Annexure AC/ 5.33

~~Annexure 4.3~~

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA (JHAJJAR)

An Autonomous Institute

'A' GRADE ACCREDITED BY NAAC

Scheme of Studies and Examinations For

Bachelor of Technology (Mechanical Engineering)

Effective from

Academic Session 2026-27 (3rd Year)

APPROVED BY AICTE, NEW DELHI AND AFFILIATED TO MDU, ROHTAK

COURSE CODE AND DEFINITIONS

Sr. No.	Category	Course Code
1	Basic Science Courses	BSC
2	Engineering Science Courses	ESC
3	Professional Core Courses	PCC
4	Professional Elective Courses	PEC
5	Humanities and Social Sciences including Management Courses	HSMC
6	Multidisciplinary Open Electives Courses	OEC
7	Value Added Courses	VAT
8	Project	PR
9	Practical Training	PT
10	Seminar	SM
11	Internship	INT
12	Mandatory Non-Credit Courses (Audit Course)	MC
13	Laboratory Courses	LC

General Notes:

1. Students will be required to obtain passing marks in Mandatory Non-Credit Courses.
2. Students will be allowed to use non programmable scientific calculator. However, sharing of calculator will not be permitted in the examination.
3. Students will be permitted to opt for any elective course run by the department. The choice of the students for any elective shall not be binding for the department to offer, if the department does not have expertise. To run the elective course a minimum of 1/3rd students of the class should opt for it.

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA JHAJJAR (HR.)

Scheme of Studies and Examinations

B. Tech (Mechanical Engineering) – 5th Semester

w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Schedule (Marks)				Exam Duration in H
				Lecture (L)	Tutorial (T)	Practical (P)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Professional Core Course	PCC-ME-301A	Solid Mechanics	3	1	0	4	4	40	60		100	3
2	Professional Core Course	PCC-ME-303A	Dynamics of Machines	3	1	0	4	4	40	60		100	3
3	Professional Core Course	PCC-ME-305A	Fluid Machines	3	0	0	3	3	40	60		100	3
4	Professional Core Course	PCC-ME-307A	Manufacturing Technology-II	3	0	0	3	3	40	60		100	3
5	Professional Elective Course	----------	**Refer Table 2**	3	0	0	3	3	40	60		100	3
6	Humanity Science & Management Courses	HSMC-02A	Economics for Engineers	3	0	0	3	3	40	60		100	3
7	Professional Core Course	LC-ME-319A	Dynamics of Machines Lab	0	0	2	2	1	25		25	50	-
8	Professional Core Course	LC-ME-321A	Fluid Machines Lab	0	0	2	2	1	25		25	50	-
9	Professional Core Course	LC-ME-323A	Manufacturing Technology-II Lab	0	0	2	2	1	25		25	50	-
10	Practical Training	PT-ME-325A	Practical Training -I	0	0	2	2	1	50			50	-
Total Credits								**24**				**800**	

Note: Assessment of Practical Training will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc.

Table 2: Professional Elective Courses-II

Sr. No.	Course Code	Course Name
1	PEC-ME-309A	Solar Energy Engineering
2	PEC-ME-311A	Mechanical Vibrations
3	PEC-ME-313A	Material Characterization Methods
4	PEC-ME-315A	Metrology and Quality Control
5	PEC-ME-317A	Operations Research
6		Any one of the MOOCs not studied earlier and of equal credits (3)

Note: Students have to select any one course from the above list, provided that the course has not been studied earlier.

GANGA INSTITUTE OF TECHNOLOGY AND MANAGEMENT, KABLANA, JHAJJAR (HR.)

Scheme of Studies and Examinations

B. Tech (Mechanical Engineering) – 6th Semester

w.e.f. 2026-27

Sr. No.	Category	Course Code	Course Title	Hours per week			Total Load Per Week	Credits	Examination Schedule (Marks)				Exam Duration in H
				Lecture (L)	Tutorial (T)	Practical (P)			Assessment	End Semester Examination		Total	
										Theory	Practical		
1	Professional Core Course	PCC-ME-302A	Design of Machine Elements-I	3	1	0	4	4	40	60		100	3
2	Professional Core Course	PCC-ME-304A	Heat Transfer	3	1	0	4	4	40	60		100	3
3	Professional Core Course	PCC-ME-306A	Internal Combustion Engine and Gas Turbine	3	0	0	3	3	40	60		100	3
4	Professional Core Course	PCC-ME-308A	Mechanical Measurements	3	0	0	3	3	40	60		100	3
5	Professional Elective Course	----------	**Refer Table 3**	3	0	0	3	3	40	60		100	3
6	Open Elective Course	----------	**Refer Table 4**	3	0	0	3	3	40	60		100	3
7	Professional Core Course	LC-ME-320A	Heat Transfer Lab	0	0	2	2	1	25		25	50	-
8	Professional Core Course	LC-ME-322A	Mechanical Measurement Lab	0	0	2	2	1	25		25	50	-
9	Professional Core Course	LC-ME-324A	Internal Combustion Engine Lab	0	0	2	2	1	25		25	50	-
10	Seminar	SM-ME-326A	Seminar	0	0	2	2	1	50			50	-
11	Mandatory Non-Credit Course	MC-301A	Essence of Indian Traditional Knowledge	2	0	0	2		40	60			3
								Total Credits	**24**			**800**	

Note: At the end of 6th semester, each student has to undergo Practical Training of 4/6 weeks in the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc. and its evaluation shall be carried out in the 7th Semester. Assessment of Practical Training will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc.

Table 3: Professional Elective Courses – III

Sr. No.	Course Code	Course Name
1	PEC-ME-310A	Gas Dynamics and Jet Propulsion
2	PEC-ME-312A	Industrial Robotics
3	PEC-ME-314A	Quality Engineering
4	PEC-ME-316A	Smart Materials
5	PEC-ME-318A	Plant Maintenance Engineering
6		Any one of the MOOCs not studied earlier and of equal credits (3)

Note: Students have to select any one course from the above list, provided that the course has not been studied earlier.

Table 4: Open Elective Courses – I

Sr. No.	Course Code	Course Title	Offered by	Departments Eligible to Choose the Course
1	OEC-01A	Engineering Ethics	Department of Electronics and Communication Engineering	All Engineering Departments
2	OEC-02A	Waste Management	Department of Civil Engineering	All Engineering Departments except the Department of Civil Engineering
3	OEC-03A	Internet of Things and Edge Computing	Department of Computer Science and Engineering	All Engineering Departments
4	OEC-04A	Project Management	Department of Mechanical Engineering	All Engineering Departments
5	OEC-05A	Renewable Energy Resources	Department of Electrical Engineering	All Engineering Departments
6	OEC-06A	United Nation's Sustainable Development Goals	Department of Electronics and Communication Engineering	All Engineering Departments
7	OEC-07A	Computer Aided Risk Analytics	Department of Fire Technology and Safety	All Engineering Departments
8	OEC-08A	Health, Safety and Environment	Department of Fire Technology and Safety	All Engineering Departments except the Department of Fire Technology and Safety
9	OEC-09A	Fundamentals of Additive Manufacturing	Department of Mechanical Engineering	All Engineering Departments except the Department of Mechanical Engineering
10	----------	MOOCs offered through SWAYAM, SWAYAM Plus, or NPTEL platforms	Online Platforms	All Engineering Departments

Note: Students have to select any one course from the above list, provided that the course has not been studied earlier.

Course Code	**PCC-ME-301A**				
Category	Professional Core Courses				
Course Title	**Solid Mechanics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To introduce the fundamental concepts and properties of materials. • To know the relationship between force, stress, and displacement. • To compute the stresses and deflections in structural and machine elements. • To study the behavior and response of a body under different loading conditions.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define fundamental concepts and properties of materials.	L1: Remember
CO2	Explain the theorems and governing equations of solid mechanics.	L2: Understand
CO3	Apply appropriate methods to solve numerical problems related to structural elements.	L3: Apply
CO4	Analyze the behaviour and response of a body under different loading conditions.	L4: Analyze

Note: The Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each, and the remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Strain Energy & Resilience**: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's theorem & Maxwell's reciprocal theorem, Numerical. **Theories of Elastic Failure**: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading, Numerical.
Unit-II	**Unsymmetrical Bending**: Properties of beam cross section, product of inertia, ellipse of inertia, slope of the neutral axis, stresses & deflections, shear center and the flexural axis Numerical. **Springs**: Stresses in close coiled and open coiled helical spring subjected to axial loads and twisting couples, leaf springs, flat spiral springs, concentric springs, Numerical.
Unit-III	**Thin Pressure Vessels**: Hoop & Longitudinal stresses & strains in cylindrical & spherical vessels & their derivations under internal pressure, wire would cylinder, Numerical. **Thick Pressure Vessels**: Derivation of Lame's equations, Radial & Hoop Stresses in compound spherical shells subjected to internal fluid pressure only, wire wound cylinders, hub shrunk on solid shaft, Numerical.

Unit-IV	**Bending of Curved Bars**: Stresses in bars of initial large radius of curvature, bars of initial small radius of curvature, stresses in crane hooks, rings of circular & trapezoidal sections, deflection of curved bars & rings, deflection of rings by Castigliano's theorem stresses in simple chain link, deflection of simple chain links, Problems.

Suggested Readings:

1. Strength of Materials – G.H. Ryder; Macmillan, India.
2. Strength of Materials – U.C. JINDAL; Pearson India
3. Strength of Materials – Sadhu Singh; Khanna Publishers
4. Book of Solid Mechanics – Kazmi; Tata Mc Graw Hill
5. Strength of Materials – D.S. Bedi; S. Chand & Co. Ltd.

Web References:

1. https://nptel.ac.in/courses/112102284
2. https://www.youtube.com/playlist?list=PLwdnzlV3ogoXCA3yBWCfaOqIQWLKLkePI
3. https://youtu.be/TsgxnU9KE5g?si=obzrbAR_ulSL92mf
4. https://youtu.be/P8dnia5x5dU?si=IBG8E0LbEC5WRl09

Course Code	**PCC-ME-303A**				
Category	Professional Core Courses				
Course Title	**Dynamics of Machines**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To introduce the student with fundamental knowledge of the dynamics of machines. • To provide fundamental knowledge of the dynamics of machines to solve problems of transmissibility of forces, isolation of systems, and vibrations. • To develop knowledge of analytical and graphical methods for calculating the balancing of rotary and reciprocating masses. • To learn the special purpose mechanisms used in designing a machine.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the concepts and basic terminologies of the dynamics of Machines.	L1: Remember
CO2	Explain the principles of force analysis, balancing, governors, gyroscopic effects, and dynamic behavior of machine systems.	L2: Understand
CO3	Apply the principles of dynamics of machines to solve problems related to forces, motion, and performance of mechanical systems.	L3: Apply
CO4	Analyze the dynamic behaviour and performance characteristics of machine systems.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Static and Dynamic Force Analysis**: Static and dynamic force analysis of planer mechanisms, including inertia and frictional forces of planer mechanisms, turning moment diagrams and flywheel applications. **Dynamics of Reciprocating Engines**: engine types, indicator diagrams, gas forces, equivalent masses, inertia forces, bearing loads in a single cylinder engine, crankshaft torque, engine shaking forces.
Unit-II	**Balancing of Rotating Components**: Static and dynamic balancing, balancing of rotating masses, two plane balancing, graphical and analytical methods, balancing of rotors, balancing machines, field balancing. **Balancing of Reciprocating Parts**: Balancing of single cylinder engine, balancing of multi cylinder, inline, radial and V type engines, firing order.

Unit-III	**Governors**: Introduction, types of governors, characteristics of centrifugal governors, gravity controlled and spring controlled centrifugal governors, hunting of centrifugal governors, inertia governors. Introduction to electronic governors and modern speed control systems. **Dynamometers**: Types of dynamometers, Prony brake, rope brake and band brake dynamometers, belt transmission dynamometer, torsion dynamometer, hydraulic dynamometer. Applications in engine testing and performance analysis.
Unit-IV	**Gyroscope**: Gyroscopes, gyroscopic forces and couples, gyroscopic stabilization, ship stabilization, stability of four wheel and two-wheel vehicles moving on curved paths. **Rotor Dynamics:** Introduction to rotor dynamics, critical speed of shafts, whirling of shafts, balancing of flexible rotors and applications in turbines and rotating machinery.

Suggested Readings:

1. Theory of Machines- R S Khurmi & J K Gupta; S Chand.
2. Theory and Machines- S.S. Rattan; Tata McGraw-Hill.
3. Theory of Mechanisms and Machines- Amitabha Ghosh and Ashok Kumar Malik, East-West Press.
4. Theory of Machines and Mechanisms- Joseph Edward Shigley, John Joseph Uicker; MGH, New York.
5. Mechanism and Machine Theory- J.S. Rao and R.V. Dukkipati, Second Edition, New Age International.
6. Theory of Machines- Beven, Pearson Indian Education Service Pvt. Ltd. India.

Web References:

1. https://nptel.ac.in/courses/112104114
2. https://nptel.ac.in/courses/112101096
3. https://youtu.be/p075LPq3Eas?si=fwUbiqsgFJznSDxP

Course Code	**PCC-ME-305A**				
Category	Professional Core Courses				
Course Title	**Fluid Machines**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce to working principles and construction details of hydraulic machines • To learn governing equations and hydraulic principles to solve the hydraulic engineering problems. • To enable students to analyze the performance of hydraulic turbines. • To impart knowledge of design aspects of impulse and reaction turbines.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define & list various components of fluid machines.	L1: Remember
CO2	Describe construction and working principles of hydraulic machines & systems.	L2: Understand
CO3	Apply governing equations and principles to solve fluid machines problems.	L3: Apply
CO4	Analyze the performance characteristics of various hydraulic machines.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Impact of jets**: Impulse–momentum principle, jet impingement on stationary and moving plates and vanes, jet propulsion of ships, applications in hydraulic systems. Numerical problems. **Impulse turbines**: Classification of turbines, Pelton wheel construction and operation, governing mechanisms, work done, effective head, available head, efficiency, design parameters, performance characteristics and applications in hydroelectric power plants, Problems.
Unit-II	**Francis turbines**: Construction, operation, governing mechanism, work done, design parameters, performance characteristics and applications, Problems. **Propeller and Kaplan turbines**: Construction, operation, governing of reaction turbines, draft tubes and their functions, performance characteristics, governing of reaction turbine, introduction to modern turbines such as Deriaz, Bulb and Tubular turbines, Problems.
Unit-III	**Dimensional Analysis and Model Similitude**: Dimensional homogeneity, Rayleigh's method, Buckingham π theorem, model studies and similitude, dimensionless numbers and their significance. Unit quantities. Numerical problems. **Centrifugal pumps**: Classification, velocity triangles and work done, manometric efficiency, vane shape, head capacity relationship and pump losses, pressure rise in impeller, minimum starting speed, design considerations, multistage pumps, cavitation, performance characteristics and applications in industrial systems, Problems.

Unit-IV	**Reciprocating Pumps**: Construction and operational details, discharge coefficient, volumetric efficiency and slip, work and power input, indicator diagrams, air vessels and their utility, rate of flow into or from the air vessel, maximum speed of the rotating crank, characteristic curves, centrifugal vs reciprocating pumps, brief introduction to screw, gear, vane and radial piston pumps, Problems. **Hydraulic systems**: Function, construction and operation of Hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic lift and hydraulic press, Fluid coupling and torque converter, Hydraulic ram, Problems.

Suggested Readings:

1. Fluid Mechanics and Hydraulic Machines – S S Rattan; Khanna Publishers.
2. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas; Tata McGraw Hill.
3. Fluid Mechanics and Fluid Power Engineering – D S Kumar; S K Kataria and Sons.
4. Hydraulics & Fluid Mechanics – Modi & Seth; Standard Book House, New Delhi.
5. Fluid Mechanics and Hydraulic Machines – R.K. Bansal; Laxmi Publications.

Web References:

1. https://nptel.ac.in/courses/112105206
2. https://nptel.ac.in/courses/112105182
3. https://www.youtube.com/@fluidmachines5626/videos

Course Code	**PCC-ME-307A**				
Category	Professional Core Courses				
Course Title	**Manufacturing Technology-II**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To understand the mechanics of metal cutting and tool behavior. • To study conventional, unconventional, and NC machining processes. • To learn jigs, fixtures, CNC programming, and machining systems. • To understand group technology and modern manufacturing concepts.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the basic concepts and terminology used in manufacturing and machining processes.	L1: Remember
CO2	Explain the working principles and operational characteristics of machining and manufacturing systems.	L2: Understand
CO3	Apply machining principles, CNC programming methods, and tooling concepts for manufacturing applications.	L3: Apply
CO4	Analyze machining performance and manufacturing systems for improving productivity and quality.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Mechanism of Metal Cutting**: Mechanics of metal cutting, chip formation, built-up edges, orthogonal and oblique cutting, Merchant cutting force circle and shear angle relationship in orthogonal cutting, factors affecting tool forces, cutting speed, feed and depth of cut, surface finish. temperature distribution at tool chip interface. Numerical. **Cutting Tool Materials & Cutting Fluids**: Characteristics of tool materials, various types of cutting tool materials, coated tools, cutting tool selection, types of tool wear, tool life, factors governing tool life, purpose and types of cutting fluids, basic actions of cutting fluids, effect of cutting fluid on tool life, selections of cutting fluid.
Unit-II	**Unconventional Machining Processes**: Abrasive jet machining, ultrasonic machining, electrochemical machining and grinding, electric discharge machining, electron beam machining, laser beam machining: principles, plasma arc machining, ion beam machining, water jet machining, hot machining, chemical machining, process parameters, advantages, limitations and applications. **Jigs & Fixtures**: Introduction, location and location devices, clamping and clamping devises, drill jigs, milling fixtures and tooling applications.

Unit-III	**Numerical Control of Machine Tools:** Introduction, Numerical Control & its growth, NC Machines tools, Axes of NC Machines, Classification of NC System, CNC, DNC and Machining Centre. Machine Control unit, NC tools & Tool changer. **Manual Part Programming**: Coordinate systems, feed, speed, tool function, preparation & miscellaneous functions, G and M codes for turning and milling operations.
Unit-IV	**Group Technology:** Definition and concept, component classification and coding systems, Group Technology layout, working of group technology, stages for adopting group technology, advantages of Group Technology. **Modern Manufacturing System**: Process planning, computer aided process planning (CAPP), lean manufacturing and quality concepts in manufacturing systems.

Suggested Readings

1. Manufacturing Technology Vol. - 2, P.N. Rao, T.M.H, New Delhi
2. Computer Aided Manufacturing: S Kumar & B Kant Khan, Satya Prakashan, New Delhi.
3. Principles of Machine Tools G.C. Sen & A. Bhattacharya, Tata McGraw Hill, New Delhi
4. Manufacturing Engineering & Technology- Serope Kalpakian, Pearson.
5. Modern Machining Processes- P.C. Pandey & H.S. Shan, T.M.H. Company, New Delhi
6. A course in Workshop Technology Vol-2 (Machine Tools)- B.S. Raghuwanshi, Dhanpat Rai & Co.

Web Reference:

1. https://nptel.ac.in/courses/112104290
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_me05
3. https://www.youtube.com/watch?v=7yzvno4AvKw
4. https://nptel.ac.in/courses/112105211
5. https://onlinecourses.nptel.ac.in/e-learning/preview/noc19_me46
6. http://www.digimat.in/nptel/courses/video/112104289/L28.html
7. https://nptel.ac.in/courses/112107078

Course Code	**PEC-ME-309A**				
Category	Professional Core Courses				
Course Title	**Solar Energy Engineering**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	**0**	**0**	**3**	
Course Objectives	The objectives of this course are • To learn the basic principles of solar energy and solar radiation. • To study solar thermal and solar photovoltaic systems and their applications. • To emphasize on the performance of solar heating, cooling, and power generation systems. • To know the environmental and economic benefits of solar energy systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the basic concepts of solar energy systems.	L1: Remember
CO2	Explain the fundamentals, principles and components of solar energy systems.	L2: Understand
CO3	Apply the principles of solar energy for energy conversion and utilization.	L3: Apply
CO4	Analyze the performance, environmental impact, and economic aspects of solar energy systems.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Solar Radiation:** Introduction to solar energy, solar system, sun-earth relationship, solar angles, solar time, solar radiation geometry, solar constant, estimation of beam and diffuse solar radiation, measurement of solar radiation using pyrheliometers and other devices. **Effect of Solar radiation upon structures:** Solar radiation properties of surfaces, absorptivity, reflectivity and transmissivity, steady and periodic heat transfer through walls and roofs, shading devices and solar heat gain.
Unit-II	**Solar Thermal Collectors:** Flat plate collectors, concentrating collectors, comparative study, materials and construction, selective coatings, collector efficiency, heliostats. **Heating Applications of Solar Energy:** Solar water heating systems, solar air heaters, thermal energy storage, solar ponds, solar cookers, solar drying of grains, solar pumping systems and industrial process heating.

Unit-III	**Cooling Applications of Solar Systems:** Solar refrigeration principles, Continuous and intermittent vapor absorption refrigeration systems, absorbent–refrigerant combinations, adsorption refrigeration systems, coefficient of performance (COP). **Passive Solar Systems:** Passive cooling and heating techniques, natural ventilation, evaporative cooling, thermal insulation, thermal mass, Trombe wall, passive solar building concepts and energy-efficient buildings
Unit-IV	**Solar Electric Conversion Systems:** Photovoltaic effect, solar cells and modules, types of solar cells, characteristics of PV systems, batteries, charge controllers, inverters, standalone and grid-connected PV systems, solar lighting systems. **Environmental Aspects:** Environmental impacts of conventional energy systems, greenhouse effect, global warming, ozone layer depletion, carbon reduction through renewable energy, economic analysis of solar energy systems, renewable energy policies and international initiatives.

Suggested Readings:

1. Solar Energy – S P Sukhatme, Tata McGraw Hill
2. Solar Energy Process – Duffie and Bechman, John Wiley
3. Applied Solar Energy – Meinel and Meinel, Addison Wiley
4. Solar Energy: Fundamentals and Applications – R P Garg and Jai Prakash, TMH.

Web Reference:

1. https://nptel.ac.in/courses/115103123
2. https://nptel.ac.in/courses/112104300
3. https://nptel.ac.in/courses/112105050

Course Code	**PEC-ME-311A**				
Category	Professional Elective Courses				
Course Title	**Mechanical Vibrations**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are to make the students • To introduce to fundamental concepts of mechanical vibration. • To provide knowledge of vibration control, isolation, balancing, and resonance prevention in machines and structures. • To familiarize students with multi-degree freedom systems, numerical methods, and critical speed analysis of rotating shafts. • To develop the ability to analyze free, damped, and forced vibrations in engineering systems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts of mechanical vibrations.	L1: Remember
CO2	Explain the free, damped, forced, and multi-degree freedom vibration systems.	L2: Understand
CO3	Apply vibration principles and numerical methods to determine vibration response and critical speeds of mechanical systems.	L3: Apply
CO4	Analyze vibration behavior, isolation systems, and vibration measurement techniques for engineering applications.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Introduction & Importance of Mechanical Vibration**: Brief history of Mechanical Vibration, Types of Vibration, Simple Harmonic Motion (S.H.M.), Principle of superposition applied to S.H.M., Concept of degree of freedom for different vibrating systems, elements of vibratory system. **Undamped Free Vibrations of Single Degree Freedom Systems**: Derivation of differential equation of motion: the energy method, the method based on Newton's second law of motion, and Rayleigh's method. Solution of differential equation of motion: Natural frequency of vibration. Systems involving angular oscillations: the compound pendulum.
Unit-II	**Damped Free Vibration of Single Degree Freedom Systems:** Viscous damping: coefficient of damping; damping ratio; under damped, over damped and critically damped systems; logarithmic decrement; frequency of damped free vibration. **Forced Vibration of Single Degree Freedom Systems:** Steady state forced vibration, sources of excitation, impressed harmonic force, resonance, impressed force due to rotating unbalance, base excitation, transmissibility and isolation, performance of different type of isolators, power absorbed by viscous damping.

Unit-III	**Two-degree Freedom Systems**: Introduction to Multi-Degree of Freedom Systems, Normal Mode Vibrations, Coordinate Coupling, Principal Coordinates, Free Vibrations in Terms of Initial Conditions, Forced Harmonic Vibrations, Vibration Absorber, Centrifugal Vibration Absorber, Vibration Damper. **Multi degrees of Freedom Systems and Numerical Methods:** Introduction, Influence Coefficients, Stiffness Matrix, Flexibility Matrix, Natural Frequencies and Normal Modes, Orthogonality of Normal Modes, Dunkerley's Equation, Method of Matrix Iteration, The Holzer Type Problem, Geared and Branched Systems, Beams.
Unit-IV	**Whirling of shafts**: Critical speeds of shafts – Critical speed of a light shaft having a single disc – without damping and with damping. Critical speed of a shaft having multiple discs – secondary critical speed. **Vibration measurement and Applications**: Piezoelectric transducers and linear variable differential transformer transducer; Vibration pickups: Vibrometer, Accelerometer, Vibration exciters- Mechanical exciters, impact hammer and electrodynamic shaker.

Suggested Readings:

1. Mechanical Vibrations- G. K. Grover, Nem Chand & Bros.
2. Mechanical Vibrations- Dr. V.P. Singh, Dhanpat Rain & Co.
3. Mechanical Vibrations- SS Rao, Pearson
4. Theory and Practice of Mechanical Vibrations- J.S. Rao and K. Gupta, Wiley Eastern Ltd.
5. Theory of Vibration with Applications- William T. William Thomson, CRC Press

Web References:

1. https://nptel.ac.in/courses/112103111
2. https://youtu.be/tJNaPt5aPmg?si=beDymd9LotwGbtGL
3. https://youtu.be/nWM5gg3SkEI?si=Drf3Xxqnngbzsxlc
4. https://www.youtube.com/watch?v=bX_m53Xexvk&list=PLAC668A0566953FB5

Course Code	**PEC-ME-313A**				
Category	Professional Elective Courses				
Course Title	**Material Characterization Methods**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are to make the students • To introduce the fundamental concepts of materials characterization techniques. • To understand different structural, chemical, thermal, mechanical, and surface characterization methods. • To study microscopy techniques and specimen preparation methods for material analysis. • To analyze material behavior using mechanical characterization and testing methods.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define fundamental concepts, terminology, and characterization techniques used for engineering materials.	L1: Remember
CO2	Explain the principles and mechanical characterization methods for materials.	L2: Understand
CO3	Apply characterization techniques, specimen preparation and testing methods for exploring material properties and behavior.	L3: Apply
CO4	Analyze the structure–property relationship and mechanical performance of materials using characterization techniques.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Materials Characterization:** Introduction to materials characterization and its significance in engineering, Objectives and scope of characterization techniques, Structure–property relationship of materials. **Types of characterization:** Structural, chemical, thermal, mechanical, and surface characterization, their advantages, limitations and applications, Specimen preparation technique.
Unit-II	**Optical Microscopy Techniques: -** Introduction to Microscope and their importance in Material Characterization, Optical microscopy: construction, working principle, magnification, and applications, Metallographic sample preparation and etching. **Electron Microscopy Techniques:** Scanning Electron Microscopy (SEM): principle, instrumentation, and applications, Transmission Electron Microscopy (TEM): working principle and applications, Comparison of optical microscopy, SEM, and TEM.
Unit-III	**Fundamentals of Mechanical Testing:** Introduction to Mechanical Characterization of Materials, Significance and Objectives of Mechanical Testing, Mechanical Properties of Materials. **Tensile & Compression Testing**: Principle, Specimen Standards, Testing Procedure, Stress–Strain Curve, Compression Testing: Principle, Specimen Preparation, Procedure and Applications.

Unit-IV	**Hardness Characterization Methods:** Hardness Testing: Introduction and Importance, Brinell Hardness Test, Rockwell Hardness Test, Vickers Hardness, Principle, Procedure, Advantages and Limitations of Hardness Test. **Impact Characterization Methods:** Izod and Charpy Impact Tests: Principle, Specimen Geometry, Testing Procedure, Comparison between Izod and Charpy impact tests, Applications of impact testing in material selection.

Suggested Readings:

1. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods – Yang Leng, Second Edition, Wiley India.
2. Strength Materials Science and Engineering: An Introduction – William D. Callister Jr. & David G. Rethwisch, Wiley India.
3. Materials Characterization Techniques – Sam Zhang, Lin Li & Ashok Kumar, CRC Press.
4. Book Mechanical Metallurgy – George E. Dieter, McGraw Hill Education.

Web References:

1. https://nptel.ac.in/courses/113104004
2. https://nptel.ac.in/courses/102108082
3. https://www.youtube.com/watch?v=0I9uZMR-9x0
4. https://www.youtube.com/watch?v=rAMBnTfXaao

Course Code	**PEC-ME-315A**				
Category	Professional Elective Courses				
Course Title	**Metrology and Quality Control**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	**3**	
Course Objectives	The objectives of this course are to make the students • To introduce basic concepts of metrology and quality control • To understand measurement and inspection techniques. • To apply quality control tools and methods • To study quality performance and process control systems				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Define concepts of metrology and quality control.	L1: Remember
CO2	Explain the measurement systems, inspection, control charts, inspections and quality concepts.	L2: Understand
CO3	Apply measurement, inspection, and statistical quality control methods for inspection and quality evaluation.	L3: Apply
CO4	Analyzing the quality performance and measurement systems for manufacturing applications.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Fundamentals of Metrology and Measurement Systems:** Definition, objectives, and significance of metrology, Standards of measurement: International, primary, secondary, and working standards, Elements of measurement systems, Accuracy, precision, sensitivity, repeatability, reproducibility, and calibration. **Linear and Angular Measurements:** Linear measuring instruments: steel rule, vernier calliper, micro-meter, slip gauges, Angular measurement instruments: bevel protractor, sine bar, angle gauges, Limits, fits, and tolerances, Interchangeability and standardization, Errors in measurement.
Unit-II	**Inspection Planning and Quality Influencing Factors:** Planning of inspection, Selection of product characteristics to be inspected, determination of inspection stages, selection of inspection locations, Types of inspection: remedial inspection, preventive inspection, and operative inspection, Inspection at various stages including incoming inspection, in-process inspection, and final inspection. **Statistical Quality Control:** Basic statistical concepts, empirical distribution and histograms, frequency, mean, mode, standard deviation, normal distribution, binomial and Poisson.
Unit-III	**Quality Concepts and Quality Management:** Definition and dimensions of quality, Quality planning, quality assurance, and quality control, Evolution of quality concepts, Quality costs and quality management principles. **Modern Quality Concepts:** Concept of total quality management (TQM), ISO-9000, concept and its evolution, QC tools, Introduction to Kaizen, 5S.

Unit-IV	**Control charts and sampling:** Introduction to control charts, namely X, R, P and C charts and their applications, Sampling plans, selection of sample size, method of taking samples, frequency of samples. **Quantities Measurement:** Measurement of mechanical quantities such as displacement, vibration, frequency, pressure temperature by electro mechanical transducers of resistance, capacitance & inductance type.

Suggested Readings:

1. Engineering Metrology and Measurements – N.V. Raghavendra and L. Krishnamurthy, Oxford University Press
2. Engineering Metrology – R.K. Jain, Khanna Publishers.
3. Mechanical Measurements and Instrumentation – R.K. Rajput, S. Chand & Co. Ltd.
4. Mechanical Measurements – Beckwith, Marangoni and Lienhard, Pearson Education

Web References:

1. https://nptel.ac.in/courses/112106179
2. http://www.digimat.in/nptel/courses/video/112106179/L08.html
3. https://www.youtube.com/watch?reload=9&v=YHu-6HSP-V4
4. http://www.digimat.in/nptel/courses/video/110104080/L34.html

Course Code	**PEC-ME-317A**				
Category	Professional Elective Courses				
Course Title	**Operations Research**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	3	
Course Objectives	The objectives of this course are • To learn the importance of Operations Research in the design, planning, scheduling, manufacturing and business applications. • To provide knowledge of linear programming, transportation, assignment, queuing, simulation, and project management models for industrial applications. • To equip students to use the resources such as capitals, materials, productions, controlling, directing, staffing, and machines more effectively. • To enhance analytical and problem-solving skills for effective resource utilization, planning, scheduling, and decision-making under different environments.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	**Skills Demonstrated**	**RBT Level**
CO1	Define the basic concepts and applications of operations research.	L1: Remember
CO2	Explain the operational research models and optimization techniques used for decision-making and resource management.	L2: Understand
CO3	Apply operations research techniques and algorithms to solve industrial and management problems.	L3: Apply
CO4	Analyze and select the suitable mathematical and techniques for modeling, optimizing and decision-making in industrial systems.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (preferably 2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	**Contents**
Unit-I	**Introduction:** Definition, role of operations research in decision-making, applications in industry. Concept on O.R. model building –Types & methods. **Linear Programming (LP)**: Definition and formulation of LPP, graphical, simplex Gauss-Jordan reduction process in simplex methods, BIG-M method. Numerical problems.
Unit-II	**Deterministic Model**: Transportation models-balanced & unbalanced, North-West rule, Vogel's approximation method, least cost method, stepping stone method, MODI methods, degeneracy, assignment, traveling salesman. Numerical problems. **Advanced Topic of LP**: Duality, Primal-Dual relationships & solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems.

Unit-III	**Waiting Line Models**: Introduction to queuing theory, queue parameters, M/M/1 queue, performance of queuing systems, applications in industries, problems. **Project Line Models**: Network diagrams, events and activities, defects in network construction, PERT & CPM, floats in networks, variance and probability of project completion time, project costs-direct, indirect and total cost, optimal project cost by crashing of network, resource leveling in project, problems.
Unit-IV	**Simulation**: Introduction to simulation, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, problems. **Decision Theory**: Decision process, Simon's model, decision-making environment- certainty, risk, uncertainty, decision making with utilities, numerical problems.

Suggested Readings:

1. Operations Research - P K Gupta, D S Hira, S Chand Publishers.
2. Operation Research: Theory and Applications - J K Sharma, MacMillan
3. Introduction to O.R - Hiller & Lieberman, Tata McGraw Hill
4. Principles of Operations Research - Wagner, PHI Publications.
5. Operations Research: An Introduction - Hamdy A. Taha, Peason

Web References:

1. https://nptel.ac.in/courses/110106062
2. https://nptel.ac.in/courses/111107128
3. https://nptel.ac.in/courses/112106134
4. https://youtu.be/a2QgdDk4Xjw?si=tcYJEm2CVvLzPvTx

Course Code	**HSMC-02A**				
Category	Humanities and Social Science including Management Courses				
Course Title	**Economics for Engineers**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	3	0	0	3	
Course Objectives	The objectives of this course are • Introduce the basic concepts of economics and their relevance to science, engineering, and national development. • Develop a foundational understanding of microeconomic principles such as demand, supply, production, cost, and market structures. • Equip students with tools to apply economic reasoning to real-world pricing, output, and market decisions. • Familiarize students with macroeconomic elements like the Indian economy, banking system, privatization, and globalization.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total	100 Marks				
Duration of Exam	03 Hours				

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

COs	Skills Demonstrated	RBT Level
CO1	Describe economic concepts, the connection between economics with engineering and technological development, along with economic laws relevant to resource-based decision making in society.	L1: Remember
CO2	Explain economic growth theories and illustrate the role of engineering and technology in supporting economic development.	L2: Understand
CO3	Apply theories of consumption and production to the design and development of engineering products.	L3: Apply
CO4	Analyze market conditions, evaluate cost structures and financial aspects to assess the feasibility of engineering projects.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts of 1.5 marks each from all units and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Definition of Economics:** Various Definitions, Types of Economics, Micro and Macro Economics, Nature of Economic Problem, Production Possibility Curve, Economic Laws and their Nature, Relationship between Science, Engineering, Technology and Economic Development**.** **Demand:** Meaning of Demand, Law of Demand, Elasticity of Demand, Meaning, Factors affecting the Elasticity of Demand, Practical Application and Importance.

Unit-II	**Production:** Meaning of Production and Factors of production, Law of Variable Proportions, Returns to Scale, Internal and External Economies and Diseconomies of Scale, Various concepts of Cost of Production- Fixed Cost, Variable Cost, Money Cost, Real Cost, Accounting Cost, Marginal Cost, Opportunity Cost, Shape of Average Cost, Marginal Cost, Total Cost etc. in short run and long run.
Unit-III	**Market:** Meaning of Market, Types of Market- Perfect Competition, Monopoly, Monopolistic Competition and Oligopoly (main features). **Supply:** Supply and Law of Supply, Role of Demand and Supply in Price Determination and Effect of Changes in Demand and Supply on Prices.
Unit-IV	**Indian Economy:** Nature and Characteristics of Indian Economy as underdeveloped, developing and mixed economy (brief and elementary introduction). **Privatization:** Meaning, Merits and Demerits. **Globalization of the Indian Economy:** Merits and Demerits **Banking:** Concept of a Bank, Commercial Bank, Central Bank, Functions of a Bank, Difference between Commercial and Central Bank.

Suggested Readings:

1. Modern Microeconomics: Theory and Applications- H.L. Ahuja, S. Chand & Company Pvt. Ltd.
2. Indian Economy- S.K. Misra & V.K. Puri, Himalaya Publishing House.
3. Indian Economy: Principles and Policies- Sri Ram Srirangam, Manish Kumar, Rohit Deo Jha; Pearson Education.
4. Managerial Economics- R. Cauvery, S. Chand & Company Pvt. Ltd.
5. Microeconomic Theory- Andreu Mas-Colell, Michael D Whinston, Jerry R Green; Oxford University Press.
6. Principles of Economics- E Case Karl; C Fair Ray, Oster Sharon E, Pearson Education.

Web References:

1. https://youtu.be/IFtOcNbej0o?si=orQ9LrQH8kdlAHgn
2. https://www.youtube.com/watch?v=VU1zySe-8NA
3. https://www.youtube.com/watch?v=HylqSa58lqQ
4. https://youtu.be/ME-0GOhhZcs?si=Tl_z8CN0-bL_kPdH

Course code	**LC-ME-319A**				
Category	Professional Core Courses				
Course title	**Dynamics of Machines Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	0	0	2	1	
Course Objectives	The objectives of this course are ● To learn the performance characteristics, stability, and sensitivity of different types of governors. ● To study gyroscopic effects and determine gyroscopic couple in rotating systems. ● To perform static and dynamic balancing of rotating masses using balancing machines. ● To determine the moment of inertia of flywheel and connecting rod using experimental methods.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

CO	Skill Demonstrated	RBT Level
CO1	Determine the effect of gyroscopic couple at different speeds.	L3: Apply
CO2	Determine the moment of inertia using experiment methods.	L3: Apply
CO3	Analyze the performance and characteristic curves for different types of governors.	L4: Analyze
CO4	Evaluate static and dynamic balancing of rotating masses.	L5: Evaluate

List of Experiments

Sr. No.	Content	COs
1	To draw performance characteristic curves, and find stability & sensitivity of Watt Governor.	**CO3**
2	To draw performance characteristic curves, and find stability & sensitivity of Porter Governor.	**CO3**
3	To draw performance characteristic curves, and find stability & sensitivity of Proell Governor.	**CO3**
4	To draw performance characteristic curves, and find stability & sensitivity of Hartnell Governor.	**CO3**
5	To perform experiments on gyroscopic effects using demonstration models.	**CO1**
6	To determine gyroscopic couple on Motorized Gyroscope.	**CO1**
7	To carry out static balancing on static balancing machine.	**CO4**
8	To carry out dynamic balancing on dynamic balancing machine.	**CO4**
9	To determine the moment of inertia of a flywheel.	**CO2**
10	Determine the moment of inertial of connecting rod by compound pendulum method.	**CO2**
11	Determine the moment of inertial of connecting rod by trifilar suspension pendulum.	**CO2**

Note: At least ten experiments are to be performed. Eight experiments should be from the above list and remaining two experiments may either be performed from the above list or as per the scope of the syllabus.

Web Reference:

1. https://dom-nitk.vlabs.ac.in/List%20of%20experiments.html

Course code	**LC-ME-321A**				
Category	Professional Core Courses				
Course title	**Fluid Machines Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	0	0	2	1	
Course Objectives	The objectives of this course are • To study the construction and working of turbines, pumps and hydraulic systems. • To understand hydro power plant layout and fluid machinery applications. • To determine the operating performance and efficiencies of hydraulic systems. • To evaluate the performance characteristics of hydraulic turbines and pumps.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

CO	Skill Demonstrated	RBT Level
CO1	Explain the construction details, working principle and fluid flow circuit of fluid machines.	L3: Apply
CO2	Demonstrate centrifugal and reciprocating pump and draw their characteristics curves.	L3: Apply
CO3	Determine the performance parameters and efficiencies of hydraulic devices.	L3: Apply
CO4	Analyze the performance characteristics of hydraulic turbines.	L4: Analyze

List of Experiments

Sr. No.	Content	COs
1	To study the constructional details of a Pelton turbine and draw its fluid flow circuit.	**CO1**
2	To draw the performance characteristics of Pelton turbine under constant head, constant speed and constant efficiency curves.	**CO4**
3	To study the constructional details of a Francis turbine and draw its fluid flow circuit.	**CO1**
4	To draw the performance characteristics of Francis turbine under constant head, constant speed and constant efficiency.	**CO4**
5	To study the construction details of a Kaplan turbine and draw its fluid flow circuit.	**CO1**
6	To draw the performance characteristics of Kaplan turbine under constant head, speed and efficiency curves.	**CO4**
7	To study the constructional details of a Centrifugal Pump and draw its characteristic curves.	**CO2**
8	To study the constructional details of a Reciprocating Pump and draw its characteristics curves.	**CO2**
9	To study the construction details of a Gear oil pump and its performance curves.	**CO3**
10	To study the constructional details of a Hydraulic Ram and determine its various efficiencies.	**CO3**
11	To study the constructional details of a Centrifugal compressor.	**CO2**

12	To study the model of Hydro power plant and draw its layout.	**CO1**

Note: At least ten experiments are to be performed. Eight experiments should be from the above list and remaining two experiments may either be performed from the above list or as per the scope of the syllabus.

Web Reference:

1. https://fmc-nitk.vlabs.ac.in/List%20of%20experiments.html
2. https://fm-iitk.vlabs.ac.in/List%20of%20experiments.html

Course code	**LC-ME-323A**				
Category	Professional Core Courses				
Course title	**Manufacturing Technology-II Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-V**
	0	0	2	1	
Course Objectives	The objectives of this course are ● To perform basic machining operations on conventional machine tools. ● To produce threads, gears, slots, and profiles accurately. ● To learn CNC programming functions and codes. ● To prepare CNC part programs for turning and milling operations.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

CO	Skill Demonstrated	RBT Level
CO1	Explain conventional and non-conventional machining processes.	L2: Understand
CO2	Perform operations on lathe, milling, shaping and drilling machines.	L3: Apply
CO3	Analyze CNC codes and part programming for operations on CNC lathe machines.	L4: Analyze
CO4	Analyze CNC codes and part programming for operations on CNC milling machines.	L4: Analyze

List of Experiments

Sr. No.	Content	COs
1	To study and practice of orthogonal & oblique cutting on a lathe.	**CO1**
2	To machine a groove in the given work piece using milling machine.	**CO2**
3	To perform V and Dovetail machining on the given workpiece on shaping machine.	**CO2**
4	To perform drilling, counter drilling and counter sinking on drilling machine.	**CO2**
5	To perform thread cutting on a lathe forming right hand and left-hand metric threads.	**CO2**
6	Study of CNC part programming codes: G-codes, M-codes and miscellaneous functions.	**CO1**
7	Part Programming and proving on a CNC lathe for facing and straight turning.	**CO3**
8	Part Programming and proving on a CNC lathe for step turning and taper turning.	**CO3**
9	Develop and execute a CNC lathe program for external thread cutting operation.	**CO3**
10	Part Programming and Proving on a CNC Milling Machine: (a) Point to Point Programming (b) Absolute Programming (c) Incremental Programming.	**CO4**
11	Part Programming and Proving for Milling a Rectangular Slot.	**CO4**
12	Develop and execute a CNC milling program for pocket milling.	**CO4**

Note: At least ten experiments are to be performed. Eight experiments should be from the above list and remaining two experiments may either be performed from the above list or as per the scope of the syllabus.

Web Reference:

1. https://fab-coep.vlabs.ac.in/exp/3d-machining/theory.html
2. https://mm-nitk.vlabs.ac.in/
3. https://vlabs.iitkgp.ac.in/vmp/exp2/index.html
4. https://mm2-nitk.vlabs.ac.in/Target%20Audience.html
5. https://www.youtube.com/watch?v=2Eponh3x1kc&t=437s

<table>
<tr><td>Course Code</td><td colspan="5">PT-ME-325A</td></tr>
<tr><td>Category</td><td colspan="5">Seminar</td></tr>
<tr><td>Course Title</td><td colspan="5">Seminar-I</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-V</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are to
• To introduce circuit simulation using industry-standard software tools for electronic analysis.
• To study technical documentation, engineering processes and industry standards in real-world projects.
• To demonstrate professional communication, time management and ethical practices in industrial settings.
• to analyze engineering problems and develop solutions using industry-standard tools and methodologies.</td></tr>
<tr><td>Assessment</td><td colspan="5">25 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">25 Marks</td></tr>
<tr><td>Total Marks</td><td colspan="5">50</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">03 Hours</td></tr>
</table>

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

COs	Skills Demonstrated	RBT Level
CO1	Describe the organizational structure, working environment, and industrial practices of the training organization.	L2: Understand
CO2	Apply engineering knowledge to understand real-time industrial processes, tools, equipment, and systems.	L3: Apply
CO3	Prepare and present a technical training report based on observations, learning, and industrial exposure.	L3: Apply
CO4	Analyze practical problems encountered during training and relate them to theoretical concepts studied in the curriculum.	L4: Analyze

Note:

1. Each student has to undergo practical training of 4/6 weeks during summer vacation and its evaluation shall be carried out in the V semester.
2. Assessment of Practical Training will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the Industry/ Institute/ Professional Organization/ Research Laboratory/ training center etc.

Course Code	**PCC-ME-302A**				
Category	Professional Core Courses				
Course Title	**Design of Machine Elements-I**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	1	0	4	
Course Objectives	The objectives of this course are • To introduce to the safety-critical design of machine components. • To learn the origins, nature and applicability of empirical design principles. • To study behavior of various members subjected to different types of loading. • To prepare students to solve real-world Design engineering problems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe concepts, philosophy & considerations of machine design.	L2: Understand
CO2	Calculate stresses induced in machine elements for different engineering applications.	L3: Apply
CO3	Analyze the behavior of various machine elements subjected to external loadings.	L4: Analyze
CO4	Design various machine components as per given specifications.	L5: Create

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Design Philosophy:** Problem identification, problem statement, Feasibility study covering technical, economic, financial, societal & environmental feasibility, Generation of solution field, Brainstorming, Selection of best possible solution, Preliminary design, Detailed design, Selection of Fits and tolerances and analysis of dimensional chains. **Selection of Materials:** Classification of engineering materials, mechanical properties of the commonly used engineering materials, hardness, strength characteristics, interpretation of stress–strain diagrams, Concept of Factor of safety in design.
Unit-II	**Threaded Joints and Power Screws:** ISO Metric Screw Threads, design of bolted joints under static axial, shear and eccentric loading conditions, Power Screws: Torque requirement for overcoming thread friction, efficiency of power screws, design of screw and nut **Welded Joints and Cotter Joints:** Types of welded joints, Design of various welded joints under different static load conditions, applications of cotter joint, design of socket and spigot cotter joints.
Unit-III	**Belt drives & Flywheel:** Flat & V-belt drives, Condition for Transmission of max. Power, Design of belt drives, Selection of belts, Flywheel: Turning Moment diagram, coefficient of fluctuation of energy and speed, design of solid disk & rimmed flywheels. **Keys and Couplings**: Sunk & Saddle keys, Feather, Woodruff, Kennedy Keys, Splines, Couplings design, Muff coupling, Clamp coupling, Rigid Flange Coupling, Bushed-Pin Flexible couplings.

Unit-IV	**Clutches:** Types of clutches, Torque transmitting capacity, Design of friction clutches, Single plate clutch, Multidisc clutch, Cone clutch & Centrifugal clutch, **Brakes:** Types of Brakes, Self energizing condition of brakes, Design of shoe brakes, Internal expanding brakes, Band brakes, Thermal Considerations in brake designing.

Suggested Readings:

1. Mechanical Engineering Design- Joseph Edward Shigley-MGH, New York
2. Design of Machine Elements- V.B. Bhandari, Tata McGraw Hill, New Delhi.
3. Engineering design- George Dieter, MGH, New York.
4. Machine Design- S.G. Kulkarni, Tata McGraw Hill
5. PSG Design Data Book.
6. Design Data Handbook for Mechanical Engineers- Mahadevan

Web References:

1. https://nptel.ac.in/courses/112105124
2. https://www.youtube.com/watch?v=oSKPirca1j4

Course Code	**PCC-ME-304A**				
Category	Professional Core Courses				
Course Title	**Heat Transfer**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	1	0	**4**	
Course Objectives	The objectives of this course are • To introduce students to the fundamental principles of heat transfer. • To provide solid understanding of conduction, convection, and radiation mechanisms. • To prepare students to solve real-world heat transfer problems.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, terminologies and laws of Heat Transfer.	L1: Remember
CO2	Explain conduction, convection, radiation, and phase change heat transfer mechanisms.	L2: Understand
CO3	Apply the laws & governing equations of heat transfer to solve the engineering problems.	L3: Apply
CO4	Analyze the performance of fins, heat exchangers, and heat transfer systems under different operating conditions.	L4: Analyze

Note: The Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each, and the remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Basics and Laws**: Definition of Heat Transfer, Modes of heat flow, Combined heat transfer system and law of energy conservation. **Steady State Heat Conduction**: Introduction, I-D heat conduction through a plane wall, long hollow cylinder, hollow sphere, Conduction equation in Cartesian, polar and spherical coordinate systems, Numerical.
Unit-II	**Steady State Conduction with Heat Generation**: Introduction, 1 – D heat conduction with heat sources, Extended surfaces (fins), Fin effectiveness 2-D heat conduction, Numerical. **Transient Heat Conduction**: Systems with negligible internal resistance, Transient heat conduction in plane walls, cylinders, spheres with convective boundary conditions, Chart solution, Relaxation Method, Numerical.
Unit-III	**Convection**: Forced Convection-Thermal and hydro-dynamic boundary layers, Equation of continuity, Momentum and energy equations, Some results for flow over a flat plate and flow through tube, Fluid friction and heat transfer (Colburn analogy), Free convection from a vertical flat plate, Empirical relations for free convection from vertical and horizontal o\planes & cylinders, Numerical. **Thermal Radiation**: The Stephen-Boltzmann law, The black body radiation, Shape factors and their relationships, Heat exchange between non-black bodies, Electrical network for radiative exchange in an enclosure of two or three gray bodies, Radiation shields, Numerical.

Unit-IV	**Heat Exchangers**: Classification, Performance variables, Analysis of a parallel/counter flow heat exchanger, Heat exchanger effectiveness, Numerical. **Heat Transfer with Change of Phase**: Laminar film condensation on a vertical plate, dropwise condensation, boiling regimes, Free convective, Nucleate and film boiling, Numerical.

Suggested Readings:

1. Heat and Mass Transfer — R. K. Rajput, S. Chand Publications.
2. Heat Transfer — Yunus A. Çengel and Afshin J. Ghajar, McGraw Hill.
3. Heat Transfer — J. P. Holman, McGraw Hill Education.
4. Heat Transfer — P. K. Nag, McGraw Hill Education.
5. Heat and Mass Transfer — Dr. D. S. Kumar, S. K. Kataria & Sons.

Web Reference:

1. https://nptel.ac.in/courses/112105771
2. https://nptel.ac.in/courses/103103031
3. https://nptel.ac.in/courses/112106315
4. https://nptel.ac.in/courses/112107211
5. https://nptel.ac.in/courses/112107256

Course Code	**PCC-ME-306A**				
Category	Professional Core Courses				
Course Title	**Internal Combustion Engines and Gas Turbines**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamentals of IC engines, classifications, and air standard cycles (Otto, Diesel, Dual cycles). • To familiarize with fuel supply systems, combustion processes, and ignition systems in S.I. and C.I. engines. • To learn lubrication, cooling systems, engine performance parameters, and testing methods. • To develop supercharging, gas turbine cycles, emission control techniques, and alternative fuels.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the basic concepts, components, systems, and performance parameters of I.C. engines and gas turbines.	L1: Remember
CO2	Explain the working and operating characteristics of various systems of I.C engine.	L2: Understand
CO3	Apply thermodynamic and engineering principles to solve problems related to I.C. engines and gas turbine systems.	L3: Apply
CO4	Analyze the effect of operating variables on the performance of I.C engines & gas turbines.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Introduction and Air Standard Cycles**: Internal and external combustion engines; classification of I.C. Engines, four stroke and two stroke I.C. Engines, Air standard cycles; Otto cycle; diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles; deviation of actual engine cycle from ideal cycle. Problems. **Carburetion, fuel Injection and Ignition systems**: Mixture requirements for various operating conditions in S.I. Engines; elementary carburetor, Requirements of a diesel injection system; types of inject systems; petrol injection, Requirements of ignition system; types of ignition systems ignition timing; spark plugs. Problems.
Unit-II	**Combustion in I.C. Engines**: Stages of combustion in S.I. Engines; factors affecting the ignition lag and velocity of flame propagation; detonation; effects of engine variables on detonation; theories of detonation; octane rating of fuels; pre-ignition; stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.

	Lubrication and Cooling Systems: Functions of a lubricating system, Types of lubrication system; mist, wet sump and dry sump systems; properties of lubricating oil; SAE rating of lubricants, engine performance and lubrication, Necessity of engine cooling; disadvantages of overcooling; cooling systems; air-cooling, water cooling; radiators.
Unit-III	**Engine Testing and Performance**: Performance parameters, measurement of operating parameters- BHP, IHP, brake mean effective pressure, indicative mean effective pressure, torque, specific fuel consumption (BSFC, ISFC), efficiencies - thermal efficiency, mechanical efficiency, volumetric efficiency; heat balance; Problems. **Air pollution from I.C. Engine and Its Remedies**: Pollutants from S.I. and C.I. Engines, Methods of emission control; alternative fuels for I.C. Engines; the current scenario on the pollution front.
Unit-IV	**Supercharging**: Objectives of supercharging, its advantages and applications; Turbocharging and supercharging of SI and CI Engines; limitations of supercharging. **Gas Turbines**: Brayton cycle; open and closed types of gas turbine plants; improvements of the basic gas turbine cycle; multi stage compression with intercooling; multi stage expansion with reheating between stages; exhaust gas heat exchanger, Applications of gas turbines. Problems.

Suggested Readings

1. Internal Combustion Engines –V. Ganesan, Pub.-Tata McGraw-Hill.
2. Gas Turbines - V. Ganesan, Pub.- Tata McGraw Hill.
3. Internal Combustion Engines- R. K. Rajput, Laxmi Publications.
4. Engineering fundamental of the I C Engine – Willard W. Pulkrabek, PHI, India
5. Internal Combustion Engines & Air pollution- Obert E.F, Hopper & Row Pub., New York
6. Internal Combustion Engines Fundamentals- John B. Heywood, McGraw Hill, New York

Web Reference:

1. https://nptel.ac.in/courses/112103316
2. https://nptel.ac.in/courses/112103262
3. https://nptel.ac.in/courses/112103275
4. https://nptel.ac.in/courses/112103313
5. https://www.youtube.com/watch?v=Kur5XTwmlGc

Course Code	**PCC-ME-308A**				
Category	Professional Core Courses				
Course Title	**Mechanical Measurements**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To provide a basic knowledge about measurement systems and their components. • To learn about various sensors used for measurement of mechanical quantities. • To learn about system stability. • To integrate the measurement systems with the process for process monitoring.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Identify the fundamental concepts, terminology, and characteristics of measurement systems.	L1: Remember
CO2	Explain the working principles and applications of transducers and measurement devices.	L2: Understand
CO3	Apply techniques for the measurement of performance, motion, force, torque, temperature, pressure, and flow.	L3: Apply
CO4	Analyze the performance and accuracy of measurement systems and instrumentation devices for engineering applications.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Measurement systems and performance:** Introduction, scope, and method of measurements and instruments, generalized measurement system, standard, and calibration. Static characteristics, dynamic characteristics, error in measurement, types of error, uncertainty analysis
Unit-II	**Transducer Elements:** Introduction, Analog and Digital Transducers, Inductive, Resistive, and Capacitive Strain Gages, Strain Gage Bridge circuits, Temperature Compensation, Balancing and Calibration, Opto-Electrical Transducers, Photo Conductive Transducers, Photo Voltaic Transducers, Digital Transducers, Frequency Domain Transducer, Vibrating String Transducer, Binary codes, Digital Encoders.
Unit-III	**Motion, Force and Torque Measurement:** Introduction, Relative motion Measuring Devices, Electromechanical, Optical, Photo Electric, Moiré-Fringe, Pneumatic, Absolute Motion Devices, Seismic Devices, Spring Mass & Force Balance Type, Calibration, Hydraulic Load Cell, Pneumatic Load Cell, Elastic Force Devices, Separation of Force Components, Electro Mechanical Methods, Strain Gage, Torque Transducer, Torque Meter.

	Temperature Measurement: Introduction, Measurement of Temperature, Non-Electrical Methods – Solid Rod Thermometer, Bimetallic Thermometer, Liquid-in-Glass thermometer, Pressure Thermometer, Electrical Methods – Electrical Resistance Thermometers, Semiconductor Resistance Sensors (Thermistors), Thermo–Electric Sensors, Thermocouple Materials, Radiation Methods (Pyrometry), Total Radiation Pyrometer, Selective Radiation Pyrometer.
Unit-IV	**Pressure and Flow Measurement:** Pressure & Flow Measurement, Introduction: Moderate Pressure Measurement, Monometers, Elastic Transducer, Dynamic Effects of Connecting Tubing, High Pressure Transducer, Low Pressure Measurement, Calibration and Testing, Quantity Meters, Positive Displacement Meters, Flow Rate Meters, Variable Head Meters, Variable Area Meters, Rotameters, Pitot-Static Tube Meter, Drag Force Flow Meter, Turbine Flow Meter, Electronic Flow Meter, Electro Magnetic Flow meter. Hot-Wire Anemometer.

Suggested Readings:

1. A Text Book of Engineering Metrology- R.K. Jain, Khanna Publishers.
2. Mechanical Measurement & Control- D.S. Kumar, Metropolitan book Co.
3. Instrumentation and control systems- W. Bolton, Newnes
4. Mechanical measurement and instrumentation- R K Rajput, S K Kataria & Sons.
5. Mechanical Measurements- Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V, Pearson Education India.
6. Process/Industrial Instruments and Controls Handbook- Gregory K. McMillan, McGraw-Hill: New York.

Web Reference:

1. https://nptel.ac.in/courses/112103261
2. https://nptel.ac.in/courses/112107242
3. https://nptel.ac.in/courses/112106138
4. https://nptel.ac.in/courses/112106140
5. https://nptel.ac.in/courses/112106139

Course Code	**PEC-ME-310A**				
Category	Professional Elective Courses				
Course Title	**Gas Dynamics and Jet Propulsion**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To study the fundamentals of compressible flow concepts. • To learn the compressible flow behaviour in constant area ducts. • To study the development of shock waves and its effects. • To familiar with types of jet engines and their performance parameters. • To introduce to the types of rocket engines and their performance parameters.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts and terminology related to compressible flow and propulsion systems.	L1: Remember
CO2	Explain the behavior of compressible flow, shock waves, and propulsion systems.	L2: Understand
CO3	Apply the governing equations and principles to solve compressible flow and propulsion problems.	L3: Apply
CO4	Analyze the working, performance, and operational characteristics of compressible flow systems, jet engines, and rocket propulsion systems.	L4: Analyze

Note: The Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each, and the remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Basic Concepts and Isentropic Flows**: Concepts of compressible flow- Mach waves and Mach cone; stagnation states; momentum and energy equations of one-dimensional flow; Isentropic flow through variable area ducts, nozzles and diffusers; subsonic and supersonic flow through variable area ducts, choked flow; Area-Mach number relations for isentropic flow.
Unit-II	**Compressible Flow Through Ducts**: Flow through constant area ducts, Rayleigh and Fanno flows, Normal shock relations, oblique shock relations, isentropic and shock tables.
Unit-III	**Jet Propulsion**: Theory of jet propulsion; thrust equation; thrust power and propulsive efficiency; operating principle and cycle analysis of ram jet, turbojet, turbofan and turboprop engines.
Unit-IV	**Space Propulsion**: Types of rocket engines; propellants & feeding systems; ignition and combustion; theory of rocket propulsion; performance study, staging, terminal and characteristic velocity, space flights

Suggested Readings

1. Modern Compressible flow- John David Anderson, McGraw Hill.
2. Fundamentals of Gas Dynamics- Robert D. Zucker & Oscar Biblarz, John Wiley & Sons Inc.
3. Gas Dynamics- Rathakrishnan E, Prentice Hall of India, New Delhi.
4. Fundamentals of Compressible Flow with Aircraft and Rocket propulsion- S.M. Yahya, New Age International Publishers.
5. Gas Turbines- V Ganesan, Tata McGrawHill, New Delhi.
6. Principles of Jet Propulsion and Gas Turbines- N J Zucrow, John Wiley, New York

Web Reference:

1. https://nptel.ac.in/courses/112103021
2. https://nptel.ac.in/courses/101106044
3. https://nptel.ac.in/courses/112106196
4. https://nptel.ac.in/courses/112106166

Course Code	**PEC-ME-312A**				
Category	Professional Elective Courses				
Course Title	**Industrial Robotics**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce to the fundamentals and industrial applications of robotic systems. • To provide knowledge of robot actuators, end effectors, and sensory devices used in automation and intelligent manufacturing systems. • To learn robot motion, coordinate transformations, and kinematic behavior of robotic manipulators. • To enhance analytical and problem-solving skills for the design, control, and application of robotic systems in modern industries.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the fundamental concepts, components, and terminology used in robotics systems.	L1: Remember
CO2	Explain the working principle of robot actuators, end effectors, sensors, and robotic systems.	L2: Understand
CO3	Apply robotic sensing, actuator systems, and kinematic to solve manipulator and motion-related problems.	L3: Apply
CO4	Analyze the robotic system performance, sensor integration, and manipulator kinematics for automation applications.	L4: Analyze

Note: The Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each, and the remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, the first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Introduction to Robotics**: Major component of a robot, robotic like devices, classification of robots - Classification by coordinate system and by control method, Specifications of robots, fixed versus flexible automation, economic analysis and overview of robot application in industry.
Unit-II	**Robot End Effectors**: Introduction, end effectors, interfacing, types of end effectors, grippers and tools, considerations in the selection and design of remote centered devices, Requirements of End effectors. **Robot Actuators**: Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives.

Unit-III	**Robotic Sensory Devices**: Objective, non-optical position sensors - potentiometers, synchros, inductosyn, optical position sensors – optical interrupters, optical encoders (absolute & incremental) Proximity Sensors: Contact type, non-contact type – inductive, capacitive proximity sensor, fiber optic proximity sensor, laser scanning proximity sensor, and reflected light sensor. **Touch & Slip Sensors**: Touch sensors - proximity rod & photo detector sensors, slip sensors - Forced oscillation slip sensor, interrupted type slip sensors.
Unit-IV	**Transformations and Kinematics**: Objectives, homogenous coordinates, basic transformation operations, homogeneous transformation. **Forward solution –** Denavit Hartenberg procedure. Problems involving 2 and 3 DOF manipulators and SCARA manipulator. Inverse or backward solution - Closed form solution, problems involved articulated manipulators and SCARA manipulator.

Suggested Readings

1. Robotic Engineering- Richard D. Klafter, Prentice-Hall of India Pvt Ltd.
2. Industrial Robotics- Mikell P. Groover, Tata McGraw-Hill Int.
3. Robotics and Control- R.K. Mittal and I. J. Nagrath, TMH.
4. Introduction To Robotics: Mechanics And Control- John J. Craig, Pearson.
5. Introduction to Robotics: Analysis, Systems, Applications, Saeed B. Niku, Prentice Hall.
6. Robotics: Control, Sensing, Vision, and Intelligence- K. S. Fu, R. C. Gonzales, and C.S. G. Lee, Tata McGraw-Hill.

Web Reference:

1. https://nptel.ac.in/courses/112105319
2. https://nptel.ac.in/courses/107106090
3. https://nptel.ac.in/courses/112101098
4. https://nptel.ac.in/courses/112104298

Course Code	**PEC-ME-314A**				
Category	Professional Elective Courses				
Course Title	**Quality Engineering**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To understand the fundamental concepts of quality, quality control, TQC, and quality systems used in manufacturing and service industries. • To use statistical concepts and control charts for quality analysis and process control. • To know the quality systems, ISO 9000 standards, and industrial inspection methods. • To study and implement Total Quality Management (TQM) philosophies and modern quality improvement techniques such Kaizen, JIT, Six Sigma, and 5-S approach.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define the concepts of quality engineering.	L1: Remember
CO2	Explain the quality systems, elements of TQC and different forms of Inspection.	L2: Understand
CO3	Apply the concepts of statistical quality control and quality management in real life scenario.	L3: Apply
CO4	Analyze various quality parameters, approaches for quality management, control and improvement.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Basic Concepts of Quality:** Definitions of Quality and its importance in industry, Quality function, Quality dimensions, Quality Characteristics, Quality process, Quality Traits, Applications of Quality, Quality costs concept and Quality cost categories. **Quality Control**: Introduction to quality control, Computer aided quality control, Total quality control (TQC) and its implementation, Elements of TQC, Quality Circle, Objectives of quality circle, Role of management in quality circle and Quality in service organizations
Unit-II	**Basic Statistical Concepts:** The Concept of variation, Distinction between variables and attributes data, The frequency distribution, graphical representation of frequency distribution. **Control chart for variables & attributes:** control chart for attributes- X-bar and R charts, control chart for individual measurement, Application of variable control charts, Control chart for attributes- P- chart, np-chart, c-chart and applications

Unit-III	**Quality systems:** Quality systems, need for quality System, Need for standardization, History of ISO:9000 series standards and its features, steps to registration, India and ISO:9000. **Inspection Systems and Industrial Applications**: Introduction to Inspection Systems, Different forms of Inspection, Automated inspection systems technologies, Industrial inspection.
Unit-IV	**Total Quality Management:** Introduction to TQM, Concepts & elements of TQM, Characteristics of TQM, Relevance of TQM, Approaches to TQM Implementation, TQM philosophies. **Tools and techniques in TQM:** PDCA cycle, Taguchi Philosophy, JIT, Kaizen, Six Sigma approach, 5-S approach, Benchmarking, Total productive maintenance

Suggested Readings:

1. Quality planning and Analysis- Joseph M. Juran and Frank M. Gryna, McGraw-Hill.
2. Quality control- Dale H. Besterfield.
3. Quality Management- Kanishka Bedi, Oxford University Press, New Delhi.
4. Fundamentals of quality control and improvement- Amitava Mitra, Wiley.
5. Statistical Quality Control- M. Mahajan, Dhanpat Rai Publications, New Delhi.

Web Reference:

1. https://nptel.ac.in/courses/110101010
2. https://nptel.ac.in/courses/110101150
3. https://nptel.ac.in/courses/110104080
4. https://www.youtube.com/@totalqualitymanagement-i5523
5. https://www.youtube.com/watch?v=NsgiCkRmAAc

Course Code	**PEC-ME-316A**				
Category	Professional Elective Courses				
Course Title	**Smart Materials**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce basic concepts of smart materials, intelligent systems, and biomimetic materials. • To familiar with principles of actuators, sensors, and smart structural systems. • To learn processing methods, shape memory alloys, and battery materials. • To analyze nanoscale materials, nanotubes, and their functional properties for applications.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Define fundamental concepts of smart materials, smart systems, and nanoscale materials.	L1: Remember
CO2	Explain the principles of smart materials, processing techniques, SMA, battery materials, and nanomaterial structures.	L2: Understand
CO3	Apply concepts of smart materials, structural systems, composite materials, and nanotube-based systems to engineering problems.	L3: Apply
CO4	Analyse properties and performance of smart materials, smart structures, energy systems, and nanoscale materials for applications.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Fundamentals of Smart Materials:** Introduction to smart materials, definition and key concepts of smart materials, basic principles behind smart properties, classification of smart materials according to production technologies and industrial applications, approaches to fabrication of smart materials, and properties of smart materials. **Intelligent and Biomimetic Materials:** Nanoscale and microscale structure–property relationships, intelligent materials and their primitive functions, intelligence inherent in materials, intelligent materials in harmony with humanity, intelligent biological materials, and biomimetics.
Unit-II	**Smart materials and structural systems:** Introduction, actuator materials, sensing technologies, micro-sensors, hybrid smart materials, passive smart structures, active smart structures, hybrid intelligent systems, smart skins. **Processing of Smart Materials:** Processing of Smart Materials Semiconductors and their processing, Metals and metallization techniques, Ceramics and their processing, Polymers and their synthesis, UV radiation curing of polymers, fluids.

Unit-III	**Shape Memory Alloys and Composite Materials:** Introduction to shape memory alloys, basic properties and characteristics, phase transition, shape-memory effect, super-elasticity, metal matrix composites, polymer matrix composites, and engineering applications of composites. **Smart Battery Materials and Energy Storage Systems:** Introduction to smart battery materials, electrochemical concepts involved in a battery, basic battery components and working principles, types of batteries, lithium-ion batteries, layered oxide cathodes, and applications of smart batteries in modern energy storage systems.
Unit-IV	**Nanoscale Intelligent Materials and Nanotube Structures:** Introduction to nanoscale intelligent materials, basic concepts of nanotechnology, nanotube geometric structures, structures of carbon nanotubes, fabrication methods, and applications of nanostructured materials. **Properties and Functional Behavior of Nanotubes:** Mechanical and physical properties of nanotubes, elastic properties, electrical conductivity, piezoelectric properties, electrochemical effects, and engineering applications of nanotube-based smart materials.

Suggested Readings:

1. Industrial Smart Material Systems and MEMS: Design and Development Methodologies, V. K. Varadan, K. J. Vinoy, S. Gopalakrishnan, John Wiley and Sons, England, 2006
2. Smart Structures and Materials, Brain Culshaw, Artech House, London, 1996
3. Smart Materials and Structures, Mukesh V. Gandhi, Brian S. Thompson, Springer, May- 1992.
4. Smart Structures: Analysis and Design, A. V. Srinivasan, Cambridge University Press, Cambridge, New York, 2001.

Web Reference:

1. http://acl.digimat.in/nptel/courses/video/112104251/L01.html
2. https://nptel.ac.in/courses/113104009
3. https://www.youtube.com/watch?v=b5IPJeCDEPw
4. https://nptel.ac.in/courses/118104008

Course Code	**PEC-ME-318A**				
Category	Professional elective Courses				
Course Title	**Plant Maintenance Engineering**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	3	0	0	**3**	
Course Objectives	The objectives of this course are • To introduce the fundamental concepts, functions, and objectives of maintenance and plant engineering systems. • To familiarize with the various aspects of plan maintenance engineering. • To provide the knowledge of facility planning, plant layout, and spare parts management for efficient industrial operations. • To enhance the problem-solving skills for improving plant performance, reliability, and maintenance efficiency.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the fundamental concepts, terminology, and functions of maintenance and plant engineering systems.	L1: Remember
CO2	Explain the plant maintenance principles, strategies, planning, and inventory control techniques used in industries.	L2: Understand
CO3	Apply the principles, strategies, and management aspects of plant maintenance for industrial systems.	L3: Apply
CO4	Analyze maintenance systems, facility planning, and resource management practices for effective plant operations.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Unit No.	Contents
Unit-I	**Principles and Practices of Maintenance**:-Awareness on maintenance and plant engineering maintenance, objectives of maintenance and plant engineering, state of plant, functions and responsibilities; Installation, commissioning, spare part management function, utility and service function, maintenance planning function, physical assets management, Basic Principles of maintenance planning – Planning function in maintenance, maintenance organization, systems of plant engineering and management, decentralization in plant engineering, advantages and drawbacks of decentralization, staffing in plant engineering, Directing, plant engineering and management as integrating function.
Unit-II	**Maintenance Strategies**: Introduction, failure-based maintenance, contractual maintenance, reliability centered maintenance, Time based maintenance, Condition based maintenance, maintenance strategy, hurdles in formulating maintenance strategy. Maintenance procedure and their selection, characteristics of maintenance strategy.

Unit-III	**Facility Planning and Plant Layout**: Introduction, objectives of good facility planning, principles of facility layout, facility location study, facilities governing selection of location, steps in facility location study, plant layout, flow patterns to facilities assembly lines.
Unit-IV	**Spare Parts Management**: Introduction, features/characteristics of spare parts, functions of spare parts management, classification of spare parts- ABC analysis, SDE Analysis, VED Analysis, CIN Analysis, HML analysis, XYZ analysis, maintenance system optimization, codification, standardization, levels of standards, advantages of standardization, barriers to standardization

Suggested Readings

1. Industrial Maintenance Management- S.K Srivastava, S. Chand and Company
2. Installation, Servicing and Maintenance- S.N Bhattacharya, S. Chand and Company
3. Maintenance Engineering- H.P. Garg, S. Chand and Company
4. Maintenance Engineering Hand book- L.R Higgins, McGraw Hill.

Web Reference:

1. https://www.youtube.com/watch?v=f58SW0Hwcf0
2. https://www.youtube.com/watch?v=H-hEH68Knkc
3. http://digimat.in/nptel/courses/video/112107241/L11.html
4. https://www.youtube.com/watch?v=EI38RPfN5Mo
5. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou21_me10

<table>
<tr><td>Course Code</td><td colspan="5">SM-ME-326A</td></tr>
<tr><td>Category</td><td colspan="5">Seminar</td></tr>
<tr><td>Course Title</td><td colspan="5">Seminar</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td rowspan="2">Semester-VI</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>1</td></tr>
<tr><td>Course Objectives</td><td colspan="5">The objectives of this course are to
• Develop technical presentation, communication and interpersonal skills.
• Enhance the ability to review and interpret technical literature.
• Promote awareness of emerging technologies and contemporary engineering developments.
• Strengthen technical report writing, documentation, and professional discussion skills.</td></tr>
<tr><td>Assessment</td><td colspan="5">50 Marks</td></tr>
<tr><td>End Semester Examination</td><td colspan="5">---</td></tr>
<tr><td>Total Marks</td><td colspan="5">50</td></tr>
<tr><td>Duration of Exam</td><td colspan="5">---</td></tr>
</table>

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Identify emerging technologies, recent developments, and contemporary issues in engineering.	L1: Remember
CO2	Explain the selected topic by interpreting technical information obtained from multiple authentic sources.	L2: Understand
CO3	Prepare a technical report and deliver an effective seminar presentation using appropriate communication and presentation tools.	L3: Apply
CO4	Analyze the significance, challenges, and future scope of the selected engineering topic.	L4: Analyze

Guidelines:

- Each student shall select a seminar topic related to Mechanical Engineering or allied emerging technologies in consultation with the faculty mentor.
- A seminar report shall be prepared in the prescribed format and submitted before the seminar presentation.
- Each student shall deliver a technical presentation followed by an interactive question-and-answer session.
- Evaluation shall be based Technical Knowledge & Conceptual Clarity, Presentation & Communication Skills Technical Discussion & Viva-Voce, Seminar Report Innovation & Future Scope
- Students are encouraged to use presentation aids such as slides, demonstrations, simulations, videos, or prototypes etc. wherever applicable.

Course Code	**MC-301A**				
Category	Mandatory Non-Credit Courses – Audit Courses				
Course Title	**Essence of Indian Traditional Knowledge**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	2	0	0		
Course Objectives	The objectives of this course are • To make the students familiar with the fundamentals, structure, and components of the Indian Knowledge System including Vedas, Upavedas, Vedangas, and Upangas. • To develop the understanding of students regarding the relationship between modern science and the Indian Knowledge System. • To familiarize the students with the principles of yoga, holistic healthcare, and their significance in physical and mental well-being. • To make the students learn the practical relevance and applications of the Indian Knowledge System through case studies and interdisciplinary approaches.				
Assessment	40 Marks				
End Semester Examination	60 Marks				
Total Marks	100				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

COs	Skills Demonstrated	RBT Level
CO1	Describe the concepts related to the Indian Knowledge System, Vedas, Upavedas, Vedangas, Upangas, yoga, and holistic healthcare.	L1: Remember
CO2	Explain the structure, principles, and interdisciplinary relevance of the Indian Knowledge System in relation to modern science and healthcare practices.	L2: Understand
CO3	Apply the concepts of yoga, holistic healthcare, and Indian Knowledge traditions for promoting well-being and understanding their practical significance in contemporary society.	L3: Apply
CO4	Analyze the contributions and applications of the Indian Knowledge System in science, healthcare, education, and societal development through case studies and interdisciplinary perspectives.	L4: Analyze

Note: Examiner will set nine questions in total. Question one will be compulsory. Question one will have 8 parts (2 from each unit/section) of 1.5 marks each and remaining eight questions of 12 marks each to be set by taking two questions from each unit. The students have to attempt five questions in total, first being compulsory and selecting one from each unit.

Course Contents

- Basic Structure of Indian Knowledge System: Ashtadasha Vidya (Eighteen Branches of Knowledge in the Indian Knowledge System), Veda, Upaveda (Ayurveda, Dhanurveda, Gandharvaveda, Sthapatyaveda etc.), Vedanga (Shiksha, Kalpa, Nirukta, Vyakarana, Jyotisha, Chhanda), Upanga (Dharmashastra, Mimansa, Purana, Tarkashastra).
- Modern Science and Indian Knowledge System.
- Yoga and Holistic Healthcare.
- Case Studies.

Suggested Readings:

- Cultural Heritage of India – Course Materials by V. Sivaramakrishnan, Bharatiya Vidya Bhavan, Mumbai
- Modern Physics and Vedant by Swami Jitatmanand, Bharatiya Vidya Bhavan
- Holistic Science and Vedant by Swami Jitatmanand, Bharatiya Vidya Bhavan
- Tarkasangraha of Annam Bhatta by V. N. Jha (English Translation), International Chinmaya Foundation, Veliyanad, Ernakulam
- Yoga Sutra of Patanjali by Ramakrishna Mission, Kolkata
- Yoga-Darshanam with Vyasa Bhashya by G. N. Jha (English Translation), Edited by R. N. Jha, Vidyanidhi Prakashan, Delhi
- Science of Consciousness, Psychotherapy and Yoga Practices by R. N. Jha, Vidyanidhi Prakashan, Delhi
- Shodashang Hridayam by P. B. Sharma (English Translation)

Course code	**LC-ME-220A**				
Category	Professional Core Courses				
Course title	**Heat Transfer Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	0	0	2	1	
Course Objectives	The objectives of this course are ● To familiarize students with different modes of heat transfer and related experimental techniques. ● To enable students to determine thermal properties and heat transfer coefficients using standard experimental methods. ● To develop the ability to analyse heat transfer behaviour in conduction, convection, radiation, and heat exchangers. ● To develop practical skills for conducting experiments, interpreting results, and comparing theoretical and experimental heat transfer performance.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

CO	Skill Demonstrated	RBT Level
CO1	Explain the principles and mechanisms of conduction, convection, radiation, and phase change heat transfer.	L2: Understand
CO2	Determine the thermal conductivity of metal rod and power using experimental method.	L3: Apply
CO3	Determine the heat transfer coefficient and emissivity using experimental method.	L3: Apply
CO4	Analyze the performance of fins and heat exchangers using experimental observations and heat transfer principles.	L4: Analyze

List of Experiments

Sr. No.	Content	COs
1	To determine the thermal conductivity of a metal rod.	**CO2**
2	To determine the thermal conductivity of insulating powder.	**CO2**
3	To analyze the temperature distribution along a pin fin and its efficiency/effectiveness.	**CO4**
4	To determine heat transfer coefficient in natural convection from a vertical/horizontal cylinder.	**CO3**
5	To determine the heat transfer coefficient for forced convection through a pipe/duct.	**CO3**
6	To verify Stefan–Boltzmann law for thermal radiation.	**CO3**
7	To determine the emissivity of a given surface.	**CO3**
8	To analyze the overall heat transfer coefficient and effectiveness of a parallel-flow heat exchanger.	**CO4**
9	To analyze the overall heat transfer coefficient and effectiveness of a counter-flow heat exchanger.	**CO4**
10	To determine radiation shape factor between surfaces.	**CO3**

11	To study pool boiling heat transfer and plot the boiling curve.	**CO1**
12	To study of thermal conductivity of a liquid.	**CO1**
13	To study dropwise and film wise condensation phenomenon.	**CO1**

Note: At least ten experiments are to be performed. Eight experiments should be from the above list and remaining two experiments may either be performed from the above list or as per the scope of the syllabus.

Web Reference:

1. https://ht-nitk.vlabs.ac.in/List%20of%20experiments.html
2. https://vlab.amrita.edu/index.php?sub=1&brch=194
3. https://learncheme.com/simulations/heat-transfer/

Course code	**LC-ME-222A**				
Category	Professional Core Courses				
Course title	**Mechanical Measurements Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	0	0	2	1	
Course Objectives	The objectives of this course are ● To learn about the applications of measurement systems. ● To know about the basics and working principle of pressure, temperature and flow measurement. ● Identify the different variation of measurement parameter with various input conditions. ● To analyse the primary, secondary and tertiary measurements. ● To learn about the various control devices and parts of measurement systems.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

CO	Skill Demonstrated	RBT Level
CO1	Explain the working principles and characteristics of mechanical measurement instruments and transducers.	L2: Understand
CO2	Measure temperature, pressure, displacement, force, torque, speed, and flow parameters.	L2: Understand
CO3	Determine stress, strain, and flow characteristics using measurement and instrumentation techniques.	L3: Apply
CO4	Analyze measurement errors, calibration methods, and performance characteristics of measurement systems.	L4: Analyze

List of Experiments

Sr. No.	Content	COs
1	To study various temperature measuring instruments such as mercury-in-glass thermometer and thermocouple.	**CO1**
2	To analyze the Bourdon pressure gauge and calibrate it using a dead weight pressure gauge tester.	**CO4**
3	To study the working of Linear Variable Differential Transformer (LVDT) and measure small displacement.	**CO2**
4	To measure tensile/compressive load using a load cell.	**CO2**
5	To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer.	**CO2**
6	To measure the speed of a rotating shaft using non-contact type pick-ups.	**CO2**
7	To measure stress and strain using strain gauges mounted on beams.	**CO3**
8	To study the construction and working of hot wire anemometer.	**CO1**
9	To analyze the various types of measurement errors and uncertainty mechanical measurement systems.	**CO4**
10	To study the construction and working of rotameter.	**CO1**

11	To measure flow rate using venturi meter/orifice meter.	**CO3**

Note: At least ten experiments are to be performed. Eight experiments should be from the above list and remaining two experiments may either be performed from the above list or as per the scope of the syllabus.

Course code	**LC-ME-224A**				
Category	Professional Core Courses				
Course title	**Internal Combustion Engines Lab**				
Scheme and Credits	L	T	P	**Credits**	**Semester-VI**
	0	0	2	1	
Course Objectives	The objectives of this course are • To study the construction and working principles of I.C engines and gas turbines. • To learn fuel supply, ignition systems, lubrication, and cooling systems of I.C. engines. • To perform experimental procedures and performance tests on engines. • To analyse engine performance characteristics and prepare performance curves and heat balance sheets.				
Assessment	25 Marks				
End Semester Practical Examination	25 Marks				
Total Marks	50				
Duration of Exam	03 Hours				

Course Outcomes: After studying this course, the students will be able to

CO	Skill Demonstrated	RBT Level
CO1	Explain the components, systems, and operating principles of I.C. engines and gas turbines.	L2: Understand
CO2	Determine the efficiencies and operating characteristics of petrol and diesel engines.	L3: Apply
CO3	Determine IHP, FHP, heat balance of an I.C. engine using experimental methods.	L3: Apply
CO4	Analyze the effect of operating conditions on engine performance, fuel consumption, and emissions.	L4: Analyze

List of Experiments

Sr. No.	Content	COs
1	To study the constructional details & working of two-stroke/ four stroke petrol engine.	CO1
2	To study the constructional detail & working of two-stroke/ four stroke diesel engine.	CO1
3	To study the different types of fuel injection systems used in I.C. engines.	CO1
4	To study lubrication and cooling systems used in I.C. engines.	CO1
5	To study battery ignition systems used in I.C. engines.	CO1
6	To conduct performance test on a petrol engine to determine the BHP, fuel consumption, and efficiencies.	CO2
7	To conduct performance test on a diesel engine to determine the BHP, fuel consumption, and efficiencies.	CO2
8	To determine the volumetric efficiency and mechanical efficiency of an I.C. engine.	CO2
9	To prepare heat balance sheet for a multi-cylinder diesel engine/petrol engine.	CO3
10	To determine the indicated horse power (IHP) of a multi-cylinder petrol engine/diesel engine using the Morse test.	CO3

11	To determine the FHP of a multi-cylinder diesel engine/petrol engine using Willian's line method & by motoring method.	CO3
12	To analyze the effect of speed variation on the performance characteristics of petrol/diesel engines and plot curves (i) BHP, IHP, FHP, vs speed (ii) volumetric efficiency & indicated specific fuel consumption vs speed.	CO4
13	To analyze the effect of constant speed on the performance characteristics of petrol/diesel engines and plot curves of (i) BHP vs fuel rate, air rate and A/F and (ii) BHP vs MEP, Mech efficiency & SFC.	CO4
14	To analyze of exhaust gases from single cylinder/multi cylinder diesel/petrol engine by Orsat Apparatus.	CO4

Note: At least ten experiments are to be performed. Eight experiments should be from the above list and remaining two experiments may either be performed from the above list or as per the scope of the syllabus.

Web Reference:

1. https://vlab.amrita.edu/index.php?sub=1&brch=194
2. https://www.vlab.co.in/broad-area-mechanical-engineering