Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Inspiring students and preparing them for successful professional careers by applying the

Knowledge of applied science and fundamental Mechanical Engineering core subjects and advanced Mechanical Engineering software.

PSO2: Ability to co-ordinate and communicate in groups by diversifying their knowledge domain in different

engineering disciplinary area.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: BIOLOGY

Course Code: BS-BIO(301)Semester of Study:

Course Type: Theory

Course Designation: Compulsory

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Program Specific Outcome (PSO):

	PSO1	PSO2	PSO3	PSO4
CO1	**L**	**M**	**L**	**L**
CO2	**L**	**M**	**L**	**L**
CO3	**L**	M	**L**	**L**
CO4	**L**	**M**	**L**	**L**
CO5	**L**	**M**	**L**	**L**
CO6	**L**	**M**	**L**	**L**

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
BS ME BIO301.1	Describe how biological observations of 18th Century that lead to major discoveries.	Define, Understand, Explain, Describe, Discuss	Understand (L1)
BS ME BIO301.2	Find that classification per se is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological.	Apply, calculate, estimate, find, solve, examine	Apply (L2)
BS ME BIO301.3	Classify the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring.	Analyze, Classify, Illustrate, categorize	Analyze (L3
BS ME BIO301.4	Examine that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine and Analyse biological processes at the reductionistic level.	Select, model, examine, design, show.	Synthesize (L4)
BS ME BIO301.5	Justify enzymes and distinguish between different mechanisms of enzyme action and Apply thermodynamic principles to biological systems.	Assess, test, justify, compare,	Evaluate (L5)
BS ME BIO301.6	Identify DNA as a genetic material in the molecular basis of information transfer and microorganisms.	Design, formulate, develop, derive, modify, build, identify	Create (L6)

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							2				1
CO2			2				3					2
CO3		3		1		1						
CO4						2						2
CO5	3				2	2	2					1
CO6	3	1		2	2		2					
Average	2.8	2	2	1.5	2	1.6	2.3	2				1.5

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Syllabus for B. Tech in Mechanical Engineering

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University Syllabus:

Module 1 : **INTRODUCTION**

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology? Discuss how biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. These examples will highlight the fundamental importance of observations in any scientific inquiry.

Purpose: To convey that Biology is as important a scientific discipline as Mathematics, Physics and Chemistry. [2L]

Module 2 **Classification**

Hierarchy of life forms at phenomenological level. A common thread weaves this hierarchy Classification. Discuss classification based on (a) cellularity- Unicellular or multicellular (b) ultrastructure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophs, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitataacquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. A given organism can come under different category based on classification. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. musculus

Purpose: To convey that classification per se is not what biology is all about. The underlying criterion, such as morphological, biochemical or ecological be highlighted. [3L]

Module 3 **Genetics**

Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

Purpose: To convey that "Genetics is to biology what Newton's laws are to Physical Sciences" [4L]

Module 4 **Biomolecules**

Molecules of life. In this context discuss monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins. Nucleotides and DNA/RNA. Two carbon units and lipids.

Purpose: To convey that all forms of life has the same building blocks and yet the manifestations are as diverse as one can imagine [4L]

Module 5 **Enzymes**

Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyzereactions. Enzyme classification. Mechanism of enzyme action. Discuss at least two examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis.

Purpose: To convey that without catalysis life would not have existed on earth [4L]

Module 6 **Information Transfer**

Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structurefrom single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.

Purpose: The molecular basis of coding and decoding genetic information is universal [4L]

Module 7 **Macromolecular analysis**

Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transrters, receptors and structural elements.

Purpose: How to analyses biological processes at the reductionistic level [5L]

Module 8 **Metabolism**

Thermodynamics as applied to biological systems. Exothermic and endothermic versus endergonic and exergonic reactions. Concept of Keq and its relation to standard free energy. Spontaneity. ATP as an energy currency. This should include the breakdown of glucose to CO_2 + H_2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming

reactions. Concept of Energy charge

Purpose: The fundamental principles of energy transactions are the same in physical and biological world. [4L]

Module 9 **Microbiology**

Concept of single celled organisms. Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics. [3L]

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Basic Electronics Engineering Course Code: ES-ECE301

Semester of Study: 3rd Semester

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Inspiring students and preparing them for successful professional careers by applying the Knowledge of applied science and fundamental Mechanical Engineering core subjects and advanced Mechanical Engineering software**.**

PSO2: Ability to co-ordinate and communicate in groups by diversifying their knowledge domain in different engineering disciplinary area.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Demonstrate the operating principle and output characteristics of pn junction diodes, zener diode, rectifiers and different diode circuits, BJT.
2. Understand the principles of semiconductor devices and their applications.
3. Design an application using Operational amplifier.
4. Understand the working of timing circuits and oscillators.
5. Understand logic gates, flip flop as a building block of digital systems.
6. Learn the basics of Electronic communication system

Course Outcome	Details/Statement	Action Verb	Knowledge Level
ES-ECE301.1	Understand the principles of semiconductor devices and their applications	Understand	K2
ES-ECE301.2	Understanding the operating principle and output characteristics of pn junction diodes, zener diode, rectifiers and different diode circuits. BJT.	Understand	K2
ES-ECE301.3	Design an application using Operational amplifier.	Apply	K3
ES-ECE301.4	Understand the working of timing circuits and oscillators.	Understand	K2
ES-ECE301.5	Understand logic gates, flip flop as a building block of digital systems.	Understand	K2
ES-ECE301.6	Learn the basics of Electronic communication system	Understand	K2

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	3	3	1	1	1	1	1	2	1	1
CO2	1	3	3	3	1	1	1	1	1	1	1	1
CO3	1	2	3	3	1	1	1	1	1	1	1	1
CO4	1	3	3	3	1	1	1	1	1	1	1	1
CO5	1	3	3	3	1	1	1	1	1	1	1	1
CO6	1	3	3	3	2	2	1	1	1	1	2	2
Average	1	2.83	3	3	1.2	1.16	1	1	1	1.16	1.16	1.16

Course Objective:

To provide an overview of electronic device components to Mechanical engineering students.

Subject Name: Basic Electronics EngineeringSubject
Code: ES-ECE301

Module 1

Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.

Module 11

Operational amplifier and its applications: Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.

Module 111

Timing Circuits and Oscillators: RC-timing circuits, IC 555 and its applications astable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.

Module IV

Digital Electronics Fundamentals :Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K-map, Logic ICs, half and full adder/sub tractor, multiplexers, De-multiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.

Module V

Electronic Communication Systems: The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Engineering Mechanics **Course Code:** ES-ME301

Semester of Study: 3Rd

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will possess strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as
well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will possess fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will possess knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will possess managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ES-ME301.1	To ***calculate*** Forces and Moments acting on the given statically determinant Structure & support reaction by using of concept of Free Body Diagram (FBD).	***CALCULATE***	P
ES-ME301.2	To ***explain*** Friction, limiting friction, static and dynamic friction, wedge friction	***EXPLAIN***	U
ES-ME301.3	To ***analysis*** of having structure like trusses, beams and frames	***ANALYSIS***	A
ES-ME301.4	To ***determine*** centroid, centre of gravity, moment of inertia for both area and mass of the given lamina and solid- standard and composite.	***DETERMINE***	P
ES-ME301.5	To ***illustrate*** the stability of an equilibrium and equilibrium of rigid body using the concept of virtual work and energy method.	***ILLUSTRATE***	A
ES-ME301.6	To ***calculate*** the velocity, acceleration, dynamics forces acting on practical and rigid bodies under rectilinear and curve linear motion.	***CALCULATE***	P

Course Articulation Matrix:

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l	PSO 1	PSO 2
CO1	3	3	2	1	2	1	-	1	2	1	-	2	3	2
CO2	2	3	2	2	1	1	-	1	2	2	-	2	3	2
CO3	2	2	2	1	2	1	-	1	1	2	-	2	3	2
CO4	3	2	2	2	1	1	-	1	1	2	-	2	3	2
CO5	3	2	2	1	1	1	-	1	1	1	-	2	3	2
CO6	2	3	2	2	2	1	-	1	2	1	-	2	3	2
Average	2.5	2.5	2	1.5	1.5	1	0	1	1.5	1.5	0	2	3	2

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University Syllabus:

Module No.	Description of Topic	Contact Hrs.
1	**Module 1***: Introduction to Engineering Mechanics covering,* Force Systems: Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminancy.	3
2	**Module 2***: Friction covering,* Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack.	4
3	**Module 3***: Basic Structural Analysis covering,* Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines.	4
4	**Module 4***: Centroid and Centre of Gravity covering,* Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; 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.	5
5	**Module 5***: Virtual Work and Energy Method-* Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.	5
6	**Module 6***: Review of particle dynamics-* Rectilinear 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). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).	5
7	**Module 7:***Introduction to Kinetics of Rigid Bodies covering,* Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.	5
8	**Module 8:***Mechanical Vibrations covering,* Basic terminology, free and forced vibrations, resonance and its effects; Degree of freedom; Derivation for frequency and amplitude of free vibrations without damping and single degree of freedom system, simple problems, types of pendulum, use of simple, compound and torsion pendulums.	5

9	**Tutorials** *from the above modules covering*, To find the various forces and angles including resultants in various parts of wall crane, roof truss, pipes, etc.; To verify the line of polygon on various forces; To find coefficient of friction between various materials on inclined plan; Free body diagrams various systems including block-pulley; To verify the principle of moment in the disc apparatus; Helical block; To draw a load efficiency curve for a screw jack.	12

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Thermodynamics **Course Code: PCME301**

Semester of Study: Third

Course Type: Theory

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Program Outcome (PO):

(1) Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences and foundational Engineering concept for application in discipline.

(2) Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

(3) Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety,

(4) Graduate will possess fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

(5) Graduate will possess knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO 2.0 & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

(6) Graduate will be able to provide engineering solution, design solution which are society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

(7) Graduates will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

(8) Graduate will learn the ability to understand the professional and ethical responsibility.

(9) Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

(10) Graduate will be able to communicate effectively in both verbal and in the written form.

(11) Graduate will possess managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

(12) Graduate will develop confidence for self and have the ability to engage in life long learning.

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Program Specific Outcome (PSO):

PSO1: Inspiring students and preparing them for successful professional careers by applying the knowledge of applied science and fundamental Mechanical Engineering core subjects and advanced Mechanical Engineering softwares.

PSO2: Ability to co-ordinate and communicate in groups by diversifying their knowledge domain in different engineering disciplinary area.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME301.1	**Explain** the fundamental thermodynamic properties to solve the problems involving thermodynamic properties viz. Internal energy, enthalpy, entropy, temperature, pressure and specific volume etc	**Explain**	U
PC ME301.2	**Interpret** the phases of the pure substances from their thermodynamic properties.	**Interpret**	U
PC ME301.3	**Evaluate** changes in thermodynamic properties of pure substances.	**Evaluate**	E
PC ME301.4	**Apply** the first and second law of thermodynamics to the thermodynamic process, cycles and devices.	**Apply**	P
PC ME301.5	**Analyse** thermodynamic systems using entropy and exergy.	**Analyse**	A
PC ME301.6	**Understand** the basics of Vapour power cycles and Gas Power cycles.	**Understand**	U

Course Articulation Matrix:

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

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Subject Code : PC-ME301	**Category:** Professional Core courses
Subject Name : Thermodynamics	**Semester** : Third
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work.	5
2	Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy.	5
3	Definition of Pure substance, 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; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart.	8
4	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.	5
5	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.	5
6	Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of s from steam tables- Principle of increase of entropy; Illustration of processes in Ts coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles- Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergy balance equation and Exergy analysis.	8
7	Thermodynamic cycles - Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle.	4

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Manufacturing Processes Course Code: PCME302

Semester of Study: 3rd

Course Type: Theory

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME302.1	Describe the fundamental principles and concepts of various manufacturing processes used in industry.	Describe	U
PC ME302.2	Apply the knowledge of metal casting principles to effectively address shrinkage, casting defects, and residual stresses in manufacturing	Apply	P
PC ME302.3	Explain the fundamentals of hot and cold working and Estimate loads and forces involved in bulk forming and sheet forming processes.	Explain	P
PC ME302.4	Apply the principles of orthogonal machining, chip formation and tool geometry in machining operations for improved tool performance and surface finish.	Apply	P
PC ME302.5	Examine the various force components involved in machining to address tool wear, and tool life	Examine	P
PC ME302.6	Discuss the physics behind welding, brazing, and soldering processes.	Discuss	U

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3	1	1	1	1	2	1	1	1	2	1	2	3	2
CO2	3	1	1	1	1	2	1	1	1	2	1	2	3	2
CO3	3	1	1	2	1	1	1	1	1	2	1	2	3	2
CO4	3	1	1	2	1	2	1	1	1	2	1	2	3	2
CO5	3	1	1	1	1	1	1	1	1	2	1	2	3	2
CO6	3	1	1	1	1	1	1	1	1	2	1	2	3	2
Average	**3**	**1**	**1**	**1.333333333**	**1**	**1.5**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**2**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

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(Applicable from the academic session 2023-2024)

University Syllabus:

Module	Description of topic	Contact Hrs
1	Conventional Manufacturing processes:Casting and moulding: Metal casting processes and equipment, Heattransfer and solidification, shrinkage, riser design, castingdefects and residual stresses.	**10**
2	Introduction to bulk and sheet metal forming, plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk forming(forging, rolling, extrusion, drawing) and sheet forming (shearing, deep drawing, bending) principles of powder metallurgy.	**10**
3	Machining: Single and multi- point machining; Orthogonal machining, cutting tool geometry of SPTT, milling cutter and drill, conversion of rake and clearance angles within ASA and ISO systems, various forcecomponents: Chip formation, Tool wear and tool life, Surface finish and integrity,Machinability, Cutting tool materials, Cutting fluids, Coating; Turning, Drilling, Milling and finishing processes, Introduction to CNC machining.	**14**
4	Joining/fastening processes: Physics of welding, brazing and soldering; design considerationsin welding, Solid and liquid state joining processes; Adhesive bonding.	**8**

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Practice of Manufacturing Processes Course Code: PCME391

Semester of Study: 3rd

Course Type: Laboratory

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

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(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME391.1	Practice pattern & mould making	Practice	P
PC ME391.2	Illustrate the fitting operation using hand tools	Illustrate	P
PC ME391.3	Perform basic forging processes	Perform	P
PC ME391.4	Perform sheet metal works	Perform	P
PC ME391.5	Practice GMAW, SMAW & Gas Welding	Practice	P
PC ME391.6	Demonstrate machining of typical products involving lathe, milling/shaping/machines	Demonstrate	P

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	1	2	2	1	1	1	1	1	1	1	2	3	3	2
CO2	1	2	2	1	1	1	1	1	1	1	2	3	3	2
CO3	1	2	2	1	1	1	1	1	1	1	2	3	3	2
CO4	1	2	2	1	3	1	1	1	2	1	2	3	3	2
CO5	1	2	3	2	1	2	1	1	2	1	3	3	3	2
CO6	1	2	2	1	1	1	1	1	1	1	2	3	3	2
Average	**1.0**	**2.0**	**2.2**	**1.2**	**1.3**	**1.2**	**1.0**	**1.0**	**1.3**	**0.8**	**2.2**	**3.0**	**3.0**	**2.0**

Course Content:

It should include about 12 practicing modules (1 module= 3Hour class a week) covering:

1. Machine Shop: Taper turning, drilling, boring, shaping and milling operations- 3 modules
2. Pattern Making: 1 or 2 wooden patterns to make- 2 modules
3. Moulding: 1 module
4. Smithy Shop: 1 module
5. Welding Shop: Practicing SMAW, Gas Welding and/or GMAW- 2 modules
6. Fitting Shop: 2 modules
7. Sheet Metal Shop: 1 module

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Materials Engineering **Course Code:** ESME401

Semester of Study: 4th Semester

Course Type: Theory

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Program Outcome (PO):

1. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

2. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

3. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

4. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

5. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems..

6. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

7. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

8. Graduate will learn the ability to understand the professional and ethical responsibility.

9. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

10. Graduate will be able to communicate effectively in both verbal and in the written form.

11. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

12. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

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(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ES ME401.1	**Analyze** and classify crystal structures and imperfections in solids using unit cells and defect mechanisms.	**Analyze**	A
ES ME401.2	**Evaluate** mechanical properties of materials through testing methods and understand their relationships, including stress-strain curves, hardness, and strength.	**Evaluate**	E
ES ME401.3	**Apply** static failure theories and fracture mechanics to predict failure modes and analyze fatigue behaviour and non-destructive testing methods.	**Apply**	P
ES ME401.4	**Interpret** phase diagrams and microstructures in alloys, including the iron-carbide phase diagram and micro structural aspects of the given steel types.	**Interpret**	U
ES ME401.5	**Apply** heat treatment techniques to control microstructure development in steel and understand the effects on properties.	**Apply**	P
ES ME401.6	**Examine** the properties and applications of alloyed steels, cast irons, copper alloys, aluminium alloys, nickel-based super alloys, and titanium alloys.	**Examine**	P

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
ES ME401.1	3	1	1	1	-	2	1	-	1	-	1	2	3	1
ES ME401.2	3	1	1	1	-	2	1	-	1	-	1	2	3	1
ES ME401.3	3	1	1	1	-	2	1	-	1	-	1	2	3	1
ES ME401.4	3	1	1	1	-	2	1	-	1	-	1	2	3	1
ES ME401.5	3	1	1	1	-	2	1	-	1	-	1	2	3	1
ES ME401.6	3	1	1	1	-	2	1	-	1	-	1	2	3	1
Avg.	3	1	1	1	-	2	1	-	1	-	1	2	3	1

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module No.	Description of Topic	Contact Hrs.
1	Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.	6
2	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; Hardness: Rockwell, Brinell and Vickers and their relation to strength.	6
3	Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, 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, Introduction to nondestructive testing (NDT)	8
4	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.	6
5	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
6	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	8

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Applied Thermodynamics Course Code: PCME401

Semester of Study: Fourth

Course Type: Theory

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Program Outcome (PO):

(1) Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences and foundational Engineering concept for application in discipline.

(2) Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

(3) Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety,

(4) Graduate will possess fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

(5) Graduate will possess knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO 2.0 & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

(6) Graduate will be able to provide engineering solution, design solution which are society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

(7) Graduates will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

(8) Graduate will learn the ability to understand the professional and ethical responsibility.

(9) Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

(10) Graduate will be able to communicate effectively in both verbal and in the written form.

(11) Graduate will possess managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

(12) Graduate will develop confidence for self and have the ability to engage in life long learning.

Program Specific Outcome (PSO):

PSO1: Inspiring students and preparing them for successful professional careers by applying the knowledge of applied science and fundamental Mechanical Engineering core subjects and advanced Mechanical Engineering softwares.

PSO2: Ability to co-ordinate and communicate in groups by diversifying their knowledge domain in different engineering disciplinary area.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME401.1	**ANALYSE** reacting systems using mass, energy and entropy balance and to determine chemical equilibrium composition.	**ANALYSE**	**A**
PC ME401.2	**ILLUSTRATE** vapour power cycles, gas power cycles and vapour compression refrigeration cycles.	**ILLUSTRATE**	**A**
PC ME401.3	**USE** psychrometric processes in real world air-conditioning systems.	**USE**	**P**
PC ME401.4	**EXPLORE** the compressible fluid flow through nozzles, diffusers etc.	**EXPLORE**	**P**
PC ME401.5	**UNDERSTAND** the operation of reciprocating compressors and to determine its performances.	**UNDERSTAND**	**U**
PC ME401.6	**ANALYSE** steam turbines thermodynamically.	**ANALYSE**	**A**

Course Articulation Matrix:

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

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Subject Code : PC-ME401	**Category:** Professional Core courses
Subject Name : Applied Thermodynamics	**Semester** : Fourth
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Module No.	Description of Topic	Contact Hrs.
1	Introduction to solid, liquid and gaseous fuels– Stoichiometry, exhaust gas analysis- First law analysis of combustion reactions- Heat calculations using enthalpy tables- Adiabatic flame temperature- Chemical equilibrium and equilibrium composition calculations using free energy.	8
2	Vapor power cycles Rankine cycle with superheat, reheat and regeneration, exergy analysis. Super-critical and ultra super-critical Rankine cycle- Gas power cycles, Air standard Otto, Diesel and Dual cycles- Air standard Braytoncycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles- Vapor compression refrigeration cycles, refrigerants and their properties.	12
3	Properties of dry and wet air, use of psychometric chart, processes involving heating/cooling and humidification/dehumidification, dew point.	4
4	Basics of compressible flow. Stagnation properties, Isentropic flow of a perfect gas through a nozzle, choked flow, subsonic and supersonic flows- normal shocks- use of ideal gas tables for isentropic flow and normal shock flow- Flow of steam and refrigerant through nozzle, super saturation- compressible flow in diffusers, efficiency of nozzle and diffuser.	8
5	Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling, minimum work for multistage reciprocating compressors.	5
6	Analysis of steam turbines, velocity and pressure compounding of steam turbines	3

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Fluid Mechanics and Fluid Machines **Course Code: PCME 402**

Semester of Study: 4th

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME402.1	**UNDERSTAND** the fluid properties and conservation laws in fluid mechanics	UNDERSTAND	U
PC ME402.2	**APPLY** the conservation laws in fluid flow system	APPLY	P
PC ME402.3	**EVALUATE** pressure drop in pipe flow using Hagen-Poiseuli's equation for laminar flow in pipe	EVALUATE	E
PC ME402.4	**DEMONSTRATE** boundary layer concept	APPLY	P
PC ME402.5	**ANALYSE** the dimensional analysis in fluid machines and in fluid flow systems	ANALYSE	A
PC ME402.6	Analyse the simple flow situation mathematically and **EVALUATE** the performance of hydraulic machines (Turbine and pump)	EVALUATE	E

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PCME402.1	3	2	2	1	1	1	1	1	1	1	-	2
PCME402.2	2	3	2	1	1	1	1	1	1	1	-	2
PCME402.3	2	3	2	1	1	2	1	1	2	1	-	2
PCME402.4	3	2	1	1	2	2	1	1	2	1	-	2
PCME402.5	3	2	2	1	1	2	1	1	1	1	-	2
PCME402.5	3	2	2	1	1	2	1	1	1	1	-	2
Average	2.7	2.3	1.8	1	1.2	1.7	1	1	1.3	1	-	2

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Subject Code : PC-ME402	**Category:** Professional Core courses
Subject Name : Fluid Mechanics & Fluid Machines	**Semester** : Fourth
L-T-P : **3-1-0**	**Credit:4**
Pre-Requisites: No-prerequisite	

Course Objective:

1. To learn about the application of mass and momentum conservation laws for fluid flows
2. To understand the importance of dimensional analysis
3. To obtain the velocity and pressure variations in various types of simple flows
4. To analyze the flow in water pumps and turbines.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	Definition of fluid, Newton's law of viscosity, Units and dimensions Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.	9
2	Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.	9
3	Need for dimensional analysis – methods of dimension analysis – Similitude – types of similitude Dimensionless parameters – application of dimensionless parameters – Model analysis.	6
4	Euler's equation – theory of Rotodynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump – working principle.	8
5	Classification of water turbines, heads and efficiencies, velocity triangles Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles – draft tube- Specific speed, unit quantities, performance curves for turbines – governing of turbines.	8

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Strength of Materials **Course Code:** PC-ME 403

Semester of Study: 4th

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

After completion of the course, the students will be able to

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC-ME 403.1	**EXPLAIN** the concept of normal and shear stresses and strains and the relation amongst three elastic constants (E, K, G).	EXPLAIN	Understand/ U
PC-ME 403.2	Discuss the bending theory to **CALCULATE** shear force and bending moment.	CALCULATE	Apply/ P
PC-ME 403.3	**DETERMINE** the slope and deflection of cantilever, simply supported beams under the given loading conditions (UDL, point load, varying loads).	DETERMINE	Apply/ P
PC-ME 403.4	**CALCULATE** the critical load by using the buckling theory of columns.	CALCULATE	Apply/ P
PC-ME 403.5	**SOLVE** the parameters (maximum shear stress, diameter, working stress, factor of safety) of the given problem related to torsion of circular shaft, helical springs.	SOLVE	Apply/ P
PC-ME 403.6	**CALCULATE** the hoop and longitudinal stresses in thin/ thick walled cylindrical/ spherical pressure vessels.	CALCULATE	Apply/ P

Course Articulation Matrix:

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

Subject Code : PC-ME403	Category: Professional Core courses
Subject Name : Strength of Materials	Semester : Fourth
L-T-P : 3-1-0	Credit:4
Pre-Requisites: No-prerequisite	

Course Objective:

1. To understand the nature of stresses developed in simple geometries such asbars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
2. To calculate the elastic deformation occurring in various simple geometries for different types of loading

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses- elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle.	8
2	Beams and types transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads.	8
3	Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems. Buckling of columns, Euler's theory, critical loads for different types of constraints.	10
4	Torsion, stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs.	8
5	Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure	8

Learning Resources:

1. D.S. Bedi, Strength of Materials, Sixth Edition, Khanna Publishing House, 2019
2. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.
3. R. Subramanian, Strength of Materials, Oxford University Press, 2007.
4. R.K. Bansal, Strength of Materials, Laxmi Publications

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Metrology & Instrumentation **Course Code: PC-ME404**

Semester of Study: 4th

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME404.1	**Understand** the working of linear and angular measuring instruments and **Determine** the error and least count	Determine	**P**
PC ME404.2	**Calculate** the limits, fits and tolerances of the Hole and Shaft system	Calculate	**P**
PC ME404.3	**Apply** measurement techniques to determine the screw thread and surface roughness parameters	Apply	**P**
PC ME404.4	**Acquire** an overview of performance characteristics of sensors and transducers for motion and dimension measurement	Acquire	**U**
PC ME404.5	**Demonstrate** the working principle and applications of devices for measurement of force, torque, strain and stress	Demonstrate	**P**
PC ME404.6	**Interpret** the use of vibration and temperature measuring instruments	Interpret	**U**

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	1	1	1	1	1	2	1	2	3	2
CO2	3	2	1	1	1	1	1	1	1	2	1	2	3	2
CO3	3	3	1	1	1	1	1	1	1	2	1	2	3	2
CO4	3	1	1	1	1	1	1	1	1	2	1	2	2	2
CO5	3	1	1	1	1	1	1	1	1	2	1	2	2	2
CO6	3	1	1	1	1	1	1	1	1	2	1	2	2	2
Average	**3.0**	**1.8**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**2.0**	**1.0**	**2.0**	**2.5**	**2.0**

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module	Description of Topic	Contact Hrs.
1	Concept of measurement:-Introduction to Metrology; Need for high precision measurements; Terminologies in Measurement- Precision, accuracy, sensitivity, calibration, resolution. Errors in Measurement, types of errors, Abbe's Principle. Basic standards of length- Line standard, End standards, Wavelength standard; Various Shop floor standards. Linear Measurement – Slip gauges, wringing, grades; Surface plate; Dial indicators; Height gauges and Vernier calliper; screw gauge. Comparators mechanical, electrical, optical and pneumatic. Angular Measurement – Bevel protractor; Sine Bar, principle and use of sine bar, sine centre; Angle gauges. Sprit level; Angle Dekkor; Clinometers.	**8**
2	Limits and Limit gauges – Making to suit, selective assembly, systems of limits and fits; Types of fits; Hole basis system and Shaft basis system. Tolerance, allowance and deviation (as per BIS). Limit Gauges – GO and NO GO gauges; types of limit gauges. Gauge design - Taylor's principle of gauging; Gauge tolerance, disposition of gauge tolerance, wear allowance. Optical Measuring Instruments: - Benefits of light waves as standards; Monochromatic light; Principle of Interference. Interference band, optical flat, surface measurement. Interferometers – NPL, Pitter-NPL, auto collimator.	**8**
3	Screw thread measurement – Screw thread terminology; Measurement of major diameter; root diameter; pitch; effective diameter with two wire method and three wire method. Measurement of flank angle and form by profile projector and microscope. Measurement of surface texture – roughness and waviness; Analysis of surface traces, peak to valley height, R.M.S. value, Centre Line Average and Ra value, Rt, Rz etc. Methods of measuring surface roughness – Stylus probe, Tomlinson surface meter, Talysurf; surface roughness measurement – assessment length, roughness width cut-off, sampling length and evaluation length.	**8**
4	Introduction to Digital Measurement– significance of Digital measurement; methods; Classification. Stages in generalized measuring system– Sensor Transducer stage, Signal-Conditioning stage, Readout-Recording stage; Types of input quantities; Active and Passive transducers. Performance characteristic of measuring devices. Drift, Resolution, Threshold, Hysteresis, Static calibration. Dynamic characteristics- different order systems and their response-, Measuring lag, Fidelity, Dynamic error; Transducers– Working, Classification of transducers. Motion and Dimension measurement – LVDT – Principle, applications, advantages and limitations.	**8**
5	Strain and Stress Measurement- Electrical resistance strain gauge Principle, operation. Measurement of Force and Torque– Strain-Gauge Load Cells, Hydraulic and Pneumatic load cells– force measurement using piezoelectric quartz crystal. Torque Measurement– Dynamometers– Mechanical, Hydraulic and Electrical. Vibration measurement– Vibrometers and Accelerometers. Temperature Measurement– Use of Thermal Expansion– Liquid-in-glass thermometers, Bimetallic strip thermometer, Pressure thermometers. Thermocouples– Resistance Temperature Detectors (RTD); Thermistors; Pyrometers.	**8**

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Practice of Manufacturing Processes & system laboratory

Course Code: PCME491

Semester of Study: 4th

Course Type: Laboratory

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME491.1	Measure the surface roughness & angles of different jobs	Measure	E
PC ME491.2	Develop simple digital logic circuit using 7400 series ICs.	Develop	P
PC ME491.3	Design and develop simple pneumatic circuits	Design	P
PC ME491.4	Acquire skill set to use precision length measuring instruments (Micro meter, Vernier, Height Gauge)	Acquire	P
PC ME491.5	Determine angles using sign bar & profile protector	Determine	P
PC ME491.6	Assess errors & correction factors of measuring devices (Micro meter, Vernier, Height Gauge)	Assess	E

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	-	3	2	1	-	-	-	-	2	-	-	2	2	3
CO2	-	3	2	2	-	-	-	-	2	-	-	2	2	3
CO3	-	3	2	2	-	-	-	-	2	-	-	2	2	3
CO4	-	3	2	1	-	-	-	-	2	-	-	2	2	3
CO5	-	3	2	1	-	-	-	-	2	-	-	2	2	3
CO6	-	3	2	1	-	-	-	-	2	-	-	2	2	3
Average	**0.0**	**3.0**	**2.0**	**1.3**	**0.0**	**0.0**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**2.0**	**2.0**	**3.0**

University Syllabus:

Course Content:

It should include about 12 experiments as outlined below:

i) Laboratory modules of pneumatics and/or electro-pneumatics

ii) Laboratory modules of hydraulics and/or electro-hydraulics

iii) Study of working of Logic Gates practically

iv) Simulation of designed pneumatics / hydraulics systems

v) Measurement of surface roughness
vi) Measurement of tapered objects using Sine Bar and using balls and rollers, etc.
vii) Measurement of threads using three wire method
viii) Measurement of gears
ix) Measurement of bore diameter using micrometer and gauges
x) Measurement of angles using bevel vernier protractor
xi) Statistical process control system to apply to measured dimension of samples
xii) Practicing different gauges to assess angles, thread, internal and external radius, etc.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Machine Drawing I **Course Code:** PC-ME492

Semester of Study: 4th

Course Type: Practical

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially. l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME 492.1	**UNDERSTAND** the product symbol of standard components in mechanical, electrical & electronic engineering symbol, welding symbol and pipe joints	**UNDERSTAND**	U
PC ME 492.2	**DRAW** orthographic projection, sectional and auxiliary sections of given machine components.	**DRAW**	A
PC ME 492.3	**DRAW** assembly and detailed drawing of different mechanical components and tools such as plummer block, flange coupling etc.	**DRAW**	A
PC ME 492.4	**UNDERSTAND** the commands and GUI of AutoCAD software	**UNDERSTAND**	U
PC ME 492.5	**DRAW** orthographic and isometric projections of given mechanical components by using AutoCAD or similar software	**DRAW**	A

Course Articulation Matrix:

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l	PSO 1	PSO 2
CO1	2	1	3	1	1	1	1	1	1	2		2	3	1
CO2	2	2	3	1	1	2	1	1	1	2		2	3	1
CO3	2	2	3	1	1	2	1	1	1	2		2	3	1
CO4	2	2	3	1	3	2	1	1	1	2		2	3	1
CO5	2	2	3	1	3	2	1	1	1	2		2	3	1
Average	2.0	1.8	3.0	1.0	3.0	1.8	1.0	1.0	1.0	2.0		2.0	3.0	1.0

University Syllabus:

Schematic product symbols for standard components in mechanical, electrical and electronic systems, welding symbols and pipe joints; Orthographic projections of machine elements, different sectional views- full, auxiliary sections; Isometric projection of components; Assembly and detailed drawings of a mechanical assembly, such as a plummer block, tool head of a shaping machine,

tailstock of a lathe, simple gear box, flange coupling, welded bracket joined by stud bolt on to a structure, welded pipe joints indicating work parts before welding, etc.

Practicing AutoCAD or similar graphics softwares and making orthographic and isometric projections of different components.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Environmental Science Course Code: MC-481(ME)

Semester of Study: 4th Sem ME

Course Type: Sessional

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

Sl No.	Description of PSOs
PSO1	The ability to analyze, design and implement application specific electronic system for complex engineering problems for analog, digital domain,communications and signal processing applications by applying the knowledge of basic sciences, engineering mathematics and engineering fundamentals.
PSO2	The ability to adapt for rapid changes into olsand technology with an understanding of societaland-ecological issues relevant top rofessional engineering practice through life-long learning.
PSO3	Excellent adaptability to function in multi-disciplinary work environment, good interpersonal skills asaleader in a teamin appreciation of professional ethics and societal responsibilities.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
CO1	Understand the natural environment and its relationships with human activities.	Understand	**L2**
CO2	Apply the fundamentalknowledge of science and engineering to assess environmental and health risk.	Apply	**L3**
CO3	Develop guidelines and procedures for health and safety issues obeying the environmental laws and regulations.	Create	**L6**
CO4	Acquire skills for scientificproblem-solving related to air, water, noise & land pollution.	Analyse	**L4**
CO5	Apply the laws and protection act of India for Environmental Management and Environmental Audit.	Analyse	**L4**
CO6	Analyze the population growth in different perspectives ofenvironmental scenarios.	Analyse	**L4**

Course Articulation Matrix:

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

CO3	1					2	2	2		1		3
CO4	1					2	2	2		1		3
CO5	1					2	2	2		1		3
CO6	1					2	2	2		1		3
Average	1					2	2	2		1		3

University Syllabus:

We as human being are not an entity separate from the environment around us rather we are a constituent seamlessly integrated and co-exist with the environment around us. We are not an entity so separate from the environment that we can think of mastering and controlling it rather we must understand that each and every action of ours reflects on the environment and vice versa. Ancient wisdom drawn from Vedas about environment and its sustenance reflects these ethoses. There is a direct application of this wisdom even in modern times. Idea of an activity based course on environment protection is to sensitize the students on the above issues through following two types of activities.

(a) Awareness Activities:

I. Small group meetings about water management, promotion of recycle use, generation of less waste, avoiding electricity waste
II. Slogan making event
III. Poster making event
IV. Cycle rally
V. Lectures from experts

(6) Actual Activities:

I. Plantation
II. Gifting a tree to see its full growth
III. Cleanliness drive
IV. Drive for segregation of waste
V. To live some big environmentalist for a week or so to understand his work
VI. To work in kitchen garden for mess
VII. To know about the different varieties of plants
VIII. Shutting down the fans and ACs of the campus for an hour or so

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Heat Transfer **Course Code: PCME 501**

Semester of Study: 5th

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC-ME501.1	**CLASSIFY** the modes of heat transfer.	UNDERSTAND	U
PC-ME501.2	**ANALYSE** steady and unsteady conduction phenomena.	ANALYSE	A
PC-ME501.3	**SOLVE** convections problems of laminar and turbulent flow situations.	APPLY	P
PC-ME501.4	**CALCULATE** radiation heat transfer between surfaces, using radiative properties, view factors etc.	APPLY	P
PC-ME501.5	**ILLUSTRATE** and design of heat exchangers.	ANALYSE	A
PC-ME501.6	**UNDERSTAND** similarities between heat and mass transfer.	UNDERSTAND	U

Course Articulation Matrix:

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

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Subject Code : PC-ME501	**Category:** Professional Core Courses
Subject Name : Heat Transfer	**Semester** : Fifth
L-T-P : **3-1-0**	**Credit: 4**
Pre-Requisites: Engineering Thermodynamics	

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances, critical insulation thickness, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction heat transfer by the use of Heissler charts.	14
2	Heat convection, basic equations, boundary layers- Forced convection, external and internal flows- Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer- Correlations for forced and free convection Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection.	10
3	Interaction of radiation with materials, definitions of radioactive properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method.	9
4	Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε - NTU methods.	7
5	Boiling and Condensation heat transfer, Pool boiling curve.	4
6	Introduction to mass transfer, Similarity between heat and mass transfer.	4

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Solid Mechanics Course Code: PC-ME502

Semester of Study: 5th

Course Type: Theory

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Program Outcome (PO):

a. Graduate will possess strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME502.1	**Understand** the basic tensors, notations of the theory of elasticity including strain/displacement and Hooke's law relationship to solve the practical problems related to the theory of elasticity.	Understand	U
PC ME502.2	**Discuss** derivation of Cauchy's relations, principal stresses and directions.	Discuss	R
PC ME502.3	**Determine** plane stress & plane strain of the given axisymmetric problems by using governing equations in cartesian, cylindrical and spherical coordinates.	Determine	P
PC ME502.4	To **Solve** problem by using concept of solid mechanics in thick cylinders, rotating discs, torsion of noncircular cross-sections & stress concentration including thermoelasticity & 2D contact stresses.	Solve	P
PC ME502.5	**Examine** the influence the influence of geometric and loading parameters in plain stress and plain strain problems.	Examine	A
PC ME502.6	To **Solve** given structural problems by applying the concepts of potentials and energy methods and plasticity.	Solve	P

Course Articulation Matrix:

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

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module	Description of topic	Contact Hrs
1	Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility, Stress: Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions.	**12**
2	Constitutive equations: Generalized Hooke's law, Linear elasticity,Material symmetry; Boundary Value Problems: concepts of uniqueness and superposition.	**10**
3	Plane stress and plane strain problems, introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems.	**10**
4	Application to thick cylinders, rotating discs, torsion of noncircular cross-sections, stress concentration problems, thermoelasticity, 2-D contact problems.	**9**
5	Solutions using potentials. Energy methods. Introduction to plasticity.	**7**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Kinematics and Theory of Machines **Course Code:** PC ME 503

Semester of Study: 5th

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will possess strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will possess fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will possess knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will possess managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially. l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PCME503.1	**ANALYZE** the motion of simple mechanisms in terms of the displacement, velocity and acceleration at any point on a rigid link. Also, determine the degree of freedom of simple mechanisms and their inversions.	**ANALYZE**	A
PCME503.2	**SYNTHESIZE** higher pair mechanisms (cam & gear systems) to generate specified output motion.	**SYNTHESIZE**	A
PCME503.3	Understand the relative motion of friction surfaces in contact and **APPLY** the knowledge during the design of the machine parts which work on the principle of rolling and sliding friction.	**APPLY**	P
PCME503.4	Understand basic concepts of vibration and **DETERMINE** vibration parameters related to problems of SDOF vibratory systems (Free, Forced with or without damping).	**DETERMINE**	P
PCME503.5	**EXPLORE** rotary and reciprocating unbalanced systems.	**EXPLORE**	P
PCME503.6	Understand the working principle of governors, flywheel & gyroscope and **DETERMINE** their operational parameters.	**DETERMINE**	P

Course Articulation Matrix:

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l	PSO 1	PSO 2
CO1	1	3	1	2	1	1	1	1	2	2	-	2	3	2
CO2	1	3	1	2	1	2	1	1	2	2	-	2	3	2
CO3	3	3	1	2	1	1	1	1	1	1	-	1	3	1
CO4	3	3	2	2	2	2	1	1	1	1	-	2	3	1
CO5	1	3	3	2	1	2	2	1	1	1	-	2	3	1
CO6	1	2	1	3	1	2	1	1	1	1	-	2	3	1
Average	1.67	2.83	1.50	2.16	1.16	1.67	1.16	1.00	1.33	1.33	-	1.83	3.00	1.33

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module No.	Description of Topic	Contact Hrs.
1	Classification of mechanisms- Basic kinematic concepts and definitions- Degree of freedom, mobility- Grashof's law, Kinematic inversions of four bar chain and slider crank chains. Limit positions- Mechanical advantage- Transmission angle Description of some common mechanisms- Quick return mechanism, straight line generators- Universal Joint- Rocker mechanisms.	6
2	Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations- kinematic analysis of simple mechanisms- slider crank mechanism dynamics- Coincident points- Corioli's component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation.	7
3	Classification of cams and followers- Terminology and definitions- Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers.	5
4	Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.	6
5	Surface contacts- sliding and rolling friction- friction drives bearings and lubrication, Friction clutches- Belt and Rope drives Friction in brakes.	6
6	Vibrations– Free and forced vibration of undamped and damped Single DOF systems, Resonance, Transmissibility Ratio, Effect of damping, Vibration Isolation, Critical Speed of Shafts.	6
7	Balancing of Reciprocating and Rotating Masses- Static balancing, Unbalance of force or moment, Dynamic balancing of rotating masses- graphical and analytical methods; Swaying couple; Hammer blow.	4
8	Governors- Use and classification; Study and analysis of Porter, Proell and Wilson-Hartnell governors; Sensitiveness, stability, isochronism, hunting, effort and power of governors.	3
9	Flywheel- Inertia force and inertia torque in reciprocating engine, correction couple (torque), Turning moment diagram and flywheel design.	3
10	Gyroscope- Gyroscopic couple and precessional motion, Effect of gyroscopic couple on aeroplane and ship, Stability of two wheel and four wheel vehicles taking turn.	2

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Humanities I- Effective Technical Communication **Course Code: HM HU 501**

Semester of Study: 3rd Year, 5th Sem Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO-1:

Inspiring students and preparing them for successful professional careers by applying the knowledge of applied science and fundamental Mechanical Engineering core subjects and advanced Mechanical Engineering software.

PSO-2:

Ability to co-ordinate and communicate in groups by diversifying their knowledge domain in different engineering disciplinary area.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
HM-HU501.1	Understand the dynamics of Verbal and Non Verbal aspects of technical communication	Understand	**L2**
HM-HU501.2	Practice multi-step writing process to plan, draft, and revise reports, correspondence, and presentations.	Remember	**L1**
HM-HU501.3	Illustrate and examine the knowledge of ethical aspects of engineering	Apply	**L3**
HM-HU501.4	Demonstrate and explain social and professional etiquettes	Analyse	**L4**
HM-HU501.5	Plan self-development and practice self-assessment to function on multi-disciplinary teams.	Evaluate	**L5**
HM-HU501.6	Organize and write business correspondence properly and correctly, using appropriate formats, grammar, vocabulary, and syntax, and demonstrate effective writing and editing skills.	Create	**L6**

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HM-HU501.1	3	1	1	1	1	1	1	1	1	3	1	3
HM-HU501.2	3	2	2	1	1	1	1	1	3	3	2	3
HM-HU501.3	1	2	2	1	1	1	1	3	3	3	1	2
HM-HU501.4	3	3	3	3	1	2	1	2	3	3	3	3
HM-HU501.5	2	3	3	2	2	2	2	2	3	3	3	3
HM-HU201.6	3	3	3	2	1	1	1	1	2	3	2	3
Average	2.5	2.3	2.3	1.7	1.2	1.3	1.2	1.7	2.5	3	2	2.8

University Syllabus:

Module	Chapter	Content
1.	**Information Design and Development**	1.1-Different kinds of technical documents1.2-Information development life cycle 1.3- Organization structures factors affecting information and document design 1.4- Strategies for organization 1.5- Information design and writing for printand for online media.
2.	**Technical Writing, Grammar and Editing**	2.1- Technical writing process, forms ofdiscourse 2.2- Writing drafts and revising 2.3- Collaborative writing creating indexes2.4-Technical writing style and language 2.5- Basics of grammar, study of advancedgrammar 2.6- Editing strategies to achieve appropriatetechnical style 2.7- Introduction to advanced technical communication, Usability, Human factors,2.8-Managing technical communication projects 2.9-Time estimation, Single sourcing, Localization.
3.	**Self**	3.1-Self assessment, Awareness, 3.2- Perception and Attitudes, Values and belief3.3-Personal goal setting, career

4.	**Developmentand Assessment-** **Communicationand Technical Writing**	Planning, Self-esteem.3.4- Managing Time 3.5- Personal memory 3.6- Rapid reading3.7- Taking notes 3.8- Complex problem solving 3.9-Creativity 4.1- Public speaking 4.2-Group Discussion4.3-OralPresentation 4.4-Interviews 4.5-Graphic presentation4.6- Presentation aids 4.7-Personality Development4.8- Writing reports 4.9-Project Proposals 4.10-Brochures, newsletters, technical articles,manuals, official Notes 4.11-Business letters, memos, progress reports,minutes of meetings, event report.
5.	**Ethics**	5.1-Business ethics 5.2-Etiquettes in social and office settings 5.3- Email Etiquettes & Telephone Etiquettes5.4-Engineering Ethics 5.5-Managing time 5.6-Role and responsibility of engineer5.7-Work culture in jobs 5.8-Personal memory5.9-Rapid Reading 5.10-Taking notes 5.11-Complex problem solving5.12-Creativity.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Mechanical EngineeringLaboratory (Thermal) I **Course Code: PCME 591**

Semester of Study: 5th

Course Type: Practical

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC-ME591.1	**DEMONSTRATE** the operation of fluid flow measuring devices.	**APPLY**	P
PC-ME591.2	**CONDUCT** experiments on water turbines and pumps.	**APPLY**	P
PC-ME591.3	**DETERMINE** the calorific value of fuels and their flash and fire points.	**APPLY**	P
PC-ME591.4	**DETERMINE** the performance parameters of four-stroke Diesel engines.	**APPLY**	P
PC-ME591.5	**EXAMINE** the thermal conductivity, emissivity and the convective heat transfer coefficient of solid and fluid materials.	**APPLY**	P

Course Articulation Matrix:

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

Subject Code : PC-ME591	**Category:** Professional Core Courses
Subject Name : Mechanical Engineering Laboratory (Thermal) I	**Semester** : Fifth
L-T-P : 0-0-3	**Credit: 1.5**
Pre-Requisites: Engineering Thermodynamics and Fluid Mechanics and Fluid Machines	

Course Contents (12 experiments/ studies/ problems are to perform from the list given below or relevant others):

1. Measurement of coefficient of discharge of given Orifice and Venturimeter
2. Determination of the density & viscosity of an oil and friction factor of oil flow in a pipe
3. Determination of the performance characteristics of a centrifugal pump
4. Determination of the performance characteristics of Pelton Wheel
5. Determination of the performance characteristics of a Francis Turbine
6. Determination of the performance characteristics of a Kaplan Turbine
7. Determination of the thermal conductivity and specific heat of given objects
8. Determination of the calorific value of a given fuel and its flash & fire points
9. Determination of the p-V diagram and the performance of a 4-stroke diesel engine
10. Determination of the convective heat transfer coefficient for flow over a heated plate
11. Determination of the emissivity of a given sample
12. Determination of the performance characteristics of a vapour compression system

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Project-I (Summer internship), Course Code: PW-ME581

Semester of Study: 5th Course Type: Sessional

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PW-ME581.1	Develop the skills, knowledge and points of view needed by engineering professionals	Develop	P
PW-ME581.2	Develop critical thinking and problem solving skills by analysing underlying issue/s to challenges	Develop	P
PW-ME581.3	Communicate with different professionals in the work environment through written and oral means	Communicate	U
PW-ME581.4	Exhibit professional ethics by displaying positive disposition during internship	Exhibit	P

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	2	1	2	1	2	2	3	1
CO2	2	2	1	2	1	1	2	1	2	2	3	1
CO3	1	1	1	1	1	1	1	1	2	3	3	2
CO4	1	1	1	1	1	1	1	2	2	2	3	2
Average	1.5	1.5	1.25	1.5	1.25	1	1.5	1.25	2	2.25	3	1.5

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Manufacturing Technology **Course Code: PC-ME601**

Semester of Study: 6th

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME601.1	**Illustrate** principles of tooling design and selection for conventional and non-conventional machining processes.	Illustrate	**U**
PC ME601.2	**Use** the principle of measurement for tool wear, part quality, and inspection in manufacturing processes.	Use	**P**
PC ME601.3	**Describe** assembly practices, process planning, and material handling in manufacturing and assembly operations.	Describe	**U**
PC ME601.4	**Discuss** the understanding of NC/CNC machine tools and systems, including their components, functions, and automation capabilities.	Discuss	**U**
PC ME601.5	**Write** the part programming for CNC lathe and milling machines	Write	**P**
PC ME601.6	**Demonstrate** rapid prototyping methods and their applications in manufacturing	Demonstrate	**U**

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	2	1	1	1	2	1	2	3	2
CO2	3	1	1	1	1	1	1	1	1	2	1	2	3	2
CO3	3	1	1	1	1	1	1	1	1	2	1	2	3	2
CO4	3	1	1	1	1	1	1	1	1	2	1	2	3	2
CO5	2	2	1	1	3	1	1	1	1	2	1	2	3	2
CO6	3	1	1	1	1	1	1	1	1	2	1	2	3	2
Average	**2.83**	**1.33**	**1.00**	**1.00**	**1.33**	**1.17**	**1.00**	**1.00**	**1.00**	**2.00**	**1.00**	**2.00**	**3.00**	**2.00**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module	Description of Topic	Contact Hrs.
1	Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tools: Jigs and fixtures, principles, applications and design; Press tools: Configuration, design of die and punch; principles of forging die design.	**12**
2	Metrology: Metrology in tool wear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality	**8**
3	Assembly Practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices.	**6**
4	NC/CNC Machine Tools and Systems Types of automation: Fixed (or hard) and programmable (or flexible); need, advantages and applications of flexible automation over fixed automation. Components and Their Functions in NC/CNC Machines MCU, DPU and CLU, Feed drives using stepper/ servo motors and recirculating ball screw-nut system, Automatic Tool Changers- Tool Turret and Tool Ma.ga.zite, Automatic pallet Changer. Basic systems of NC and CNC machines Coordinate system, gontrol— open loop and closed loop, Dimensioning— absolute and incremental, Point—to—point and contour motion, Linear and circular Interpolation. CNC Machine Tools and Integrated Automation Structure and working principle of CNC lathe, milling machine, Examples and use of CNC machines, Machining Centre (Vertical and Horizontal), Integrated Automation systems (DNC-Direct and Distributed or BTR and Dedicated system, FMS- FFMS, FMC and FMM)– characteristics and applications.	**8**
5	Part Programming for CNC machines Manual Part Programming using ISO G and M Codes in CNC lathe and milling machine for simple jobs, Canned cycle. Computer Aided Part Programming using MACRO statements in APT for simple jobs in CNC lathe and milling machine.	**8**
6	Rapid Prototyping Overview of Rapid Prototyping, Basic Process-CAD Model Creation, Conversion to STL format, Slicing the STL File, Layer by layer construction. Use of CMM and 3-D Camera for making virtual model. Principles, systems, relative advantages and applications of the common RP methods, such as Stereo lithography (SLG), Selective laser sintering (SLS), Fused deposition modelling (FDM), Laminated objects manufacturing (LOM), 3-D Printing.	**6**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Design of Machine Elements **Course Code: PC-ME602**

Semester of Study: 6th

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC-ME602.1	**Understand** the failure criteria, concept of mechanics of materials, empirical design formula & safety considerations, codes & standards for design.	Understand	**U**
PC-ME602.2	**Analyze** permanent and temporary joints viz. riveted joints, welded joints and bolted joints based on design aspect.	Analyze	**A**
PC-ME602.3	**Analyze** design of shafts, belts, gears, chains and pulleys.	Analyze	**A**
PC-ME602.4	**Solve** design problems on spring, cotter joint, knuckle joint based on optimum criteria.	Solve	**P**
PC-ME602.5	**Determine** optimum design of Coupling, brakes and screw jack based on friction principle.	Determine	**P**
PC-ME602.6	**Apply** knowledge of design principles and calculations to design springs, clutches and bearings.	Apply	**P**

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	2	1	3	1	1	1	1	-	2	3	1
CO2	2	2	2	2	1	3	2	1	1	1	-	2	3	1
CO3	2	2	2	2	1	3	2	1	1	1	-	2	3	1
CO4	2	2	2	2	1	3	2	1	1	1	-	2	3	1
CO5	2	2	2	2	1	3	2	1	1	1	-	2	3	1
CO6	2	2	2	2	1	3	2	1	1	1	-	2	3	1
Average	**2**	**1.8**	**2**	**2**	**1**	**3**	**1.8**	**1**	**1**	**1**	**-**	**2**	**3**	**1**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module	Description of Topic	Contact Hrs.
1	Design considerations; Review and selection of materials and manufacturing processes; codes and standards;	**4**
2	Modes of failure; Design/allowable stress; Factor of safety (FoS); Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria; Design for stability : buckling analysis – Johnson and Euler columns.	**4**
3	Fatigue in metals; S-N curve; Endurance limit and fatigue strength; Stress concentration factors – effect of discontinuity, fillets and notches; Effect of size, surface finish, stress concentration and degree of reliability on endurance limit; Design for finite and infinite life; Goodman, modified Goodman and Soderberg diagrams with respect to fatigue failure under variable stresses; Cumulative fatigue damage – Miner's equation.	**5**
4	Design of (i) Cotter joint; (ii) Knuckle joint and (iii) Fillet Welded joint of brackets under different types of loading.	**6**
5	Bolted joints : Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts; Riveted joints : Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap /cover plate; simple strength design; joint efficiencies.	**6**
6	Design of : (i) Solid and hollow shafts, strength design of shafts, design based on torsional rigidity; (ii) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling; (iii) Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers' catalogues, pulley (iv) Chain drives – roller chains, polygonal effect, power rating, sprocket wheel, silent chain.	**10**
7	Design of: (i) Transmission screw, Screw jack, (ii) Helical compression spring - stress and deflection equations, stiffness, curvature effect : Wahl's factor, springs in parallel and series; (iii) Multi-leaf springs : load-stress and load-deflection equations, Nipping.	**8**
8	Analysis and design of sliding and rolling contact bearings, Design of transmission elements: spur, helical, bevel and worm gears; Analysis of clutches and brakes	**5**

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Internal Combustion Engines & Gas Turbines Course Code: PEME601A

Semester of Study:

Course Type: Theory

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Program Outcome (PO):

(1) Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences and foundational Engineering concept for application in discipline.

(2) Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

(3) Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety,

(4) Graduate will possess fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

(5) Graduate will possess knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO 2.0 & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

(6) Graduate will be able to provide engineering solution, design solution which are society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

(7) Graduates will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

(8) Graduate will learn the ability to understand the professional and ethical responsibility.

(9) Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

(10) Graduate will be able to communicate effectively in both verbal and in the written form.

(11) Graduate will possess managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

(12) Graduate will develop confidence for self and have the ability to engage in life long learning.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Inspiring students and preparing them for successful professional careers by applying the knowledge of applied science and fundamental Mechanical Engineering core subjects and advanced Mechanical Engineering softwares.

PSO2: Ability to co-ordinate and communicate in groups by diversifying their knowledge domain in different engineering disciplinary area.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PEME601A.1	**UNDERSTAND** the basic concepts, components and operations of IC Engines.	**UNDERSTAND**	**U**
PEME601A.2	**ILLUSTRATE** the process of curburattion and ignition of SI Engines and injections of CI Engines.	**ILLUSTRATE**	**P**
PEME601A.3	**DESCRIBE** the conventional and alternative fuels and combustion phenomena in SI and CI engines.	**DESCRIBE**	**U**
PEME601A.4	**EVALUATE** the performance parameters of IC engines.	**EVALUATE**	**E**
PEME601A.5	**CLASSIFY** the essential components of gas turbines along with its performance improving methods (intercooling, reheating and regenerating).	**CLASSIFY**	**A**
PEME601A.6	**ILLUSTRATE** the working principles of various types jet propulsive rockets.	**ILLUSTRATE**	**P**

Course Articulation Matrix:

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

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Subject Code: A	**Category:** Professional Elective Courses
Subject Name: Internal Combustion Engines and Gas Turbines	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Thermodynamics, Heat Transfer	

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Basic Engine components and Nomenclature, Classification of Engines, The working principle of Engines, Comparison of 2-Stroke and 4-Stroke Engines; CI, and SI Engines, Ideal and Actual Working Cycles and their analysis, Valve timing Diagram. **Fuels:** Fossil fuels, Chemical structure of Petroleum, Properties of SI and CI Engine Fuels, Fuel Ratings; Octane Number, Cetane Number.	6
2	**Carburetors & Fuel Injection:** Air Fuel Mixture Requirements, Construction and Working of Simple Carburetor, Calculation of Air-Fuel Ratio, Parts of Carburetor. Requirement of Injection Systems, Classification of Injection Systems, Fuel Feed pump, Injection Pumps, Working principles of Governors, Nozzles and Fuel Injector, Injection in SI and CI Engines. **Combustion and Ignition Systems in SI and CI Engines:** Normal and Abnormal Combustion in SI and CI Engines, Stages of Combustion, Detonation and Knocking.	7
3	**Performance parameters for IC Engines:** Engine Power, Engine Efficiencies, Performance Characteristics, Variables Effecting Performance Characteristics, Methods of Improving Engine Performance, Heat Balance. **Modern Automotive Engines:** Changes in Fuel injection Methods in S.I and C.I engines, Common Rail Direct Injection System, Gasoline Direct Injection, Variable Valve Technology, A brief review of Design changes to achieve high efficiency.	7
4	**Alternate Fuels For IC Engines:** Need for use of alternate fuels. Use of alcohol fuels. Biodiesel. Biogas and Hydrogen in engines.	3
5	**Gas Turbine:** Introduction to Gas Turbines, Development, Classification and Application of Gas Turbines, Ideal and Actual Cycles; Effect of Inter cooling, Reheating, Regeneration, Combined cycle and Cogeneration.	6

6	**Gas Turbine Cycles for Aircraft Propulsion:** Criteria of performance, Intake, and propelling nozzle efficiencies, Simple Turbojet Cycle, The turboprop engine, Thrust augmentation, Gas turbine combustion systems, Combustion chamber designs, Gas Turbine Emissions.	7

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: TURBOMACHINERY **Course Code:PE-ME602C**

Semester of Study: 6th

Course Type: Theory

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PE ME602C.1	To **Understand** energy transfer from fluid to machine and vice versa.,	**Understand**	**U**
PE ME602C.2	To E**valuate** non dimensional nos. by dimensional Analysis of incompressible and compressible fluid flow machines	E**valuate**	**E**
PE ME602C.3	To **Analise** incompressible fluid flow machines (both for impact and reaction type turbines.(Pelton,Francis' & Kaplan turbine) and analysis of Draft tubes. Application of velocity triangles	**Analise**	**A**
PE ME602C.4	To **Analise** Centrifugal Pump .	**Analise**	**A**
PE ME602C.5	**Analysis** of compressible fluid flow machines. choking of nozzles,**Illustrate** rows of blades for pressure compounding and velocity compounding	**Analise**	**A**
PE ME602C.6	**Evaluation** of Turbo machines for performance analysis,**illustrate** Cavitation phenomena.	E**valuate**	**E**

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Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1	2	1	1	1	1	2	2	-	2
CO2	1	3	1	2	1	3	1	1	2	2	-	2
CO3	3	3	1	2	1	1	1	1	1	1	-	1
CO4	3	3	2	2	2	2	1	1	1	1	-	2
CO5	1	3	3	2	1	2	2	1	1	1	-	2
CO6	1	3	3	2	1	2	2	1	1	1	-	2
Average	1.67	3	1.83	2	1.16	1.83	1.33	1	1.33	1.33	-	1.83

University Syllabus:

Course Content:

Module No.	Description of Topic	Contact Hours
1	**Introduction:** Classification: Incompressible and compressible flow machines;Radial, axial and mixed flow machines; Turbines vs pumps, fans and compressors. Applications: Water supply, ventilation, power generation, propulsion.	2
2	**Incompressible- Flow Machines:** i) Hydraulic Turbines: Headrace, penstock, nozzle, runner, draft tube and tail race; Gross head and net head; Velocity diagrams for impulse and reaction turbines; Discharge, head, power and efficiencies.	8
3	ii) Pumps: Reservoir, foot valve, suction line, pump, delivery line and overhead tank; Static head and losses; Velocity diagrams; Discharge, head, power and efficiencies.	8
4	**Compressible-Flow Machines:** Static and stagnation states; Isentropic and adiabatic expansion and compression processes; Nozzle, diffuser and rows of stationary and moving blades; Efficiencies.	8
5	**Dimensional Analysis:** Similarity laws, volume-flow, mass-flow head and power coefficients, pressure ratio, enthalpy ratio, Reynolds number, Mach number; Specific speed and machine selection.	4
6	**Testing and Performance Analysis:** Measurement devices; affinity laws and unit quantities. Set up and operating characteristics of pumps, turbines; fans andturbo-compressors. Cavitation– cause of cavitation and definition of Thoma's cavitation parameter, surge and choking.	6

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Mechatronics **Course Code: PE-ME602G**

Semester of Study: 6th

Course Type: Theory

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Vision of the M. E. Department

To produce professionally competent engineers to cater to the needs of the industry, society and nation.

Mission of the M. E. Department

To provide excellent opportunity for producing professionally competent engineers with the sense of social and moral responsibility by creating value added teaching and motivation for research.

PEO-1: To provide conducive learning environment and quality technical education emphasizing the mathematics and science fundamentals related to mechanical engineering program to achieve professional excellence.

PEO-2: Graduates should prepare themselves for carrying out higher studies and quality technological research & development skills to keep pace with the current technological trends through out the career, either in industry or in entrepreneurship and ready to take leadership & capable of working as a member of multi discipline team.

PEO-3: To foster a sense of responsibility, professionalism, team work and ethical values by developing skills in, management and allied studies through well balanced courses which will help to develop a symbiotic relationship between the institution, society and the community.

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

(A) PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

(a) **Engineering Knowledge:** Graduate will possess strong **fundamental knowledge** on applied mathematics, applied sciences and foundational Engineering concept for application in discipline.

(b) **Problem Analysis:** Graduate will develop confidence and will be able to **design** and conduct experiment on it as well as to **analyze** the problem and interpret data.

(c) **Design/Development of solutions:** Graduate will have the ability to design components, **fluid** & **thermal** systems ,**manufacturing** processes and **conduct testing experiment** on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

(d) **Investigation of Complex problems:** Graduate will possess fundamental knowledge and will have the ability to investigate **complex problems** with **multidisciplinary team** effort.

(e) **Modern Tool Usage:** Graduate will possess knowledge of using **Modern tools** e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO 2.0 & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

(f) **The Engineer and Society:** Graduate will be able to provide engineering solution, design solution which are society friendly and in this context graduates will also be able to analyze the local and **global impact** of Engineering on **society**.

(g) **Environment and Sustainability:** Graduates will be able to develop an **environment friendly and cost effective** new system and also have serious concern for the society.

(h) **Ethics:** Graduate will learn the ability to understand the **professional and ethical responsibility**.

(i) **Team Work:** Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

(j) **Communication:** Graduate will be able to **communicate** effectively in both verbal and in the written form.

(k) **Project Management and Finance:** Graduate will possess **managerial skills** and also

have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

(l) **Life-Long Learning:** Graduate will develop confidence for self and have the ability to engage in **life-long learning**.

(B) PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

2. Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	**Details/Statement**	**Action Verb/Bloom's Level**	**Knowledge Category/Level**
After completion of this course the students will			
PE ME602G.1	***review*** the basics of Electrical and electronics devices for various applications signal and data processing devices.	R (Remember)	C
PE ME602G.2	***understand*** the design philosophy of mechatronics, basic principles of control engineering and sensor technology having required knowledge to analyze the system in time domain.	U (Understand)	C, FD
PE ME602G.3	be able to ***apply*** electrical and electronics devices and sensors, and different drive systems including electrical, mechanism, and pneumatic and hydraulic drives and actuators.	P (Apply)	CS PC
PE ME602G.4	be able to ***analyze*** the control systems using frequency domain analysis, stability analysis, in state space etc. and analyze the performance of drive systems, microprocessor program.	A (Analyze)	P
PE ME602G.5	be able to ***evaluate*** any mechatronic control system, performance of drive systems and control programs.	E (Evaluate)	P
PE ME602G.6	be able to ***design*** and *fabricate* microprocessor-microcontroller based Mechatronics control system, PLC based systems using proper drive system.	C (create)	DI

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	3	1	1	1	1	2	1		1	3	2
CO2	1	1	1	3	1	2	1	1	2	1		1	3	2
CO3	1	1	1	3	1	2	1	1	2	1		1	3	2
CO4	1	1	1	3	1	2	1	1	2	1		1	3	2
CO5	1	1	1	3	1	2	1	1	2	1		1	3	2
CO6	1	1	1	3	1	2	1	1	2	1		1	3	2
Average	1	1	1	3	1	1.8	1	1	2	1		1	3	2

Subject Code: G (PE-ME602G)	**Category:** Professional Elective Courses
Subject Name: Mechatronics	**Semester**: Sixth
L-T-P: **3-0-0**	**Credit: 3**
Pre-Requisites: Fluid Mechanics and Fluid Machinery, Kinematics and Theory of Machines, Basic Electrical Engineering, Basic Electronics Engineering	

Course Objectives:

To provide knowledge on electrical circuits, signal conditioning.
To make familiar about control system and power electronics in designing mechatronic system

Course Contents (Syllabus and CO Mapping):

Module No.	Description of Topic	Contact Hrs.	CO Mapping
1	Introduction to Mechatronics: Definition, Mechatronics in design and manufacturing, Comparison between Traditional and Mechatronic approach; Concurrent engineering	3	CO2, CO3
2	Review of fundamentals of electronics: Logic gates and their operations, Signal processing devices, Data conversion devices, Input and output devices. Sensors and Transducers, Actuators, Limit switches, Relays	6	CO1
3	Control Systems: Open loop and closed loop control, block diagrams, transfer functions, Laplace transforms.	3	CO2
4	Electrical Drives: Stepper motors, servo drives.	2	CO3
5	Mechanical Drives: Different mechanisms, Ball screws, Linear motion bearings, Transfer systems.	3	CO3
6	Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulic drives, comparison between them. Design of pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc.	4	CO6

7	Basics of 8085 microprocessor, programmable register architecture, buses, memory mapping, clock pulse and data transfer operations, and simple assembly and mnemonic programming on 8085 microprocessor.	5	CO3, CO6
8	Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller using Ladder diagram.	4	CO6
9	Mathematical modeling of physical systems, such as spring-mass vibration system, linear and rotory motion and its Laplace Transform.	2	CO5
10	Basics of time domain analysis, Introduction to discrete-time systems and Z-transform.	2	CO5
11	Introduction to Mechatronic systems, such as automatic brake, door closing and opening, robot, CNC machine, AGV, etc.	2	CO3, CO6

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Mechanical Engineering Laboratory II (Design) **Course Code:** PC-ME691

Semester of Study: 6th

Course Type: Practical

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially. l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME 691.1	**DEMONSTRATE** kinematic characteristics of mechanisms (Cam-Follower, 4 BAR linkages)	**DEMONSTRATE**	U
PC ME 691.2	**ANALYZE** rotating balancing problem and vibration characteristics of different undamped and damped system (free, forced)	**ANALYZE**	A
PC ME 691.3	**CONDUCT** the experiment of hardness and toughness of given materials and apply them practically	**CONDUCT**	A
PC ME 691.4	**DETERMINE** elastic parameters of given materials in tension/compression and in shear test	**DETERMINE**	A
PC ME 691.5	**PREPARE** standard metallographic heat treated samples for the given engineering materials to examine microstructure.	**PREPARE**	A
PC ME 691.6	**MEASURE** strain of the given materials by using strain gauge rosettes.	**MEASURE**	U

Course Articulation Matrix:

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l	PSO 1	PSO 2
CO1	1	2	1	3	1	1		1	2	1		2	3	2
CO2	1	2	1	3	1	1		1	2	1		2	3	2
CO3	2	2	1	3	1	1		1	2	1		2	3	2
CO4	2	2	1	3	1	1		1	2	1		2	3	2
CO5	1	2	3	3	1	1		1	2	1		2	3	2
CO6	1	2	2	3	1	1		1	2	1		2	3	2
Average	1.67	2	1.5	3	1.0	1.0		1.0	2.0	1.0		2.0	3.0	2.0

University Syllabus:

1. Uniaxial tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on a metallic specimen
4. Brinnell/ Vickers and Rockwell hardness tests on metallic specimens

5. Bending deflection test on beams
6. Strain measurement using Rosette strain gauge, or like.
7. Microscopic examination of heat-treated and untreated metallic samples
8. Determination of velocity ratios of simple, compound, epicyclic and differential gear trains
9. Studying kinematics of four bar, slider crank, crank rocker, double crank, double rocker and oscillating cylinder mechanisms
10. Studying kinematics of typical mechanisms like pantograph, some straight line motion mechanisms, wiper, drafter, etc.
11. Motion studies of different cams & followers
12. Single degree of freedom Spring-mass-damper system: determination of natural frequency and damping coefficient
13. Determination of torsional natural frequency of single and double rotor system sundamped and damped natural frequencies
14. Studying machine vibration using sensor
15. Solving simple balancing problems experimentally

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Project-II (Summer internship), Course Code: PW-ME681

Semester of Study: 6th Course Type: Sessional

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PW-ME681.1	Develop the skills, knowledge and points of view needed by engineering professionals	Develop	P
PW-ME681.2	Develop critical thinking and problem solving skills by analysing underlying issue/s to challenges	Develop	P
PW-ME681.3	Communicate with different professionals in the work environment through written and oral means	Communicate	U
PW-ME681.4	Exhibit professional ethics by displaying positive disposition during internship	Exhibit	P

Course Articulation Matrix:

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

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Advanced Manufacturing Technology Course Code: PC-ME701

Semester of Study: 7th

Course Type: Theory

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME701.1	Identify different non traditional machining processes and their applications.	Identify	U
PC ME701.2	Describe the basic working principles and mechanism of metal removal in ultrasonic machining and Abrasive jet machining and Assess its effectiveness in various applications	Describe	A
PC ME701.3	Apply the knowledge of process parameters, tool selection, and working medium to achieve desired MRR and accuracy in ECM & EDM	Apply	P
PC ME701.4	Illustrate the characteristics and applications of laser beam machining, electron beam machining, ion beam machining, and plasma arc machining.	Illustrate	U
PC ME701.5	Discuss the working principles, process variables, and performance of advanced finishing processes such as abrasive flow machining (AFM), magnetic abrasive finishing (MAF), and chemomechanical polishing.	Discuss	U
PC ME701.6	Describe the principles of micromachining, including chip formation and size effect, and Identify the challenges associated with micro-machining and its applications	Describe	U

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3	1	1	1	1	2	1	1	1	2	1	2	3	2
CO2	3	1	1	1	1	2	1	1	1	2	1	2	3	2
CO3	3	1	1	2	1	1	1	1	1	2	1	2	3	2
CO4	3	1	1	2	1	2	1	1	1	2	1	2	3	2
CO5	3	1	1	1	1	1	1	1	1	2	1	2	3	2
CO6	3	1	1	1	1	1	1	1	1	2	1	2	3	2
Average	**3.0**	**1.0**	**1.0**	**1.3**	**1.0**	**1.5**	**1.0**	**1.0**	**1.0**	**2.0**	**1.0**	**2.0**	**3.0**	**2.0**

University Syllabus:

Module	Description of topic	Contact Hrs
1	Mechanical Advanced Machining Processes: Need and classification of nontraditional machining processes – Materialremovalin traditional and nontraditional machining processes - considerations inprocess selection. Ultrasonic machining – Working principle, mechanism of metal removal – Theory of Shaw, elements of the processes, tool feed mechanism, effect of parameters, applications andnumerical. Abrasive jet machining, Water jet machining and abrasive water jet machine - Basic principles, equipments, process variables, mechanicsof metal removal, MRR, application and limitations	**6**
2	Electro–Chemical Processes: Principle of ECM process, chemistry of the ECM processes, Parametersof the process, determination of themetal removal rate, dynamicsof ECM process, polarization, tool design, advantages and disadvantages, application, electrochemical grinding, electrochemical honing, electrochemical deburring, Application of ECM for deephole drilling - electrostream drilling and shaped tube electrolytic machining. Chemical machining - Fundamental principle, typesof chemical machining, maskants, etchants, advantages, disadvantages, applications	**6**

3	Electric Discharge Machining: Working principle of EDM, Power circuits for EDM - RCpulse generatorand controlledpulse generator– Analysis of R-C Circuits – Mechanics of metal removal in EDM, Process parameters, selectionof tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface and recent development in EDM. Wire EDM – Working principle, process variables, process characteristics and applications. Electric discharge grinding and electric discharge diamond grinding - working principle, process capabilities and applications.	**6**
4	**Laser, Electron Beam, IonBeam and Plasma Arc Machining:** General working principle oflaser beam machining – Generation of Laser, types ofLasers, process characteristics and applications. Electron Beam Machining - Equipment for production of Electron Beam,theory of EBM, thermal and non-thermal type, process characteristics and applications. Ion Beam Machining - Mechanism of metal removal and associatedequipments, process characteristics and applications. Plasma Arc Machining - Metal removal mechanism, process parameters, process characteristics, types of torches, applications.	**6**
5	Advanced Finishing Processes: Abrasive flow Machining (AFM)- working principle, AFM system,process variables, process performance and applications. Magnetic abrasive finishing (MAF)- working principle, MAF system, material removal and surface finish, process variables and applications. Chemomechanical polishing,working principle, material removal and surface finish and applications.	**6**
6	Micro-Machining: Need- evolution- fundamentals and trends in micro technologiesConsequences ofthe technology and society- challenges to manufacturing technology- evolution of precision in manufacturing, tooling and current scenario, requirements and applicationsTheory of micromachining- Chip formation- Size effect in micromachining- microturning- microdrilling.	**6**

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Advanced Welding Technology **Course Code: PE-ME701H**

Semester of Study: 7th

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PE-ME701H.1	**Understand** the principles and characteristics of various welding processes and their parametric influences.	**Understand**	U
PE-ME701H.2	**Discuss** appropriate welding techniques and joint design for different types of materials and welding processes.	**Discuss**	R
PE-ME701H.3	**Apply** the knowledge of power sources, polarity, and electrode characteristics for the selection of suitable arc welding technique.	Apply	P
PE-ME701H.4	**Explain** critical and precision welding processes, such as USW, PAW, LBW, and EBW, in terms of their advantages and limitations.	**Explain**	U
PE-ME701H.5	**Assess** the weldability of different materials, including plain carbon steel, stainless steel, cast iron, and aluminium alloys, based on their metallurgical properties and behaviour during welding.	**Assess**	P
PE-ME701H.6	**Identify** common welding defects, understand their causes and remedies, and Select appropriate inspection and testing methods for welded joints.	**Identify**	A

Course Articulation Matrix:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	3	2	1	1	1	1	1	1	1	2	2	2
CO2	2	2	3	2	1	2	2	1	1	1	1	2	2	2
CO3	2	2	2	3	2	2	1	1	2	1	1	2	2	3
CO4	2	2	3	3	1	2	1	1	1	1	1	2	2	1
CO5	2	2	3	3	1	2	1	1	1	1	1	2	2	3
CO6	2	2	3	2	1	2	1	1	1	1	1	2	2	3
Average	2.0	2.0	2.8	2.5	1.2	1.8	1.2	1.0	1.2	1.0	1.0	2.0	2.0	2.3

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module	Description of topic	Contact Hrs
1	Review of welding processes, joint design	**3**
2	Descriptions and Parametric influences on Welding processes: Arc Welding- SMAW, Stud Arc welding, SAW, GMAW, GMAW-P, FCAW, GTAW, GTAW-P. Resistance Welding processes- Spot, Butt, Seam, Projection. Solid State Welding processes- Forge welding, Friction welding, Friction Stir welding, Diffusion welding, Roll welding.	**6**
3	Arc Welding- Different types of equipment, Power sources, Choice of Polarity, Arc characteristics, Modes of Metal Transfer, Welding Positions, Electrode selection.	**5**
4	Critical and Precision Welding processes- USW, PAW, LBW, EBW. Underwater Welding- Wet Welding and Dry Welding: Hyperberic and Cavity. Welding of Plastics- Hot Gas Welding, Hot Tool Welding, Hot Press Welding, Friction Welding, Ultrasonic Welding. Joining of Ceramics and Composites	**8**
5	Welding Metallurgy, HAZ, Effect of different process parameters on the characteristics of weldment. Weldability of Plain Carbon Steel, Stainless Steel, Cast Iron, Aluminium and its Alloys.	**8**
6	Welding Defects- Types, Causes, Inspection and Remedial Measures. Testing of Welded Joints- Visual Inspection, Dye-Penetration (DP) Test, Ultrasonic Test and Radiography Test.	**3**
7	Welding Fixtures, Welding Automation and Robotic Welding. Safe Practices in Welding.	**3**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Automobile Engineering, Course Code: PEME701A

Semester of Study: 7TH

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PE ME701A.1	Understand the basic lay-out of an automobile and engines for two-wheelers, three wheelers, four wheelers, & other passenger and commercial vehicles.	Describe	U
PE ME701A.2	Explain the operation of engine cooling, lubrication, ignition, electrical, electronics and air conditioning systems.	Explain	U
PE ME701A.3	Illustrate the principles of transmission, suspension, steering and braking systems and construction of wheels and tyres.	Illustrate	A
PE ME701A.4	Determine the tractive effort and power requirements & learn the use of torque-speed curve.	Determine	P
PE ME701A.5	Learn automobile restraint system.	Illustrate	P
PE ME701A.6	Know the latest developments in automobiles.	Tell	R

Course Articulation Matrix:

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

CO3	2	3	2	1	2	1	1	1	2	1	1	2
CO4	2	3	2	1	2	1	1	1	2	1	1	2
CO5	2	3	2	1	2	2	1	2	2	1	1	2
CO6	2	3	2	1	2	2	1	2	2	1	1	2
Average	**2**	**3**	**2**	**1**	**2**	**1.66**	**1.33**	**1.5**	**2**	**1**	**1**	**2**

Module No.	Description of the Topic	contact Hrs
1	**Introduction**: Hrs. History & Development of Automobiles. Various subsystems of Automobiles.	1
2	**Prime Movers:** Engine for Two-Wheeler & Three-Wheeler vehicles, Engine for passenger cars, commercial and other vehicle, Fuel system for carburetted engine, MPFI engine and Diesel engine, Lubrication and cooling system.	5
3	**Auto Electrical:** Electric Motor as prime mover, Battery, generator, Ignition system, Starting system, lighting & signaling	6
4	**Steering System:** Devis steering & Ackerman steering system. Rack & pinion, cam & lever, worm & sector system.	3
5	**Transmission System:** Flywheel & clutch. Gearbox sliding and constant mesh type, Automatic Transmission, Universal joint, Propeller shaft.	6
6	**Differential & Axle:** Construction & function of differential, Different types of front & rear axles.	3
7	**Suspension System:** Conventional and independent suspension system, application.	3
8	**Brake System:** Disc & drum brake, Hydraulic brake, Parking brake. Stopping distance.	3
9	**Power Requirement:** Various resistances such as air resistance, gradient resistance, rolling resistance. Tractive effort. Torque- Speed curve. Horse power calculation.	3
10	**Automotive air conditioning:** Ventilation, heating, air condition, refrigerant, compressor and evaporator.	3

	Wheels and tyres: Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications.Automotive Restraint Systems: Seat belt, automatic seat belt tightener system, collapsible steering column and air bags.	

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: CAD/CAM **Course Code: PE-ME702J**

Semester of Study: 7th

Course Type: Theory

Course Designation: Professional Elective

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Students will be able to:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PE-ME702J.1	**Understand** overview of CAD/CAM (process, benefits & applications).	Understand	**U**
PE-ME702J.2	**Illustrate** aspects of geometric modeling viz. wireframe, surface and solid modeling.	Illustrate	**P**
PE-ME702J.3	**Analyze** stress using FEM.	Analyze	**A**
PE-ME702J.4	**Write** part programme using the knowledge of CNC machines, tools & work handling system.	Write	**P**
PE-ME702J.5	**Illustrate** types, anatomy, drives and application of robotics.	Illustrate	**P**
PE-ME702J.6	**Explain** components of computer aided manufacturing including Group Technology, Reverse Engineering, Computer-aided process planning, Control systems and Automatic inspection systems.	Explain	**U**

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	3	1	1	1	1	1	-	1	1	3
CO2	2	2	2	2	3	1	1	1	1	1	-	1	1	3
CO3	2	2	2	2	3	1	1	1	1	1	-	1	1	3
CO4	2	2	2	2	3	1	1	1	1	1	-	1	1	3
CO5	2	1	2	2	3	1	1	1	1	1	-	1	1	3
CO6	2	1	2	2	3	1	1	1	1	1	-	1	1	3
Average	2	1.6	2	2	3	1	1	1	1	1	-	1	1	3

Module	Description of Topic	Contact Hrs.
1	Fundamentals of CAD- Design process, benefits of computer aided design, graphics standards	**3**
2	Geometric modeling- wire-frame, surface and solid modeling Transformation- translation and rotation exercise problems and programming. Stress analysis- basics of FEM, formation of stiffness matrix for two elements.	**6**
3	Introduction to computer aided manufacturing (CAM) systems, basic building blocks of computer integrated manufacturing (CIM).	**4**
4	Toolings of CNC machines, tool and work handling systems involving robot, AGV, RTV, AS/RS, ATC, APC.	**3**
5	Robotics; types, anatomy, drives and applications.	**3**
6	Computer aided production planning and control, Manufacturing from product design- CADCAM interface, concept of group technology (GT), CAPP.	**6**
7	Control systems, Process monitoring, Adaptive control systems, etc.	**2**
8	Automatic inspection systems, use of CMM, Reverse Engineering.	**1**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Selection and Testing of Materials **Course Code:** PE-ME-702E

Semester of Study: 7th Semester

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

1. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

2. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

3. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

4. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

5. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems..

6. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

7. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

8. Graduate will learn the ability to understand the professional and ethical responsibility.

9. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

10. Graduate will be able to communicate effectively in both verbal and in the written form.

11. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

12. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PE-ME-702E.1	**Understand** properties and application of Engineering Materials viz. ceramic, composites, polymers, elastomers	**Understand**	U
PE-ME-702E.2	**Select** Materials based on Ashby Material Selection Chart for Engineering Applications	**Select**	P
PE-ME-702E.3	**Explain** material properties.	**Explain**	U
PE-ME-702E.4	**Analyze** material properties and defects using suitable testing technique.	**Analyze**	A
PE-ME-702E.5	**Understand** Macroscopic and Microscopic observation through material characterization techniques	**Understand**	U
PE-ME-702E.6	**Analyze** Material properties through thermal and chemical testing	**Analyze**	A

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
PE-ME-702E.1	2	3	2	2	1	1	1	1	1	1	0	1	2	3
PE-ME-702E.2	2	3	2	2	1	1	1	1	1	1	0	1	2	3
PE-ME-702E.3	2	3	2	2	1	1	1	1	1	1	0	1	2	3
PE-ME-702E.4	2	3	2	2	1	1	1	1	1	1	0	1	2	3
PE-ME-702E.5	2	3	2	2	1	1	1	1	1	1	0	1	2	3
PE-ME-702E.6	2	3	2	2	1	1	1	1	1	1	0	1	2	3
Avg.	2	3	2	2	1	1	1	1	1	1	0	1	2	3

Module No.	Description of Topic	Contact Hrs.
1	**Engineering Materials** Introduction – classification of engineering materials – selection of materials for engineering purposes –selection of materials and shape –classification metal and alloys, polymers, ceramics and glasses, composites, natural materials,-non metallic materials- smart materials - physical, metrical properties of metals.	5
2	**Material Properties** Mechanical properties - fatigue strength - fracture Toughness - Thermal Properties - Magnetic Properties - Fabrication Properties - electrical, optical properties - Environmental Properties, Corrosion properties - shape and size - Material Cost and Availability– failure analysis.	3
3	**Materials Selection Charts and Testing** Ashby material selection charts-Testing of Metallic Materials - Selection of Materials for Biomedical Applications - Medical Products - Materials in Electronic Packaging - Advanced Materials in Sports Equipment - Materials Selection for Wear Resistance - Advanced Materials in Telecommunications - Using Composites - Manufacture and Assembly with Plastics, fiber and Diamond Films	6
4	**Mechanical Testing** Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations, Applications.	6
5	**Non Destructive Testing** Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.	6
6	**Material Characterization Testing** Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.	6
7	**Other Testing** Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermomechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.	4

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: **Machine Learning** **Course Code: OE-ME701H**

Semester of Study: 7th

Course Type: Theory

Course Designation: Open Elective

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Vision of the M. E. Department

To produce professionally competent engineers to cater to the needs of the industry, society and nation.

Mission of the M. E. Department

To provide excellent opportunity for producing professionally competent engineers with the sense of social and moral responsibility by creating value added teaching and motivation for research.

PEO-1: To provide conducive learning environment and quality technical education emphasizing the mathematics and science fundamentals related to mechanical engineering program to achieve professional excellence.

PEO-2: Graduates should prepare themselves for carrying out higher studies and quality technological research & development skills to keep pace with the current technological trends throughout the career, either in industry or in entrepreneurship and ready to take leadership & capable of working as a member of multi discipline team.

PEO-3: To foster a sense of responsibility, professionalism, team work and ethical values by developing skills in, management and allied studies through well balanced courses which will help to develop a symbiotic relationship between the institution, society and the community.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

(A) PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

(a) **Engineering Knowledge:** Graduate will possess strong **fundamental knowledge** on applied mathematics, applied sciences and foundational Engineering concept for application in discipline.

(b) **Problem Analysis:** Graduate will develop confidence and will be able to **design** and conduct experiment on it as well as to **analyze** the problem and interpret data.

(c) **Design/Development of solutions:** Graduate will have the ability to design components, **fluid** & **thermal** systems ,**manufacturing** processes and **conduct testing experiment** on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

(d) **Investigation of Complex problems:** Graduate will possess fundamental knowledge and will have the ability to investigate **complex problems** with **multidisciplinary team** effort.

(e) **Modern Tool Usage:** Graduate will possess knowledge of using **Modern tools** e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO 2.0 & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

(f) **The Engineer and Society:** Graduate will be able to provide engineering solution, design solution which are society friendly and in this context graduates will also be able to analyze the local and **global impact** of Engineering on **society**.

(g) **Environment and Sustainability:** Graduates will be able to develop an **environment friendly and cost effective** new system and also have serious concern for the society.

(h) **Ethics:** Graduate will learn the ability to understand the **professional and ethical responsibility**.

(i) **Team Work:** Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

(j) **Communication:** Graduate will be able to **communicate** effectively in both verbal and in the written form.

(k) **Project Management and Finance:** Graduate will possess **managerial skills** and also

have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

(l) **Life-Long Learning:** Graduate will develop confidence for self and have the ability to engage in **life-long learning**.

(B) PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

2. Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	**Details/Statement**	**Action Verb/Bloom's Level**	**Knowledge Category/Level**
After completion of this course the students will			
PE ME602G.1	Gain *knowledge* in graphical models, Classification of Machine learning and different machine learning algorithms and they have to *recall* foundational mathematics.	R (Remember)	C
PE ME602G.2	Be able to *understand* concept learning, machine learning model, linear models, different algorithms, neural networks and associated algorithms, concept of over fitting and under fitting.	U (Understand)	C, FD
PE ME602G.3	Be able to *apply* different machine learning algorithms and find out applications with different case studies.	P (Apply)	CS PC
PE ME602G.4	Be able to *analyze* and *interpret* the efficiency, accuracy of different algorithms.	A (Analyze)	P
PE ME602G.5	Be able to *evaluate* the performance of different algorithms.	E (Evaluate)	P
PE ME602G.6	Be to *create* various neural networks, decision trees, support vector models, Baysian models, Logistic regression and others for solution to various problems.	C (create)	P

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	3	2	1	1	1	1	1		1	3	2
CO2	1	1	1	3	2	1	1	1	1	1		1	3	2
CO3	1	1	1	3	2	1	1	1	1	1		1	3	2
CO4	1	2	2	3	3	1	1	1	1	1		1	3	2
CO5	1	2	2	3	3	1	1	1	1	1		1	3	2
CO6	1	2	2	3	3	1	1	1	1	1		1	3	2
Average	1	1.5	1.5	3	2.5	1	1	1	1	1		1	3	2

University Syllabus:

Subject Code : H	**Category:** Open Elective Courses
Subject Name : Machine Learning	**Semester** : Seventh
L-T-P : **3-0-0**	**Credit: 3**
Pre-Requisites: Mathematics- IB, Mathematics- IIB, Mathematics- III	

Course Content:

Module No.	Description of Topic	CO-Mapping	Contact Hrs.
1	Introduction: Learning– Types of Machine Learning– Supervised Learning– The Brain and the Neuron– Design a Learning System– Perspectives and Issues in Machine Learning– Concept Learning Task– Concept Learning as Search– Finding a Maximally Specific Hypothesis– Version Spaces and the Candidate Elimination Algorithm– Linear Discriminants– Perceptron– Linear Separability– Linear Regression.	CO1	8
2	Linear Models: Multi-layer Perceptron– Going Forwards– Going Backwards: Back Propagation Error– Multilayer Perceptron in Practice– Examples of using the MLP– Overview– Deriving Back Propagation– Radial Basis Functions and Splines– Concepts– RBF Network– Curse of Dimensionality– Interpolations and Basis Functions– Support Vector Machines.	CO4	7
3	Tree and Probabilistic Models: Learning with Trees– Decision Trees– Constructing Decision Trees– Classification and Regression Trees– Ensemble Learning– Boosting– Bagging– Different ways to Combine Classifiers– Probability and Learning– Data into	CO3	7

	Probabilities– Basic Statistics– Gaussian Mixture Models– Nearest Neighbor Methods– Unsupervised Learning– K means Algorithms– Vector Quantization– Self Organizing Feature Map.		
4	Dimensionality Reduction and Evolutionary Models: Dimensionality Reduction– Linear Discriminant Analysis– Principal Component Analysis– Factor Analysis– Independent Component Analysis– Locally Linear Embedding– Isomap– Least Squares Optimization. Evolutionary Learning– Genetic algorithms– Genetic Offspring- Genetic Operators– Using Genetic Algorithms– Reinforcement Learning– Overview– Getting Lost Example– Markov Decision Process.	CO2, CO1	7
5	Graphical Models: Markov Chain Monte Carlo Methods– Sampling– Proposal Distribution– Markov Chain Monte Carlo– Graphical Models– Bayesian Networks– Markov Random Fields– Hidden Markov Models– Tracking Methods.	CO2	7

Learning Resources:

1. Jeeva Jose, Introduction of Machine Learning, Khanna Publishing House, 2019.

2. S. Marsland-, Machine Learning– An Algorithmic Perspective, 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

3. T.M. Mitchell, Machine Learning, First Edition, McGraw Hill Education, 2013.

4. P. Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, First Edition, Cambridge University Press, 2012.

5. J. Bell, Machine learning– Hands on for Developers and Technical Professionals, First Edition, Wiley, 2014.

6. E. Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning Series), 3rd Edition, MIT Press, 2014

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Water Resource Engineering Course Code: OEME 701I

Semester of Study: 7th

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
OEME 701I.1	**UNDERSTAND** the basic concept of fluid dynamics in water resource engineering	UNDERSTAD	U
OEME 701I.2	**APPLY** conservation laws in water flow system and concept to solve fluid mechanics problems	APPLY	P
OEME 701I.3	**DESIGN** fluid flow system in open channel and pipe networking system	CREATE	C
OEME 701I.4	**SOLVE** non-dimensional parameters in fluid machines using dimensional analysis	APPLY	P
OEME 701I.5	**ANALYSE** the surface water hydrology problems	ANALYSE	A
OEME 701I.6	**EVALUATE** aquifer parameters using graphical and analytical approaches and apply the equations of groundwater flow to analyze groundwater systems in both unconfined and confined aquifers	EVALUATE	E

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
OEME701I.1	1	2	3	1	1	1	1	1	1	1	-	2
OEME701I.2	1	3	2	1	1	1	1	1	1	1	-	1
OEME701I.3	1	3	2	1	1	2	1	1	2	1	-	2
OEME701I.4	1	2	3	1	1	2	1	1	2	1	-	1
OEME701I.5	1	2	3	1	1	2	1	1	1	1	-	1
OEME701I.6	1	1	3	1	1	2	1	1	1	1	-	2
Average	1	2.2	2.7	1	1	1.7	1	1	1.3	1		1.5

Subject Code: I	Category: Open Elective Courses
Subject Name: Water Resource Engineering	Semester: Seventh
L-T-P: 3-0-0	Credit: 3
Pre-Requisites: Fluid Mechanics	

Course Objectives:

The objective of this course is to provide an understanding of the concepts of closed conduit flow, open channel flow, surface water hydrology and rainfall, and also groundwater hydrology and its characteristics.

Course Content:

Module No.	Description of Topic	Contact Hrs.
1	**Fluid Mechanics:** Review of fluid statics, Review of fluid dynamics; dimensional analysis.	4
2	**Closed Conduit Flow:** Closed conduit flow, Design of water distribution systems, pipe network analysis: Hardy Cross Method, Design of Network Reservoir pipeline.	9
3	**Open Channel Flow:** Continuity, momentum equations, Chezy, Mannings and energy equations, Water surface profiles.	9
4	**Surface Water Hydrology:** Rainfall depth, duration, distribution, determination of average rainfall depth by Arithmatic, Mean Method, Thiessen Polygon Method and Isohyetal Method, Rainfall/runoff equations, Rainfall/ runoff models, unit hydrograph, hydrologic routing models.	10
5	Groundwater Hydrology: Porosity and water content, Equations of ground water flow (unconfined aquifers/ confined, aquifers/ unsaturated flow), Estimation of aquifer parameters using graphical and analytical approach.	4

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Economics for Engineers **Course Code:** HM-HU 701

Semester of Study: 8th

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially. l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
HM HU 701.1	**EXPLAIN** principles of decision making in fixed and variable cost, life cycle cost, estimating models, improvement and learning curve.	**EXPLAIN**	**U**
HM HU 701.2	**ANALYZE** economic conditions viz. inflation, deflation, economic criterion and present worth.	**ANALYZE**	A
HM HU 701.3	**ANALYZE** cash flow, rate of return, cost ratio, and break even analysis.	**ANALYZE**	A
HM HU 701.4	**UNDERSTAND** depreciation, types of property, tax regulation and capital allowance.	**UNDERSTAND**	A
HM HU 701.5	**DESCRIBE** inflation, price change, types of index and use of price index.	**DESCRIBE**	U
HM HU 701.6	**UNDERSTAND** accounting, balance sheet, income statement, cost accounting, direct and Indirect cost.	**UNDERSTAND**	U

Course Articulation Matrix:

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l	PSO 1	PSO 2
CO1	1	2	2	2		2	2	1	1	1	3	2	1	3
CO2	1	2	2	2		2	2	1	1	1	3	2	1	3
CO3	1	2	2	2		2	2	1	1	1	3	2	1	3
CO4	1	2	2	2		2	2	1	1	1	3	2	1	3
CO5	1	2	2	2		2	2	1	1	1	3	2	1	3
CO6	1	2	2	2		2	2	1	1	1	3	2	1	3
Average	1.0	2.0	2.0	2.0		2.0	2.0	1.0	1.0	1.0	3.0	2.0	1.0	3.0

University Syllabus:

Module No.	Description of Topic	Contact Hrs.
1	Economic Decisions Making- Overview, Problems, Role, Decision making process.	**2**
2	Engineering Costs & Estimation- Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring and Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types of Estimate, Estimating Models - Per- Unit Model, Segmenting Model, Cost Indexes, Power- Sizing Model, Improvement & Learning Curve, Benefits.	**4**

3	Present Worth Analysis: End-of-Year Convention, Viewpoint of Economic Analysis Studies, Borrowed Money Viewpoint, Effect of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.	**4**
4	Cash Flow & Rate of Return Analysis- Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing an Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity and Break Even Analysis. Economic Analysis in the Public Sector- Quantifying and Valuing Benefits & drawbacks.	**4**
5	Depreciation- Basic Aspects, Deterioration & Obsolescence, Depreciation and Expenses, Types of Property, Depreciation Calculation Fundamentals, Depreciation and Capital Allowance Methods, StraightLine Depreciation Declining Balance Depreciation, Common Elements of Tax Regulations For Depreciation and Capital Allowances.	**4**
6	Inflation and Price Change- Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes in Engineering Economic Analysis, Cash Flows that inflate at different Rates.	**3**
7	Accounting- Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	**3**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Mechanical Engineering Laboratory III (Manufacturing)

Course Code: PC-ME791, Semester of Study: 7th

Course Type: Practical

Course Designation: Compulsory

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PC ME791.1	Perform Part Programming on CNC Lathe for Multi Stepped Shaft & Single Stepped Shaft with Round End.	Perform	P
PC ME791.2	Apply Part Programming on CNC Milling for Single Slot, Curve Slot and Square Loop.	Apply	P
PC ME791.3	Demonstrate various axes movement of vertically articulated robot arm.	Demonstrate	U
PC ME791.4	Determine cutting forces in turning by using Dynamometer	Determine	P
PC ME791.5	Conduct experiment in MMA welding and Examine dye penetration test for determination of welding joint defect.	Conduct	P
PC ME791.6	Determine fineness number, AFS clay content and permeability number of moulding sand.	Determine	P

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	2	2	2	2	3	1	2	1	1	1	1	2	3	2
CO2	2	2	2	2	3	1	2	1	1	1	1	2	3	2
CO3	2	2	2	2	3	1	2	1	1	1	1	2	3	1
CO4	2	2	3	2	1	1	1	1	1	1	1	2	2	1
CO5	2	2	3	2	1	1	2	1	1	1	1	2	2	1
CO6	2	2	3	2	1	1	1	1	1	1	1	2	2	1
Average	2.0	2.0	2.5	2.0	2.0	1.0	1.7	1.0	1.0	1.0	1.0	2.0	2.5	1.3

Course Contents (12 Experiments/ Problems/ Studies are to do):

1. Measurement of Cutting Force in Turning
2. Study of the effect of parametric variation in arc welding
3. Testing of moulding sand
4. Testing for Weld Quality
5. Study of and Solving problems on geometry of robot manipulator, actuators and grippers
6. Programming on CNC Lathe using G and M Codes
7. Programming on CNC Lathe using APT
8. Programming on CNC Milling Machine using G and M Codes
9. Programming on CNC Milling Machine using APT
10. Programming on CNC machine Simulator and to observe virtual machining
11. Robot Programming
12. Experiments on AJM/ USM/ WEDM/ EDM/ ECM/ LBM
13. Design and manufacture of products using Additive Manufacturing

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Project III Course Code: PWME 881

Semester of Study: 7th

Course Type: Sessional

Course Designation: Project

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PWME 781.1	Selecting topic of the project & Generating its objectives	Create	C
PWME 781.2	Practice finding relevant course material on the Internet and non-electronic sources	Create	C
PWME 781.3	Preparing work plan and Preliminary report	Create	C
PWME 781.4	Preparing presentation and explaining it to the audience	Create	C
PWME 781.5	Selecting topic of the project & Generating its objectives	Create	C

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PWME 781.1	3	3	3	3	3	3	3	3	3	3	3	3
PWME 781.2	3	3	3	3	3	3	3	3	3	3	3	3
PWME 781.3	3	3	3	3	3	3	3	3	3	3	3	3
PWME 781.4	3	3	3	3	3	3	3	3	3	3	3	3
PWME 781.5	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Analysis And Performance Of Fluid Machines **Course Code: PEME 801A**

Semester of Study: 8th

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PEME 801A.1	**UNDERSTAND** of the fluid properties and conservation laws in fluid machines	UNDERSTAND	U
PEME 801A.2	**ANALYSE** the dimensional analysis principle to design and select fluid machinery	ANALYSE	A
PEME 801A.3	**ILLUSTRATE** heads, losses and efficiencies for pumps, fans and turbines.	ANALYSE	A
PEME 801A.4	**EVALUATE** the Interaction between pumps and Turbines and systems in both series and parallel connections and the Performance characteristics of pumps and turbines.	EVALUATE	E
PEME 801A.5	**ASSESS** about Cavitation: NPSH, Thoma's cavitation parameter and suction specific speed also know to design hydraulic machine design.	EVALUATE	E
PEME 801A.6	**Apply** the principle of flow through special devices propellers and windmills and jet propulsion and to determine the parameters like work done, efficiency of propeller, jet propulsion etc.	APPLY	P

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEME801A.1	1	2	2	1	1	1	1	1	1	1	-	2
PEME801A.2	1	3	2	1	1	1	1	1	1	1	-	1
PEME801A.3	1	3	2	2	1	1	1	1	2	1	-	2
PEME801A.4	1	2	3	1	1	2	1	1	2	1	-	1
PEME801A.5	1	2	3	1	1	2	1	1	2	1	-	2
PEME801A.6	1	2	3	1	1	1	1	1	1	1	-	1
Average	1	2.3	2.5	1.2	1	1.3	1	1	1.5	1		1.5

Subject Code : A	**Category:** Professional Elective Courses
Subject Name : Analysis and Performance of Fluid Machines	**Semester**: Eighth
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Fluid Mechanics and Fluid Machinery	

Course Objective:

1. To know about the dimensional analysis for fluid machinery.
2. To learn about different heads, losses and efficiencies for pumps, fans and turbines.
3. To know about the Interaction of pumps and Turbines and systems.
4. To know about the Performance characteristics of pumps and turbines.
5. To learn about Cavitation: NPSH, Thoma's cavitation parameter and suction specific speed.
6. To know about the Analysis of flow through propellers and windmills and jet propulsion.

Course Content:

Module No.	Description of Topic Contact	Hrs.
1.	Dimensional analysis for fluid machinery: Dimensionless quantities and their use in design, selection and testing.	**3**
2.	Different heads, losses and efficiencies for pumps, fans and turbines.	**3**
3.	Interaction of pumps and Turbines and systems: Series and Parallel operation of Pumps, Performance and selection of Pumps for different systems characteristics, Surging in Pipelines.	**12**
4.	Performance characteristics: Pumps and Fans-Radial, Mixed flow and Axial flow. Turbines-Francis, Kaplan and Pelton wheel-operating characteristics and Muschel curves, Governing of Turbines.	**8**
5.	Cavitation: NPSH, Thoma's cavitation parameter and suction specific speed.	**4**
6.	Special Devices: Analysis of flow through propellers and windmills, Slipstream and actuator disc theory; Jet propulsion devices.	**6**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Power Plant Engineering Course Code: PEME 801B

Semester of Study: 8th

Course Type: Theory

Course Designation: Professional Elective

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PEME801B.1	**Analyze** the vapour power cycles and their modifications.	**Analyze**	A
PEME801B.2	**Understand** boilers & calculate its performance parameters.	**Understand**	U
PEME801B.3	**Analyze** the combustion phenomenon of fuels.	**Analyze**	A
PEME801B.4	**Determine** the performance parameters of steam nozzles and steam turbines.	**Determine**	P
PEME801B.5	**Illustrate** and **Design** the condensers and cooling towers.	**Design**	C
PEME801B.6	**Determine** power plant economic parameters and know about the Diesel and gas plants, pollution and its control.	**Determine**	P

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	2	3	2	1	1	1	1	1	2	1	1	2	2	3
CO2	2	3	2	1	2	2	2	2	2	1	2	2	2	3
CO3	2	3	2	1	1	1	1	1	2	1	1	2	2	3
CO4	2	3	2	1	2	1	1	1	2	1	2	2	2	3
CO5	2	3	3	1	2	2	2	2	2	1	2	2	2	3
CO6	2	3	2	1	1	2	2	2	2	1	2	2	2	3
Average	**2**	**3**	**2.16 6666 667**	**1**	**1.5**	**1.5**	**1.5**	**1.5**	**2**	**1**	**1.666 66666 7**	**2**	**2**	**3**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module	Description of topic	Contact Hrs
1	Analysis of Steam Cycles: Introduction to the course, Power plant layout and essential feature ofRankine cycle, Reheating and regeneration, Problems on Rankine Cycle, Combined cycle power generation, Binary vapour cycles.	**3**
2	Boilers: Definition, classification, fire tube and water tube boilers, mountingsand accessories. Draft in boilers, performanceof boiler - boilers efficiency,equivalent evaporation, Losses in boilers. Coal and combustion: Properties of coal, ultimate analysis and proximate analysis, combination calculation. Super heater, economizer andairpre heater. Handling of coal and ash.	**8**
3	Fuel bed firing, PF firing andFluidized bed boilers. Introduction to boiling and circulation in boilers. Power station boilers - Benson, Lamont. Supercritical boiler.	**4**
4	Steam turbine: i) parts and classification, ii) nozzles types, flow through nozzlesandnozzle efficiency. Impulse turbine - velocitydiagram, work done and blade efficiency.	**6**
5	Turbines: Pressure compounding and velocity compounding of steam turbine.Impulse reaction turbine - Velocity diagram,degree of reaction and Parsons turbine. Governingin Steam turbine.	**6**
6	Condensers: Direct ContactCondenser Surface Condensers, Effect of variousparameters on condenser performance, Design of condensers, cooling towers and cooling ponds.	**6**
7	Power plant economics and other issues:	**3**

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Maintenance Engineering **Course Code:** PE ME 802I

Semester of Study: 8th

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially. l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PE ME 802I.1	**UNDERSTAND** maintenance systems through condition monitoring; Maintainability, failure pattern, availability of equipment / systems and design for maintainability.	**UNDERSTAND**	U
PE ME 802I.2	**ANALYZE** the Total Productive Maintenance (TPM).	**ANALYZE**	A
PE ME 802I.3	**UNDERSTAND** the Organizational structures for maintenance.	**UNDERSTAND**	U
PE ME 802I.4	**ANALYZE** the Economic Aspect of Maintenance.	**ANALYZE**	
PE ME 802I.5	**UNDERSTAND** the Function and use of Maintenance Equipment.	**UNDERSTAND**	U
PE ME 802I.6	**UNDERSTAND** the lubrication, Repair & Maintenance Procedures	**UNDERSTAND**	U

Course Articulation Matrix:

	PO a	PO b	PO c	PO d	PO e	PO f	PO g	PO h	PO i	PO j	PO k	PO l	PSO 1	PSO 2
CO1	1	-	1	3	1	2	1	1	1	1	2	2	2	3
CO2	1	-	1	3	1	2	1	1	1	1	2	2	2	3
CO3	1	-	1	3	1	2	1	1	1	1	2	2	2	3
CO4	1	-	1	2	1	2	1	1	1	1	2	2	2	2
CO5	1	-	1	3	1	2	1	1	1	1	2	2	2	3
CO6	1	-	1	3	1	2	1	1	1	1	2	2	2	3
Average	1.0	-	1.0	3.0	1.0	2.0	1.0	1.0	1.0	1.0	2.0	2.0	2.0	3.0

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Module No.	Description of Topic	Contact Hrs.
1	**Introduction:** Definitions of repair and maintenance; Importance of maintenance; Different maintenance systems- breakdown, preventive, planned; predictive maintenance through condition monitoring; Maintainability, failure pattern, availability of equipment/ systems, design for maintainability.	5
2	**Total Productive Maintenance (TPM):** definition, objective & methodology; Implementation of TPM; Lean maintenance; Overall equipment effectiveness (OEE).	3
3	**Organizational structures for maintenance:** Objective; Maintenance functions and activities; Organizational requirements; Types of maintenance organizations, Manpower planning; Engineering stores & inventory management.	4
4	**Economic Aspect of Maintenance:** Life cycle costing; Maintenance cost & its impact; Maintenance budget; Cost control; Maintenance audit- Procedure, tools, planning, reports.	4
5	**Function and use of Maintenance Equipment, Instruments & Tools:** Facilities like NDT, painting, coating and cladding, Gas cutting and welding, crack detection, vibration monitor, balancing equipment, compressor, basic machine tools, lubricators and lubricants, chain pulley block, Tools like different types of wrenches, torque wrench, pipe wrench, plier, screw driver, dimension measuring instruments, feeler gauge, scraper, fitting shop tools, spirit level, hand grinder & drill, screw jack, etc.	6
6	**Lubrication:** Purpose & importance; Type of lubricants, Properties of lubricants; Types of lubrication and their typical applications, lubrication devices, centralized lubrication system; Gasket, packing and seals.	4
7	**Repair & Maintenance Procedures:** Repair of cracks, threads, worn shafts, keyways, bush bearing, damaged gear tooth. Assembly and dismantling of antifriction bearing; Maintenance of bearing, clutches, coupling, brakes, Alignment of shafts, belt and chain drives, gear drives, centrifugal pump, pipe and pipe fittings, electrical wiring, isolators and main switches, small induction motors; Steps for installation of a machine.	10

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: 3D Printing and Design **Course Code: PE-ME802F**

Semester of Study: 8th

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

Engineering Graduates will be able to:

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PE-ME802F.1	**Understand** the working principles and process parameters of additive manufacturing processes.	Understand	U
PE-ME802F.2	**Describe** the CAD and data format for 3D printing purpose.	Describe	R
PE-ME802F.3	**Analyze** materials suitable for 3D printing.	Analyze	A
PE-ME802F.4	**Illustrate** additive manufacturing equipments.	Illustrate	P
PE-ME802F.5	**Identify** suitable post processing operation based on product repair requirement	Identify	P
PE-ME802F.6	**Describe** the quality of 3D printed products.	Describe	A

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	3	2	2	1	1	1	1	1	1	2	2	3
CO2	2	2	2	2	3	1	2	1	2	2	1	1	2	3
CO3	2	2	2	2	2	3	2	1	1	1	2	3	2	3
CO4	2	2	2	3	2	2	2	1	1	1	1	2	2	3
CO5	2	2	2	3	2	2	2	1	1	1	1	2	2	3
CO6	2	2	2	2	2	2	3	2	2	1	1	2	2	3
Average	2.0	1.8	2.2	2.3	2.2	1.8	2.0	1.2	1.3	1.2	1.2	2.0	2.0	3.0

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

University Syllabus:

Module	Description of Topic	Contact Hrs.
1	3D Printing (Additive Manufacturing): Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.	**2**
2	CAD for Additive Manufacturing: CAD Data formats, Data translation, Data loss, STL format	**3**
3	Additive Manufacturing Techniques: 3.1 Stereo-Lithography, LOM, FDM, SLS, SLM, Binder Jet technology. 3.2 Process, Process parameter, Process Selection for various applications. 3.3 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools	**10**
4	Materials: 4.1 Polymers, Metals, Non-Metals, Ceramics 4.2 Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties. 4.3 Support Materials	**7**
5	Additive Manufacturing Equipment: 5.1 Process Equipment- Design and process parameters 5.2 Governing Bonding Mechanism 5.3 Common faults and troubleshooting 5.4 Process Design	**8**
6	Post Processing: Requirement and Techniques	**3**
7	Product Quality: 7.1 Inspection and testing 7.2 Defects and their causes	**3**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Industrial Pollution and Control Course Code: OEME 801D

Semester of Study: 8th

Course Type: Theory

Course Designation: Open Elective

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
OEME801D.1	**Describe** types of pollution caused by the industries and their effects on the environment	Describe	U
OEME801D.2	**Explain** the physical effects, sampling method of air pollution	Explain	U
OEME801D.3	**Discuss** the processes and control techniques of air pollution	**Discuss**	U
OEME801D.4	**Demonstrate** the causes, processes and control techniques of water pollution	**Demonstrate**	P
OEME801D.5	**Learn** the physics of sound generation, transmission and physical characteristics of noise	**Learn**	U
OEME801D.6	**Illustrate** measuring instruments, assesment processes and techniques to control the noise pollution	**Illustrate**	P

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	1	1	2	2	-	-	3	1	1	1	-	1	3	2
CO2	1	1	2	2	-	-	3	1	1	1	-	1	3	2
CO3	1	1	2	2	-	-	3	1	1	1	-	1	3	2
CO4	1	1	2	2	-	-	3	1	1	1	-	1	3	2
CO5	1	1	2	2	-	-	3	1	1	1	-	1	3	2
CO6	1	1	2	2	-	-	3	1	1	1	-	1	3	2
Average	1	1	2	2	0	0	3	1	1	1	0	1	3	2

University Syllabus:

Module	Description of topic	Contact Hrs
1	Introduction; classification ofpollution; effects of pollution onhuman beings, plants andanimals.	**8**
2	Air pollution: physicaleffects; atmospheric dispersion and diffusion;	**10**

	method of sampling and analysis; modeling technique; practical controlof air pollution and abatement.	
3	Water pollution: water quality parameters; dispersion and diffusionof pollutants in water;control and abatement of waterpollution.	**9**
4	Noise pollution: physics of sound generation and transmission;physical charactersof noise; physiological effects of noise; measuring instrumentsand technique; assessment of noise; noise control principle, practice and laws.	**9**

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Waste to Energy: An Overview, Course Code: OEME801F

Semester of Study: 8TH

Course Type: Theory

Course Designation: Elective

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in
mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
OE ME801F.1	**Understand** the types of bio-wastes like Agro based, Forest residue, Industrial waste, Municipal Solid Wastes.	Describe	U
OE ME801F.2	**Classify** the biomass resources and biomass conversion devices.	Classify	A
OE ME801F.3	**Describe** about biomass pyrolysis, the products and by-products.	Describe	U
OE ME801F.4	**Illustrate** gasification and, gasifiers & its construction and operation.	Illustrate	P
OE ME801F.5	**Analyze** the biomass combustion and combustors.	Analyze	A
OE ME801F.6	**Analyze** biogas plants and their productions.	Analyze	A

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1	1	**3**	1	2	1	1	2
CO2	2	2	2	2	2	2	**3**	2	2	1	2	2
CO3	2	2	2	2	1	1	**3**	1	2	1	1	2
CO4	2	2	2	2	2	1	**3**	1	2	1	2	2
CO5	2	2	3	2	2	2	**3**	2	2	1	2	2
CO6	2	2	2	2	1	2	**3**	2	2	1	2	2
Average	2	2	2	2	1.5	1.5	3	1.5	2	1	1.66	2

Module No.	Description of the Topic	Contact Hrs
1	Introduction to Energy from Waste: Classification of waste as fuel– Agro based, Forest residue, Industrial waste- MSW– conversion devices– Incinerators, gasifiers, digesters	6
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gasses, yields and applications	5
3	Biomass Gasification: Gasifiers– Fixed bed system– Downdraft and updraft gasifiers– Fluidized bed gasifiers– Design, construction and operation	5
4	Biomass Combustion: Biomass stoves– Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors.	4
5	Biogas: Properties of biogas (Calorific value and composition)- Biogas plant technology and status– Bio energy system- Design and constructional features- Biomass resources and their classification– Biomass conversion processes- Thermo chemical conversion- Direct combustion- biomass gasification- pyrolysis and liquefaction- biochemical conversion- anaerobic digestion– Types of biogas Plants.	10

Maulana Abul Kalam Azad University of Technology, West Bengal

(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: **Data Sciences** **Course Code: OE-ME802L**

Semester of Study: 8th

Course Type: Theory

Course Designation: Open Elective

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Vision of the M. E. Department

To produce professionally competent engineers to cater to the needs of the industry, society and nation.

Mission of the M. E. Department

To provide excellent opportunity for producing professionally competent engineers with the sense of social and moral responsibility by creating value added teaching and motivation for research.

PEO-1: To provide conducive learning environment and quality technical education emphasizing the mathematics and science fundamentals related to mechanical engineering program to achieve professional excellence.

PEO-2: Graduates should prepare themselves for carrying out higher studies and quality technological research & development skills to keep pace with the current technological trends throughout the career, either in industry or in entrepreneurship and ready to take leadership & capable of working as a member of multi discipline team.

PEO-3: To foster a sense of responsibility, professionalism, team work and ethical values by developing skills in, management and allied studies through well balanced courses which will help to develop a symbiotic relationship between the institution, society and the community.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

(A) PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

(a) **Engineering Knowledge:** Graduate will possess strong **fundamental knowledge** on applied mathematics, applied sciences and foundational Engineering concept for application in discipline.

(b) **Problem Analysis:** Graduate will develop confidence and will be able to **design** and conduct experiment on it as well as to **analyze** the problem and interpret data.

(c) **Design/Development of solutions:** Graduate will have the ability to design components, **fluid** & **thermal** systems ,**manufacturing** processes and **conduct testing experiment** on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

(d) **Investigation of Complex problems:** Graduate will possess fundamental knowledge and will have the ability to investigate **complex problems** with **multidisciplinary team** effort.

(e) **Modern Tool Usage:** Graduate will possess knowledge of using **Modern tools** e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO 2.0 & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

(f) **The Engineer and Society:** Graduate will be able to provide engineering solution, design solution which are society friendly and in this context graduates will also be able to analyze the local and **global impact** of Engineering on **society**.

(g) **Environment and Sustainability:** Graduates will be able to develop an **environment friendly and cost effective** new system and also have serious concern for the society.

(h) **Ethics:** Graduate will learn the ability to understand the **professional and ethical responsibility**.

(i) **Team Work:** Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

(j) **Communication:** Graduate will be able to **communicate** effectively in both verbal and in the written form.

(k) **Project Management and Finance:** Graduate will possess **managerial skills** and also

have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

(l) **Life-Long Learning:** Graduate will develop confidence for self and have the ability to engage in **life-long learning**.

(B) PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

2. Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	**Details/Statement**	**Action Verb/Bloom's Level**	**Knowledge Category/Level**
After completion of this course the students will			
PE ME602G.1	Students will **Gain knowledge** in Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting.	R (Remember)	C
PE ME602G.2	*learn* the use of programming tools and be able to *visualize* data and be able to work with data, and they will ***understand*** the mathematical foundations.	U (Understand)	C, FD
PE ME602G.3	be able to ***apply*** different machine learning algorithms and find out applications with different case studies.	P (Apply)	CS PC
PE ME602G.4	be able to ***analyze*** and *interpret* the efficiency, accuracy of different algorithms.	A (Analyze)	P
PE ME602G.5	be able to ***evaluate*** the performance of different algorithms, and also *evaluate* results of various problems related to statistics, probability and other correlated mathematical problems.	E (Evaluate)	P
PE ME602G.6	be able to ***create*** various neural networks, decision trees, support vector models, Baysian models, Logistic regression and others for solution to various problems.	C (create)	P

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	2	3	2	1	1	1	1		1	3	2
CO2	1	1	1	2	3	2	1	1	1	1		1	3	2
CO3	1	1	1	2	3	2	1	1	1	1		1	3	2
CO4	1	2	2	3	3	2	1	1	1	1		1	3	2
CO5	1	2	2	3	3	2	1	1	1	1		1	3	2
CO6	1	2	2	3	3	2	1	1	1	1		1	3	2
Average	3	2	2	2.5	3	2	1	1	1	1		1	3	2

University Syllabus:

Subject Code : L (OE-ME802L)	**Category:** Open Elective Courses
Subject Name : Data Sciences	**Semester :** Eighth
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Introduction to Programming, Probability	

Course Objective:

The objective of this course is to impart necessary knowledge of the mathematical foundations
needed for data science and develop programming skills required to build data science applications.

Course Content:

Module No.	Description of Topic	Contact Hrs.	Co Mapping
1	**Introduction to Data Science:** Concept of Data Science, Traits of Big data, Web Scraping, Analysis vs Reporting.	3	CO2
2	**Introduction to Programming Tools for Data Science**: 2.1 Toolkits using Python: Matplotlib, NumPy, Scikit-learn, NLTK 2.2 Visualizing Data: Bar Charts, Line Charts, Scatter plots 2.3 Working with data: Reading Files, Scraping the Web, Using APIs (Example: Using the Twitter APIs), Cleaning and Munging, Manipulating Data, Rescaling, Dimensionality Reduction.	5	CO3
3	**Mathematical Foundations:**	10	CO2

	3.1 Linear Algebra: Vectors, Matrices, 3.2 Statistics: Describing a Single Set of Data, Correlation, Simpson's Paradox, Correlation and Causation 3.3 Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Random Variables, Continuous Distributions, The Normal Distribution, The Central Limit Theorem 3.4 Hypothesis and Inference: Statistical Hypothesis Testing, Confidence Intervals, P- hacking, Bayesian Inference		
4	**Machine Learning:** Overview of Machine learning concepts– Over fitting and train/test splits, Types of Machine learning– Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks - Learning and Generalization, Overview of Deep Learning.	12	CO1, CO2, CO3, CO4, CO5, CO6
5	**Case Studies of Data Science Application:** Weather forecasting, Stock market prediction, Object recognition, Real Time Sentiment Analysis.	4	CO5, CO4, CO5, CO6

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: **Automation and Control** **Course Code: OE-ME802G**

Semester of Study: 8th

Course Type: Theory

Course Designation: Open Elective

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Vision of the M. E. Department

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PEO-3: To foster a sense of responsibility, professionalism, team work and ethical values by developing skills in, management and allied studies through well balanced courses which will help to develop a symbiotic relationship between the institution, society and the community.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

(A) PROGRAM OUTCOMES (POs)

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(c) **Design/Development of solutions:** Graduate will have the ability to design components, **fluid** & **thermal** systems ,**manufacturing** processes and **conduct testing experiment** on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

(d) **Investigation of Complex problems:** Graduate will possess fundamental knowledge and will have the ability to investigate **complex problems** with **multidisciplinary team** effort.

(e) **Modern Tool Usage:** Graduate will possess knowledge of using **Modern tools** e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO 2.0 & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

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(B) PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

2. Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	**Details/Statement**	**Action Verb/Bloom's Level**	**Knowledge Category/Level**
After completion of this course the students will			
PE ME602G.1	Gain the *knowledge* for definition and classification of control systems, *recall* the foundational mathematics, and *remember* masons gain formula and stability criteria.	R (Remember)	C
PE ME602G.2	Be able to understand the theory of control systems, mathematical modeling and behavior of the system in time domain and frequency domain.	U (Understand)	C, FD
PE ME602G.3	Be able to *apply* their knowledge for solving problems related to control engineering.	P (Apply)	CS PC
PE ME602G.4	Be able to *analyze* control system in time-domain and frequency domain and also analyze performance of control systems.	A (Analyze)	P
PE ME602G.5	Be able to *evaluate* the performance and parameters of control systems, steady sate error etc.	E (Evaluate)	P
PE ME602G.6	Be able to *design* and *create* control system using the acquired knowledge of time-domain, frequency domain, Bode plot, Nyquist plot etc.	C (create)	P

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	3	1	1	1	1	1	1		2	3	2
CO2	1	1	1	3	1	1	1	1	1	1		2	3	2
CO3	1	1	1	3	1	1	1	1	1	1		2	3	2
CO4	1	1	1	3	1	1	1	1	1	1		2	3	2
CO5	1	1	1	3	1	1	1	1	1	1		2	3	2
CO6	1	1	1	3	2	1	1	1	1	1		2	3	2
Average	1	1	1	3	1.17	1	1	1	1	1		2	3	2

University Syllabus:

Subject Code : G	**Category:** Open Elective Courses
Subject Name : Automation and Control	**Semester :** Eighth
L-T-P : 3-0-0	**Credit:** 3
Pre-Requisites: Basic Electronics Engineering, Mathematics	

Course Objective:

To know about various types of control systems used in different industries.

To learn about mathematical representation and analysis of control systems.

Course Content:

Module No.	Description of Topic	CO Mapping	Contact Hrs.
1	**Introduction to control system:** Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servo mechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function. **Mathematical modeling of dynamic systems:** Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. **Control system components:** Potentiometer, Synchros, Resolvers, Position encoders.	CO1 CO2	8
2	**Time domain analysis:** Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise	CO3, CO4	8

	time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications. **Error Analysis:** Steady state errors in control systems due to step, ramp and parabolic inputs. Concepts of system types and error constants.		
3	**State variable Analysis:** State variable model of Linear Time invariant system, properties of the State transition matrix, State transition equation, Definition of transfer function & Characteristic equation, definition of controllability and observability.	CO3	8
4	**Stability Analysis using root locus:** Importance of Root locus techniques, construction of Root Loci for simple systems. Effects of gain on the movement of Pole and Zeros. **Frequency domain analysis of linear system:** Bode plots, Polar plots, Nichols chart, Concept of resonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase and gain margin. Determination of margins in Bode plot. Nichols chart. M circle and M-Contours in Nichols chart	CO3, CO5, CO6	12
5	**Control System performance measure:** Improvement of system performance through compensation. Lead, Lag and Lead-lag compensation, PI, PD and PID control.	CO5, CO6	4

Learning Resources:

1. K. Ogata, Modern Control Engineering, 4th Edition, Pearson Education, 2010.
2. I.J. Nagrath and M. Gopal, Control System Engineering, New Age International, 2009.
3. D. Roy Choudhury, Control System Engineering, PHI, 2005.
4. B.C. Kuo and F. Golnaraghi, Automatic Control Systems, 8th Edition, PHI, 2014.
5. M.N. Bandyopadhyay, Control Engineering Theory & Practice, PHI, 2002.
6. K.R. Varmah, Control Systems, Mc Graw Hill, 2010.
7. Norman Nise, Control System Engineering, 5th Edition, John Wiley & Sons, 2010.
8. R.C. Dorf and R.H. Bishop, Modern Control System, 11th Edition, Pearson Education, 2011.
9. C.G. Graham, F. Graebe, F. Stefan, S.E. Mario, Control System Design, PHI, 2009.
10. N.F. Macia and G.J. Thaler, Modeling & Control of Dynamic System, Thompson, 2004.

11. C.T. Kilian, Modern Control Technology Components & Systems, 3rd Edition, Cengage Learning, 2005.
12. Y. Singh and S. Janardhanan, Modern Control Engineering, Cengage Learning, 2010.
13. R. Anandanatarajan and R. Ramesh Babu, Control System Engineering, Scitech, 2015.
14. W.A. Wolovich, Automatic Control system, Oxford University Press, 1995.

Maulana Abul Kalam Azad University of Technology, West Bengal

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Project-IV **Course Code: PWME 881**

Semester of Study: 8th

Course Type: Sessional

Course Designation: Project

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Program Outcome (PO):

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project Management and Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PWME 881.1	**DEMONSTRATING** qualitative solutions to research/industry problems involving contemporary issyes.	Create	C
PWME 881.2	**FORMULATING** hypothesis/design/methodology	Create	C
PWME 881.3	**ACQUIRING** the knowledge of the techniques, skills, and modern engineering tools necessary for Mechanical Engineering practice	Create	C
PWME 881.4	**PRESENTING** features of the developed project to the targeted group through written and oral communication.	Create	C
PWME 881.5	**CONTRIBUTING** in a team in development of technical seminar.	Create	C

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PWME 881.1	3	3	3	3	3	3	3	3	3	3	3	3
PWME 881.2	3	3	3	3	3	3	3	3	3	3	3	3
PWME 881.3	3	3	3	3	3	3	3	3	3	3	3	3
PWME 881.4	3	3	3	3	3	3	3	3	3	3	3	3
PWME 881.5	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Course Name: Comprehensive Viva-Voce, Course Code: PW-ME882
Semester of Study: 8th Course Type: Sessional
Course Designation: Compulsory

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Program Outcome (PO):

a. Graduate will posses strong fundamental knowledge on applied mathematics, applied sciences, and fundamental engineering concept for application in discipline.

b. Graduate will develop confidence and will be able to design and conduct experiment on it as well as to analyze the problem and interpret data.

c. Graduate will have the ability to design components, fluid & thermal systems, manufacturing processes and conduct testing experiment on it and interpret data for its development to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety.

d. Graduate will posses fundamental knowledge and will have the ability to investigate complex problems with multidisciplinary team effort.

e. Graduate will posses knowledge of using Modern tools e.g. CAD/CAM and other Mechanical Engineering software like Inventor, Auto-CAD, CREO & ANSYS and have the ability to apply their knowledge from these for the solution of Mechanical Engineering problems.

f. Graduate will be able to provide engineering solution, design solution which is society friendly and in this context graduates will also be able to analyze the local and global impact of Engineering on society.

g. Graduate will be able to develop an environment friendly and cost effective new system and also have serious concern for the society.

h. Graduate will learn the ability to understand the professional and ethical responsibility.

i. Graduate will learn the ability to function individually and on multidisciplinary teams to solve complex Engineering problems by mutually sharing the knowledge with other team members.

j. Graduate will be able to communicate effectively in both verbal and in the written form.

k. Graduate will posses managerial skills and also have the knowledge of contemporary issues and will be able to perform in a project team. Graduate will gather the ability to calculate average cost of component, system and are capable of handling the project financially.

l. Graduate will develop confidence for self and have the ability to engage in lifelong learning.

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Syllabus for B. Tech in Mechanical Engineering

(Applicable from the academic session 2023-2024)

Program Specific Outcome (PSO):

PSO1: Graduates will demonstrate the knowledge of applied mathematics and advanced software tools for design specification, development such as fabrication, analysis such as testing and operation of the physical systems, components and processes involved in mechanical engineering.

PSO2: Graduates will demonstrate the knowledge, skill and attitude to analyze the cause and effects on machine elements, processes and systems.

Course Outcome:

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
PW-ME882.1	Demonstrate systematic understanding of knowledge related to 4 years study of B. Tech. in ME	Demonstrate	U
PW-ME882.2	Apply critical thinking skills to analyze and evaluate complex engineering problems.	Apply	P
PW-ME882.3	Demonstrate effective communication skills in presenting technical concepts and ideas to both technical and non-technical audiences.	Demonstrate	U
PW-ME882.4	Demonstrate confidence and versatility in answering the varieties of questions posed by a group of interviewer in a moderately short duration.	Demonstrate	U

Course Articulation Matrix:

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

University Syllabus:

The Comprehensive Viva-Voce will be conducted by a Committee consisting of Head of the Department and all Faculty members of the department. The Comprehensive Viva-Voce is intended to assess the student's understanding of the courses he/ she studied during the 4 years B. Tech. programme.