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**

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 PublishingHouse, 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

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: 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, Moment of 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 IV: **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

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: 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	9

cycles, and supercritical Rankine cycles.	
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

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: 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

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: 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.	6

Advantages and disadvantages of Powder Metallurgy. Ceramics: Types and applications, Shape Memory Alloys, Composites and its classifications, Processing of Fibre Reinforced Plastics, Glasses, Nanomaterials	
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 IndiaPrivate 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

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: 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	6

Based Metrology.	
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

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
2	Determination of the coefficient of discharge of Orificemeter	CO1
3	Determination of the coefficient of discharge of Venturimeter	CO1

4	Determination of the coefficient of discharge of rectangular and V notch	CO1
5	Determination of the loss of head in the pipe fittings (Minor losses)	CO5
6	Determination of friction factor of four different materials (Major losses)	CO5
7	Verification of Bernoulli's equation	CO3
8	Determination of C_d, C_c and C_v of orifice	CO2
9	Determination of output power and overall efficiency of Pelton wheel turbine	CO6
10	Determination of output power and overall efficiency of Francis turbine	CO6
11	Determination of volume flow rate and volumetric efficiency of centrifugal blower	CO6
12	Determination of volumetric efficiency and compression ratio of centrifugal compressor	CO6
13	Determination of overall efficiency and pump efficiency of centrifugal pump	CO6
14	Determination of different parameters of reciprocating pump	CO6

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

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)

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

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)

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