

Curriculum and Syllabus for M. Tech in Turbomachinery (2024-26 Admission Batch)

(Approved by Academic Council and Board of Studies)



GIFT Autonomous, Bhubaneswar

(Approved by AICTE, New Delhi, Affiliated to BPUT, Rourkela)

Bhubaneswar, Odisha, India

Course Types & Definitions

L	Lecture
T	Tutorial
P	Laboratory / Practical / Sessional
WCH	Weekly Contact Hours
BS	Basic Sciences
HS	Humanities & Social Sciences (including Management)
ES	Engineering Sciences
PC	Professional Core
PE	Professional Elective
OE	Open Elective
MC	Mandatory Course
SC	Skill Course
EEC	Employability Enhancement Course



GIFT Autonomous, Bhubaneswar
Course structure of M.TECH (Turbomachinery)

1st Semester					2nd Semester				
Sl. No.	CODE	SUBJECT	L-T-P	CREDIT	Sl. No.	CODE	SUBJECT	L-T-P	CREDIT
1		Fundamentals of Thermodynamics	3-1-0	4	1		Turbomachinery Design Principles	3-1-0	4
2		Fundamentals of Turbomachinery	3-1-0	4	2		Gas Dynamics	3-1-0	4
3		Fundamentals of Fluid Dynamics	3-1-0	4	3		Turbomachinery Performance Analysis	3-1-0	4
4		Basics of Vibrations	3-1-0	4	4		Application of Machine Learning in Turbo Machinery	3-1-0	4
5		NPTEL Course: Introduction to Turbomachinery	3-1-0	4	5		NPTEL or choose one from Electives: 1. Gas Turbine Propulsion 2. Roto Dynamics 3. Turbomachinery Maintenance and Reliability	3-1-0	4
CREDITS (THEORY)				20	CREDITS (THEORY)				20
PRACTICALS/SESSIONALS					PRACTICALS/SESSIONALS				
Sl. No.	CODE	SUBJECT	L-T-P	CREDIT	Sl. No.	CODE	SUBJECT	L-T-P	CREDIT
1		Software Laboratory – I CAD/CAE and Basics of CFD Tools	0-0-4	2	1		Software Practice – II CAD/CAE and Advanced CFD tools	0-0-4	2
2		Laboratory Practice– I Fluid Machines Lab	0-0-4	2	2		Laboratory Practice – II Heat Transfer	0-0-4	2
CREDITS (PRACTICALS/SESSIONALS)				4	CREDITS (PRACTICALS/SESSIONALS)				4
TOTAL SEMESTER CREDITS				24	TOTAL SEMESTER CREDITS				24
TOTAL CUMULATIVE CREDITS				24	TOTAL CUMULATIVE CREDITS				48
3rd Semester					4th Semester				
Sl. No.	CODE	SUBJECT	L-T-P	CREDIT	Sl. No.	CODE	SUBJECT	L-T-P	CREDIT
1		Instrumentation and Control in Turbomachinery	3-1-0	4					
2		Introduction to Combustion	3-1-0	4					
3		Turbomachinery Manufacturing Processes	3-1-0	4					
4		Research Methodology and Project Proposal	3-1-0	4					
CREDITS (THEORY)				16	CREDITS (THEORY)				0
PRACTICALS/SESSIONALS					PRACTICALS/SESSIONALS				
Sl. No.	CODE	SUBJECT	L-T-P	CREDIT	Sl. No.	CODE	SUBJECT	L-T-P	CREDIT
1		Minor Project	0-0-4	2			Dissertation: Phase II		16
2		Dissertation: Phase I	0-0-4	2					4
3		Industry Based Internship and Seminar	0-0-4	2					
CREDITS (PRACTICALS/SESSIONALS)				6	CREDITS (PRACTICALS/SESSIONALS)				20
TOTAL SEMESTER CREDITS				30	TOTAL SEMESTER CREDITS				20
TOTAL CUMULATIVE CREDITS				78	TOTAL CUMULATIVE CREDITS				98

Gandhi Institute for Technology
Scheme of Teaching and Examinations – 2024-25
M.Tech in Turbomachinery
Choice Based Credit System (CBCS) Based Education (OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical	Skill Development Activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PC		Fundamentals of Thermodynamics	03	--	02	03	40	60	100	4
2	PC		Fundamentals of Turbomachinery	03	--	02	03	40	60	100	4
3	PC		Fundamentals of Fluid Dynamics	03	--	02	03	40	60	100	4
4	PC		Basics of Vibrations	03	--	02	03	40	60	100	4
5	PC		NPTEL Course: Introduction to Turbomachinery	03	--	02	03	40	60	100	4
6	PC		Software Laboratory – I CAD/CAE and Basics of CFD tools	--	04	--	03	40	60	100	2
7	PC		Laboratory Practice– I Fluid Machines Lab	02	--	--	03	40	60	100	2
TOTAL				17	04	10	21	280	420	700	24

Note: PC: Professional core.

Skill development activities:

Students and course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills.

The students should interact with industry (small, medium and large), understand their problems or foresee what can be undertaken for study in the form of research/ testing / projects, and for creative and innovative methods to solve the identified problem.

The students shall

- (1) Gain confidence in modelling of systems and algorithms.
- (2) Work on different software/s (tools) to Simulate, analyse and authenticate the output to interpret and conclude. Operate the simulated system under changed parameter conditions to study the system with respect to thermal study, transient and steady state operations, etc.
- (3) Handle advanced instruments to enhance technical talent.
- (4) Involve in case studies and field visits/ field work.
- (5) Accustom with the use of standards/codes etc., to narrow the gap between academia and industry.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Internship: All the students have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. An examination shall be conducted during III semester and the prescribed credit shall be counted for the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent examination after satisfying the internship requirements.

Note: (i) Four credit courses are designed for 50 hours Teaching – Learning process.

(ii) Three credit courses are designed for 40 hours Teaching – Learning process.

Gandhi Institute for Technology

Scheme of Teaching and Examinations – 2024-25

M. Tech in Turbomachinery

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical/ seminar	Skill Development Activities (SDA)	Duration in hours	CIE Marks	SEE Marks	Total Marks	
1	PC		Turbomachinery Design Principles	03	--	02	03	40	60	100	4
2	PC		Gas Dynamics	03	--	02	03	40	60	100	4
3	PC		Turbomachinery Performance Analysis	03	--	02	03	40	60	100	4
4	PE		Application of Machine Learning in Turbo Machinery	04	--	--	03	40	60	100	4
5	PE		NPTEL or choose one from Electives: 1. Gas Turbine Propulsion, 2. Roto Dynamics, 3. Turbomachinery Maintenance and Reliability	04	--	--	03	40	60	100	4
6	PC		Software Practice – II CAD/CAE and Advanced CFD tools	--	04	--	03	40	60	100	2
7	PC		Laboratory Practice – II: Heat Transfer	--	02	--	--	100	--	100	2
TOTAL				17	06	06	18	340	360	700	24

Note: PC: Professional core, PE: Professional Elective.

Note:

1. Technical Seminar: CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Participation in the seminar by all postgraduate students of the same and other semesters of the programme shall be mandatory.

The CIE marks awarded for Technical Seminar, shall be based on the evaluation of Seminar Report, Presentation skill and Question and Answer session in the ratio 50:25:25.

2. Internship: All the students shall have to undergo mandatory internship of 6 weeks during the vacation of I and II semesters and /or II and III semesters. An examination shall be conducted during III semester and the prescribed credit shall be counted in the same semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in internship course and have to complete the same during the subsequent examination after satisfying the internship requirements.

Gandhi Institute for Technology

Scheme of Teaching and Examinations – 2024-25

M. Tech in Turbomachinery

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination			Credits	
				Theory	Practical/ Minor –Project/ Internship	Skill Development activities (SDA)	Duration in hours	CIE Marks	SEE Marks		Total Marks
1	PC		Instrumentation and Control in Turbomachinery	03	--	02	03	40	60	100	4
2	PE		Introduction to Combustion	03	--	--	03	40	60	100	3
3	PE		Turbomachinery Manufacturing Processes	03	--	--	03	40	60	100	3
4			Research Methodology and Project Proposal	--	02	--	--	100	--	100	2
5	PC		Minor Project	--	02	--	--	100	--	100	2
6			Dissertation: Phase I				03	40	60	100	6
7	Internship		Industry Based Internship and Seminar	(Completed during the intervening vacation of I and II semesters and /or II and III semesters.)							
TOTAL				09	04	02	12	360	240	600	20

Note: PC: Professional core, PE: Professional Elective.

Note:

1. Project Phase-1: Students in consultation with the guide/co-guide if any, shall pursue literature survey and complete the preliminary requirements of selected Project work. Each student shall prepare relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE (Semester End examination) shall be as per the Institute norms.

2. Internship: Those, who have not pursued /completed the internship shall be declared as fail in internship course and have to complete the same during subsequent SEEs after satisfying the internship requirements. Internship SEE shall be as per the Institute norms.

Gandhi Institute for Technology

Scheme of Teaching and Examinations – 2024 -25

M. Tech in Turbomachinery

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
1	Project		Dissertation: Phase II	--	04	03	40	60	100	20
TOTAL				--	04	03	40	60	100	20

Note:

1. Project Phase-2:

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a Senior faculty of the department. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report subjected to plagiarism check, Project Presentation skill and Question and Answer session in the ratio 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the Institute norms.



M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER -I

Fundamentals of Thermodynamics

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Basic Concepts

Continuum and macroscopic approach, Thermodynamic systems (closed and open), Thermodynamic properties and equilibrium, State of a system, State postulate for simple compressible substances, State diagrams, paths and processes on state diagrams, Concepts of heat and work, Different modes of work, Zeroth law of thermodynamics, Concept of temperature

Module 2: First Law of Thermodynamics

Concept of energy and various forms of energy, Internal energy, Enthalpy, Specific heats, First law applied to elementary processes, First law applied to closed systems and control volumes, Steady and unsteady flow analysis

Module 3: Second Law of Thermodynamics

Limitations of the first law of thermodynamics, Concepts of heat engines and heat pumps/refrigerators, Kelvin-Planck and Clausius statements and their equivalence, Reversible and irreversible processes, Carnot cycle and Carnot principles/theorems

Module 4: Applications of the Second Law of Thermodynamics

Thermodynamic temperature scale, Clausius inequality and concept of entropy, microscopic interpretation of entropy, The principle of increase of entropy, T-s diagrams, Second law analysis of control volume, Availability and irreversibility, Third law of thermodynamics

Module 5: Properties of Pure Substances

Thermodynamic properties of pure substances in solid, liquid and vapor phases, P-v-T behaviour of simple compressible substances, Phase rule, Thermodynamic property tables and charts, Ideal and real gases, Ideal gas equation of state and van der Waals equation of state, Law of corresponding states, Compressibility factor and generalized compressibility chart

Module 6: Thermodynamic Relations

T-ds relations, Helmholtz and Gibbs functions, Gibbs relations, Maxwell relations, Joule-Thomson coefficient, Coefficient of volume expansion, Adiabatic and isothermal compressibility, Clapeyron and Clapeyron-Clausius equations

Course outcomes:

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

1. Understand and apply the fundamental concepts of thermodynamics, including systems, properties, equilibrium, heat, and work.
2. Analyse and apply the first law of thermodynamics to various processes and systems, including energy, internal energy, enthalpy, and specific heats.
3. Comprehend the limitations of the first law and understand the second law of thermodynamics, including heat engines, heat pumps/refrigerators, and reversible and irreversible processes.
4. Apply the second law of thermodynamics to real-world scenarios, understanding entropy, thermodynamic temperature scales, and performing second law analysis of control volumes.
5. Gain knowledge of the thermodynamic properties of pure substances in various phases, including P-v-T behaviour, phase rule, property tables, and equations of state.
6. Understand various thermodynamic relations, including T-ds relations, Helmholtz and Gibbs functions, Maxwell relations, and Joule-Thomson coefficient.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
 - Each full question is for 20 marks.
 - There will be two full questions (with a maximum of four sub questions) from each module.
 - Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Year
1	Engineering Thermodynamics	P.K. Nag	Mc Graw Hill	6 th Edition
2	Engineering Thermodynamics	R.K Rajput		2009

Reference Books

1	Thermodynamics: An Engineering Approach (SIE)	Yunus A. Cengel and Michael A. Boles	Mc Graw Hill	2010
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M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER -I

Fundamentals of Turbomachinery

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Introduction and Classification

Axial flow, radial flow and mixed flow machines, the equations of motion in rotating frame of reference, effects of Coriolis and Centrifugal forces, momentum and energy equation, Euler work, illustrative examples

Module 2: Gas Turbine Cycle

Brayton Cycle, regenerative cycle, reheat, inter-cooling, turboprop, turbojet and turbofan engine, thrust augmentation, illustrative examples

Module 3: Similarity Analysis

Similarity rules, specific speed, Cordier diagram, illustrative examples

Module 4: Cascade Analysis

Two-dimensional cascade theory, lift and drag, blade efficiency, estimation of loss, compressor and turbine cascade, blade geometry, illustrative examples

Module 5: Axial Flow Compressor

Two-dimensional pitch line design and analysis, h-s diagram, degree of reaction, the effect of Mach number, performance and efficiency, three-dimensional flow, tip clearance, losses, compressor performance, illustrative examples

Module 6: Centrifugal Pump and Compressor

Theoretical analysis and design, the effect of circulation and Coriolis forces, reversal eddies, slip factor, head and efficiency, diffuser, introduction to the combustion system, illustrative examples

Course outcomes:

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

1. Understand and classify turbomachines, applying motion equations.
2. Analyse gas turbine cycles and engine functionalities.
3. Apply similarity rules and interpret the Cordier diagram.
4. Utilize cascade theory for performance analysis of blades.
5. Design and analyse axial flow compressors with performance factors.
6. Analyse and design centrifugal pumps and compressors, considering efficiency and combustion systems.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Introduction to Aerospace Engineering	John D. Anderson Jr.	McGraw-Hill Education	2017
2	Aerodynamics for Engineers	John J. Bertin, Michael L. Smith	Pearson	2013

Reference Books

1	Aircraft Structures: Concepts and Analysis	T.H.G. Megson	Wiley	2011
2	Flight Stability and Automatic Control	Robert C. Nelson	McGraw-Hill Education	2019

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-I

Fundamentals of Fluid Dynamics

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Introduction

Historical remarks, properties of fluids and the continuum hypothesis, classical thermodynamics, dimensional analysis

Module 2: Vector Calculus and Kinematics

Symbolic or Gibbs notation and index notation, tensors and tensor operations, integral formulas, Lagrangian and Eulerian descriptions, stream, path and streak lines, deformation and deformation-rate tensors, vorticity and circulation

Module 3: Conservation Laws

Conservation of mass, momentum and energy, introduction to Newtonian and non-Newtonian rheologies, derivation of Navier-Stokes equation

Module 4: Analytic Solutions

Pressure driven (Poiseuille) flows, plane and circular Couette flows, double falling film, impulsively started plate (Stokes' first problem, the Rayleigh problem), oscillating plate (Stokes' second problem), diffusion of vortex sheet, decay of line vortex

Module 5: Flow Types

Ideal flows, boundary layer flows, Laminar and Turbulent Flow, Instabilities in flow.

Module 6: Fluid Dynamics Applications

Fluid physics of sustainability, fluid dynamics of cardiovascular systems, fluid dynamics of lung systems, fluid dynamics of gastrointestinal systems

Course outcomes:

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

1. Understand fluid properties, continuum hypothesis, and dimensional analysis.
2. Apply vector calculus and kinematics in fluid motion.
3. Understand and apply conservation laws for mass, momentum, and energy.
4. Analyse and solve various flow problems.
5. Understand ideal flows, boundary layers, and fluid instabilities.
6. Explore fluid dynamics in sustainability and biological systems.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

S l	Title of the book	Name of the Author/s	Publisher Name	Edition and year
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1	Fluid Mechanics	Kundu, Cohen, & Dowling	Academic Press, 2011 or later.	5th Edition or later
2	Aircraft Performance	Mario Asselin	Wiley	2016
Reference Books				
1	Aircraft Performance Analysis: An Advanced Approach"	Maurits W. Hendriks, Edmar O. Kato	Springer	2012
2	Flight Performance of Fixed and Rotary Wing Aircraft	Antonio Filippone	Elsevier	2006

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER -I

Basics of Vibrations

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Introduction to Mechanical Vibrations

Simple harmonic motion, natural frequency, equation of motion, energy method, Rayleigh method, free vibration of single degree of freedom (DOF) systems with damping, viscous damping, logarithmic decrement, Coulomb damping, energy dissipated by damping, structural damping, equivalent viscous damping

Module 2: Forced Harmonic Vibration

Magnification factor, transmissibility, vibration isolation, base excitation, rotating unbalance, whirling of shafts, resonance, vibration measuring instruments, seismometer, accelerometer

Module 3: Two Degree of Freedom Systems and Multi Degree of Freedom Systems

Normal mode vibration, principal coordinates, coupling, beat phenomenon, undamped vibration absorbers, vibration dampers, multi degree of freedom systems, matrix formulation, influence coefficients, flexibility matrix, stiffness matrix

Module 4: Lagrange's Equation and Continuous Systems

Lagrange's equation, solution to problems using Lagrange's equation, vibration of continuous systems, vibrating strings, longitudinal vibration of rods, torsional vibration of rods

Module 5: Transient Vibrations

Impulse excitation, convolution integral, introduction to non-linear vibrations and random vibrations

Module 6: Advanced Topics in Vibrations

Non-linear vibrations, random vibrations, advanced methods for solving vibration problems, applications in engineering systems.

Course outcomes:

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

1. Understand basics of mechanical vibrations and damping methods.
2. Analyse forced harmonic vibrations and measurement tools.
3. Study two- and multi-degree freedom systems and matrix methods.
4. Apply Lagrange's equations to solve vibration problems.
5. Investigate transient, non-linear, and random vibrations.
6. Explore advanced vibration topics and engineering applications.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl. No.	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Outline of Mechanical Vibrations	Graham Kelly S, Schaum	Schaum's Outlines, 1996	1996

2	Mechanical Vibrations	Singiresu S Rao,	Pearson,	2016
Reference Books				
1	Mechanical Vibrations	Den Hartog, J P	McGrawHill	1956
2	Elements of Vibration Analysis	Leonard Meirovitch	McGraw-Hill Education	1975

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-I

SOFTWARE LABORATORY – I
CAD/CAE AND BASICS OF CFD TOOLS

Course Code		CIE Marks	40
Teaching Hours/Week (L: T:P)		SEE Marks	60
Credits		Exam Hours	03
Sl. No.	Experiments		
1	Use CAD software to create 3D models of basic aircraft component- a wing		
2	Use CAD software to create 3D models of basic aircraft component- fuselage		
3	Aerodynamic Analysis of Airfoil (a simple aerofoil profile)		
4	Stress Analysis of Simple Structures- A beam		
5	Thermal Analysis of Heat Transfer (Only Temperature and Heat Transfer of a component)		
6	Pressure Distribution on Aerodynamic Surface (an aerofoil geometry using CAD)		
7	Aircraft Weight and Balance Calculation (Aircraft weight and payload)		
8	Engine Performance Simulation (a simplified aircraft engine model to be used)		
9	Aircraft Systems Diagram (electrical or hydraulic or pneumatic)		
10	Perform CFD analysis to visualise pressure distribution and flow pattern around an aerofoil		
Course outcomes: At the end of the course the student will be able to: 1. Create 3D models of aircraft components using CAD. 2. Perform aerodynamic and pressure analysis on airfoils. 3. Conduct stress and thermal analysis on structures. 4. Calculate aircraft weight and balance. 5. Simulate engine performance. 6. Design and analyse aircraft system diagrams.			

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-I

LABORATORY PRACTICE– I
FLUID MACHINES LAB

Course Code	24MSAL16	CIE Marks	40
Teaching Hours/Week (L:T:P)	0:0:4	SEE Marks	60
Credits	02	Exam Hours	03

Sl. No.	Experiments
1	Bernoulli's Principle Demonstration
2	Reynolds Number Experiment
3	Flow Measurement Using Venturi Meter
4	Flow Measurement Using Orifice Plate
5	Performance Characteristics of Centrifugal Pumps
6	Reciprocating Pump Efficiency and Flow Rate
7	Performance of a Pelton Wheel Turbine
8	Performance of a Pelton Francis Turbine
9	Performance of a Centrifugal Compressor
10	Performance of a Submersible Pump

Course outcomes:

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

1. Demonstrate Bernoulli's Principle and understand its applications in fluid dynamics.
2. Analyse the significance of Reynolds number in determining flow regimes.
3. Perform flow measurements using Venturi meters and orifice plates.
4. Evaluate the performance characteristics of centrifugal and reciprocating pumps.
5. Assess the efficiency and performance of Pelton wheel and Francis turbines.
6. Measure the performance of centrifugal compressors and submersible pumps.

*** END ***

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-II

Turbomachinery Design Principles

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Introduction to Turbomachinery

Machine definitions, angular momentum, Euler turbomachinery equation, relative frame of reference/rhothalpy, velocity triangles, performance parameters and loss, geometry and flow-field analysis, compressor cascades, turbine cascades

Module 2: Axial Turbines

Kinematics, design parameters, thermodynamic performance, reaction, turbine classification, multi-stage performance, structural and heat transfer considerations.

Module 3: Axial Compressors

Kinematics, design parameters, thermodynamic performance, multi-stage performance, stall and surge in air compressor.

Module 4: Three-Dimensional Effects and Centrifugal Machines

Radial equilibrium, three-dimensional flow features and loss mechanisms, design elements, kinematics, centrifugal pumps and compressors, diffusers, radial turbines.

Module 5: Propellers, Hydraulic Turbines, and Wind Turbines

Propellers, cavitation, hydraulic turbine classification and design, wind turbines.

Module 6: Advanced Topics in Turbomachinery

Modern advancements in turbomachinery design and analysis, computational fluid dynamics (CFD) applications, experimental techniques, sustainability in turbomachinery.

Course outcomes:

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

1. Understand basic turbomachinery principles and performance parameters.
2. Analyse axial turbine design and thermodynamic performance.
3. Study axial compressor design and phenomena like stall and surge.
4. Explore three-dimensional flow effects and centrifugal machines.
5. Design and evaluate propellers, hydraulic turbines, and wind turbines.
6. Apply advanced turbomachinery techniques, including CFD and sustainability.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl No	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Fluid Mechanics and Thermodynamics of Turbomachinery	S. Larry Dixon, Cesare Hall		7th Edition

2	Introduction to Avionics Systems	R.P.G. Collinson	Springer	2011
Reference Books				
1	Flight Dynamics, Simulation, and Control: For Rigid and Flexible Aircraft	Ranjan Vepa	AIAA (American Institute of Aeronautics and Astronautics)	2013
2	Digital Avionics Handbook	Cary R. Spitzer	CRC Press	2014

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-II

Gas Dynamics

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Concepts from Thermodynamics

The basic equations of fluid motion, one-dimensional gas dynamics, isentropic conditions, speed of sound, Mach number, area velocity relations

Module 2: Normal Shock Wave Relations

Normal shock relations for a perfect gas, Fanno and Rayleigh flow, one-dimensional wave motion, the shock tube.

Module 3: Waves in Supersonic Flow

Oblique shock waves, supersonic flow over a wedge, Mach lines, piston analogy, supersonic compression by turning, supersonic expansion by turning, the Prandtl-Meyer function, reflection and intersection of oblique shocks, Mach reflection, shock expansion theory, thin aerofoil theory.

Module 4: Flow in Ducts and Wind Tunnels

Area relation, nozzle flow, normal shock recovery, effects of second throat, wind tunnel pressure ratio, supersonic wind tunnels.

Module 5: Small Perturbation Theory

The method of characteristics, methods of measurement, elements of hypersonic flow.

Module 6: Advanced Topics in Fluid Dynamics

Recent advancements in fluid dynamics, experimental techniques, computational fluid dynamics (CFD) applications, sustainability in supersonic and hypersonic flows.

Course outcomes:

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

1. Understand basic thermodynamics and fluid motion concepts.
2. Analyse normal shock wave relations and shock tubes.
3. Study supersonic flow waves and the Prandtl-Meyer function.
4. Examine flow in ducts and supersonic wind tunnels.
5. Apply small perturbation theory and measurement methods.
6. Explore advanced fluid dynamics topics, including hypersonic flow and CFD.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl. No.	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Modern Compressible Flow	J. D. Anderson	Mc Graw Hill	1989
2	The Dynamics and Thermodynamics of Compressible Flow	H. Shapiro	Ronald Press	1954

Reference Books

1	Elements of Gas Dynamics	H. W. Liepmann and A. Roshko	John Wiley	1960
2	Compressible Fluid Dynamics (with P.C. applications)	B. K. Hodge and C. Koenig	PH	1995

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-II

Turbomachinery Performance Analysis

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Basic Equations and Dimensional Analysis

Basic equations, dimensional analysis, two-dimensional cascades

Module 2: Principles of Performance Analysis for Axial Turbines

Principles of performance analysis for axial turbines

Module 3: Performance Analysis for Axial Compressors

Performance analysis for axial compressors

Module 4: Performance Analysis for Fans

Performance analysis for fans

Module 5: Simplified Meridional Flow Analysis for Axial Turbomachines

Simplified meridional flow analysis for axial turbomachines

Module 6: Vorticity Production in Turbomachines and Its Influence upon Meridional Flows

Vorticity production in turbomachines, influence of vorticity on meridional flows

Course outcomes:

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

1. Understand basic equations and dimensional analysis in fluid motion.
2. Analyse axial turbine performance.
3. Evaluate axial compressor performance.
4. Analyse fan performance.
5. Apply meridional flow analysis in turbomachines.
6. Understand vorticity production in turbomachines.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl. No.	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Turbomachinery Performance Analysis	R. I. Lewis	Butterworth-Heinemann	1st Edition, 1996

2	Turbomachinery: Design and Theory	J. W. Nash	McGraw-Hill Education	2nd Edition, 2015
Reference Books				
1	Gas Turbine Engineering Handbook	M. L. Kerrebrock	Marcel Dekker	3rd Edition, 2007
2	Aerodynamics of Turbomachines	H. Glauert	Longman	5th Edition, 2010

M. Tech in Turbomachinery Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER-II				
Machine Learning in Turbomachinery				
Course Code		CIE Marks	40	
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60	
Credits	04	Exam Hours	03	
Module 1: Introduction to Machine Learning				
Motivation and role of machine learning in computer science and problem solving, representation (features), linear transformations, appreciating linear transformations and matrix vector operations in the context of data and representation, problem formulations (classification and regression)				
Module 2: Fundamentals of Machine Learning				
Probability distributions in the context of data, prior probabilities and Bayes Rule, PCA and dimensionality reduction, nearest neighbors and KNN, linear regression, decision tree classifiers				
Module 3: Notion of Generalization and Overfitting				
Generalization and overfitting, training, validation, and testing, connecting generalization and overfitting				
Module 4: Selected Machine Learning Algorithms				
Ensembling and random forests (RF), linear SVM, K-means clustering, logistic regression, naive Bayes				
Module 5: Neural Network Learning				
Role of loss functions and optimization, gradient descent and perceptron/delta learning, multilayer perceptron (MLP), backpropagation, MLP for classification and regression				
Module 6: Advanced Topics in Machine Learning				
Deep learning, reinforcement learning, unsupervised learning techniques, real-world applications, ethical considerations in machine learning				
Course outcomes: At the end of the course the student will be able to: - Understand machine learning basics and linear transformations. - Analyse key ML fundamentals, including probability distributions and PCA. - Comprehend generalization, overfitting, and validation. - Evaluate various ML algorithms like SVM, K-means, and random forests. - Learn neural network techniques, including optimization and backpropagation. - Explore advanced ML topics and ethical considerations.				
Question paper pattern: The SEE question paper will be set for 100 marks. - The question paper will have ten full questions carrying equal marks. - Each full question is for 20 marks. - There will be two full questions (with a maximum of four sub questions) from each module. - Each full question will have sub question covering all the topics under a module. - The students will have to answer five full questions, selecting one full question from each module.				
Textbook/ Textbooks				
Sl. No.	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Machine Learning	Tom M. Mitchell	McGraw Hill Education,	

2	Mathematics for Machine Learning	Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong	Cambridge University Press	23 April 2020
Reference Books				
1	Artificial Intelligence in Aviation: A Smart Guide for Pilots and Aviation Professionals	Max Pragmatic	Independently published	2021
2	Applications of Artificial Intelligence in Aviation: Theory and Practice	Captain John Smith	Routledge	2018

M. Tech in Turbomachinery Choice Based Credit System (CBCS) and Outcome Based Education (OBE) SEMESTER-I			
LABORATORY PRACTICE– I HEAT TRANSFER LAB			
Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)		SEE Marks	60
Credits		Exam Hours	03
Sl. No.	Experiments		
1	Determine the thermal conductivity of various metals		
2	Study heat transfer in pipes under forced convection conditions.		
3	Observe heat transfer over a vertical plate due to natural convection		
4	Evaluate the effectiveness of parallel and counter-flow heat exchangers.		
5	Determination of the critical heat flux in boiling heat transfer.		
6	Investigate heat transfer from pin fins under forced convection		
7	Study thermal radiation between different surfaces and shapes.		
8	Verification of the Stefan-Boltzmann law by measuring radiation heat transfer		
9	Study the heat transfer through composite walls and determine overall heat transfer coefficient.		
10	Calibrate thermocouples and study their response time and sensitivity		
Course outcomes: At the end of the course the student will be able to: 1. Determine thermal conductivity of metals. 2. Study heat transfer in pipes and over vertical plates. 3. Evaluate effectiveness of heat exchangers. 4. Investigate critical heat flux in boiling. 5. Analyse heat transfer from pin fins and radiation. 6. Calibrate thermocouples and study composite walls.			

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M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-III

Instrumentation and Control in Turbomachinery

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Selection and Application of Measurement Instruments

Selection and application of temperature, pressure, flow, and level measuring instruments, standards and calibration, calibration of temperature, pressure, and flow measuring devices

Module 2: Electromagnetic Compatibility (EMC) and Safety

Introduction to EMC, interference coupling mechanisms, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding, introduction to safety, electrical hazards, hazardous area classification, non-hazardous areas, enclosures (NEMA types), fuses and circuit breakers, protection methods (purging, explosion-proofing, and intrinsic safety)

Module 3: Instrument Specifications and Project Documentation

Specification of instruments, preparation of project documentation, process flow sheet, instrument index sheet, instrument specifications sheet, panel drawing and specifications, project procedures, schedules, vendor drawings, tender documentation, selection of measurement methods and control panels

Module 4: State-space Models and Linear State Equations

Review of vectors and matrices, canonical models from differential equations and transfer functions, interconnection of subsystems, analysis of linear state equations, first-order scalar differential equations, system modes, and modal decomposition

Module 5: Lyapunov's Stability Theory for Linear Systems

Equilibrium points and stability concepts, stability definitions, linear system stability, the direct method of Lyapunov, use of Lyapunov's method in feedback design

Module 6: Advanced Topics in Instrumentation and Control

Recent advancements in instrumentation and control systems, integration of modern technologies, case studies of industrial applications, future trends in measurement and control techniques

Course outcomes:

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

1. Select and apply measurement instruments for temperature, pressure, flow, and level, including standards and calibration.
2. Understand electromagnetic compatibility (EMC) and safety measures, including electrical hazards and protection methods.
3. Specify instruments and prepare comprehensive project documentation.
4. Analyse state-space models and linear state equations in control systems.
5. Apply Lyapunov's stability theory to linear systems and feedback design.
6. Explore advanced topics in instrumentation and control, including modern technologies and industrial applications.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl. No.	Title of the book	Name of the Author/s	Publisher Name	Year
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1	Aircraft Maintenance and Repair	Michael J. Kroes, William A. Watkins, Frank Delp	McGraw-Hill Education	2018
2	Reliability-Centered Maintenance	John Moubray	Industrial Press, Inc.	2011
Reference Books				
1	Aircraft Maintenance Management	Harry A. Kinnison, Tariq Siddiqui	McGraw-Hill Education	2010
2	Aircraft Maintenance Engineering: A Comprehensive Guide	Sadraey, M. H.	Butterworth- Heinemann	2017

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-III

Introduction to Combustion

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Introduction to Combustion

Thermo-chemistry of combustion, concept of adiabatic flame temperature, numerical problems, chemical kinetics, differences between equilibrium and rate-controlled reactions, global versus elementary reactions, elementary reaction rates, bimolecular reactions and collision theory, other elementary reactions, relation between rate coefficients and equilibrium constants, steady-state approximation, mechanism for uni-molecular reactions, chain and chain-branching reactions

Module 2: Introduction to Species Mass Transfer

Rudiments of mass transfer, mass transfer rate laws, species conservation, the Stefan problem, liquid-vapor interface boundary conditions, droplet evaporation, numerical problems

Module 3: Simplified Conservation Equations for Reacting Flows

Overview of conservation equations, overall mass conservation (continuity), species mass conservation (species continuity), momentum conservation (1-D and 2-D forms), energy conservation (general 1-D form), Shvab-Zeldovich forms, definition of mixture fraction

Module 4: Laminar Premixed Flames

Physical description, definition, principal characteristics, typical laboratory flames, simplified analysis, assumptions, conservation laws, solution, factors influencing flame velocity and thickness, temperature, pressure, equivalence ratio, fuel type, flame speed correlations for selected fuels, quenching, flammability, and ignition, flame lift-off (blow-off) and flashback, concept of flame stretch-Karlovitz number, flame stabilization

Module 5: Introduction to Turbulent Flames

Theories of flame propagation, thermal, diffusion and comprehensive theories, turbulent length and time scales, weak turbulent flames, wrinkled reaction sheets, distributed reaction zones

Module 6: Advanced Topics in Combustion

Recent advancements in combustion research, computational fluid dynamics (CFD) applications in combustion, experimental techniques in combustion studies, sustainability and environmental impact of combustion processes, future trends in combustion technology

Course outcomes:

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

1. Understand combustion chemistry and adiabatic flame temperature.
2. Analyse species mass transfer and conservation.
3. Apply conservation equations to reacting flows.
4. Evaluate laminar premixed flames and influencing factors.
5. Understand turbulent flame theories and propagation.
6. Explore advanced combustion topics and CFD applications.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl. No.	Title of the Book	Name of the Author/s	Publisher Name	Year
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1	Introduction to Combustion: Concepts and Applications	Stephen R. Turns	McGraw-Hill Education	2011
2	An Introduction to Combustion: Concepts and Applications (International Edition)	Stephen R. Turns	McGraw Hill / Asia	2011
Reference Books				
1	Understanding Combustion	Mukunda H S	Tata McGraw-Hill	2008
2	Fundamentals of Combustion	Mishra D P	PHI Learning	2014

M. Tech in Turbomachinery
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SEMESTER-III

Turbomachinery Manufacturing Process

Course Code		CIE Marks	40
Teaching Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Credits	04	Exam Hours	03

Module 1: Casting

Introduction to casting methods (sand casting, investment casting, die casting), solidification principles and defects, casting of turbine blades, impellers, and casings

Module 2: Bulk Deformation Processes

Forging: Hot and cold forging, open-die and closed-die forging, rolling: Hot and cold rolling for shafts, disks, and rings, extrusion: Extruded profiles for compressor blades

Module 3: Sheet Metal Forming

Bending, deep drawing, and spinning, sheet metal components in turbomachinery

Module 4: Traditional and Nontraditional Material Removal Processes

Traditional processes: Turning, milling, and drilling, machining of shafts, hubs, and flanges, nontraditional processes: Waterjet machining (abrasive waterjet cutting), electric discharge machining (EDM), chemical machining

Module 5: Manufacturing of Polymers and Composites

Polymer matrix composites for fan blades, injection molding for plastic components, processing of metal powders and ceramics, powder metallurgy techniques, ceramic matrix composites

Module 6: Joining and fastening

Welding (SAW, TIG, MIG, gas welding, laser welding), bolted joints and adhesive bonding

Course outcomes:

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

1. Understand casting methods and principles.
2. Apply bulk deformation processes in manufacturing.
3. Master sheet metal forming techniques.
4. Analyse material removal processes, including traditional and EDM.
5. Learn manufacturing techniques for polymers and composites.
6. Explore joining and fastening methods.

Question paper pattern:

The SEE question paper will be set for 100 marks

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbook/ Textbooks

Sl. No.	Title of the book	Name of the Author/s	Publisher Name	Year
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1	Manufacturing Engineering and Technology	Serope Kalpakjian, Steven Schmid	Pearson Education	2013
2	Fundamentals of Modern Manufacturing: Materials, Processes, and Systems	Mikell P. Groover	John Wiley & Sons	2020
Reference Books				
1	Manufacturing Processes for Engineering Materials	Serope Kalpakjian, Steven Schmid	Pearson Education	2007
2	Principles of Metal Casting	Richard W. Heine, Carl R. Loper, Philip C. Rosenthal	McGraw-Hill Education	2003

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-II

Industry Based Internship and Seminar

Course Code		CIE Marks	100
Number of contact Hours/week	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

The objective of the seminar is to inculcate self-learning, face audience confidently, enhance communication skill, involve in group discussion and present and exchange ideas.

Each student, under the guidance of a faculty, is required to

- Choose, preferably through peer reviewed journals, a recent topic of his/her interest relevant to the Course of Specialization.
- Carryout literature survey, organize the Course topics in a systematic order.
- Prepare the report with own sentences.
- Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities.
- Present the seminar topic orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question-and-answer session and quality of report) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculties from the department with the senior most acting as the Chairperson.

Marks distribution for CIE of the course seminar:

Seminar Report: 30 marks

Presentation skill:50 marks

Question and Answer:20 marks

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-III

Research Methodology and Project Proposal

Course Code	24MSA17	CIE Marks	40
Teaching Hours/Week (L:T:P)	2:0:0	SEE Marks	60
Credits	02	Exam Hours	03

Module 1: Research Methodology

Introduction to research methodology, meaning, objectives, motivation, types, approaches, significance, methods versus methodology, scientific method, research process, criteria of good research, problems in India, defining the research problem, selecting and defining the problem, technique and illustration

Module 2: Literature Review and Research Design

Place of literature review, clarity and focus on the research problem, improving methodology, broadening knowledge, contextual findings, how to review, searching and reviewing literature, theoretical and conceptual frameworks, writing about the literature, research design meaning, need, features of a good design, concepts, different designs, principles of experimental designs, important designs

Module 3: Sampling, Measurement, and Data Collection

Introduction to sampling, sample design, sampling and non-sampling errors, sample survey versus census survey, types of sampling designs, measurement and scaling, qualitative and quantitative data, classification of scales, goodness of scales, error sources, scaling techniques, multidimensional scaling, deciding the scale, data collection through experiments and surveys, collection of primary and secondary data, selecting the method, case study method

Module 4: Hypothesis Testing and Chi-Square Test

Introduction to hypothesis testing, concepts, procedure, hypothesis testing for mean, proportion, variance, differences between two means, proportions, variances, p-value approach, power of test, limitations, chi-square test, test of differences, independence of attributes, goodness of fit, cautions

Module 5: Interpretation, Report Writing, and Intellectual Property

Meaning of interpretation, techniques, precautions, significance of report writing, steps, layout, types of reports, oral presentation, mechanics, precautions, introduction to intellectual property, system in India, TRIPS compliance, patents, trademarks, designs, geographical indications, copyrights, plant varieties, semiconductor designs, trade secrets, utility models, biodiversity, convention on biological diversity, rationales for IPR protection, international instruments, WIPO, WTO, Paris Convention, patent cooperation treaty, Berne Convention, TRIPS agreement, protection under TRIPS

Module 6: Advanced Research Topics

Current trends in research methodologies, ethical considerations, advanced statistical methods, qualitative research techniques, research funding and grant writing, presentation skills, publication process, peer review, open access, data privacy and protection, research impact and metrics, research communication and dissemination

Course outcomes:

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

1. Understand basic research methodology and problem definition.
2. Conduct literature reviews and design research studies.
3. Apply sampling, measurement, and data collection techniques.
4. Perform hypothesis testing and chi-square analysis.
5. Interpret findings, write reports, and understand intellectual property.
6. Explore advanced research topics and ethical considerations.

Question paper pattern:

The SEE question paper will be set for 100 marks.

- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks.
- There will be two full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Textbooks

Sl. No.	Title of the book	Name of the Author/s	Publisher Name	Edition and year
1	Research Methodology: Methods and Techniques	C.R. Kothari, Gaurav Garg	New Age International	4 th Edition, 2018
2	Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2)	Ranjit Kumar	SAGE Publications	3 rd Edition, 2011
3	Study Material (For the topic Intellectual Property under module 5)	Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.		

Reference Books

1	Research Methods: the concise knowledge base	Trochim	Atomic Dog Publishing	2005
2	Conducting Research Literature Reviews: From the Internet to Paper	Fink A	Sage Publications	2009

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER-III

Dissertation: Phase I

Course Code		CIE Marks	100
Number of contact Hours/Week (L:T:P)	0:0:2	SEE Marks	--
Credits	02	Exam Hours	--

Course objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student, under the guidance of a faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Revised Bloom's Taxonomy Level

L₃ – Applying, L₄ – Analysing, L₅ – Evaluating, L₆ – Creating.

Course outcomes:

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

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilising a systems approach.
Communicate with engineers and the community at large in written and oral forms.
4. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER -III

Internship / Professional Practice

Course Code		CIE Marks	40
Number of contact Hours/Week	0:0:2	SEE Marks	60
Credits	06	Exam Hours	03

Course objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.
- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.

Internship/Professional practice: Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.
- The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

1. Gain practical experience within industry in which the internship is done.
2. Acquire knowledge of the industry in which the internship is done.
3. Apply knowledge and skills learned to classroom work.
4. Develop a greater understanding about career options while more clearly defining personal career goals.
5. Experience the activities and functions of professionals.
6. Develop and refine oral and written communication skills.

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination

SEE marks for the internship report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session) by the examiners appointed by the Institute.

M. Tech in Turbomachinery
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER -IV

Project Work Phase -2

Course Code		CIE Marks	40
Number of contact Hours/Week(L:T:P)	0:0:4	SEE Marks	60
Credits	20	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation:

Project Report: 20 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 10 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 10 marks.

The student shall be evaluated based on the ability in the Question-and-Answer session for 10 marks.

Semester End Examination

SEE marks for the project report (30 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session) by the examiners appointed by the Institute.

