CURRICULUM STRUCTURE

FOR

BACHELOR OF TECHNOLOGY
IN
MECHANICAL ENGINEERING

(Applicable from the academic session 2024-2025)

Haldia Institute of Technology

(An Autonomous Institution Under Maulana Abul Kalam Azad University of Technology, West Bengal)

Haldia Institute of Technology

(An Autonomous Institution Under Maulana Abul Kalam Azad University of Technology, West Bengal)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2024-2025)

SEMESTER-I

THEORY							
Sl No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	BS-M 101	Mathematics-I	3	1	0	4	4
2	BS-PH 101	Physics	3	1	0	4	4
3	ES-EE 101	Basic Elec. & Electro. Engg.	3	1	0	4	4
4	BS-BT 101	Biology for Engineers	2	0	0	2	2
TOTAL THEORY						**14**	**14**
PRACTICAL							
5	BS-PH 191	Physics Lab	0	0	3	3	1.5
6	ES-EE 191	Basic Elec. & Electro. Engg. Lab	0	0	3	3	1.5
7	ES-ME 191	Workshop Practice	0	0	3	3	1.5
8	AU 101	NSS	0	0	0	0	0
TOTAL PRACTICAL						**9**	**4.5**
TOTAL						**23**	**18.5**

SEMESTER-II

THEORY							
Sl No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	BS-M 201	Mathematics-II	3	1	0	4	4
2	BS-CH 201	Chemistry	3	1	0	4	4
3	ES-CS 201	Programming for problem solving	3	1	0	4	4
4	HS-MC 201	Values, Ethics and Indian Knowledge System	2	0	0	2	2
5	HM-HU 201	English Language and Technical Communication	2	0	0	2	2
TOTAL THEORY						**16**	**16**
PRACTICAL							
6	BS-CH 291	Chemistry Lab	0	0	3	3	1.5
7	ES-CS 291	Programming for problem solving Lab	0	0	3	3	1.5
8	ES-ME292	Engineering Drawing	0	0	3	3	1.5
9	HM-HU 291	English Language and Technical Communication Lab	0	0	2	2	1
TOTAL PRACTICAL						**11**	**5.5**
TOTAL						**27**	**21.5**

SEMESTER-III

THEORY							
Sl. No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	BS-M 301	Mathematics-III	3	0	0	3	3
2	ES-ME 301	Engineering Mechanics	3	0	0	3	3
5	ES-ME 302	Engineering Thermodynamics	3	0	0	3	3
3	PC-ME 301	Fluid Mechanics and Hydraulic Machines	3	1	0	4	4
4	PC-ME 302	Material Science	3	0	0	3	3
6	PC-ME 303	Metrology and Measurement	3	0	0	3	3
7	MC 301	Essence of Constitution of INDIA & Laws in Engineering Practices	2	0	0	2	0
	Total Theory					**21**	**19**

PRACTICAL							
1	PC-ME 391	Fluid Mechanics and Hydraulic Machines Lab	0	0	3	3	1.5
2	PC-ME 392	Metrology and Measurement Lab	0	0	3	3	1.5
3	PC-ME 393	Machine Drawing	0	0	3	3	1.5
					Total Practical	**09**	**4.5**
					Total of Semester	**30**	**23.5**

SEMESTER-IV

THEORY							
Sl. No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	HM-ME 401	Engineering Economics	2	0	0	2	2
2	ES-ME 401	Numerical Methods and Programming	2	0	0	2	2
3	PC-ME 401	Strength of Materials	3	0	0	3	3
4	PC-ME 402	Manufacturing Processes	3	0	0	3	3
5	PC-ME 403	Analysis and Synthesis of Mechanisms	3	0	0	3	3
6	PC-ME 404	Applied Thermodynamics	3	0	0	3	3
7	MC 401	Industrial safety	2	0	0	2	0
					Total Theory	**18**	**16**
PRACTICAL							
1	ES-ME 491	Numerical Methods and Programming Lab	0	0	2	2	1
2	PC-ME 491	Strength of Materials Lab	0	0	3	3	1.5
3	PC-ME 492	Manufacturing Processes Lab	0	0	3	3	1.5
					Total Practical	**8**	**4**
					Total of Semester	**26**	**20**

SEMESTER-V

THEORY							
Sl. No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	HM-ME501	Principles and Practices of Management	3	0	0	3	3
2	PC-ME 501	Machining Principles & Machine Tools	3	0	0	3	3
3	PC-ME 502	IC Engines and Gas Turbines	3	0	0	3	3
4	PC-ME 503	Heat Transfer	3	1	0	4	4
5	PC-ME 504	Design of Machine Elements	3	0	0	3	3
6	PE-ME 501	Professional Elective-I (Course category – 2, Design)	3	0	0	3	3
					Total Theory	**19**	**19**
PRACTICAL/SESSIONAL							
1	PC-ME 591	Machine Tools Lab	0	0	3	3	1.5
2	PC-ME 592	Thermal Engineering Lab	0	0	3	3	1.5
3	PC-ME 593	Heat Transfer Lab	0	0	3	3	1.5
					Total Practical	**9**	**4.5**
					Total of Semester	**28**	**23.5**

SEMESTER-VI

THEORY							
Sl. No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	PC-ME 601	Air-conditioning and Refrigeration	3	0	0	3	3
2	PC-ME 602	Modern Manufacturing Processes	3	0	0	3	3

3	PC-ME 603	Design of Mechanical Systems	3	0	0	3	3
4	PC-ME 604	Dynamics of Machines	3	0	0	3	3
5	PE-ME 601	Professional Elective-II (Course category – 1, Manufacturing, Production & Industrial)	3	0	0	3	3
6	PE-ME 602	Professional Elective-III (Course category – 3, Thermal)	3	0	0	3	3
					Total Theory	**18**	**18**
PRACTICAL							
1	PC-ME 691	Air-conditioning and Refrigeration Lab	0	0	3	3	1.5
2	PC-ME 692	Modern Manufacturing Process Lab	0	0	3	3	1.5
3	PC-ME 693	Design Practice Lab	0	0	3	3	1.5
4	PC-ME 694	Dynamics of Machines Lab	0	0	3	3	1.5
5	PW-ME 681	Project- I *	0	0	4	4	2
					Total Practical	**16**	**8**
					Total of Semester	**34**	**26**

***** Project- I include seminar on the project topic's introduction, literature survey, research gap finding, problem formulation and objectives.

NOTE: Vocational Training/Internship conducted up to sixth semester will be evaluated in seventh semester. Total accumulated hours of Vocational Training/Internship are 40 hours/week × 24 weeks = 960 hours

SEMESTER-VII

THEORY							
Sl. No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	PC-ME 701	Power Plant Engineering.	3	0	0	3	3
2	HM-ME 701	Production and Operations Management	3	0	0	3	3
3	PE-ME 701	Professional Elective-IV (Course category – 1, Manufacturing, Production & Industrial)	3	0	0	3	3
4	PE-ME 702	Professional Elective-V (Course category – 2, Design)	3	0	0	3	3
					Total Theory	**12**	**12**
SESSIONAL							
1	PW-ME 781	Project – II **	0	0	6	6	3
2	PW-ME 782	Summer Internship / Vocational Training	0	0	0	0	2
					Total Practical	**6**	**5**
					Total of Semester	**18**	**17**

****** Project – II include Design of product, experiment, strategy, algorithm, hypothesis, service aid, gadgets and thorough analysis.

SEMESTER-VIII

THEORY							
Sl. No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	PE-ME 801	Professional Elective-VI (Course category – 3, Thermal)	3	0	0	3	3
2	OE-ME 801	Open Elective-I	2	0	0	2	2
3	OE-ME 802	Open Elective-II	3	0	0	3	3
					Total Theory	**8**	**8**
SESSIONAL							
1	PW-ME 881	Project – III ***	0	0	10	10	5

2	PW-ME 882	Comprehensive Viva Voce	0	0	0	0	2
					Total Practical	**10**	**7**
					Total of Semester	**18**	**15**
	Total Credit					**165**	

*** Project–III entails upshot of the project (keeping in view of utility, technical feasibility, economic viability, eco-friendliness) and also to divulge conclusion and future scope.

A multidisciplinary laboratory using AICTE IDEA lab, IoT lab, Computing lab etc. have to be conducted for a duration of 7 hours/week × 90 weeks (15 weeks/Semester × 6 Semester) = 630 hours.

List of Professional Electives
Maximum two (02) professional electives can be selected from each course category

Course Code	
Course Category – 1 (Manufacturing, Production& Industrial Engineering)	
A	Supply Chain Management
B	Total Quality Management
C	Material Handling Systems
D	Computer Integrated Manufacturing
E	Additive Manufacturing
F	Quantity Production Methods
G	Advanced Welding Technology
H	Surface Engineering & Laser Additive Manufacturing
I	Material Characterization
Course Category –2 (Design Engineering)	
J	Engineering Tribology
K	Finite Element Analysis
L	Mechanics of Composite Materials
M	Theory of Elasticity
N	Advanced Solid Mechanics
O	Non-Destructive Testing
P	Advanced Materials
Q	Mechanical Vibration
R	Fracture Mechanics
S	Bio-Mechanics
Course Category - 3 (Thermal Engineering)	
T	Computational Fluid Dynamics
U	Renewable Energy
V	Hydraulic and Pneumatic Control
W	Turbo-machinery
X	Two-phase Flow and Heat Transfer
Y	Automobile Engineering
Z	Advanced Fluid Mechanics

List of Open Electives (Interdisciplinary and Multidisciplinary)

Course Code	**Course Name**
A	Enterprise Resource Planning (ERP)
B	Marketing Management
C	Management Information System
D	System Engineering and Data Analytics

E	Operations Research
F	Mechatronics
H	Engineering Optimization
I	Industrial Robotics & Automation
J	Energy Storage
K	AI & Data Science
L	Project Planning and Cost Estimation
M	Microprocessor & Microcontroller
N	Fuel Cell Technology
O	Project Management
P	Electrical Vehicle Technology

Detailed Semester-wise Credit Distribution Across Course Categories

Category	Semester								
	1st	2nd	3rd	4th	5th	6th	7th	8th	Total
HM/HSMC	**-**	**5**	**-**	**2**	**3**	**-**	**3**	**-**	**13**
BS	**11.5**	**9.5**	**3**	**-**	**-**	**-**	**-**	**-**	**24**
ES	**7**	**7**	**6**	**3**	**-**	**-**	**-**	**-**	**23**
PC	**-**	**-**	**14.5**	**15**	**17.5**	**18**	**3**	**-**	**68**
PE	**-**	**-**	**-**	**-**	**3**	**6**	**6**	**3**	**18**
OE	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**5**	**5**
PW	**-**	**-**	**-**	**-**	**-**	**2**	**5**	**7**	**14**
MC	**-**	**-**	**0**	**0**	**-**	**-**	**-**	**-**	**0**
Credit	**18.5**	**21.5**	**23.5**	**20**	**23.5**	**26**	**17**	**15**	**165**

HM/HSMC: Humanities and Social Sciences including Management Courses
BS: Basic Science Courses
ES: Engineering Science Courses
PC: Professional core courses
PE: Professional Elective courses
OE: Open Elective courses
PW: Project work etc.
MC: Mandatory courses

Haldia Institute of Technology

(An Autonomous Institution Under Maulana Abul Kalam Azad University of Technology, West Bengal)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2024-2025)

SEMESTER-III

THEORY							
Sl. No.	**Course Code**	**Subject Name**	**Contact period per week**				**Credit**
			L	**T**	**P**	**Total**	
1	BS-M 301	Mathematics-III	3	0	0	3	3
2	ES-ME 301	Engineering Mechanics	3	0	0	3	3
5	ES-ME 302	Engineering Thermodynamics	3	0	0	3	3
3	PC-ME 301	Fluid Mechanics and Hydraulic Machines	3	1	0	4	4
4	PC-ME 302	Material Science	3	0	0	3	3
6	PC-ME 303	Metrology and Measurement	3	0	0	3	3
7	MC 301	Essence of Constitution of INDIA and Laws in Engineering Practices	2	0	0	2	0
					Total Theory	**21**	**19**
PRACTICAL							
1	PC-ME 391	Fluid Mechanics and Hydraulic Machines Lab	0	0	3	3	1.5
2	PC-ME 392	Metrology and Measurement Lab	0	0	3	3	1.5
3	PC-ME 393	Machine Drawing	0	0	3	3	1.5
					Total Practical	**09**	**4.5**
					Total of Semester	**30**	**23.5**

Haldia Institute of Technology

(An Autonomous Institution Under Maulana Abul Kalam Azad University of Technology, West Bengal)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2024-2025)

Course Code: BS-M 301	**Category**: Basic Science course
Course Name: Mathematics-III	**Semester**: Third
L-T-P: 3-0-0	**Credit**:3
Contact Per Week- 3L	**Contact Weeks / Semester=** 15
Total Contacts: 45*(L)+ 0(T) + 0 (P) + 45 (SL)=90	**Pre-Requisites: Mathematics I & II**

UNIT I	**Contact Hours**
Introduction to Partial Differential Equations (PDEs), Linear and non-linear first order partial differential equations, Lagrange method for solution of first order quasi-linear PDEs, Solution to homogeneous and non-homogeneous linear partial differential equations of second order by complementary function and particular integral method.	**8**
UNIT II	
Classification of second order linear PDEs, Initial and Boundary value problems, Solution of PDEs by separation of variables method, Heat diffusion and vibration problems, The Laplace Equation, D'Alembert's solution of the Wave equation; Duhamel's principle for one-dimensional Wave equation, The Laplacian in cylindrical and spherical polar coordinates, Bessel and Legendre functions.	**8**
UNIT III	
Introduction to Probability, Conditional probability, Independent events, Bayes' theorem, Bernoulli Trials, Random variables: Discrete and Continuous, Probability density function (PDF) and Probability mass function (PMF), Distribution functions, Expectation, Variance, Standard Deviation and Moments.	**7**
UNIT IV	
Binomial distribution, Poisson distribution, Normal distribution, Standard Normal distribution, Exponential distribution, Gamma distribution, Bivariate distributions, Conditional PDF/PMF, Covariance, Bivariate transformation, Chebyshev's inequality.	**7**
UNIT V	
Basic Statistics: Mean, Median and Mode, Measures of Central tendency: Moments, Skewness and Kurtosis, Correlation and regression, Rank correlation. Curve fitting by the method of least squares-fitting of straight lines, Second degree parabola.	**8**
UNIT VI	
Sampling: population and sample, types of sampling, parameter and statistics, sampling distribution, Testing of hypothesis: Introduction, Types of errors, Critical region, Level of significance, Testing of significance for single proportion, difference of proportions, single mean, difference of means and difference of standard deviation, Chi-square test for goodness of fit.	**7**
Total	**45***

Text and Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 2019.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
4. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.

Learning outcome:

Analyze and **model** engineering systems by formulating and solving partial differential equations and probabilistic models; **evaluate** mechanical processes using statistical methods; and **create** data-driven solutions for experimental validation in mechanical engineering applications.

Course Outcomes:

Upon successful completion of the course, students will be able to

BS-M 301.1	Solve field problems in engineering involving PDEs.
BS-M 301.2	Construct a PDE for a given physical problem.
BS-M 301.3	Formulate the solved problems involving random variables
BS-M 301.4	Understand and apply standard probability distributions in modeling experiments
BS-M 301.5	Apply statistical tools for quality control and data analysis in mechanical engineering experiments.
BS-M 301.6	Analyze mechanical engineering case studies using hypothesis testing techniques.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS-M 301.1	3	2	1	–	–	–	–	–	–	–	–	–	3	2	1
BS-M 301.2	3	2	1	–	–	–	–	–	–	–	–	–	3	2	1
BS-M 301.3	3	2	1	–	–	–	–	–	–	–	–	–	1	1	3
BS-M 301.4	3	2	1	1	–	–	–	–	–	–	–	–	1	2	3
BS-M 301.5	3	2	1	–	1	–	–	–	–	–	–	–	-	2	3
BS-M 301.6	3	2	1	–	–	–	–	–	–	–	–	–	1	1	3
Average	**3**	**2**	**1**	**1**	**1**								**1.8**	**1.67**	**2.33**

Course Code: ES-ME 301	**Category**: Engineering Science Courses
Course Name: Engineering Mechanics	**Semester**: Third
L-T-P: 3-0-0	**Credit**:3
Contact Per Week- 3L	**Contact Weeks / Semester=** 15
Total Contacts: 45*(L) + 0(T) + 0 (P) + 45 (SL)=90	**Pre-Requisites:** Class XII physics

Course Content:

UNIT I: **Concept of Force**	**Contact Hours.**
Fundamentals of Vector Algebra, Force Systems: Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Lame's Theorem, Components in Space – Resultant- Moment of Forces and its Application; Principle of Moments- Varignon's Theorem, Couple/Moment of a couple, and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Types of beams; Statically Indeterminate Systems. Principle of virtual work for rigid bodies in static equilibrium. Types of friction, Limiting friction, Laws of Friction, Angle of Repose, Angle of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack.	**14**
UNIT II: **Analysis of Structure**	
Element of a Truss; Assumptions for Truss Analysis; Determinacy and Stability; Method of Sections; Method of Joints; Simple Trusses; Zero force members.	**5**
UNIT III: **Centroid, Centre of Gravity and Moment of Inertia**	
Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its applications; Area moment of inertia- Definition, Momentof inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.	**8**
UNIT IV: **Kinematics of Particle**	
Rectilinear motion; Circular Motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates).	**7**
UNIT V: **Kinetics of Rigid Bodies**	
Basic terms, general principles in dynamics; Types of motion; Impulse-momentum (linear, angular); Impact (Direct and oblique); D'Alembert's principle and its applications in plane motion and connected bodies; potential energy; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body; Torque; Power.	**7**
UNIT VI: **Simple Lifting Machines**	
Definition of Lifting Machine, Applications and Advantages, Load, Effort, Mechanical Advantage, Velocity Ratio, Efficiency of Simple Machines and their relationships. Law of machine.	**4**
Total	**45***

Text and Reference Books:

1. M.P. Poonia & D.S. Bedi, Engineering Mechanics, Khanna Publishing House, 2019
2. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
3. R.S. Khurmi, Engineering Mechanics, S.Chand Publications, Delhi
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, OxfordUniversity Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
7. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
8. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications
10. Engineering Mechanics by Timoshenko & Young – McGraw Hill
11. Engineering Mechanics by Meriam & Kraige – Statics (Vol I) and Dynamics (Vol II) – John Wiley
12. Vector Mechanics for Engineers by Beer & Johnston – McGraw Hill

Learning Outcome:

Students will be able to **formulate** problems pertaining to Force system, friction, centre of gravity, moment of inertia, kinematics and kinetics, enabling **analysis and design** of structural elements under various loading conditions using fundamental engineering principles.

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

ES-ME 301.1	Define fundamental concepts in engineering mechanics, such as forces, moments, and equilibrium and formulate the key equations related to static equilibrium and basic mechanical principles.
ES-ME 301.2	Explain the principles of statics and dynamics and their applications in engineering and analyze the forces using free body diagrams and governing equations.
ES-ME 301.3	Apply principles of mechanics to solve engineering problems related to forces, moments, and equilibrium and utilize mathematical tools to solve engineering mechanics problems.
ES-ME 301.4	Analyze complex structures and systems under various loading conditions using principles of engineering mechanics and break down real-world engineering problems into components for analysis and solution.
ES-ME 301.5	Evaluate the stability and safety of structures under different loading scenarios and critically assess the appropriateness of different engineering solutions to specific problems.
ES-ME 301.6	Design and create engineering solutions for practical problems using principles of mechanics and develop new applications or modifications based on engineering mechanics principles.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ES-ME 301.1	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
ES-ME 301.2	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
ES -ME 301.3	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
ES -ME 301.4	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
ES -ME 301.5	2	3	3	2	2	-	-	-	-	1	-	2	3	2	2
ES -ME 301.6	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
Average	**2.83**	**3**	**3**	**2.83**	**2**					**1**		**2**	**3**	**2**	**2**

Course Code: ES-ME 302	**Category**: Engineering Science Courses
Course Name: Engineering Thermodynamics	**Semester**: Third
L-T-P: 3-0-0	**Credit**: 3
Contact Per Week: 3L	**Contact Weeks / Semester**: 15
Total Contacts: 45(L)* +0(T) +0 (P) +45 (SL)=90	**Pre-Requisites**: Class XI physics

Course Content:

UNIT I: FUNDAMENTAL CONCEPTS	**Contact Hours**
System & Control volume; Property, State & Process; Exact & Inexact differentials, Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Definition of heat; definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work	**4**
UNIT II: FIRST LAW FOR FLOW PROCESSES AND APPLICATIONS	
Heat and Work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy; Entropy concept; Various modes of energy, Internal energy and Enthalpy., First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume.	**8**
UNIT III: SECOND LAW CONCEPTS AND APPLICATIONS	
Second law - Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale. Second law analysis for a control volume, Carnot theorem, Carnot heat engine, Carnot refrigerator and heat pump. Perpetual motion machine of second law of thermodynamics, Energy balance equation and Energy analysis.(SFEE).	**8**
UNIT IV: ENTROPY	
Definition of Entropy; Evaluation of entropy for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Clausius's inequality, Determination of Entropy from steam tables- Principle of increase of entropy; Illustration of processes in T-S coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles.	**8**
UNIT V: PURE SUBSTANCE AND CHARECTERISTICS	
Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts, properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Phase Transformations – Triple point at critical state properties during change of phase, Use of steam tables and Mollier's chart; Saturation tables; Superheated tables; Identification of states & determination of properties,.	**8**
UNIT VI: VAPOUR POWER CYCLES	
Basic steam power plant, Rankine cycle; Means of increasing the Rankine cycle efficiency, The reheat cycle, The regenerative feed heating cycle, Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle. Introduction to Geotropic vapor cycles, Organic Rankine Cycle, Trilateral flash cycles, and supercritical Rankine cycles.	**9**
Total	**45***

Text and Reference Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.
5. M.P. Poonia & S.C. Sharma, Basics of Mechanical Engineering, Khanna Publishing House, N. Delhi.

Learning Outcome:

Students will be able to apply the laws of thermodynamics to analyze energy interactions, entropy changes, and performance of pure substances, power cycles, and thermodynamic systems.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

ES-ME 302.1	Understand the basic concepts and laws of thermodynamics
ES-ME 302.2	Analyze energy interactions using the First Law of Thermodynamics.
ES-ME 302.3	Apply the Second Law of Thermodynamics to determine the direction of processes
ES-ME 302.4	Evaluate the performance of thermodynamic cycles.
ES-ME 302.5	Interpret thermodynamic properties using tables, charts, and equations of state.
ES-ME 302.6	Apply thermodynamic principles to engineering applications.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ES ME 302.1	2	3	2	2	2	3	2	1	1	1	1	2	2	3	1
ES ME 302.2	3	2	3	3	2	3	2	2	2	1	1	1	2	2	1
ES ME 302.3	2	2	3	3	2	2	3	2	2	2	1	2	2	3	2
ES ME 302.4	3	3	3	3	3	2	2	2	2	1	1	1	2	3	2
ES ME 302.5	3	2	2	2	2	2	2	2	2	2	1	1	1	2	3
ES ME 302.6	2	3	3	3	3	3	3	2	2	1	2	2	2	2	2
Average	**2.5**	**2.5**	**2.67**	**2.67**	**2.33**	**2.5**	**2.33**	**1.83**	**1.83**	**1.33**	**1.17**	**1.5**	**1.83**	**2.5**	**1.83**

Course Code: PC-ME 301	**Category**: Professional Core Courses
Course Name: Fluid Mechanics and Hydraulic Machines	**Semester**: Third
L-T-P: 3-1-0	**Credit**:4
Contact Per Week-3L + 1T	**Contact Weeks / Semester=**15
Total Contacts: 60*(L)+14(T) +0 (P) +60 (SL)=120	**Pre-Requisites:** Engineering Mechanics (ES-ME 301)

Course Content:

UNIT I: Properties and kinematics of fluid	**Contact Hours**
Review of fluid properties: Newton's Law of Viscosity, Surface Tension, Pressure measurement, Pascal's Law, Centre of pressure, Hydrostatic forces on submerged surfaces; Buoyancy and Floatation, Kinematics of fluid flow: Streamline, pathline, streakline; Continuity equation in 1D and 3D. Velocity and acceleration field; Potential flow; Stream function.	**10**
UNIT II: Fluid dynamics and its applications	
Euler's equation; Bernoulli's equation and its applications: Venturimeter, orificemeter, pitot-tube. Introduction to viscous flow: Hagen Poiseuille formula, flow between parallel plates. Couette flow, Momentum analysis: Linear momentum equation.	**10**
UNIT III: Flow through pipes and open channels	
Flow through pipes: Darcy-Weisbach equation, major and minor losses in pipes. Hydraulic and energy grade lines. Flow through pipes in series and parallel. Flow through open channels: Chezy's formula, types of flows in channels. Sustainable water transport systems: Minimizing energy losses in pipe networks and open channels.	**10**
UNIT IV: Dimensional analysis and boundary layer theory	
Dimensional analysis: Buckingham Pi theorem. Important dimensionless numbers: Reynolds, Froude, Weber, Mach numbers. Boundary layer concepts: Displacement thickness, momentum thickness, energy thickness. Boundary layer separation and control.	**10**
UNIT V: Flow over submerged bodies	
Drag and Lift forces. Flow past immersed bodies: streamlined and bluff bodies. Introduction to compressible flow (basic concepts only).	**10**
UNIT VI: Fluid machinery	
Hydraulic turbines: Working principle and velocity triangle diagram of Pelton wheel, Francis, and Kaplan turbines; Draft tube, cavitation. Hydraulic pumps: Reciprocating and centrifugal pumps: Components, principles, multistage pumps, pump characteristics. Role of hydraulic machines in renewable energy systems. Case study on Analysis of sustainable hydropower systems.	**10**
Total	**60***

Text and Reference Books:

1. Fluid Mechanics & Hydraulic Machines, S.S. Rattan, Khanna Book Publishing Co., 2018
2. Fluid Mechanics and Machinery, R.K.Bansal, Laxmi Publication.
3. Introduction to Fluid Mechanics & Fluid Machines, Som and Biswas, TMH.
4. A Textbook on Fluid Mechanics and Machines, S.Pati, McGrawHill.
5. Fluid Mechanics and Machinery, C.S.P.Ojha, R. Berndtsson and P. N. Chadramouli, Oxford University Press, 2010.
6. Hydraulics and Fluid Mechanics, P M Modi and S M Seth, Standard Book House.

Learning outcome:

Upon successful completion of this course, students will be able to analyze and apply the fundamental principles of fluid mechanics and hydraulic machines for solving engineering problems related to fluid flow, pipe networks, open channels, and sustainable water and energy systems.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

PC-ME 301.1	Understand the fundamental properties and behavior of fluids.
PC-ME 301.2	Apply fluid statics and kinematics principles to practical engineering systems.
PC-ME 301.3	Students recognize the role of fluid dynamics in sustainable engineering solutions.
PC-ME 301.4	Conduct dimensional analysis and interpret boundary layer phenomena.
PC-ME 301.5	Evaluate flow over submerged bodies considering drag and lift.
PC-ME 301.6	Understand and apply fluid mechanics principles in designing energy-efficient and environmentally sustainable systems.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 301.1	3	2	–	–	–	–	–	–	–	1	–	2	3	2	1
PC-ME 301.2	3	3	2	–	2	–	–	–	–	1	–	2	3	2	2
PC-ME 301.3	2	2	3	–	–	2	3	–	–	1	–	2	3	3	2
PC-ME 301.4	3	2	2	3	2	–	–	–	–	1	–	2	3	2	2
PC-ME 301.5	3	3	2	2	2	–	–	–	–	1	–	2	3	2	2
PC-ME 301.6	2	2	3	2	–	2	3	–	–	1	–	3	3	2	2
Average	**2.67**	**2.33**	**2.4**	**2.33**	**2**	**2**	**3**			**1**		**2.17**	**3**	**2.17**	**1.83**

Course Code: PC-ME 302	**Category**: Professional Core Courses
Course Name: Material Science	**Semester**: Third
L-T-P: 3-0-0	**Credit**:3
Contact Per Week- 3L	**Contact Weeks / Semester**=15
Total Contacts: 45(L)* +0(T) +0 (P) +45 (SL)=90	**Pre-Requisites:** Chemistry (BS-CH 201)

Course Content:

UNIT I: Atomic Structure	**Contact Hours**
Electronic structure and atomic bonding. Crystal Structure: Unit cells, Metallic crystal structures, Diffraction of X-Rays and Bragg's law, Techniques of material characterization, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolvedshear stress.	**8**
UNIT II: Mechanical Properties	
Mechanical Property measurement: Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress- strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Strain hardening, precipitation hardening Hardness: Rockwell, Brinell and Vickers and their relation to strength.	**8**
UNIT III: Failure criteria	
Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von- mises, Maximum normal stress, Mohr's Circle, Mohr-Coulomb and Modified Mohr- Coulomb; Fracture mechanics: Introduction to Stress-intensity factor approach and Griffith criterion. Fatigue failure: High cycle fatigue, Stress-life approach, SN curve, endurance and fatigue limits, effects of mean stress using the Modified Goodman diagram; Fracture with fatigue, Creep & Creep curves Introduction to nondestructive testing (NDT)	**8**
UNIT IV: Phase diagram	
Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binaryphase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstrctural aspects of ledeburite, austenite, ferrite and cementite, cast iron. Alloying of steel, properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminium and Al-Cu – Mg alloys- Nickel based superalloys and Titanium alloys.	**9**
UNIT V: Heat treatment	
Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo- nitriding, flame and induction hardening, vacuum and plasma hardening.	**6**
UNIT VI: Powder metallurgy and smart materials	
Powder Metallurgy: Basics steps of powder metallurgy: Powder production, atomization, mixing and blending, compacting (CIP & HIP), sintering, impregnation. Testing and inspection. Properties of powder particles. Advantages and disadvantages of Powder Metallurgy. Ceramics: Types and applications, Shape Memory Alloys, Composites and its classifications, Processing of Fibre Reinforced Plastics, Glasses, Nanomaterials	**6**
Total	**45***

Text and Reference Books:

1. W. D. Callister, 2006, "Materials Science and Engineering-An Introduction", 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011

Learning outcome:

At the end of the course, students will be able to analyze the structure-property-processing-performance relationship of engineering materials and apply this knowledge to select and modify materials for diverse mechanical applications.

Course Outcomes:
Upon successful completion of the course, students are expected to be able to:

PC-ME 302.1	Explain the electronic structure of atoms and various crystal structures, including imperfections in solids, and their impact on material behavior.
PC-ME 302.2	Evaluate the mechanical properties of materials using standard testing methods such as tensile, hardness, and impact tests, and interpret stress-strain behavior
PC-ME 302.3	Apply static failure theories and concepts of fracture mechanics to assess failure modes in ductile and brittle materials under complex loading.
PC-ME 302.4	Interpret binary phase diagrams and correlate microstructural changes with phase transformations in various alloy systems including steels and non-ferrous metals
PC-ME 302.2	Analyze different heat treatment processes and predict resulting microstructures and mechanical properties of ferrous alloys
PC-ME 302.1	Describe the processes and applications of powder metallurgy, ceramics, composites, and smart materials, and compare their advantages for modern engineering applications

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 302.1	3	2	1	–	–	–	–	–	–	–	–	1	3	2	2
PC-ME 302.2	3	3	2	2	1	–	–	–	–	–	–	1	3	2	2
PC-ME 302.3	3	3	3	2	–	–	–	–	–	–	–	2	3	2	2
PC-ME 302.4	3	2	3	2	1	–	–	–	–	–	–	2	3	2	2
PC-ME 302.5	3	2	2	1	1	–	–	–	–	–	–	2	3	2	2
PC-ME 302.6	3	2	2	2	3	2	1	–	–	1	–	2	3	2	2
Average	**3**	**2.33**	**2.17**	**1.8**	**1.5**	**2**	**1**			**1**		**1.67**	**3**	**2**	**2**

Course Code: PC-ME 303	**Category**: Professional Core Courses
Course Name: Metrology and Measurement	**Semester**: Third
L-T-P: 3-0-0	**Credit**:3
Contact Per Week- 3L	**Contact Weeks / Semester**=15
Total Contacts: 45(L)* +0(T) +0 (P) +45(SL)=90	**Pre-Requisites:** Mathematics-II

Course Content:

UNIT I: INTRODUCTION	**Contact Hours**
Measurement fundamentals: Methods of measurements, Units of measurement, Errors in measurement, Measurement uncertainty - Introduction, Standard deviation as a measure, statistical concepts- Sampling, least squares model, covariance and correlation. Calculation of uncertainties- Law of propagation, correlated inputs, probability densities, sampling distributions, case studies and problems.	**6**
UNIT II: LINEAR, ANGULAR AND OPTICAL MEASUREMENTS	
Length Measuring Instruments: Vernier, Micrometer, Slip Gauges; Angle measuring instruments: Sine bar, Angle Gauges, Optical Measurement and Interferrometry: Optical Measurement Techniques: Tool Maker's Microscope, Profile Projector, Optical Squares; Laser Interferometers. Comparators: Functional Requirements; Classification of Comparators, Comparators: Electrical, Optical, Mechanical and Pneumatic.	**9**
UNIT III: LIMITS, FITS AND TOLERANCES	
Principle of Interchangeability; Tolerances; Max and min metal conditions; Fits; Basic-Hole System; Basic-Shaft System; Allowance; System of Limits and Fits; Tolerance grades; Design of limit gauges, Inspection; Selection of Gauging Equipment;	**8**
UNIT IV: SURFACE METROLOGY AND MEASUREMENT OF GEARS AND SCREW THREADS	
Surface Metrology Concepts; Analysis of Surface Traces; Specification of Surface Texture Characteristics; Methods of Measuring Surface Finish; Stylus Probe Instruments; Other Methods for Measuring Surface Roughness, Gear measurement: Introduction and Classification of gears; Forms of gear teeth; Gear tooth terminology; Methods of measuring tooth thickness, tooth profile & pitch, Gear Errors; Screw Thread Measurement: Terminology, Forms of thread, Errors in threads, Measurement of major, minor and effective diameters (2-wire and 3-wire methods)	**10**
UNIT V: QUALITY CONTROL, TOTAL QUALITY MANAGEMENT AND SIX SIGMA	
Quality Control, Quality characteristics of Product and Quality Assurance; Statistical Quality Control; Total Quality Management; Six Sigma; Quality Standards.	**6**
UNIT VI: MISCELLANEOUS MEASURING INSTRUMENTS AND WORKING PRINCIPLES	
Displacement by LVDT; force by strain – gauge load cell and piezoelectric load cell; pressure by Bourdon– tube gauge; temperature by liquid-in-glass thermometer, thermocouples, optical pyrometer; liquid velocity by pitot tube; water flow by orifice meter, Coordinate Measuring Machine – constructional features – types – Applications of CMM, Importance of Nanometrology, Vision Based Metrology.	**6**
Total	**45***

Text and Reference Books:

1. Engineering Metrology by R.K.Jain, Khanna publishers.
2. A text book of Engineering Metrology by I.C.Gupta, Dhanpat Rai publications.
3. A text book of Measurement and Metrology by A.K. Sawhney, and M. Mahajan Dhanpat Rai & Co.
4. Principles of Engineering Metrology by R. Rajendra, Jaico Pub. House.
5. Mechanical Measurements by Beckwith, Lienhard and Marangoni, 6th ed. Pearson.
6. Measurement systems – Application and Design by E.O. Doebelin and D.N. Manik, 5th ed., Tata McGraw Hill.

Learning Outcome:

Evaluate and apply advanced metrological techniques and measurement systems to analyze mechanical components and processes, ensuring compliance with engineering standards and enhancing product quality.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

PC-ME 303.1	Analyze various measurement systems, their functional elements, standards, and system response.
PC-ME 303.2	Evaluate measurement errors and uncertainties using statistical tools for engineering decision-making.
PC-ME 303.3	Apply appropriate instruments and techniques for linear and angular measurement of mechanical components.
PC-ME 303.4	Analyze surface finish, tolerances, and geometrical measurements using advanced metrological equipment.
PC-ME 303.5	Select and justify the use of comparators, interferometry, and other precision tools in quality control.
PC-ME 303.6	Design an inspection system using CMM and modern metrological methods to ensure manufacturing quality

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 303.1	3	2	-	-	-	-	-	-	-	-	-	-	3	2	2
PC-ME 303.2	3	3	-	2	-		-	-	-	-	-	1	2	3	2
PC-ME 303.3	3	2	2	-	2	-	-	-	-	-	1	-	3	3	2
PC-ME 303.4	3	2	3	-	2	-	-	-	-	-	2	-	3	3	2
PC-ME 303.5	2	3	2	-	3	-	-	-	-	-	3	-	2	3	3
PC-ME 303.6	2	2	3	-	3	-	-	-	2	2	3	2	3	3	3
Average	**2.67**	**2.33**	**2.5**	**2**	**2.5**				**2**	**2**	**2.25**	**1.5**	**2.67**	**2.83**	**2.33**

Course Code: MC 301	**Category**: Mandatory courses
Course Name: Essence of Constitution of INDIA and Laws in Engineering Practices	**Semester**: Third
L-T-P: 2-0-0	**Credit**: 0
Contact Per Week- 2L	**Contact Weeks / Semester**=15
Total Contacts: 30(L)* +0(T) +0 (P) +30 (SL)=60	**Pre-Requisites:** No- Prerequisites

Course Contents:

UNIT I: Constitution of India – Fundamentals	**Contact Hours**
Introduction to the Constitution of India; objectives and significance; Preamble; basic structure of the Constitution; fundamental rights and duties; directive principles of state policy with relevance to engineers.	**5**
UNIT II: Governance, Judiciary, and Engineers' Responsibilities	
Structure of Union and State governments; legislature, executive, and judiciary; role of judiciary; independence of judiciary; judicial review; responsibilities of engineers as professionals in a constitutional framework.	**5**
UNIT III: Engineering Ethics and Professional Conduct	
Engineering ethics; professional responsibilities of mechanical engineers; safety, health, and welfare of society; ethical decision-making; professional misconduct; role of institutions such as Engineering Council of India; case studies related to mechanical engineering practices.	**5**
UNIT IV: Industrial and Labour Laws Relevant to Mechanical Engineering	
Factories Act; Industrial Disputes Act; Workmen's Compensation Act; Employees' State Insurance Act; Contract Labour Act; occupational health and safety provisions; role of engineers in compliance and implementation.	**5**
UNIT V: Environmental and Safety Laws in Engineering Practices	
Environmental Protection Act; Air and Water Acts; hazardous waste management rules; sustainability and environmental responsibility of engineers; industrial safety laws; liability issues in engineering projects; role of mechanical engineers in environmental protection.	**5**
UNIT VI: Intellectual Property Rights and Engineering Contracts	
Basics of intellectual property rights (patents, copyrights, trademarks); patents related to mechanical innovations; technology transfer; engineering contracts; tendering process; legal aspects of project execution; dispute resolution and arbitration.	**5**
Total	**30***

Text and Reference Books:

1. Durga Das Basu, *Introduction to the Constitution of India*, LexisNexis.
2. P. M. Bakshi, *The Constitution of India*, Universal Law Publishing.
3. R. Subramanian, *Professional Ethics*, Oxford University Press.
4. K. Aswathappa, *Human Resource and Personnel Management*, McGraw-Hill.

Learning Outcome:

Students will be able to analyze constitutional provisions and engineering-related laws, evaluate ethical, legal, and environmental implications of mechanical engineering practices, and formulate legally compliant and socially responsible engineering decisions in professional practice.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

MC 301.1	Understand the fundamental principles of the Indian Constitution and their relevance to engineering practice.
MC 301.2	Interpret the role of governance, judiciary, and constitutional provisions affecting engineers and industrial activities.
MC 301.3	Apply ethical principles and professional responsibilities in mechanical engineering practices.
MC 301.4	Identify and comply with industrial and labour laws relevant to mechanical engineering industries.

MC 301.5	Analyze environmental and safety legislations affecting mechanical systems and industrial operations.
MC 301.6	Apply knowledge of intellectual property rights and engineering contracts in real-world mechanical engineering projects.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC 301.1	2	1	–	–	–	3	2	2	–	–	–	2	2	1	–
MC 301.2	1	2	–	–	–	3	1	2	–	–	–	1	2	1	–
MC 301.3	2	2	2	–	–	3	–	3	1	1	–	2	2	2	–
MC 301.4	2	3	2	–	–	3	1	2	–	–	–	1	2	3	–
MC 301.5	2	3	2	–	–	3	3	2	–	–	–	1	2	3	–
MC 301.6	2	2	3	–	1	2	–	2	1	1	3	2	2	3	1
Average	**1.83**	**2.17**	**2.25**	**–**	**1.00**	**2.83**	**1.75**	**2.17**	**1.00**	**1.00**	**3.00**	**1.50**	**2.00**	**2.17**	**1.00**

Subject Code: PC-ME 391	**Category:** Professional Core courses	**PCIE Marks**	40
Subject Name: Fluid Mechanics and Hydraulic Machines Lab.	**Semester:** Third	**PSEE Marks**	60
L-T-P:0-0-3	**Credit:** 1.5	**Total Marks**	100
Pre-Requisites: Physics (BS-PH 101)			
Examination (SEE): Experimental			

Course Content:

- **Flow Measurement and Discharge Experiments**
  - Calibration and determination of the coefficient of discharge for flow measuring devices such as Orificemeter, Venturimeter, and rectangular/V-notch weirs.
  - Determination of flow characteristics through orifices including coefficient of discharge (Cd), coefficient of contraction (Cc), and coefficient of velocity (Cv).
- **Energy and Momentum Analysis**
  - Experimental verification of Bernoulli's equation to demonstrate energy conservation in steady incompressible fluid flow.
  - Determination of the impact of a jet on flat and curved vanes to analyze the momentum transfer and force exerted by a fluid jet.
- **Pipe Flow and Losses**
  - Measurement of major head losses in pipes due to friction, using pipes of different materials to determine the friction factor.
  - Estimation of minor losses in pipe systems due to various fittings such as bends, elbows, valves, and contractions.
- **Hydraulic Turbines and Performance Analysis**
  - Evaluation of the output power and overall efficiency of hydraulic turbines such as the Pelton wheel and Francis turbine under different load conditions.
  - Understanding draft tube action and efficiency parameters relevant to hydropower systems.
- **Pumps, Blowers, and Compressors**
  - Performance testing of centrifugal pumps and reciprocating pumps including measurement of overall efficiency and pump-specific parameters.
  - Determination of volume flow rate, volumetric efficiency, and compression ratio in centrifugal blowers and compressors.

List of Experiments / Assignments

Sl. No.	Name of the Experiment	Mapped CO(s)
1	Determination of impact of jet on vanes	CO4, CO3
2	Determination of the coefficient of discharge of Orificemeter	CO1, CO3
3	Determination of the coefficient of discharge of Venturimeter	CO1, CO3
4	Determination of the coefficient of discharge of rectangular and V notch	CO1, CO3
5	Determination of the loss of head in the pipe fittings (Minor losses)	CO5, CO3
6	Determination of friction factor of four different materials (Major losses)	CO5, CO3
7	Verification of Bernoulli's equation	CO3, CO1
8	Determination of C_d, C_c and C_v of orifice	CO2, CO1, CO3
9	Determination of output power and overall efficiency of Pelton wheel turbine	CO6, CO4, CO3

10	Determination of output power and overall efficiency of Francis turbine	CO6, CO3
11	Determination of volume flow rate and volumetric efficiency of centrifugal blower	CO6, CO1
12	Determination of volumetric efficiency and compression ratio of centrifugal compressor	CO6, CO3
13	Determination of overall efficiency and pump efficiency of centrifugal pump	CO6, CO3, CO1
14	Determination of different parameters of reciprocating pump	CO6, CO3, CO1

Learning Outcome:

Students will be able to experimentally evaluate key parameters of fluid flow and hydraulic machines, including flow measurement, energy and momentum principles, pipe flow losses, and performance characteristics of turbines, pumps, blowers, and compressors.

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

PC-ME 391.1	Identify and determine the discharge coefficients of various flow measuring devices such as Orificemeter, Venturimeter, and notches through calibration and experimentation.
PC-ME 391.2	Evaluate orifice flow parameters including the coefficient of discharge (Cd), coefficient of contraction (Cc), and coefficient of velocity (Cv) using standard fluid flow experiments.
PC-ME 391.3	Apply Bernoulli's theorem to experimentally verify the principle of energy conservation in steady fluid flow systems.
PC-ME 391.4	Analyze the momentum transfer in fluid jets by determining the impact forces on various vane configurations.
PC-ME 391.5	Measure and interpret major and minor head losses in pipe flow systems, including the estimation of friction factors for different pipe materials and fitting types.
PC-ME 391.6	Assess the performance characteristics and efficiency of hydraulic turbines, pumps, blowers, and compressors under varying operating conditions.

CO-PO & CO-PSO Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 391.1	3	2	2	1	1	-	-	-	2	3	-	2	3	3	1
PC-ME 391.2	3	2	2	1	1	-	-	-	2	3	-	2	3	3	1
PC-ME 391.3	3	2	2	2	-	-	-	-	2	3	-	2	3	3	1
PC-ME 391.4	3	3	2	2	1	-	-	-	2	3	-	2	3	3	2
PC-ME 391.5	3	3	3	2		-	-	-	2	3	-	2	3	3	2
PC-ME 391.6	3	2	3	2	1	-	-	-	2	3	-	2	3	3	2
Average	**3.00**	**2.33**	**2.33**	**1.67**	**1.00**				**2.00**	**3.00**		**2.00**	**3.00**	**3.00**	**1.50**

Subject Code: PC-ME 392	**Category:** Professional Core courses	**PCIE Marks**	40
Subject Name: Metrology and Measurement Lab	**Semester:** Third	**PSEE Marks**	60
L-T-P:0-0-3	Credit: 1.5	**Total Marks**	100
Pre-Requisites: Metrology & Measurement (PC-ME 303)			
Examination (SEE): Experimental			

Course Content:

- Study of Micrometer and Measurement of dimension of combined slip gauges.
- Measurement of external taper angle of a taper object.
- Measurement of internal taper angle of a taper object.
- Measurement of bore diameter using micrometer and gauges.
- Linear Measurement using Vernier height gauge and micrometer (internal and external depth).
- Measurement of threads parameter using tool maker's microscope and optical profile projector.
- Measurement of taper angle of a given work piece by bevel protector and sine bar (using balls and rollers).
- Measurement of thread parameters – Screw thread Micrometers and Three wire methods (floating carriage micrometer).
- Measurements of surface roughness using Tally Surf/Mechanical Comparator.
- Taking measurements using following instruments: (i) Vernier height & depth gauge, (ii) Dial micrometer, (iii) Thread gauge, (iv) Radius gauge, (v) Filler gauge, (vi) Slip gauge.
- Checking / measuring parallelism, cylindricity and concentricity of components using dial indicator.
- Measuring flatness with light band readings by using monochromatic light source.
- Measurement of angle of a component using: (i) Vernier bevel protractor, (ii) angle gauges, (iii) Sine-bar and slip gauges.

List of Experiments / Assignments

Sl. No:	Description/Title	CO Mapping
1	Study of Various Types of Vernier Caliper and Determination of Volume of Sphere and Hollow Cylinder by using those.	CO1, CO2, CO5, CO6
2	Study of Various Types of Micrometer and Determination of Thickness of Sheet, Roller Diameter, Sphere Diameter and Study of Combined Slip Gauges and Calibration of Micrometer Using Slip Gauge as Standard	CO1, CO2, CO5, CO6
3	Measurement of External Taper Angle of a Tapered Object Using Rollers, Sine Bar, and Bevel Protractor	CO2, CO3, CO4, CO5, CO6
4	Measurement of Internal Taper Angle of an Object Using Balls	CO3, CO4, CO5, CO6
5	Determination of Diameter of a Parallel Bore Using Two-Ball and Four-Ball Methods	CO2, CO3, CO4, CO5, CO6
6	Measurement of Thread Parameters Using Screw Thread Micrometers, Thread Gauges, and Optical Profile Projector	CO2, CO3, CO5, CO6
7	Checking/Measuring Parallelism, Cylindricity, Concentricity, Roundness, and Flatness of Components Using Dial Indicator	CO2, CO4, CO5, CO6
8	Measuring Flatness Using Light Band Readings with a Monochromatic Light Source	CO2, CO4, CO5, CO6
9	Measurement of Surface Roughness Using Tally Surf	CO2, CO3, CO5, CO6
10	Taking Measurements Using Radius Gauge, Feeler Gauge, and Drill Gauge	CO2, CO5, CO6
11	Determination of Diameter of Parallel Bore Using Telescopic Gauge	CO2, CO3, CO5, CO6
12	Measurement of Gear Tooth Thickness Using Gear Tooth Vernier Caliper	CO2, CO5, CO6
13	To Check Internal Diameter and Thickness of Given Workpieces Using Plug Gauge and Snap Gauge	CO1, CO2, CO5, CO6

Learning Outcome:

Evaluate the accuracy and precision of mechanical components by analyzing measurement data, calibrating instruments, and applying advanced metrological techniques to ensure compliance with engineering standards

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

PC-ME 392.1	Demonstrate the knowledge/skill on standards, calibration process and analyze the characteristics of instruments keeping in mind technical, economical, safety issues.
PC-ME 392.2	Demonstrate the knowledge/skill on measurement of length, angle and form surface measurement
PC-ME 392.3	Set up testing strategies and select proper instruments to evaluate performance characteristics
PC-ME 392.4	Evaluate possible causes of discrepancy in practical experimental observations in comparison to theory
PC-ME 392.5	Demonstrate the ability to interact effectively on a social and interpersonal level with fellow students, and will demonstrate the ability to divide up and share task responsibilities to complete assignments.
PC-ME 392.6	Prepare professional quality textual and graphical presentations of laboratory data and computational results

CO-PO & CO-PSO Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 392.1	3	2	-	2	-	2	-	-	-	-	-	-	3	2	1
PC-ME 392.2	3	1	-	2	-	-	-	-	-	3	-	2	2	3	1
PC-ME 392.3	3	2	2	3	2	-	-	2	3	-	-	-	3	3	2
PC-ME 392.4	3	3	2	3	1	2	2	-	-	-	-	-	2	2	1
PC-ME 392.5	-	-	-	-	-	-	-	-	-	-	3	2	1	-	2
PC-ME 392.6	2	1	-	2	2	-	-	-	-	-	3		2	2	2
Average	**2.80**	**1.80**	**2.00**	**2.40**	**1.67**	**2.00**	**2.00**	**2.00**	**3.00**	**3.00**	**3.00**	**2.00**	**3.00**	**3.00**	**1.50**

Subject Code: PC-ME 393	**Category:** Professional Core courses	**PCIE Marks**	40
Subject Name: Machine Drawing	**Semester:** Third	**PSEE Marks**	60
L-T-P: 0-0-3	Credit: 1.5	**Total Marks**	100
Pre-Requisites: Engineering Drawing (ES-ME 292)			
Examination (SEE): Experimental/Drawing Assignment			

Course Content:

- Orthographic projections: first & third angle projection.
- Sectional views (full, half, offset, partial, broken, revolved, removed, auxiliary & sectional representation of pipes & rods);
- Isometric projection: isometric foreshortening; isometric view & projection.
- Representation of surfaces and welding symbols.
- Assembly and detailed drawings of a mechanical assembly: plummer block, tool head of a shaping machine, tailstock of a lathe, simple gear box, flange coupling, etc.
- Practicing graphics softwares and to make detailed and assembly drawings.

List of Experiments / Assignments

Sl. No:	Description/Title	CO mapping
1	**Orthographic projections of machine elements,** Concept of orthographic projection, concept of first and third angle projection.	CO1
2	Isometric projection of components; Concept of isometric orientation, concept of isometric projection and isometric view, isometric shortening.	CO1
3	**Different sectional views- full, auxiliary sections;** Representation of cutting plane, Idea of sections [full section, half section, offset section, broken section, revolved section, removed section, phantom section, auxiliary section, aligned section, adjacent section, enlarged section, simple problems showing the representation of different sections.	CO1 & CO3
4	**Schematic product symbols for standard components in** • Mechanical (Shaft, Bearing Support, spur gear (fixed & Sliding), Bevel gear, Chain & Sprocket, Belt & Pulley, Transmission ratio, a simple gear box. • Welding symbols. • Surface Texture Representation.	CO2
5	Assembly and detailed drawings of a mechanical assembly, such as • A plummer block, • A flange coupling,	CO3, CO4, CO5
6	Practicing AutoCAD or similar graphics softwares and making assembly drawings.	CO6

Learning Outcome:

Students will develop the ability to interpret and create technical drawings, understand manufacturing processes, and apply standard conventions to communicate design ideas effectively and accurately.

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

PC-ME 393.1	understand and represent a component in three dimensional to two-dimensional frame of reference and vice versa.
PC-ME 393.2	Acquire knowledge about the various practices with regard to the sectional views of machine parts.
PC-ME 393.3	Understand product symbols for standard components in surface representation, weld joint and drive elements.
PC-ME 393.4	Ideate bill of materials for preparation of part or assembly drawings as per the conventions.
PC-ME 393.5	Interpret machine drawings with the ray of manufacturing feasibility (process planning).
PC-ME 393.6	Understand and practice the drafting software for assembly drawing.

CO-PO & CO-PSO Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 393.1	3	2	2	2	3					1		2	3	3	1
PC-ME 393.2	2	2	2	3	3					1		2	3	3	1
PC-ME 393.3	2	2	2	3	3					1		2	3	3	1
PC-ME 393.4	3	2	3	2	3					1		2	3	3	2
PC-ME 393.5	2	2	2	2	3					1		2	3	3	2
PC-ME 393.6	3	2	3	3	3					2		2	3	3	2
Average	**2.50**	**2**	**2.33**	**2.5**	**3.0**	**-**	**-**	**-**	**-**	**2.17**	**-**	**2**	**3.00**	**3.00**	**1.50**

Haldia Institute of Technology

(An Autonomous Institution Under Maulana Abul Kalam Azad University of Technology, West Bengal)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2024-2025)

SEMESTER-IV

THEORY							
Sl. No.	**Course Code**	**Subject Name**	**Contact period per week**			**Total**	**Credit**
			L	**T**	**P**		
1	HM-ME 401	Engineering Economics	2	0	0	2	2
2	ES-ME 401	Numerical Methods and Programming	2	0	0	2	2
3	PC-ME 401	Strength of Materials	3	0	0	3	3
4	PC-ME 402	Manufacturing Processes	3	0	0	3	3
5	PC-ME 403	Analysis and Synthesis of Mechanisms	3	0	0	3	3
6	PC-ME 404	Applied Thermodynamics	3	0	0	3	3
7	MC 401	Industrial safety	2	0	0	2	0
	Total Theory					**18**	**16**
PRACTICAL							
1	ES-ME 491	Numerical Methods and Programming Lab	0	0	2	2	1
2	PC-ME 491	Strength of Materials Lab	0	0	3	3	1.5
3	PC-ME 492	Manufacturing Processes Lab	0	0	3	3	1.5
	Total Practical					**8**	**4**
	Total of Semester					**26**	**20**

Haldia Institute of Technology

(An Autonomous Institution Under Maulana Abul Kalam Azad University of Technology, West Bengal)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2024-2025)

Course Code: HM-ME 401	**Category**: Professional Core Courses
Course Name: Engineering Economics	**Semester**: Fourth
L-T-P: 2-0-0	**Credit**: 2
Contact Per Week: 2L	**Contact Weeks / Semester**=15
Total Contacts: 30(L)* +0(T) +0 (P) +30 (SL)=60	**Pre-Requisites:** Nil

Course Content:

UNIT I: INTRODUCTION	**Contact Hours**
Introduction to Economics; Definitions, Nature, Scope, Difference between Microeconomics and Macroeconomics, Theory of Demand and Supply; Meaning, Determinants, Law of Demand, Law of Supply, Equilibrium between Demand and Supply Elasticity; Elasticity of Demand, Price Elasticity, Income Elasticity, Cross Elasticity	**5**
UNIT II: ENGINEERING COSTS AND ESTIMATION	
Theory Of Production; Production Function, Meaning, Factors of Production (Meaning & Characteristics of Land, Labour, Capital and Entrepreneur), Law of Variable Proportions and Law of Returns to Scale Cost; Meaning, Short Run and Long Run Cost, Fixed Cost, Variable Cost, Total Cost, Average Cost, Marginal Cost, Opportunity Cost. Break Even Analysis; Meaning, Explanation, Numerical.	**5**
UNIT III: TIME VALUE OF MONEY	
Simple and compound interest, Interest Formulas: Single-Payment Compound Amount, Single-Payment Present Worth Amount, Equal-Payment Series Compound Amount, Equal-Payment Series Sinking Fund, Equal-Payment Series Present Worth Amount, Equal-Payment Series Capital Recovery Amount.	**5**
UNIT IV: PRESENT AND FUTURE WORTH METHOD OF COMPARISON	
Introduction, Cash Flow Diagram, Revenue-dominated Cash Flow Diagram, Cost-dominated Cash Flow Diagram	**5**
UNIT V: PROJECT EVALUATION INDICES	
Net Present Value, Benefit-Cost Ratio Analysis, Internal Rate of Return, Modified Internal Rate of Return, Payback Period Method	**4**
UNIT VI: DEPRECIATION	
Basic Aspects, Methods of Depreciation: Straight Line Method of Depreciation, Declining Balance Method of Depreciation, Sum-of-the-Years-Digits Method of Depreciation, Sinking Fund Method of Depreciation, Service Output Method of Depreciation.	**4**
Total	**30***

Text and Reference Books:

1. Premvir Kapoor, Sociology & Economics for Engineers, Khanna Publishing House, Delhi.
2. J.L. Riggs, D.D. Bedworth and S.U. Randhawa, Engineering Economics, 4th Edition, McGraw Hill International Edition, 1996.
3. D. Newnan, T. Eschembach and J. Lavelle, Engineering Economics Analysis, Oxford University Press, 2019.
4. J.A. White, K.E. Case and D.B. Pratt, Principle of Engineering Economic Analysis, John Wiley, 2016.
5. W.G. Sullivan, E.M. Wicks and C.P. Koelling, Engineering Economy, 17th Edition, Pearson, 2018.
6. R. Panneerselvan, Engineering Economics, Prentice Hall of India, 1999.
7. M.R. Lindeburg, Engineering Economics Analysis: An Introduction, Professional Publication, 1993.

Learning Outcome

Analyze and evaluate economic feasibility and cost-effectiveness of engineering alternatives using principles of engineering economics, and develop optimized solutions for mechanical engineering projects based on life-cycle cost analysis and financial decision-making models.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

HM-ME 401.1	Understand the fundamental principles of engineering economics and their significance in engineering decisions.
HM-ME 401.2	Analyze engineering problems using cost analysis, break-even analysis, and economic decision-making tools.
HM-ME 401.3	Apply the time value of money, depreciation methods, and replacement analysis to evaluate engineering alternatives.
HM-ME 401.4	Evaluate financial feasibility and risks associated with engineering projects using NPV, IRR, BCR, and sensitivity analysis.
HM-ME 401.5	Develop economic solutions with consideration to ethical, environmental, societal, legal, and sustainability aspects.
HM-ME 401.6	Demonstrate managerial and financial literacy for team-based and multidisciplinary engineering projects.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HM-ME 401.1	3	-	-	-	-	-	-	-	-	-	-	2	2	2	2
HM -ME 401.2	-	3	-	2	-	-	-	-	-	-	3	-	3	2	2
HM -ME 401.3	2	3	-	-	2	-	-	-	-	-	2	-	3	3	3
HM -ME 401.4	-	3	2	-	-	-	-	-	-	-	3	-	3	3	3
HM -ME 401.5	-	-	-	-	-	2	2	2	2	2	-	-	2	2	3
HM -ME 401.6	-	-	2	-	-	-	-	-	3	3	3	2	2	2	2
Average	**2.5**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2.67**	**2**	**2.6**	**2.4**	**2.6**

Course Code: ES-ME 401	**Category**: Engineering Science Courses
Course Name: Numerical Methods and Programming	**Semester**: Fourth
L-T-P: 2-0-0	**Credit**:2
Contact Per Week- 2L	**Contact Weeks / Semester=**15
Total Contacts: **30(L)* +0(T) +0 (P) +30 (SL)=60**	**Pre-Requisites:** Mathematics-I (BS-M 101) and Mathematics-II (BS-M 201)

Course Content:

UNIT I: Errors and Interpolation	**Contact Hours**
Approximation in numerical computation, Errors in numerical computation, Different types of operators, Concept of interpolation, Newton's Forward Interpolation Formula, Newton's Backward Interpolation Formula, Lagrange's Interpolation Formula.	**8**
UNIT II: Numerical Integration	
Introduction to numerical integration, Trapezoidal Rule, Simpson's 1/3 Rule, Expressions for corresponding error terms	**4**
UNIT III: Numerical Solution of Algebraic Equations	
Introduction to nonlinear algebraic equations, Bisection Method, Regular-Falsi (False Position) Method, Newton–Raphson Method	**5**
UNIT IV: Numerical Solution of System of Linear Equations	
Gauss Elimination Method, Matrix Inversion Method, Gauss–Seidel Iterative Method, LU decomposition method.	**5**
UNIT V: Numerical Solution of Ordinary Differential Equations	
Introduction to ordinary differential equations, Euler's Method, Modified Euler's Method, Runge–Kutta Methods, Finite Difference Methods.	**4**
UNIT VI: Programming Concepts for Numerical Methods	
Algorithms and flowcharts for basic numerical methods, Conditional statements, looping constructs, arrays, Function declaration, Implementation of numerical methods using programs.	**4**
Total	**30***

Text and Reference Books:

1. S. A. Mollah: Numerical Analysis and Computational Procedures
2. C. Xavier: C Language and Numerical Methods.
3. Dutta & Jana: Introductory Numerical Analysis.
4. J. B. Scarborough: Numerical Mathematical Analysis.
5. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).
6. Balagurusamy: Numerical Methods, Scitech.
7. Baburam: Numerical Methods, Pearson Education.
8. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
9. Srimanta Pal: Numerical Methods, OUP

Learning Outcome: Students will be able to implement suitable numerical methods and develop mathematical solutions using computational techniques to analyze mechanical engineering problems.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

ES-ME 401.1	Analyze errors in numerical computations and apply interpolation techniques for data approximation.
ES-ME 401.2	Apply numerical integration techniques to evaluate definite integrals and estimate associated

	error bounds.
ES-ME 401.3	Solve nonlinear algebraic equations using standard numerical methods and assess their convergence behaviour.
ES-ME 401.4	Solve systems of linear equations using direct and iterative numerical techniques.
ES-ME 401.5	Apply numerical methods to obtain approximate solutions of ordinary differential equations.
ES-ME 401.6	Implement numerical algorithms using fundamental programming constructs such as loops, arrays, and functions.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ES-ME 401.1	3	2	1	2	1	-	-	-	-	-	-	1	3	2	1
ES-ME 401.2	3	2	1	2	1	-	-	-	-	-	-	1	3	2	1
ES-ME 401.3	3	3	2	2	1	-	-	-	1	1	-	1	3	3	2
ES-ME 401.4	3	3	2	2	1	-	-	-	1	1	-	1	3	3	2
ES-ME 401.5	3	3	2	2	1	-	-	-	1	1	-	1	3	3	2
ES-ME 401.6	2	2	2	1	3	-	-	-	1	2	1	2	2	3	3
Average	**2.83**	**2.50**	**1.67**	**1.83**	**1.33**	**-**	**-**	**-**	**1**	**1.25**	**1**	**1.17**	**2.83**	**2.67**	**1.83**

Course Code: PC-ME 401	**Category**: Professional Core Courses
Course Name: Strength of Materials	**Semester**: Fourth
L-T-P: 3-0-0	**Credit**:3
Contact Per Week- 3L	**Contact Weeks / Semester=**14
Total Contacts: **45(L)* +0(T) +0 (P) +45 (SL)=90**	**Pre-Requisites:** Engineering Mechanics (ES-ME 301)

Course Content:

UNIT I: Concept Of Stresses and Strains	**Contact Hours**
Concept of stress and strain, Hooke's law, Tensile, compressive, and shear stresses, Poisson's ratio. Elastic constants and their relationship, volumetric strain, bars of uniform and varying sections subjected to single load and varying loads. Tutorial on stress, stress, Hooke's law, elastic constants and volumetric strain, bars of uniform and varying sections subjected to single load and varying loads. Analysis of bars of composite sections& Tutorial. Concept of Thermal stresses in simple and composite bars & Tutorial. Principal plane, principal stress, Analytical method: Direct stress in two mutually perpendicular directions accompanied by a simple shear stress& Tutorial. Mohr's circle: direct stress in two mutually perpendicular directions with and without shear stress, Concept of principal Stress.	**10**
UNIT II: Analysis of Beams	
Introduction to types of beams and loads, Shear force and bending moment diagrams for cantilever beam due to pure point load, pure Uniformly Distributed Load (UDL), pure Uniformly Varying Load (UVL) & Tutorial. Shear force and bending moment diagrams for simply supported beam due to pure point load, pure UDL, pure UVL& Tutorial. Shear force and bending moment diagrams for overhanging beam due to pure point load, pure UDL, pure UVL & Tutorial. Theory of pure bending derivation and bending stress in simple beams of sections having at-least one axis of symmetry& Tutorial. Tutorial on bending stress in simple beams sections having at-least one axis of symmetry & Tutorial. Derivation of shear stress distribution in beams of different sections (rectangular, circular), having at-least one axis of symmetry.	**10**
UNIT III: Torsion	
Theory of pure torsion, derivation of shear stress produced in terms of torque in a circular shaft. Strength, stiffness of shaft and Torsional rigidity & power transmitted. Tutorial on solid shaft, finding the dimensions. Expression for torque in terms of polar moment of inertia in a circular shaft subjected to torsion. Tutorial on hollow shaft, finding dimensions, percentage of material savings. Circular shafts in series and parallel& Tutorial. Concepts on Strain energy due to torsion& Tutorial. Circular shaft subjected to combined bending and torsion& Tutorial. Composite Shaft & Tutorial. Concept of closed and open coiled helical springs, Stresses and deflection of helical springs under axial pull.	**8**
UNIT IV: Deflection of Beams	
Relationship between deflection, slope, radius of curvature, shear force and bending moment& Tutorial. Slope and deflection of cantilever beam with a point load, UDL by Double integration method& tutorial. Slope and deflection of simply supported beam with a point load, UDL by Double integration method& tutorial. Slope and deflection of simply supported beam with an eccentric, point load, UDL by Macaulay's method& tutorial. Slope and deflection of cantilever beam and simply supported beam with point load and UDL by moment area method & tutorial. Castigliano's theorem.	**8**
UNIT V: Columns	
Columns and struts, Members subjected to combined bending and axial loads, Expression for crippling load with different end conditions based on Euler's theory & tutorial. Rankine's theory.	**3**
UNIT VI: Cylinders	
Thin cylindrical shells subjected to internal pressure, change in dimensions of thin cylindrical shells due to internal pressure & tutorial. Thin spherical shells subjected internal pressure, change in dimensions of thin spherical shells due to internal pressure & tutorial. Lame's theory on stresses in thick cylinders & tutorial. Stresses in compound thick cylinder and shrink fit.	**6**
Total	**45***

Text and Reference Books:

1. Elements of Strength of Materials by Timoshenko & Young, East west press.
2. Introduction to Solid Mechanics by Shames & Pitarresi, Prentice Hall India.
3. Mechanics of Materials by Beer & Johnston, TMH
4. Engineering Mechanics of Solids by E.P. Popov, Prentice Hall India
5. Fundamentals of Strength of Materialsby Nag & Chanda, Wiley India
6. Strength of Materials by R. Subramanian, Oxford Univ. Press
7. Strength of Materials by Ryder, Mcmillan press
8. Strength of Materials by S S Rattan, McGraw Hill Education India
9. Strength of Materials by S SBhavikatti, Vikas Publishing House Pvt Ltd.

Learning Outcome:

Students will be able to **formulate** problems pertaining to stress-strain, material properties and deformation, enabling **analysis and design** of structural elements under various loading conditions using fundamental engineering principles.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

PC-ME 401.1	Envisage the cause and effect of the force on deformable bodies.
PC-ME 401.2	Evaluate the nature of stress developed in various geometries such as bars, cantilevers, beams, shafts, cylinders, spheres under various types of single or combinatorial loads.
PC-ME 401.3	Inculcate the concept of flexure and its theoretical and practical implications.
PC-ME 401.4	Inculcate the concept of torsion and its theoretical and practical implications.
PC-ME 402.2	Understand the concept of column and critical load in different boundary conditions.
PC-ME 402.1	Evaluate the behavior and strength of structural elements under the action of compound stresses and thus understand failure concepts.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 401.1	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PC-ME 401.2	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PC-ME 401.3	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PC-ME 401.4	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PC-ME 401.5	2	3	3	2	2	-	-	-	-	1	-	2	3	2	2
PC-ME 401.6	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
Average	**2.83**	**3**	**3**	**2.83**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**3**	**2**	**2**

Course Code: PC-ME 402	**Category**: Professional Core Courses
Course Name: Manufacturing Process	**Semester**: Fourth
L-T-P: 3-0-0	**Credit**: 3
Contact Per Week- 3L	**Contact Weeks / Semester=**15
Total Contacts: **45(L)* +0(T) +0 (P) +45 (SL)=90**	**Pre-Requisites:** Engineering Drawing (ES-ME 292), Material Science (PC-ME 303)

Course Content:

UNIT I: PATTERN MAKING, MOULDING and CASTING	**Contact Hours**
Introduction to Manufacturing: Definitions and broad grouping. **Introduction to Casting**: History, Definition, Advantages and disadvantages, Procedure, Major Classification, Casting Materials and equipment. **Pattern**: Pattern allowances, Types of patterns, Pattern materials. **Moulding:** Molding Materials, Properties of molding sand and core sand, Testing of properties of molding sand, Types of mould and core, CO_2 molding. Gating system: Gating elements and their characteristics - Sprue, Runner, In gate & Riser, Gating ratio, Design of gating system. Estimation of pouring time, Aspiration effect, Estimation of mould filling up time, Casting Yield. Cupola Furnace: Different zones and Reaction, control of composition of steel. Estimation of Total Solidification Time (TST) using Chvorinov's rule.	**12**
UNIT II: SPECIAL CASTING PROCESSES	
Procedure, Advantages and application of Shell mould casting, Investment casting, Permanent mould casting, Die casting, Centrifugal casting. Casting defects: Types, Causes & remedy.	**5**
UNIT III: FORMING	
Plastic deformation of metals: Hot and cold working of metals, Recrystallization, Variation of grain structure at different working condition. Discussion of Yield criteria and flow stress. Classification of metal forming processes. Rolling: Pressure and Forces in rolling, types of rolling mills, Rolling defects. Forging: Smith Forging, Drop and Press forging, M/c forging, Forging defects. Extrusions: Direct, Indirect, Impact and Hydrostatic extrusion and their applications, Extrusion of tubes. Wire drawing methods and variables in wire-drawing. Brief introduction to sheet metal working: Shearing, Bending, Forming and Deep drawing.	**10**
UNIT IV: ARC WELDING	
Introduction to Welding: Definition, Major grouping of joining processes, Broad classification of welding processes, Principles, equipment of MMAW, Submerged arc welding TIG & MIG, Plasma arc welding, characteristics & applications, Open Circuit Voltage and Open Circuit Current, Current and voltage for maximum power, Sources of heat-chemical action, heat affected zone, Thermit welding.	**10**
UNIT V: SOLID STATE AND PRECISION WELDING PROCESSES	
Solid state welding: Principles, advantages & applications, Types - Hot forge welding, Friction welding Pressure & percussion welding, Resistance welding. Precision welding processes: Ultrasonic welding Laser beam welding Electron beam welding.	**5**
UNIT VI: GAS WELDING	
Different types of Gas welding, Equipment, Principle and Procedure of Oxy Acetylene gas welding.	**3**
Total	**45***

Text and Reference Books:

1. Manufacturing technology, Foundry, Forming & Welding-P.N Rao.
2. Manufacturing Science-A Ghosh & A Mullick.
3. Manufacturing Engineering & Technology-S Kalpakjian; Pub: Addison Wesley.
4. Principles of manufacturing materials & processes-James & Campbell.
5. Manufacturing engineering & technology-K Jain.
6. Materials & processes in manufacturing-E.P Degarmo, Black & Kohser, Pub: Wiley (10th ed.)
7. Processes & materials of manufacturing-R.A Lindberg.
8. Introduction to manufacturing technology-PP Date, Pub: Jaico.
9. Manufacturing processes-S.K Sharma & S Sharma, Pub: I.K International.

Learning Outcome

Students will be able to demonstrate the processes pertaining to pattern making, molding, casting, welding and forming enabling exhibit expertise and analysis in fabrication works.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

PC-ME 402.1	Select appropriate Manufacturing Processing to manufacture any component.
PC-ME 402.2	Interpret foundry practices like Pattern making, Mold making, Core making, Casting and Inspection of defects.
PC-ME 402.3	Differentiate various metal forming processes such as Hot and Cold Working, Rolling, Forging, Extrusion and Drawing Processes.
PC-ME 402.4	Classify and interpret different sheet metal working processes Shearing, Bending, Forming and Deep drawing,
PC-ME 402.5	Select appropriate Joining Processes to join Work piece.
PC-ME 402.6	Implement the Knowledge of Gained Subject in Industry.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 402.1	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PC-ME 402.2	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PC-ME 402.3	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PC-ME 402.4	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
PC-ME 402.5	2	3	3	2	2	-	-	-	-	1	-	2	3	2	2
PC-ME 402.6	3	3	3	3	2	-	-	-	-	1	-	2	3	2	2
Average	**2.83**	**3**	**3**	**2.83**	**2**	-	-	-	-	**1**	-	**2**	**3**	**2**	**2**

Course Code: PC-ME 403	**Category**: Professional Core Courses
Course Name: Analysis and Synthesis of Mechanisms	**Semester**: Fourth
L-T-P: 3-0-0	**Credit**:3
Contact Per Week- 3L	**Contact Weeks / Semester**=15
Total Contacts: **45(L)* +0(T) +0 (P) +45(SL)=90**	**Pre-Requisites:** Engineering Mechanics (ES-ME 301)

Course Content:

UNIT I: Introduction to kinematics of machines	**Contact Hours**
Kinematic chain, mechanism and structure, kinematic pairs and their classification; degree of freedom; Grubler & Kutzbach criterion for plane mechanism'; 4-bar linkage mechanism, Grashof's criteria, slider crank mechanism; kinematic inversion.	**5**
UNIT II: Velocity and Acceleration analysis	
Velocity analysis by graphical method (relative velocity and instantaneous centre method), Kennedy's theorem, acceleration analysis by graphical method, Klein's construction, Acceleration of slider crank mechanism-Coriolis component of acceleration.	**9**
UNIT III: Synthesis of mechanisms	
Types of dimensional synthesis, two and three position synthesis for function generation, path generation and rigid body guidance; approximate and exact synthesis, graphical and analytical methods of syntheses, (Freudenstein equation, Chebysev spacing, approximate syntheses	**9**
UNIT IV: Mechanisms in practice	
Drag link mechanism, automobile steering mechanism, slider-crank mechanism, swinging block mechanism, quick return mechanism, isosceles linkage, elliptic trammel, toggle mechanism, straight line mechanism, pantograph, universal joint, Geneva wheel mechanism	**9**
UNIT V: Cam mechanism	
Classification of cams and followers, terms used in radial cams, motion of followers, displacement, velocity and acceleration diagram with different kinds of follower motions – inline and offset, construction of cam profiles.	**4**
UNIT VI: Drive systems	
Gears: Fundamental laws of gearing, types of gear tooth profiles: involute and cycloidal; types of gear: spur, helical, bevel and worm gears; rack and pinion, gear nomenclature, interference and undercutting - minimum number of teeth to avoid interference, backlash. Gear trains: simple, epicyclical, epicyclical bevel gear trains, train value; applications: automobile transmission and others. Belt drives.	**9**
Total	**45***

Text and Reference Books:

1. Elements of Mechanism – Daughty and James, McGraw Hill
2. Theory of Machines – S S Rattan, Tata McGraw Hill
3. Theory of Mechanisms & Machines – A.Ghosh & A.K.Mallik, AEWP
4. Design of Machinery – R.L.Norton, Tata McGraw Hill
5. Mechanism & Machine Theory – Rao, R.V. Dukkipati, Wiley
6. Theory of Machines, V.P.Singh, Dhanpat Rai & Co
7. Joseph E. Shigley, John Joseph Uicker - Theory of Machines and Mechanisms (McGraw-Hill series in mechanical engineering)
8. Uicker, Pennock & Shigley, Theory of Machines and Mechanisms, Oxford University Press.
9. Rao & Dukkipati, Mechanism and Machine Theory, New Age Int. Pub.
10. J.S. Rao, The Theory of Machines Through Solved Problems, New Age Int. Pub.

Learning Outcome:

Students will be able to analyze and synthesize planar mechanisms, cam systems, and gear drives using fundamental kinematic principles and graphical or analytical methods for effective mechanical design and motion transmission.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

PC-ME 403.1	Understand and classify mechanical systems using kinematic concepts such as degrees of freedom, links, pairs, and mechanisms
PC-ME 403.2	Apply graphical and analytical techniques to analyze velocity and acceleration in planar mechanisms.
PC-ME 403.3	Perform dimensional synthesis of mechanisms for function, path, and motion generation using graphical and analytical approaches.
PC-ME 403.4	Recognize and evaluate the working principles of commonly used mechanical mechanisms in engineering applications.
PC-ME 403.5	Design and analyze cam-follower systems for specified motion profiles using displacement and acceleration diagrams.
PC-ME 403.6	Analyze and select appropriate gear and belt drive systems based on kinematic requirements and operational constraints.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 403.1	3	2	-	-	-	-	-	-	-	-	-	2	3	2	2
PC-ME 403.2	3	3	2	-	2	-	-	-	-	-	-	2	3	2	2
PC-ME 403.3	3	2	3	-	2	-	-	-	-	-	-	2	3	2	2
PC-ME 403.4	2	2	2	-	-	-	1	-	2	-	-	2	3	2	2
PC-ME 403.5	3	2	3	-	2	-	-	-	-	-	-	2	3	2	2
PC-ME 403.6	3	2	3	-	2	-	-	-	-	-	-	2	3	2	2
Average	**2.83**	**2.17**	**2.6**	**-**	**2**	**-**	**1**	**-**	**2**	**-**	**-**	**2**	**3**	**2**	**2**

Course Code: PC-ME 404	**Category**: Engineering Science Courses
Course Name: Applied Thermodynamics	**Semester**: Fourth
L-T-P: 3-0-0	**Credit**: 3
Contact Per Week- 3L	**Contact Weeks / Semester**=15
Total Contacts: 45(L)* +0(T) +0 (P) +48 (SL)=90	**Pre-Requisites:** Thermodynamics (ES-ME 302)

Course Content:

UNIT I: EXERGY AND SECOND LAW ANALYSIS OF THERMODYNAMIC SYSTEMS	**Contact Hours**
Exergy analysis, Maximum Work in a Reversible Process, Irreversibility and Gouy-Stodola Theorem, Exergy change of a system, Exergy transfer by Heat, Work and Mass, 2nd Law efficiency.	**6**
UNIT II: RECIPROCATING AIR COMPRESSORS	
Reciprocating Air Compressors, Staging of Reciprocating Compressors, Volumetric Efficiency, Optimal Stage Pressure Ratio, Effect of Intercooling, Minimum Work for Multistage Reciprocating Compressors.	**8**
UNIT III: THERMODYNAMIC PROPERTY RELATIONS	
Maxwell's Equations, TdS Equations, Difference in Heat Capacities, Ratio of Heat Capacities, Joule-Kelvin Effect, Clausius-Clapeyron Equation, Gibbs Phase Rule.	**8**
UNIT IV: MODIFIED VAPOUR POWER CYCLES	
Vapour Power Cycles, Binary Vapour Power Cycle, Thermodynamics of Coupled Cycles, Cogeneration. Hybrid Gas-steam power plant	**8**
UNIT V: PSCYCHROMETRICS AND AIR-CONDITIONING SYSTEMS	
Vapour Compression Refrigeration Cycle, Comparison with Carnot Cycle, Vapour Absorption Refrigeration Cycle, Gas Cycle Refrigeration, Heat Pump System, Properties of Atmospheric Air, Use of Psychometric Charts, Psychometric Processes. Vortex tube refrigeration system	**7**
UNIT VI: GAS POWER CYCLES	
Air Standard Otto Cycle, Diesel Cycle, Dual Combustion Cycle, Comparison of Otto, Diesel, and Dual Cycles, Brayton Cycle & Its Modifications, Brayton-Rankine Combined Cycle.: calculation of air standard efficiencies, mean effective pressure, brake thermal efficiencies, relative efficiencies of I.C. engine	**8**
Total	**45***

Text and Reference Books:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.
4. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.
5. M.P. Poonia & S.C. Sharma, Basics of Mechanical Engineering, Khanna Publishing House, N. Delhi.

Learning Outcome:

Students will be able to apply thermodynamic principles to analyze and evaluate the performance of compressors, power and refrigeration cycles, and psychrometric systems using advanced laws and relations.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

PC-ME 404.1	Remember the fundamental laws of thermodynamics and their application to real-world engineering problems.
PC-ME 404.2	Develop the ability to analyze and evaluate energy systems, including heat engines, refrigeration cycles, and power plants, using thermodynamic principles.
PC-ME 404.3	Apply thermodynamic concepts to design and optimize thermal systems, considering factors such as efficiency, energy transfer, and environmental impact.
PC-ME 404.4	Gain proficiency in analyzing and designing gas and vapor cycles, such as Brayton and

	Rankine cycles, and their applications in power generation and propulsion.
PC-ME 404.5	Apply knowledge of heat transfer mechanisms to solve practical problems, including the design of heat exchangers and thermal systems with a focus on efficiency and sustainability.
PC-ME 404.6	Develop problem-solving skills and the ability to think critically in the application of thermodynamic principles to solve complex thermal engineering challenges, fostering a practical and analytical mindset.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC ME 404.1	2	3	3	2	2	3	2	1	1	1	1	2	2	3	1
PC ME 404.2	3	2	3	3	2	3	2	2	2	1	1	1	2	2	1
PC ME 404.3	2	2	3	3	2	2	3	2	2	2	1	2	2	3	2
PC ME 404.4	3	3	3	3	3	2	2	2	2	1	1	1	2	3	2
PC ME 404.5	3	2	2	2	2	2	2	2	2	2	1	1	1	2	3
PC ME 404.6	2	3	3	3	3	3	3	2	2	1	2	2	2	2	2
Average	**2.5**	**2.5**	**2.83**	**2.67**	**2.33**	**2.5**	**2.33**	**1.83**	**1.83**	**1.33**	**1.17**	**1.5**	**1.83**	**2.5**	**1.83**

Course Code: MC 401	**Category**: Mandatory courses
Course Name: Industrial Safety	**Semester**: Fourth
L-T-P: 2-0-0	**Credit**:0
Contact Per Week- 2L	**Contact Weeks / Semester**=14
Total Contacts: 30(L)* +0(T) +0 (P) +30 (SL)=60	**Pre-Requisites:** No- Prerequisites

Course Content:

UNIT I: Introduction to Industrial Safety	**Contact Hours**
Evolution and importance of industrial safety; occupational health and safety; status of OSH in India.	**4**
UNIT II: Accidents and Their Prevention	
Accident theories and causes; cost of accidents; principles and methods of accident prevention; safe work practices; housekeeping; job safety analysis; accident investigation; ergonomics; personal protective equipment; safety programs	**6**
UNIT III: Fire Hazards and Safety Practices	
Types and causes of fire; fire hazards and prevention; fire protection systems; emergency escape; safety inspection and supervision; safety training, communication, and audit.	**5**
UNIT IV: Occupational Health and Industrial Hygiene	
Occupational health and services; occupational diseases; work-related hazards; industrial hygiene; basics of OHSAS 18001.	**5**
UNIT V: Health and Safety at Workplaces	
Workplace health and safety hazards; welfare requirements; duties of workers and occupiers; safety guidelines; emergency actions; overview of safety legislation related to industries.	**4**
UNIT VI: Safety Management and Accident Compensation	
Safety management principles; role of safety supervisor; safety policies and planning; risk management; accident compensation laws; role of National Safety Council and ILO.	**4**
Total	**30***

Text and Reference Books:

1. Safety management Systems, A. Waring, (Chapman & Hall, 1996)
2. Environmental Health & Safety Management – A Guide to Compliance, N. P. Cheremisinoff, M. L. Graffia, (Noyes Publin. 2003)
3. Safety at Work, J. Ridley & J. Channing (5th. Edn.), (Butterworth & Heinemann, 2001)
4. Occupational Health & Hygiene, J.Stranks, (Pitman Publn., 1995)
5. Safety management: Strategy & Practice, R. Pybuss, (Butterworth & Heinemann, 1997)
6. Essentials of Safety management, H. L. Kalia, A. Singh, S. Ravishankar & S. V. Kamat, (Himalaya Publishing House, 2002)
7. Industrial Health & Safety Management, A.M.Sarma, (Himalaya Publishing House, 2002)
8. Encyclopaedia of Occupational Health & Safety (4th Ed.), Vol –I-IV, Ed. J. M. Stellman – International Labour Office, Geneva.
9. Safety Management System – Alan Waring, Chapman & Hill, London
10. Practical Health & Safety Management for small business- Jacqneline Jaynes, 2000, Butterworth Heinemann,
11. Industrial Safety and Human Behaviour, H. L. Kalia, AITBS Publishes, India.

Learning Outcome:

Students will be able to analyze industrial safety problems, evaluate occupational health risks and compliance with safety legislation, and design appropriate accident prevention and safety management strategies for mechanical engineering workplaces.

Course Outcomes:

Upon successful completion of the course, students are expected to be able to:

MC 401.1	Understand the fundamentals, evolution, and importance of industrial safety and occupational health in engineering industries.

MC 401.2	Identify causes of industrial accidents and apply basic accident prevention techniques and safe work practices in mechanical systems.
MC 401.3	Recognize fire hazards in industrial environments and apply appropriate fire prevention and emergency response measures.
MC 401.4	Identify occupational health hazards and industrial hygiene practices relevant to mechanical engineering workplaces.
MC 401.5	Interpret health, safety, and welfare requirements along with major safety legislations applicable to mechanical engineering industries.
MC 401.6	Apply basic principles of safety management, risk assessment, and accident compensation systems in industrial settings.

CO-PO & CO-PSO Articulation Matrix:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MC 401.1	3	1	–	–	–	2	2	1	–	–	–	2	2	1	–
MC 401.2	2	3	2	1	–	3	–	2	–	–	–	1	2	3	–
MC 401.3	2	3	3	1	–	3	2	2	–	–	–	–	2	3	1
MC 401.4	2	2	–	1	–	3	3	2	–	–	–	–	2	2	–
MC 401.5	1	2	–	–	–	3	2	3	–	–	–	1	1	2	–
MC 401.6	2	3	3	–	1	3	2	2	1	1	2	2	2	3	1
Average	**2**	**2.33**	**2.67**	**1**	**1**	**2.83**	**2.2**	**2**	**1**	**1**	**2**	**1.5**	**1.83**	**2.33**	**1**

Course Code: ES-ME 491	**Category:** Engineering Science Courses	**PCIE Marks**	40
Course Name: Numerical Methods and Programming Lab	**Semester:** Fourth	**PSEE Marks**	60
L-T-P-SL: 0-0-2-0	**Credit:** 1	**Total Marks**	100
Pre-Requisites: Programming for Problem Solving (ES-CS 201)			
Examination (SEE): Experimental			

Course Content:

- **Programming Concepts (C Programming):**
  Basic structure of C programs, input–output statements, conditional statements (if–else), looping constructs (for, while, do–while), one-dimensional and two-dimensional arrays, user-defined functions, and structured programming for numerical algorithms.
- **Numerical Solution of Algebraic Equations:**
  Problems on Bisection Method, Regula–Falsi Method, Newton–Raphson Method.
- **Numerical Solution of Ordinary Differential Equations:**
  Problems on Euler's Method, Modified Euler's Method, Runge–Kutta Methods.
- **Interpolation:**
  Problems on Newton's Forward and Backward Interpolation, Lagrange's Interpolation.
- **Numerical Integration:**
  Problems on Trapezoidal Rule, Simpson's 1/3 Rule, Weddle's Rule.
- **Numerical Solution of System of Linear Equations:**
  Problems on Gauss Elimination Method, Gauss–Seidel Iterative Method.

List of Experiments / Assignments

Sl. No:	Description/Title	CO mapping
1	Program to find roots of algebraic equations using Bisection Method	**CO1**
2	Program to find roots of algebraic equations using Regula–Falsi Method	**CO1**
3	Program to find roots of algebraic equations using Newton–Raphson Method	**CO1**
4	Program to solve ordinary differential equations using Euler's Method	**CO2**
5	Program to solve ordinary differential equations using Runge–Kutta Method (Second and Fourth Order)	**CO2**
6	Program to implement Newton's Forward Interpolation	**CO3**
7	Program to implement Newton's Backward Interpolation	**CO3**
8	Program to implement Lagrange's Interpolation Formula	**CO3**
9	Program to evaluate definite integrals using Trapezoidal Rule with interpretation of results	**CO4 & CO6**
10	Program to evaluate definite integrals using Simpson's 1/3 Rule with interpretation of results	**CO4 & CO6**
11	Program to evaluate definite integrals using Weddle's Rule with interpretation of results	**CO4 & CO6**
12	Program to solve a system of linear equations using Gauss Elimination Method with interpretation of results	**CO5 & CO6**
13	Program to solve a system of linear equations using Gauss–Seidel Iterative Method with interpretation of results	**CO5 & CO6**

Learning Outcome: Students will be able to select appropriate numerical methods and develop mathematical solutions using C programming for effective computational analysis to analyze mechanical engineering problems.

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

ES-ME 491.1	Develop C programs to obtain numerical solutions of nonlinear algebraic equations using appropriate methods.
ES-ME 491.2	Implement numerical methods for solving ordinary differential equations relevant to mechanical engineering applications.
ES-ME 491.3	Implement interpolation using C programming.
ES-ME 491.4	Implement numerical integration techniques using C programming.
ES-ME 491.5	Solve systems of linear equations using direct and iterative numerical techniques through programming.
ES-ME 491.6	Analyze numerical results obtained through computational methods and present solutions effectively using well-documented C programs.

CO-PO & CO-PSO Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ES-ME 491.1	3	3	2	2	1	-	-	-	-	-	-	1	3	3	2
ES-ME 491.2	3	3	2	2	1	-	-	-	-	-	-	1	3	3	2
ES-ME 491.3	3	2	1	1	1	-	-	-	-	-	-	1	3	2	1
ES-ME 491.4	3	2	1	2	1	-	-	-	-	-	-	1	3	2	1
ES-ME 491.5	3	3	2	2	1	-	-	-	-	-	-	1	3	3	2
ES-ME 491.6	2	2	2	2	3	-	-	-	1	2	1	2	2	3	3
Average	**2.83**	**2.50**	**1.67**	**1.83**	**1.33**	**-**	**-**	**-**	**1.00**	**2.00**	**1.00**	**1.17**	**2.83**	**2.67**	**1.83**

Subject Code: PC-ME 491	**Category:** Professional Core courses	**PCIE Marks**	40
Subject Name: Strength of Materials Lab	**Semester:** Fourth	**PSEE Marks**	60
L-T-P-SL: 0-0-3-0	**Credit:** 1.5	**Total Marks**	100
Pre-Requisites: Material Science (PC-ME 302), Strength of Materials (PC-ME 401)			
Examination (SEE): Experimental			

Course Content:

- Tension Test and Compression Test of ductile and brittle materials: stress–strain diagram, determination of yield strength, ultimate strength, modulus of elasticity, percentage elongation and percentage reduction in area, and observation of fractured surfaces.
- Determination of spring stiffness under tensile and compressive loading.
- Torsion Test on a mild steel rod.
- Bend and re-bend test of flat test pieces and determination of bending stresses.
- Hardness Tests: Brinell, Vickers, and Rockwell tests.
- Impact tests: Charpy and Izod tests.
- Fatigue test of a typical specimen.
- Test for drawability of sheet metals through cupping test.
- Sample preparation, heat treatment, and metallographic examination of ferrous and non-ferrous metals and alloys, including etching, hardness testing, and analysis of microstructural changes in carbon steels under different cooling rates.
- Detection of surface and sub-surface defects using non-destructive testing techniques such as dye penetration test, magnetic particle (Magnaflux) test, ultrasonic test, and eddy current test.

List of Experiments:

Sl. No:	Description/Title	CO mapping
1	**Tension Test and Compression Test of ductile and brittle materials –** Determination of stress–strain behavior, yield strength, ultimate strength, elastic modulus, ductility measures, and fracture characteristics.	**CO1, CO2, CO3**
2	**Determination of spring stiffness under tensile and compressive loading** – Evaluation of load–deflection relationship and stiffness constant of springs.	**CO1, CO3**
3	**Torsion Test on a mild steel rod –** Determination of shear modulus, torsional rigidity, and torque–twist relationship.	**CO1, CO3**
4	**Bend and re-bend test of flat test pieces –** Determination of bending stresses and assessment of ductility through re-bending behavior.	**CO2, CO3**
5	**Hardness Tests: Brinell, Vickers, and Rockwell** – Measurement and comparison of material hardness using standard indentation methods.	**CO3**
6	**Impact tests: Charpy and Izod** – Evaluation of impact strength and notch sensitivity under sudden loading.	**CO2, CO3**
7	**Fatigue test of a typical specimen –** Study of material behavior and failure under cyclic loading conditions.	**CO4**
8	**Test for drawability of sheet metals through cupping test –** Assessment of sheet metal formability and plastic deformation characteristics.	**CO4**
9	**Sample Preparation, Heat Treatment, and Metallographic Examination of Metals and Alloys–** Preparation and etching of specimens followed by heat treatment of carbon steels to examine microstructural and hardness changes using metallography.	**CO4, CO5**
10	**Non-destructive testing of materials –** Detection of surface and sub-surface defects using DP, Magnaflux, ultrasonic, and eddy current tests.	**CO6**

Learning Outcome:
Students will be able to **analyze, evaluate, and design** experimental approaches to characterize mechanical behavior, material properties, and failure mechanisms of engineering materials under static, dynamic, and cyclic loading conditions, supporting informed decisions in mechanical system **design and quality assessment**.

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

PC-ME 491.1	**Recall** fundamental concepts of stress, strain, elasticity, plasticity, and failure relevant to mechanical testing of materials.
PC-ME 491.2	**Explain** stress–strain behavior, deformation modes, and fracture characteristics of ductile and brittle materials based on experimental observations.
PC-ME 491.3	**Apply** standard experimental procedures to determine mechanical properties using tensile, compression, torsion, bending, hardness, and impact tests.
PC-ME 491.4	**Analyze** fatigue, formability, and metallographic test results to interpret cyclic behavior, sheet metal drawability, and microstructural features.
PC-ME 491.5	**Evaluate** the influence of heat treatment and cooling rates on material properties by correlating hardness values with microstructural changes.
PC-ME 491.6	**Design** and justify a systematic experimental approach for detecting and interpreting surface and sub-surface defects using appropriate non-destructive testing techniques.

CO-PO & CO-PSO Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 491.1	3	1	–	–	–	–	–	–	–	–	–	2	3	1	–
PC-ME 491.2	3	2	–	1	–	–	–	–	–	–	–	2	3	2	–
PC-ME 491.3	3	2	–	3	2	–	–	–	1	1	–	2	2	3	2
PC-ME 491.4	2	3	–	3	2	–	–	–	1	1	–	2	2	3	2
PC-ME 491.5	2	2	1	3	2	–	–	–	–	1	–	2	2	3	2
PC-ME 491.6	2	3	3	3	3	2	–	1	1	1	–	2	2	3	3
Average	**2.50**	**2.17**	**2.00**	**2.60**	**2.25**	**2.00**	**–**	**1.00**	**1.00**	**1.00**	**–**	**2.00**	**2.33**	**2.50**	**2.25**

Subject Code: PC-ME 492	**Category:** Professional Core courses	**PCIE Marks**	40
Subject Name: Manufacturing Processes Lab	**Semester:** Fourth	**PSEE Marks**	60
L-T-P-SL: 0-0-3-0	**Credit:** 1.5	**Total Marks**	100
Pre-Requisites: Material Science (PC-ME 303), Manufacturing Processes (PC-ME 402)			
Examination (SEE): Experimental			

Course Content:

- Sand preparation and testing: specimen preparation for testing permeability, clay content, grain fineness number, moisture content, green compression strength, green shear strength, splitting strength, hardness, etc.;
- Preparation of foundry sand and Molds. Casting of metals after preparation of suitable moulds.
- Experiments on properties of post casting, fettling, cleaning, deburring, and polishing operations.
- Practicing smithy or forging of carbon steels and testing for its property changes.
- Laboratory experiments in Fabrication processes to observe effects of varying process parameters in GMAW and SMAW and GTAW.
- Testing for Joint defects.

List of Experiments / Assignments:

Sl. No:	Description/Title	CO mapping
1	**Pattern Making and discussion of pattern allowances**	**CO1**
2	**Sand preparation and testing** specimen preparation for testing permeability, clay content, grain fineness number, moisture content, green compression strength, green shear strength, splitting strength, hardness, etc.	**CO2**
3	**Mold preparation and Casting:** Preparation of foundry sand and Molds. Casting of metals after preparation of suitable moulds.	**CO3**
4	**Forging:** Practicing smithy or forging of carbon steels and testing for its property changes	**CO4**
5	**Fabrication processes:** Laboratory experiments in Fabrication processes to observe effects of varying process parameters in GMAW and SMAW and GTAW.	**CO5**
6	**Testing for Joint defects**	**CO6**

Learning Outcome:
The student will be having the capability of selecting suitable manufacturing processes to manufacture the products optimally.

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

PC-ME 492.1	Build practical knowledge about Pattern Making; pattern material, pattern allowances and types of patterns casting processes
PC-ME 492.2	Testing of Molding sand properties to ensure good characteristics of the Mold.
PC-ME 492.3	Apply practical understanding for use of Molding tools: Green Sand Molding, Gating system, Risering system, Core making and Pouring molten metal for final Casting.

PC-ME 492.4	Plan and create jobs using forging processes.
PC-ME 492.5	Apply advanced skills in fabrication processes and parameter control to analyze joint by testing and defect analysis.
PC-ME 492.6	Relate the job manufactured from practical relevance point of view

CO-PO & CO-PSO Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PC-ME 492.1	3	2	2	2	3					1		2	3	3	1
PC-ME 492.2	2	2	2	3	3					1		2	3	3	1
PC-ME 492.3	2	2	2	3	3					1		2	3	3	1
PC-ME 492.4	3	2	3	2	3					1		2	3	3	2
PC-ME 492.5	2	2	2	2	3					1		2	3	3	2
PC-ME 492.6	3	2	3	3	3					2		2	3	3	2
Average	**2.50**	**2**	**2.33**	**2.5**	**3.0**	**-**	**-**	**-**	**-**	**2.17**	**-**	**2**	**3.00**	**3.00**	**1.50**