASUREMENTS

Course Code	OEMET725	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. Introduce the significance and need for mechanical measurements and inspection
2. To learn various measurement techniques, innovations, refinements.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Significance of Mechanical Measurements, Need of Inspection, Classification of measuring instruments, generalized measurement system, Types of inputs, Static characteristics & Dynamic characteristics. Errors in measurement and data analysis, Statistical analysis of data	9
2	Displacement measurement: Transducers for displacement measurement – Potentiometers, LVDT, Capacitance type, Digital transducers, Nozzle Flapper transducer. Measurement of Surface Characteristics: Measurement of straightness, flatness, squareness, parallelism etc., measurement of surface finish Strain measurement: Theory of strain gauges, gauge factor, Temperature compensation, Bridge circuit, Orientation of strain gauges for force and torque measurement, Strain gauge-based load cells and torque sensors	9
3	Force measuring devices: Torque and shaft power measurement, Basic method of force measurements, elastic force transducers, torque measurement on rotating shaft, shaft power measurement. Pressure measuring devices: Air micro manometers, sonar manometers, low pressure gauges such as McLeod gauge, Thermal conductivity gauge, Pirani gauge, Ionization Gauge, Piezo-electric pressure transducers, Elastic	9

	Transducers, Force balance Transducers. Dead weight gauges, elastic transducers and force balance transducer.	
4	Flow measurement: Gross flow rate measuring meters, constant area , variable pressure drop meters, local flow velocity magnitude and direction meters, hot wire anemometer velometer Temperature measurement: Measurement of temperature by liquid - in - glass thermometers, pressure thermometers, thermocouples, their calibration, resistance thermometer, Bi metallic thermometer, thermistors, radiation and optical pyrometers.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To identify and classify different measuring instruments and their static and dynamic characteristics, ensuring proper selection and usage for various engineering applications	K2
CO2	To measure and analyse displacement, strain and surface characteristics using appropriate techniques and devices, ensuring quality control and performance optimization in manufacturing and engineering processes	K3
CO3	To examine various devices to measure force, pressure accurately using a variety of devices and techniques	K5
CO4	To acquire the ability to measure flow and temperature and enabling them to address complex engineering challenges in these areas effectively.	K4
CO5	To select measurement system for engineering applications	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	3	2	-	-	-	-	-	-	-
CO2	3	3	3	-	2	-	-	-	-	-	-	-
CO3	3	3	-	3	2	-	-	-	-	-	-	-
CO4	3	-	-	3	1	-	-	-	-	-	-	-
CO5	3	-	3	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Measurement Systems (Applications and Design)	E.O.Dobelin	McGraw Hill	4th, 1990
2	Mechanical Measurements and Instrumentation & Control	A.K. Sawhney & Puneet Sawhney	Dhanpat Rai & Co	12th 2009.
3	Instrumentation Measurement and Analysis	B.C. Nakra and K.K. Chaudhry	Tata McGraw Hill	3rd 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering metrology and Measurements	N.V. Raghavendra	Oxford University press	2013
2	A Text Book of Engineering Metrology	R.K.Jain	Khanna Publishers, Delhi	2022
3	Mechanical Measurement and Control	D.S Kumar	Metropolitan Publication	2012
4	Industrial Instrumentation and Control	S. K. Singh	McGraw Hill Education (India)	2009
5	Mechanical Measurements and Instrumentation	R. K. Rajput	S K Kataria & Sons,	2006

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/107/112107242
2	http://en.wikipedia.org/wiki/Metrology
3	https://youtu.be/i0yRjm-dSuI
4	https://youtu.be/V1qrHvMs8tE
5	https://archive.nptel.ac.in/courses/112/104/112104250
6	https://nptel.ac.in/courses/112106138

SEMESTER S7

COMPUTATIONAL HEAT TRANSFER

Course Code	OEMET726	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Basic knowledge of Fluid mechanics and heat transfer	Course Type	Theory

Course Objectives:

1. To familiarize students with basic understanding of fluid flow and heat transfer.
2. To understand how to model simple heat transfer problems in one and two dimensions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basics of Heat Transfer-Conduction, convection and radiation heat transfer. Mathematical description of fluid flow and heat transfer: conservation equations for mass, momentum, energy and chemical species in Cartesian and cylindrical coordinates. Classification of Partial differential equations – elliptic, parabolic and hyperbolic equations. Initial and boundary conditions	9
2	Finite difference form of PDE equations-Taylor's series approach. Central difference, backward difference, and forward difference of first and second order derivatives. Solution of Laplace equation (conduction problems) using finite difference equations. Discretization error, truncation error, round off error, Convergence of iteration.	9
3	Solution of unsteady conduction equation using finite difference method-Explicit, implicit and semi-implicit methods. Stability of numerical solutions. Solution of linear algebraic equations- direct methods and indirect methods. Point by point iterations, Tri diagonal matrix method (TDMA)	9

4	Introduction to Finite volume method. Solution of one-dimensional steady state conduction problems. Handling different boundary conditions. Solution of one-dimensional convection diffusion problems using central difference schemes and upwind scheme. Introduction to SIMPLE algorithm for incompressible flows.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To understand the basics of governing equations of fluid flow and heat transfer	K2
CO2	To understand PDE equations and its classification.	K2
CO3	To familiarize with numerical techniques like FDM and FVM	K1
CO4	To understand various methods to solve system of linear algebraic equations	K2
CO5	To solve simple problems of steady and unsteady conduction using numerical techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	2	-	-	-	-	-	-	-	-
CO2	2	2	-	2	-	-	-	-	-	-	-	-
CO3	2	2	-	2	-	-	-	-	-	-	-	-
CO4	2	2	-	3	-	-	-	-	-	-	-	-
CO5	3	3	-	3	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introductory methods to numerical analysis	S S Sastry	PHI learning Private Ltd.	2012
2	Numerical Heat Transfer and Fluid Flow	Suhas V Patankar	Crc Press	2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computational fluid dynamics	Anderson, John David and Wendt, John	McGraw-Hill International Editions: Mechanical Engineering	1995
2	An Introduction to Computational Fluid Dynamics the Finite Volume Method	H. Veersted W. Malalasekera	Pearson; 2nd edition (1 January 2008); Pearson India	2008
3	Heat transfer	S P Venkatesh	Ane books Pvt Ltd	2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1- 4	https://archive.nptel.ac.in/courses/112/108/112108091

SEMESTER S7

POWER PLANT ENGINEERING

Course Code	OEMET727	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course Objectives:

1. To develop a comprehensive understanding of steam, gas, hydro and nuclear power plants and various energy storage systems.
2. To familiarise various terms related to power plant economics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Analysis of Steam Cycle Steam engineering-temperature entropy diagram- mollier diagram- Rankine cycle-steam power plant, internally irreversible and externally irreversible Rankine cycle-Mean temperature of heat addition-Effect of superheat and inlet pressure-Reheating of steam, Regeneration-Regenerative feed water heating.	9
2	Steam generator classifications Cochran boiler-Lancashire boiler-Cornish boiler-locomotive boiler-Babcock and Wilcox boiler Stirling boiler-high pressure boilers-boiler mountings and accessories Steam nozzles Flow through steam nozzles-throat pressure for maximum discharge- effect of friction-super saturated flow	9

	Steam turbines Impulse and reaction turbines-velocity diagram-condition for maximum efficiency-compounding-reheat factor-blade height-governing of steam turbines-cogeneration and combined cycle power generation	
3	Thermal power plants General layout-site selection-fuel handling, storage and burning systems-dust and ash handling system-chimney draught Nuclear power plants Classification-components-safety measures-effects of nuclear radiation-nuclear waste disposal. Gas turbine power plants Classification-closed open and other systems Hydro Electric Power Plants Classification- Typical Layout and associated components	9
4	Energy Storage Pumped hydro, Compressed air energy storage, flywheel energy storage, Electrochemical energy storage, magnetic energy storage, Thermal energy storage. Economics of power generation Estimation of load-load curve-load factor-diversity factor-capacity factor-use factor-economics in plant selection-economics of generation and distribution of power-useful life-tariff for electrical energy. Environmental pollution and its control Pollutants from power plants-control of pollutants-control of particulate matter -Control of SO₂- control of wastewater from steam power plants-pollution from nuclear power plants.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the layout, components and working of steam, gas, hydro, and nuclear power plants.	K2
CO2	Calculate the performance parameters of simple and modified Rankine cycles.	K3
CO3	Calculate the performance parameters of steam turbines and steam nozzles.	K3
CO4	Explain the working of various energy storage systems	K2
CO 5	Discuss the economics of power generation and pollution from power plants and their effect on the environment	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	3	-	-	-	-	-	-	-	-	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2
CO4	3	2	2	-	-	-		-	-	-	-	2
CO5	3	2	2	-	-	-	3	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Power Plant Technology	M. M. El Wakil	McGraw Hill Education	1, 2017
2	Power Plant Engineering	P. K. Nag	McGraw Hill Education	4, 2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Power Plant Engineering	G. R. Nagpal, S. C. Sharma	KHANNA Publishers	16, 2012
2	Power Plant Engineering	Manoj Kumar Gupta	PHI Learning Pvt. Ltd	1, 2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/107/112107291/
2	https://archive.nptel.ac.in/courses/112/107/112107291/
3	https://archive.nptel.ac.in/courses/112/107/112107291/
4	https://archive.nptel.ac.in/courses/112/107/112107291/

SEMESTER 8

MECHANICAL ENGINEERING

SEMESTER S8

CRYOGENIC ENGINEERING

Course Code	PEMET861	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCMET403 Engineering Thermodynamics	Course Type	Theory

Course Objectives:

1. Understand the Fundamental Principles and Applications of Cryogenic Engineering
2. Analyse and Evaluate the Performance of Cryogenic Systems and Components

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to cryogenic engineering - Historical background - Major events in the development of cryogenic engineering. Low Temperature Properties of Engineering Materials - Mechanical properties, Thermal properties, Electric and magnetic properties. Cryogenic fluids (N ₂ , O ₂ , H ₂ , He, Ar, Ne, CH ₄) and their properties. Applications of cryogenics - Applications in space, food processing, superconductivity, electrical power, biology, medicine, electronics, quantum computing, and manufacturing industry.	9
2	Cryogenic Liquefaction systems – System performance parameters, ideal liquefaction system, Joule-Thomson expansion, Adiabatic expansion. Liquefaction systems for gases other than Neon, Hydrogen and Helium- Simple Linde - Hampson system, Claude, Cascade System, and Auto-cascade system.	9

	Liquefaction systems for Neon, Hydrogen and Helium – LN ₂ precooled Linde Hampson and Claude systems, Ortho to Para conversion arrangement in hydrogen liquefaction system, Simon Helium liquefaction system, Collins Helium liquefaction system. Critical components of Liquefaction systems – critical components, types of heat exchanger used in cryogenic systems and their effect on system performance.	
3	Cryogenic Refrigeration systems- Ideal isothermal and isobaric refrigeration systems, Refrigeration using liquids as refrigerant- Linde-Hampson refrigerator, Claude refrigerator. Refrigeration using gases as refrigerant- Stirling cycle cryocoolers, Philips refrigerator, Effect of regenerator effectiveness on performance of the Philips refrigerator, Gifford McMahon refrigerators, Pulse tube cryocoolers. Refrigerators using solids as working media-Magnetic refrigerators – Thermodynamics of magnetic refrigerators, dilution refrigerators.	9
4	Cryogenic fluid storage and transfer systems-Cryogenic fluid storage vessel, Thermal insulations and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems, Cryo pumping. Cryogenic instrumentation, Pressure measurement – McLeod gauge, Pirani gauge, and Penning gauge, Flow measurement – Orifice meter, Venturi meter, and Turbine flow meter. Liquid level gauges-hydrostatic, resistance gauge, capacitance gauge, and thermodynamic gauge, Temperature measurements- ITS-90, Thermocouple, RTD, magnetic thermometers, and vapor pressure thermometers, Safety in cryogenic fluid handling, storage and use.	9

Course Assessment Method

(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe and analyse the mechanical, thermal, electrical, and magnetic properties of engineering materials at cryogenic temperatures and determine their suitability for various applications.	K1, K2
CO2	Identify and explain the properties of common cryogenic fluids and evaluate their applications in various industries	K1, K2
CO3	Analyse and compare different cryogenic liquefaction systems	K2, K3
CO4	Analyse and compare different cryogenic refrigeration systems	K2, K3
CO5	Demonstrate knowledge of cryogenic instrumentation techniques for pressure, flow, and temperature measurement and safety protocols for the handling, storage, and use of cryogenic fluids	K1, K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryogenic systems	Randal F. Barron	McGraw Hill	1986
2	Fundamentals of Cryogenic Engineering	M Mukhopadhyay	PHI Learning	2010
3	Cryogenic Process Engineering	K. D. Timmerhaus and T.M. Flynn	Springer	2013
4	Cryogenics	S.S Thipse	Narrosa	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryogenic Mixed Refrigerant Processes	G Venkatarathnam	International Cryogenics Monograph Series, Springer International Publishing	2007
2	Cryocoolers: Theory and Applications	M. D. Atrey (Ed)	International Cryogenics Monograph Series, Springer International Publishing	2020
3	Cryogenic Technology and applications,	A. R. Jha,	Elsevier Science	2011

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1-IV	Cryogenic Engineering, Prof. M D Atrey, IIT Bombay https://nptel.ac.in/courses/112101004

SEMESTER S8

PRESSURE VESSEL AND PIPING DESIGN

Course Code	PEMET862	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To present the industrial related problems, procedures and design principles for pressure vessels and enhance the understanding of design procedure of pressure vessel and Design of piping layout.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Pressure vessel – Terminology – Types of loads – Types of pressure- Types of supports. Stresses in pressure vessels – Dilation of pressure vessels. Membrane stress analysis of vessel shell components- cylindrical shells, spherical shells, torus, conical head, elliptical head, (Familiarisation of corresponding ASME section 8 codes for membrane stress equations)) Discontinuity stress analysis in pressure vessels.	9
2	Stresses in thick-walled cylinders –Lame’s equation for internal and external pressure, Shrink-fit stresses in Built up cylinders, auto frettage of thick cylinders. Theory of reinforced opening (Familiarisation of corresponding ASME section 8 codes for reinforcement analysis)	9
3	Design of tall vessel under wind and seismic load. Design of leg, lug and saddle supports. Buckling -Analysis of Elastic buckling of cylinders or pipes under external pressure- Design of Stiffeners for pressure vessel (Use relevant ASME codes and standard practices in pressure vessel	9

	design for the entire third module)	
4	Pipes- Size and wall thickness specification, Type of pipes based on manufacturing technique. Piping components - bends, tees, elbows, reducers, bellows, flanges and valves. Stress Analysis, sizing and thickness calculation of pipes (Familiarise with ASME B31.3). Allowable and displacement stress range for expected cyclic life-stress intensification factor- Flexibility Analysis (Analysis as per clause 119.7.1 in Code ASME B31.1/ clause 319.4.1 in ASME B31.3 only)	9

Course Assessment Method

(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Theory and Design of Pressure Vessels	John F. Harvey	CBS Publisher and Distributors	
2	Process Equipment Design	Brownell, L. E., and Young, E. H.,	John Wiley and Sons	
3	Pressure Vessels Design and practice	Somnath Chathopadhyay	C. R. C Press	
4	Pressure vessel design handbook	Eugene F megyesy	Pressure vessel publishing Inc	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Pressure Vessel Design Manual	Dennis R. Moss,	Elsevier Inc	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc23_ch69/preview
2	https://onlinecourses.nptel.ac.in/noc23_ch69/preview
3	https://onlinecourses.nptel.ac.in/noc23_ch69/preview
4	https://onlinecourses.nptel.ac.in/noc23_ch69/preview

SEMESTER S8

HYBRID AND ELECTRIC VEHICLES

Course Code	PEMET863	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To understand the basic concepts of hybrid and electric vehicles.
2. To study the various energy storage and propulsion systems of hybrid and electric vehicles.
3. To study the various motor drives and controllers of hybrid and electric vehicles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Vehicle fundamentals – general description, vehicle resistances, tractive effort, vehicle performance - maximum speed, power, gradability, etc. Electric vehicles – introduction, history, social and environmental importance of hybrid and electric vehicles, Types of EVs. EV transmission – configurations – front wheel drive and rear-wheel drive. Traction motor characteristics and comparison with IC engine characteristics. Hybrid electric vehicles – concept, architecture, classification, series, parallel, series-parallel and complex, hybrid drivetrains, the configuration of the series hybrid electric drive train, the configuration of the parallel hybrid electric drive train.	9

2	Energy storage – Battery basics, battery parameters, battery technologies - Lead-Acid Battery, Nickel-Cadmium Battery, Nickel-Metal-Hydride (NiMH) Battery, Li-Ion Battery, Li-Polymer Battery. Alternative energy sources – fuel cell, supercapacitors and ultracapacitors, flywheel (Overview only). Battery pack design, battery management system (BMS), sensors used in BMS, thermal management systems of battery, battery safety standards in India, AIS 156 (2020) and AIS 038 Rev (2020). EV charging – types, layout of AC and DC chargers, different charging protocols-CHAdemo, CCS2, GB/T, battery swapping.	9
3	Electric propulsion system – electric motors, classification, induction motors, basic principles and construction, torque–slip characteristics. Permanent magnets, ferrite, SmCo and NdFeB types, PM motors-BLDC, PMSM, basic principles and construction, switched reluctance motors (SRM), basic principles and construction. Regenerative braking – principle, block diagram. Gearbox, selection of gear ratio, Different kinds of gearboxes. EV motor sizing – need of gearbox.	9
4	Motor controllers – motor drive components, power electronic switches, MOSFET and IGBT, bidirectional switch. Induction motor controls – constant speed/frequency control, variable DC/AC inverter with sinusoidal PWM, field orientation control. BLDC motor controls – torque control and speed control methods, principles and block diagrams. SRM drive converter - classical half-bridge converter. Vehicle Sensors specific to EV sensors interfaced to the ECU's in the vehicle network. Controller Area Networking (CAN) – frame types of CAN, layered architecture of CAN.	9

	Vehicle Validation - 6 levels of EV validations. Advances in electric and hybrid vehicle technology – autonomous driving, connected vehicles (overview only).	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub-divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course, students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the general architecture of Electric vehicles.	K2
CO2	Describe various battery, charging types and battery management of Electric vehicles.	K2
CO3	Describe various motors and drives of Electric vehicles.	K2
CO4	Explain details of power transmission of Electric vehicles and select the appropriate components based on requirement.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					2	2					3
CO2	3	1				1						3
CO3	3					1						3
CO4	3					1						2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electric and Hybrid Vehicles”: Design Fundamentals	Iqbal Husain	CRC press	2nd edition, 2010
2	Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design	Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi	CRC press	3rd edition, 2018
3	Electric Vehicle Technology Explained	James Larminie, John Lowry	Wiley-Blackwell	2nd edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Electric and hybrid vehicles	Denton T.	CBS Publishers & Distributors Pvt. Ltd.	2nd edition, 2020
2	Electric Vehicle Battery Systems	Dhameja S.	Newnes (an imprint of Butterworth-Heinemann Ltd)	2001

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/108106170
2	https://nptel.ac.in/courses/108106170
3	https://onlinecourses.swayam2.ac.in/ntr24_ed54/preview
4	https://onlinecourses.swayam2.ac.in/ntr24_ed54/preview

SEMESTER S8

MICRO AND NANO MANUFACTURING

Course Code	PEMET864	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To give awareness of different techniques used in micro and nano manufacturing
2. To give in-depth idea of the conventional techniques used in micro manufacturing
3. To introduce Non-conventional micro-nano manufacturing and finishing approaches
4. To introduce Micro and Nanofabrication Techniques and other processing routes in
5. Micro and nano manufacturing
6. To know different techniques used in Micro Joining and the metrology tools in micro and nano manufacturing.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Precision engineering, Introduction to macro, meso, micro, and nano manufacturing - Classification —Traditional Mechanical Micromachining Process: Micro Turning, Micro Drilling, Micro Grinding, High-Speed Machining – Micro tools. Diamond micro turning- principle, process, description and applications. Mechanical type micromachining processes - Abrasive based nano finishing process Introduction to beam energy based micro machining processes- Ultrasonic micro machining, Focused Ion Beam machining, Laser Beam micro machining.	10

	Thermo-Electric type micromachining processes - Chemical and Electro-Chemical Type Advanced Machining Processes	
2	Micro forming techniques: laser micro-bending, micro-deep drawing, and micro-extrusion, Micro moulding processes: Injection moulding, hot embossing - micromolding tools-applications. Micro welding and joining techniques: Laser micro welding- Electron Beam Micro welding. Micro/ Nano finishing processes- Abrasive Flow Machining, Magnetic Abrasive Finishing, Magneto Rheological Abrasive Flow Machining, Magneto Rheological Finishing. Elastic Emission machining (EEM), IonBeam Machining (IBM), Chemical Mechanical Polishing (CMP)- principle, equipment and applications Hybrid micro/nano machining – Electro Chemical Spark Micro Machining, Electro Discharge Grinding, Electrolytic in Process Dressing Grinding. Laser technology in micro manufacturing- Practical Lasers, application of technology fundamentals.	10
3	Characterizing etching processes in bulk micromachining; basics of micro-fabrication, integrated circuit fabrication; crystallography and its effects, silicon as substrate and structural material, stress and strain, crystal plane effects on etching, wet etching process, reaction phenomena, anisotropic etching, isotropic etch curves, masking for anisotropic etchants, etching control, fusion bonding of silicon on an insulator, deep reactive ion etching, fabrication of a cantilever probe, manufacture, microprocessors and applications; problems with etching in bulk micromachining. Micro fabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding, MEMS Fabrication Techniques, Micro-fabrication using deposition techniques: epitaxial, sputtering, chemical vapour deposition (CVD) techniques. Bulk Micromachining, Surface Micromachining, High- Aspect- Ratio Micromachining, Photolithography, LIGA process.	12
4	Introduction to Nanofabrication, Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp) e-Beam Nanolithography – important techniques, Introduction to Nanotechnology. Principle of the soft lithography and applications; principle of micro	12

	contact printing and applications; characterizing the surface micromachining process, isolation layer, sacrificial layer, structural material, selective etching – properties, stress, stress measurement, friction; wafer bonding: anodic and fusion, bonding. Manipulative techniques – process principle, applications. Introduction to Carbon nano materials — properties and applications, Carbon Nanotubes Transistors – (Description only) Diamond - Properties and applications, CVD Diamond Technology. Introduction to micro-nano inspection and metrology- Scanning electron microscopy- principle and description, Scanning white light interferometry- principle and description. Optical microscopy- principle and description. Scanning probe microscopy, Scanning tunnelling microscopy- principle, description and applications. Confocal microscopy, Atomic force microscopy- principle and description. Introduction to On-machine metrology.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain different techniques used in micro and nano manufacturing	K2
CO2	Describe conventional techniques and non-conventional micro-nano manufacturing approaches	K2
CO3	Outline the working principle and applications of micro and nano finishing processes	K2
CO4	Explain the basics of micro and nano fabrication techniques	K2
CO5	Select a suitable Metrology for measurement of dimensional, form, and surface integrity of components manufacturing using micro and nano Manufacturing	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	1	-	2	1	1	-
CO2	3	-	-	-	-	-	1	-	2	1	1	-
CO3	3	-	-	-	-	-	1	-	2	1	1	-
CO4	3	-	-	-	-	-	1	-	2	1	1	-
CO5	3	-	-	-	1	-	2	-	2	1	1	1

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Microfabrication and Nano manufacturing	Mark J. Jackson	Taylor and Francis-CRC press	2006
2	Micro manufacturing Processes	Jain V.K	CRC Press	2012
3	Nano Materials	Bandyopadhyay A.K	New Age International Publishers, New Delhi	2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Micro and Nano manufacturing	Mark. J. Jackson	Springer	2007
2	Introduction to Micromachining First edition	Jain V.K	Narosa publishing house	2017
3	MEMS and microsystems: design, manufacture, and nanoscale engineering	Hsu, Tai-Ran	John Wiley & Sons	2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtube.com/playlist?list=PLB8BC0AB0AD5DA4E2&si=5K0kjXdseqIVUSxq
2	https://youtu.be/YJ5OhYLbeSE?si=uzqWytqgjRbI5I1i
3	https://youtube.com/playlist?list=PLgMDNELGJ1CbHti4HN0BuagtoD06H78YT&si=R-34kA6jB8QL-bKN
4	https://youtu.be/TbYU8df53V4?si=vck_ULHZL908ZmHK

SEMESTER S8

ADVANCED NUMERICAL CONTROL IN MANUFACTURING

Course Code	PEMET866	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To know the operational difference between NC and CNC systems
2. To understand the controlling elements in CNC machines
3. To learn the programming used in CNC machines

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Principles of Numerical Control Structure of NC systems, Applications of CNC machines in manufacturing, Advantages of CNC machines. Historical developments and future trends. Future of NC Machines, Difference between ordinary and NC Machine tools, Machining Capabilities of a CNC Machine, Methods for improving accuracy and productivity. Control of NC Systems: Classification of CNC control systems Open and Closed loop systems, Types of CNC Machine Tools systems devices.	9
2	Encoders and interpolators, Features of CNC Systems, Direct Numerical Control (DNC), Standard Controllers and General Programming features available in CNC Systems, Computer Process monitoring and Control. Adaptive control systems.	8
3	NC Part Programming: Axis identification and coordinate systems, Structure of CNC part program, Programming codes, Programming for 2 and 3 axis control systems, Manual part programming for a turning center, Programming using tool nose radius compensation, Tools offsets, Do loops,	10

	sub routines and fixed cycles. Manual Programming for simple parts.	
4	Computer aided part programming; Tools for computer aided part programming, Computer aided NC Programming in APT language, use of canned cycles, Generation of NC Programmes through CAD/CAM systems, Design and implementation of post processors. Constructional Details of CNC Machines: Machine structure, Slide –ways , Motion transmission elements , Swarf removal and safety considerations , Automatic tool changers and multiple pallet systems, Sensors and feedback devices in CNC machines.	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the working of NC and CNC systems	K2
CO2	Understand feedback mechanisms in CNC machines	K2
CO3	Create programming code in CNC	K6
CO4	Understand the construction details of CNC machines	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3-	-	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	-	2	-	-	-	1	-	-	-
CO4	3	2	2	-	-	-	-	-	1	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Numerical Controls in Manufacturing	Frank W Wilson	McGraw-Hill	1963
2	Introduction to Numerical Control in Manufacturing	American Society of Tool and Manufacturing Engineers, Chester Joseph Kishel	American Society of Tool and Manufacturing Engineers,	1969

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computer Control of Manufacturing Systems	Yoram Koren	McGraw-Hill Inc.,US	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1-4	https://archive.nptel.ac.in/courses/112/105/112105211/

SEMESTER S8

METAL ADDITIVE MANUFACTURING

Course Code	PEMET867	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To understand IoT and digital manufacturing demands for quicker and modular manufacturing solutions
2. To familiarise the current status of metal AM basics, materials, processes, and major important related aspects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Additive Manufacturing (AM)– Process, Materials, Applications- Modular Design and Topology–Customization, Efficiency, Scalability - Design freedom in AM– Complex Geometries, Lightweight Structures, Material Efficiency -Benefits of Topology Design Freedom– Performance Enhancement, Innovation, Sustainability	9
2	CAD for AM, Integration of CAD with Additive Manufacturing, Design for AM, Topology Optimization, Metal AM physics and processes – PBF, DED, Binder Jetting, Sheet Lamination. Laser and Extrusion – SLS, SLM, DMLS, FDM, Robocasting. Metal AM processes, Filament, Powder and Sheet Systems, Metal AM as an Extension of Welding Techniques (GTAW/GMAW).	9
3	Metal AM physics and processes, Directed Energy, Binder and Material Jetting Feedstocks, Metallurgy and properties of materials– Microstructure, Mechanical, Thermal and Chemical Properties, Post processing and testing –	9

	Heat Treatment, Hot Isostatic Pressing, Machining, Surface Treatment and NDT Methods.	
4	Reverse Engineering for metal AM, Data Handling, Simulation and Analysis, Modelling for AM –Support Structures, Functional Integration, Value analysis – Cost, Time, Performance and Sustainability -Future of metal AM	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To study the basic Metal Additive Manufacturing Techniques	K2
CO2	To understand the features and control of various MAM Methods	K2
CO3	To familiarize the metallurgy of MAM Processes.	K3
CO4	To study the relation between reverse engineering and additive manufacturing.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	2	-	-	-	-	-	-	-	-	2
CO2	2	-	-	-	3	-	-	-	-	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2
CO4	3	-	-	-	-	2	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Additive Manufacturing of Metals: The Technology, Materials, Design and Production	Li Yang, Pan Michaleris	Springer	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Additive Manufacturing of High-Performance Metals and Alloys	Robert Pederson, Matthew S. Sokolov, Chao Ma	IntechOpen	
2	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing	Ian Gibson, David W. Rosen, Brent Stucker, MahyarKhorasani	Springer	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/hOkV4Uo_w2Y
2	https://youtu.be/G9T9MkbjB68
3	https://youtu.be/_V_CUDPSzJE
4	https://youtu.be/EyEg57tlS1k

SEMESTER S8

NANOTECHNOLOGY

Course Code	PEMET868	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. Develop an understanding of nanomaterials and properties
2. Apply nanomaterials and engineering solutions to new technologies

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Nanoscience and technology: Introduction, brief history, Discussion on Feynman's talk, size effect, anomalous behavior of materials at nanoscale, impact of nanoscale on various properties of materials (structural, mechanical, thermal, optical, electronic), applications, examples from nature	9
2	Fabrication of Nanomaterials, Top-down and Bottom-up approaches Top-down fabrication: Mechanical methods, thermal methods, High energy methods, Chemical and lithographic methods Bottom-up methods: gaseous phase methods, liquid phase methods, solid bottom-up methods, Template synthesis	9
3	Carbon-based nanomaterials: Bonding in C materials, Synthesis and properties of fullerene, graphene, and CNT. Diamondoid nanomaterials,, Carbon dots, Pyrolyzed nanocarbon materials. Emerging 2D materials: Transition metal dichalcogenides, Hexagonal Boron nitride, M-Xenes synthesis, properties, and applications.	9

4	Nanomaterials for Energy and Environment: Electrochemical energy storage, hydrogen storage, solar cells, organic solar cells, photocatalysis, water purifications, desalination, solid waste removal Nanobiotechnology: micro and nanofluidics, biochips, lab-on chips and integrated systems. Nanoparticle-based drug delivery, nanostructures in diagnostics Nanocomposites, biodegradable nanocomposites	9
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Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand anomalous behavior of material at nanoscale dimensions	K3
CO2	Get an introduction to the nanoscale properties of materials	K3
CO3	Understand nanomaterial synthesis methods	K3
CO4	Explore the properties and application of C-based nanomaterials and other emerging 2D nanomaterials	K3
CO5	Get exposure to nanomaterials for energy and nanobiotechnology	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-
CO5	3	3	2	-	-	-	2	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to nanoscience and technology	Gabor L Hornyak	CRC Press	2009
2	Fundamentals of nanotechnology	Gabor L Hornyak	CRC press	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to nanotechnology	Charles P Poole, Frank J Owens	Wiley	2003
2	Introduction to nanoscience and nanotechnology	K K Chattopadhyay, A N Banerjee	PHI	2009
3	Basic Principles of Nanotechnology	Wesley C. Sanders	CRC Press	2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/118102003
2	https://nptel.ac.in/courses/118102003
3	https://nptel.ac.in/courses/118102003
4	https://onlinecourses.nptel.ac.in/noc23_ge21/preview

SEMESTER S8

AIRCRAFT DESIGN

Course Code	PEMET865	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	40
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Calculate jet and propeller driven airplane performance (take-off/landing distance, endurance, climb, manoeuvre)
2. Perform conceptual airplane and propulsion sizing estimate to meet specified operational and performance requirements
3. To develop problem solving skills i.e. identifying main issues in aeronautical problems, simplify the problem and solve it using standard tools

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Phases of the design process, conceptual design, preliminary design, detailed design. Typical program organization and personnel responsibilities. Role of aircraft design engineer. Major difference between manned and unmanned air vehicle design.	8
2	Basic aircraft terminology and conventions. Coordinate systems, forces and moments, aerodynamic coefficient. Significance of aerodynamic center. Aircraft weight breakdown and definition. Basic aircraft performance terminology (flight in the horizontal and vertical planes). Aircraft sizing. Factors influencing the aircraft configuration, size, weight. Weight breakdown. Historical weight data. The lift curve and parabolic drag polar.	10

3	Aircraft performance and fuel fraction estimates. Range, Endurance, Manoeuvring flight in the vertical and horizontal planes, Climbing flight, Descend/ Glide, Field Performance- Take-off and Landing. Special performance requirements like accelerated flight.	8
4	Propulsion system selection. Flight regimes, Refined performance estimating methods, Installation factors. Configuration trade studies- Configuration types(tailless, canard, conventional), wing location design, Empennage configurations(cruciform, T, H, V, cathedral). Engine placements(single or multi engine). Landing gear type and placement(tail dragger, tricycle, tandem). Airofoil selection,packaging for storage/transport	10

Course Assessment Method

(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To make the required decisions during the total design cycle of an aircraft including conceptual, preliminary and detailed design	K2
CO2	To distinguish and understand the design phases of an aircraft.	K2
CO3	To be able to calculate the performance characteristics of aircraft	K2
CO4	To evaluate and understand layout design of different aircrafts	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Design: A conceptual Approach	Daniel P. Raymer	AIAA	2012
2	Introduction to Aircraft Design	John P Fielding	Cambridge Aerospace Series	2 2017
3	Aircraft Performance	Martin E. Eshelby	Elsevier	2000

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Engineering Design, Structures and Systems	Ian Booth	NY research press	2018

SEMESTER S8

INDUSTRIAL HYDRAULICS AND AUTOMATION

Course Code	OEMET831	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To know about the basic elements of closed loop hydraulic system
2. To do the sizing and system design of typical hydraulic systems
3. To design and develop low-cost automation circuits for industrial problems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators –election, specification and characteristics	8
2	Control and regulation elements: Pressure - direction and flow control valves -relief valves, non-return and safety valves - actuation systems.	8
3	Hydraulic system for industrial equipment. e.g. Counter balance circuit, sequencing circuit, the tandem actuator of hydraulic actuators, steering circuit used in automobiles, Hydraulic press circuit operation, closed-circuit and open-circuit hydrostatic transmission, Accumulator circuit for intermittent operation of actuators	10
4	Circuits: sequential circuits - cascade methods - mapping methods – step counter method, compound circuit design - combination circuit design. -fault finding of circuits - use of microprocessors for sequencing Introduction to different types of industrial controllers- Types of automation system ,PLC, Low cost automation	10

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the various components in industrial hydraulic system	K2
CO2	Understand the various hydraulic circuits used in industries	K2
CO3	To design simple hydraulic circuits	K3
CO4	Understand the industrial controllers and automation systems	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	1	1	-	-	-	-	-	-	-
CO2	3	3	-	1	1	-	-	-	-	-	-	-
CO3	3	3	-	1	1	-	-	-	-	-	-	-
CO4	3	3	-	1	1	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Hydraulic and Pneumatics	Andrew Parr	Jaico Publishing House,	1,1999
2	Hydraulic systems: Principles and maintenance	Majumdar, S. R.	. Tata McGraw-Hill Education	1,2013
3	Fluid power circuits and controls: fundamentals and applications.	Cundiff, J. S.	CRC Press.	1,2001

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Pneumatic systems: Principles and maintenance.	Majumdar, S. R.	. Tata McGraw-Hill Education	1,2010
2	Hydraulic control systems.	Herbert E. Merritt.	John Wiley & Sons.	1,1967
3	Fundamentals of fluid power control	Watton, J	University Press	1,2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc24_me69/preview
2	https://onlinecourses.nptel.ac.in/noc24_me69/preview
3	https://onlinecourses.nptel.ac.in/noc24_me69/preview
4	https://onlinecourses.nptel.ac.in/noc24_me69/preview

SEMESTER S8

3D PRINTING AND TOOLING

Course Code	OEMET832	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course Type	Theory

Course Objectives:

1. To demonstrate appropriate level of understanding on principles of additive manufacturing
2. To understand the different additive manufacturing technologies.
3. To choose appropriate materials for additive manufacturing processes.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Additive Manufacturing (AM) –Basic principle of AM- Procedure of product development in AM process chain. Classification of additive manufacturing processes, Basic concept, Digitization techniques, Benefits and challenges in AM. Data processing for AM- CAD model preparation, Part orientation and support generation, Slicing methods, Tool path generation, STL Formats. Demonstration of slicing software packages.	8
2	Common AM technologies: Principle, materials, process parameters, advantages and applications of: Stereo Lithography (SLA), Digital Light Processing (DLP), Continuous Liquid Interface Production (CLIP), Laminated Object Manufacturing (LOM), Ultrasonic AM (UAM), 3D printing, Binder Jetting, Material Jetting, Fused Deposition Modelling (FDM), Direct Ink Writing (DIW).	10

3	Common AM technologies: Principle, materials, process parameters, advantages and applications of: Selective Laser Sintering (SLS), Selection Laser Melting (SLM), Electron Beam Melting (EBM), Wire Arc Additive Manufacturing (WAAM), Laser Engineering Net Shaping (LENS).	10
4	Indirect methods for Rapid Tool Production- Role of indirect methods in tool production, Metal deposition Tools, RTV Tools, Eoxy Tools, Ceramic Tools, Cast Metal Tools, Investment Casting, Fusible Metallic Core and Sand casting. Direct Methods for Rapid Tool Production- Classification of Direct Rapid Tool Methods, Laminated Object Manufactured Tools, Vacuum Forming Tools, Paper Pulp Molding Tools, Framework for Composite Manufacture.	8

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the development of AM from conventional manufacturing systems.	K2
CO2	Understand the data processing techniques in AM process	K2
CO3	Understand the principles of AM processes.	K2
CO4	Understand the RP tooling applications of AM processes.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-		-	-	-	-	-	-	-
CO2	2	2	2	-	3	-	-	-	-	-	-	-
CO3	2	-	-	-		-	-	-	-	-	-	-
CO4	2	-	-	-		-	-	-	-	-	-	-
CO5	2	-	-	-		-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Additive Manufacturing Technologies-3D Printing, Rapid Prototyping, and Direct Digital Manufacturing.	Gibson I D. W. Rosen I and B. Stucker	Springer	Second Edition, 2015
2	Rapid prototyping: Principles and applications	Chua, C.K., Leong K.F. and Lim C.S.	World Scientific Publishers	Third edition, 2010.
3	Rapid Manufacturing The Technologies and Applications of Rapid Prototyping and Rapid Tooling	D.T. Pham and S.S. Dimov	Springer London Ltd	Reprint of the original 1st ed. 2001, 2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Additive Manufacturing: Principles, technologies and Application	C.P. Paul , A.N. Jinoop	McGraw Hill	First Edition, 2021
2	Additive Manufacturing Technologies	S. Shiva, Anuj K. Shukla	Wiley	First Edition, 2024
3	Additive Manufacturing: Fundamentals and Advancements	Manu Srivastava, SandeepRathe, Sachin Maheshwari	CRC Press	First Edition, 2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1,2,3 and 4	NOC: Fundamentals of Additive Manufacturing Technologies, IIT Guwahati by Prof. Sajan Kapil Link: https://nptel.ac.in/courses/112103306

SEMESTER S8

NUMERICAL TECHNIQUES ENGINEERING

Course Code	OEMET833	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To get an awareness about the usefulness of numerical methods in solving different engineering problems
2. To understand the error involved in numerical analysis

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Motivation and Applications of numerical methods, Significant digits, Accuracy and precision; Truncation and round-off errors. Roots of nonlinear equations-Bisection method, Newton Raphson method Solution of system of linear equations-Gauss elimination, Gauss Jordan, Gauss Siedel, LU decomposition Curve fitting:Least square regression-Linear regression, linearization of nonlinear relationships, Polynomial and multiple linear regression	8
2	Curve fitting: Interpolation-Newton's forward, backward, divided difference, Lagrange's interpolation, cubic spline Numerical differentiation-Difference formula, Newton's forward, backward and divided difference method, Sterling's formula Numerical integration-Trapezoidal, Simpson's one-third rule, Simpson's three-eighth rule, Gauss Quadrature	10

3	Numerical solution of ordinary differential equations-Initial value and boundary value problems Taylor's method, Euler method, Modified Euler method, Runge Kutta fourth order method for first order, second order and simultaneous first order differential equations, Predictor corrector method, Shooting method, finite difference method	9
4	Numerical solution of partial differential equation-Types, Difference equations Elliptic equation-Laplace equation, Poisson's equation, Liebmann's iterative method, Parabolic equation-explicit and implicit method, convergence and stability, Crank Nicolson method, Hyperbolic equation	9

Course Assessment Method

(CIE: 40marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply numerical methods to solve linear and nonlinear equations	K3
CO2	Implement numerical schemes to fit data	K3
CO3	Solve differentiation and integration numerically	K3
CO4	Execute numerical procedures to solve ordinary and partial differential equations	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	3	-	-	-	-	-	-	2
CO2	3	2	-	2	3	-	-	-	-	-	-	2
CO3	3	2	-	-	3	-	-	-	-	-	-	2
CO4	3	2	-	-	3	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Numerical methods for Engineers	Steven C Chapra, Reymond P Canale	Mc Graw Hill	6th Edition, 2010
2	Numerical Methods for Engineers	Gupta S.K.	New Age International	1995
3	Numerical methods	E Balagurusamy	Mc Graw Hill Education	2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Applied Numerical Analysis	Gerald, C. F. and Wheatly P O	Wesley	6th Edition
2	Numerical Methods for Scientific and Engineering Computation	Jain, M. K., Iyengar, S. R. K. and Jain, R. K.	New Age Pvt. Pub, New Delhi	
3	Elementary Numerical Analysis	Conte, S. D. and De Boor, C.	Mc Graw Hill Publisher	
4	Applied Numerical Analysis	Krishnamurthy, E. V. & Sen, S. K.	East West Publication	
5	An introduction to numerical analysis	Suli & Mayers	Cambridge University Press	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1-4	https://archive.nptel.ac.in/courses/127/106/127106019/

SEMESTER S8

BUSINESS ORGANIZATION AND DEVELOPMENT

Course Code	OEMET834	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)		Course Type	Theory

Course Objectives:

1. To understand the Business organisation and Enterprises.
2. To acquire knowledge about Development & Establishment of Enterprises

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION:- Business-Concept-Objectives-Characteristics .Business plan- Structure of Business plan-Major Financial decisions in Business-External and Internal factors affecting. Distinction of Business, Commerce and Trade. Industrialization- Globalization and Modern day Business. Need of Business Ethics and Business Responsibility.	9
2	BUSINESS ORGANIZATIONS:- Forms of Business Organizations- Sole proprietor – Partnership- Types- One person Company- Joint stock Company- Private & Public limited Companies. Limited liability Partnership (LLP). Co-operative Organizations, Multi National Companies (MNC).Entrepreneurship -Forms of Entrepreneurship -Indian Scenario-Skill India- Make in India-Start up India.	9
3	DEVELOPMENT & ESTABLISHMENT OF BUSINESS:- Business Formation stages- Promotion- Incorporation and registration -Capital-Sources of Capital-Commencement-Documentation- Memorandum and articles of association-Prospectus. Establishing- Alternative identification -expansion-Market feasibility -Market Assessment-Technology in Business-Financial allocation- HR upgradation.Supporting Organisations- Chamber of Commerce.	9

4	BUSINESS CHANNELS : - Distribution Channels- Functions- Types- Internal and external trades. Import and export.Whole sale and retail system. Theory of retailing. Business channel Intermediaries. Franchising – Branding. Business Insurance system. Business Combination systems- Needs- Acquisition-Merging- Takeover.	9
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Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of Business organisation.	K1
CO2	To acquire the knowledge on distinction of different organisations.	K2
CO3	To familiarize the stages of development and establishment of Business.	K2
CO4	To identify different Business channels	K1

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	1	-	1	-	-	1
CO2	2	1	-	-	-	1	-	-	-	-	-	1
CO3	1	1	-	-	1	-	-	-	-	-	1	1
CO4	1	1	-	-	-	1	-	-	-	-	-	1

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Business Organisation & Management	T.N Chhabra	Sun India	2021
2	Modern Business Organisation & Management	S. A Sherlekar	Himalaya publishing	2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Business Organisation and Management	Basu C R	Tata McGraw-Hill	2017
2	Essentials of Management	Singh B P & Singh A K	Excel Books	2002
3	Business Organisation & Management	Vasishth N & Rajput N	Kitab Mahal	2019

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/110/107/110101146/
2	https://archive.nptel.ac.in/courses/110/107/110101146/
3	https://archive.nptel.ac.in/courses/110/107/110101146/
4	https://archive.nptel.ac.in/courses/110/107/110101146/

SEMESTER S8

WORLD CLASS MANUFACTURING

Course Code	OEMET835	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GCPHT121	Course Type	Theory

Course Objectives:

1. Understand the Industrial practices adopted in World class manufacturing.
2. To familiarise the strategic planning for WCM.
3. To familiarise WCM tools.
4. Acquire the knowledge about Recent trends in WCM

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION: World class manufacturing-Definition-Historic Journey- Five levels led to WCM -characteristics of WCM-Pillars of WCM-Control Techniques of World class Manufactures- Principles of WCM- JIT- Zero waste Concept- TQM- TPM.	9
2	PLANNING& HRD PRACTICES IN WCM: Manufacturing strategy – Strategy Procedure- Types of strategy -Competitive priorities-Aggregate planning-Master Production schedule. Employee Morale-Team work- Employee Involvement-Cross functional teams-Motivation &Appraisal. Work study methods	9
3	WCM CONCEPTS & TOOLS : concepts –AMBITE- MRP II-TOPP- Automation systems- Types-Modern Manufacturing systems- Flexible Manufacturing- Lean Mnufacturing-5S-Agile Manufacturing Six Sigma-Automated Material Handling systems. Process Design & Process design tools. Bar code systems. IOT in manufacturing.	9
4	WORLD CLASS MANUFACTURING -RECENT TRENDS &INDIA: World class manufacturing Companies in INDIA-Production 4.0-Industry 4.0-Digitalization process in India-AI-Robotics-3D Printing-Extended Realities- VR& AR –Digital Twins .Automation in Industries-Case studies. Reshoring-Make in INDIA-Sustainable Manufacturing.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To familiarise with the basic concepts in World class Manufacturing.	K1
CO2	To understand the Strategy planning in WCM	K1
CO3	To Identify the employee involvement in WCM	K1
CO4	To Examine & Categorize different tools in WCM	K2
CO5	Learn different concepts in Modern day Manufacturing	K1
CO6	Analyse Indian scenario & WCM	K2
CO7	Identify various modern day trends and terminologies in WCM	K1

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1						1		1			1
CO2	2	1				1						1
CO3	1							1	1			1
CO4	2	1			1	1	1	1				1
CO5	1	1				1						1
CO6	1						1				1	2
CO7	1				1			1				1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	World class Manufacturing, The lessons of simplicity applied.	Richard J Schonberger	The FREE PRESS	(2013)
2	World class Manufacturing	B.S. Sahay, K B C Saxena, Ashish Kumar	Infinity Publishers	Ist Edition (2018)
3	Strategic Decision making in Modern Manufacturing	Harinder Sing Jagdev, Attracta Brennan, J. Browne	Springer	Reprint Edition (2013)

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	World class Manufacturing	Adeel Hejaji	Lambert	2015
2	World class Manufacturing and Material Handling	Edward H Frazelle	Mc GrawHill	2nd Edition 2016

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/110/107/110107116/
2	https://archive.nptel.ac.in/courses/110/107/110107116/
3	https://archive.nptel.ac.in/courses/110/107/110107116/
4	https://archive.nptel.ac.in/courses/110/107/110107116/

SEMESTER S8

MICRO ELECTRO MECHANICAL SYSTEMS

Course Code	OEMET836	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To Understand micro electromechanical systems and components
2. To understand the science of microsystems design in detail
3. To understand MEMS Fabrication technologies and the importance of CAD in MEMS Fabrication

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Definition of MEMS. MEMS devices. Silicon as a MEMS material – mechanical properties of silicon. Mechanical components in MEMS. Design concepts of mechanical components. Working Principles of Microsystems.	9
2	Engineering Science for Microsystems design and Fabrication. Scaling laws – Scaling in geometry, rigid body dynamics, electrostatic forces, electromagnetic forces, electricity-fluid mechanics and heat transfer	9
3	Materials for MEMS and Microsystems. Fabrication technologies – Photolithography – Ion implantation – diffusion – oxidation – CVD – Physical Vapour Deposition – Etching. Micro manufacturing – Bulk and surface micro machining – LIGA	9
4	Microsystems Design – Design considerations – Process design – Mechanical Design – CAD – Micro system packaging – Levels – Bonding – Interfaces – Assembly – Selection of Packaging Materials.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand micro electromechanical systems, MEMS components, MEMS design concepts and working principles.	K2
CO2	Understand the engineering and physics of MEMS Fabrication Process	K2
CO3	Understand the various processes in MEMS Fabrication	K2
CO4	Understand the interface between MEMS and CAD	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	2	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	2	-	-	-	-	-	-	-	-	3

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mems & Microsystems Design and Manufacturing	Tai-Ran Hsu	John Wiley & Sons	2008 2nd Edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Microfabrication	Marc J Madou	CRC Press	2002 2nd Edition
2	The MEMS Handbook	Mohamed Gad-el-Hak	CRC Press	2002

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1-2	https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=16&lesson=17 https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=16&lesson=18 https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=16&lesson=19
3-4	https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=22&lesson=23 https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=22&lesson=24 https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=22&lesson=25 https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=22&lesson=26 https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=22&lesson=27 https://onlinecourses.nptel.ac.in/noc24_ee108/unit?unit=30&lesson=33

SEMESTER S8

PRODUCT DESIGN AND INNOVATION

Course Code	PEMET837	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To create confidence in developing new products.
2. To acquaint with methods and tools for product design and development.
3. To equip with practical knowledge in conceptualization, design and development of new product

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Classification/ Specifications of Products, Product life cycle, product mix. Introduction to product design, Modern product development process Design by evolution, Design by innovation, Morphology of design Ethics in product design, legal factors and social issues	9
2	Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design. Conceptual Design: Generation, selection & embodiment of concept, Product architecture. Industrial design: process, need. Robust Design: Taguchi Designs, Design of experiments	9
3	Design for Manufacturing and Assembly: Methods of designing for Manufacturing and Assembly. Design for Maintenance. Design for Environment. Ergonomics in product design. Aesthetics in product design. Concepts of size and texture colour. Value Engineering - Definition. Methodology, Case studies.	9

4	Product costing. Economic analysis: Qualitative & Quantitative. Psychological and Physiological considerations Concurrent Engineering - Elements of concurrent engineering, Benefits Rapid prototyping: concepts, processes and advantages. Reverse engineering: steps in reverse engineering- hardware and software in reverse engineering. Tools for product design – Drafting / Modelling software. Patents & IP Acts- Overview, Disclosure preparation	9
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Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the life cycle of a product and product development process	K2
CO2	Develop knowledge of robust design and conceptual design	K2
CO3	Introduce the concept of Design for Manufacturing and Assembly in product design	K2
CO4	Use value engineering in the development of product	K2
CO5	Incorporate ergonomics and rapid prototyping in product development	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Product Design & Development.	Karl T Ulrich, Steven D Eppinger	Tata McGraw Hill	2003

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Product Design: “Techniques in Reverse Engineering and new Product Development.”,	Kevin Otto & Kristin Wood	Pearson Education New Delhi	2000

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1-4	https://archive.nptel.ac.in/courses/107/103/107103082/