COURES STRUCTURE & SYLLABUS

FOR

B. TECH. MECHANICAL

SEMESTER- III & IV

(CBCS 2023 COURSE AS PER NEP 2020 GUIDELINES)

Bharati Vidyapeeth

(Deemed to be University)

College of Engineering, Pune

Department of Mechanical Engineering

Vision of the Bharati Vidyapeeth (Deemed to be University) College of Engineering is:

To be a World Class Institute for Social Transformation through Dynamic Education

Missions of the Bharati Vidyapeeth (Deemed to be University) College of Engineering are:

- *To provide quality technical education with advanced equipment, qualified faculty members, and infrastructure to meet the needs of the profession & society.*
- *To provide an environment conducive to innovation, creativity, research, and entrepreneurial leadership.*
- *To practice and promote professional ethics, transparency, and accountability for the social community, economic & environmental conditions.*

Goals of the Bharati Vidyapeeth (Deemed to be) University College of Engineering are:

- *Recruiting experienced faculty.*
- *Organizing faculty development programs.*
- *Identifying socio-economically relevant areas & emerging technologies.*
- *Constant review & upgradation of curricula.*
- *Upgradation of laboratories, library & communication facilities.*
- *Collaboration with industry and research & development organizations.*
- *Sharing of knowledge, infrastructure, and resources.*
- *Training, extension, testing, and consultancy services.*
- *Promoting interdisciplinary research.*

The vision of the Mechanical Engineering Department is:

To develop high-quality Mechanical Engineers through dynamic education to meet social and global challenges.

Mission Statements of the Mechanical Engineering Department are:

- *To provide extensive theoretical and practical knowledge to the students with well-equipped laboratories and ICT tools through motivated faculty members.*
- *To inculcate aptitude for research, innovation, and entrepreneurial qualities in students.*
- *To acquaint students with ethical, social, and professional responsibilities to adapt to the demands of the working environment.*

Program Educational Objectives (PEOs) of the B. Tech. Mechanical are:

Graduates will be able,

- *To fulfill the needs of industry and society with theoretical and practical knowledge.*
- *To engage in research, innovation, lifelong learning, and continued professional development.*
- *To fulfill professional ethics and social responsibilities.*

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually based mathematics, numerical analysis, data analysis, statistics, and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas of the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior, and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability, etc., with mutual understanding and respect, and of inclusive attitudes.

PROGRAM OUTCOMES

PO1: Engineering Knowledge: *Apply knowledge of mathematics, natural science, computing, engineering fundamentals, and an engineering specialization as specified in WK1 to WK4, respectively, to develop solutions to complex engineering problems.*

PO2: Problem Analysis: *Identify, formulate, review research literature, and analyze complex engineering problems, reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)*

PO3: Design/Development of Solutions: *Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for public health and safety, whole-life cost, net zero carbon, culture, society, and environment as required. (WK5)*

PO4: Conduct Investigations of Complex Problems: *Conduct investigations of complex engineering problems using research-based knowledge, including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).*

PO5: Engineering Tool Usage: *Create, select, and apply appropriate techniques, resources, and modern engineering & IT tools, including prediction and modelling, recognizing their limitations to solve complex engineering problems. (WK2 and WK6)*

PO6: The Engineer and The World: *Analyze and evaluate societal and environmental aspects while solving complex engineering problems for their impact on sustainability with reference to economy, health, safety, legal framework, culture, and environment. (WK1, WK5, and WK7).*

PO7: Ethics: *Apply ethical principles and commit to professional ethics, human values, diversity, and inclusion; adhere to national & international laws. (WK9)*

PO8: Individual and Collaborative Team work: *Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.*

PO9: Communication: *Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, making effective presentations considering cultural, language, and learning differences*

PO10: Project Management and Finance: *Apply knowledge and understanding of engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.*

PO11: Life-Long Learning: *Recognize the need for and have the preparation and ability for i) independent and life-long learning, ii) adaptability to new and emerging technologies, and iii) critical thinking in the broadest context of technological change. (WK8)*

Statements of Program Specific Outcomes (PSOs)

PSO1: Use the knowledge of thermal, design, manufacturing engineering, and computational sciences to solve Mechanical Engineering problems.

PSO2: Use Mechanical Engineering principles for research, innovation, and develop entrepreneurial skills.

B. Tech. (Mechanical Engineering): Semester–III (CBCS 2023 Course as per NEP 2020 Guidelines)

Sr. No	Category	Subject Code	Subject	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
				L	P	T	ESE	IA	TW	PR	OR	Total	TH	Pr/ Or	Tut	Total
1.	MJ	MJ1111301	Manufacturing Technology	3	2	0	60	40	25	25	-	150	3	1	-	4
2.	MJ	MJ1111302	Mechanics of Fluids	3	2	1	60	40	25	25	-	150	3	1	1	5
3.	MJ	MJ1111303	Thermodynamics-Principles	3	0	0	60	40	-	-	-	100	3	0	0	3
4.	MJ	MJ1111304	Strength of the Machine Components	3	0	0	60	40	-	-	-	100	3	0	0	3
5.	MJ	MJ1111305	Mechanisms of Machines#	3	2	0	60	40	25	-	25	150	3	1	0	4
6.	SE	SE1111306	Skill-Based Course-III Programming in Python	0	2	0	-	-	25	25	-	50	0	1	0	1
			Total	**15**	**8**	**1**	**300**	**200**	**100**	**75**	**25**	**700**	**15**	**4**	**1**	**20**
7.	*MOOC	AE1111307	MOOC-I	-	-	-	-	-	-	-	-	-	-	-	-	2
8.	*VA	VA1111308	Value Added Course-I: Computer-Aided Drafting	2	-	-	-	100	-	-	-	100	2	-	-	2

#: Course with theory paper of 4 hrs.; * Mandatory Additional Courses

B. Tech. (Mechanical Engineering): Semester–IV (CBCS 2023 Course as per NEP 2020 Guidelines)

Sr. No	Category	Subject Code	Subject	Teaching Scheme			Examination Scheme-Marks						Credits			
				L	P	T	ESE	IA	TW	PR	OR	Total	TH	Pr/ Or	Tut	Total
1.	MJ	MJ1111401	Science of Engineering Materials	3	2	0	60	40	25	-	25	150	3	1	0	4
2.	MJ	MJ1111402	Theory of Machines	3	0	1	60	40	-	-	-	100	3	0	1	4
3.	MJ	MJ1111403	Thermodynamics-Applications	3	2	-	60	40	25	-	25	150	3	1	0	4
4.	MJ	MJ1111404	Hybrid Electric Vehicles	3	-	-	60	40	-	-	-	100	3	0	0	3
5.	MJ	MJ1111405	Machine Design & Analysis-I#	3	2	-	60	40	25	-	25	150	3	1	0	4
6.	SE	SE1111406	Skill-Based Course-IV Solid Modeling	-	2	-	-	-	25	25	-	50	0	1	0	1
			Total	**15**	**8**	**1**	**300**	**200**	**100**	**25**	**75**	**700**	**15**	**4**	**1**	**20**
7.	*AC	AC1113407	Indian Knowledge System	2	-	-	-	50	-	-	-	50	2	-	-	2
8.	*EC	EC1111408	Social Activity	-	-	-	-	-	-	-	-	-	-	-	-	2

Course Codes and Definitions

Course Code	Definitions
AC	Audit Course
AE	Ability Enhancement Course
BC	Basic Chemistry Course
BM	Basic Mathematics Course
BP	Basic Physics Course
CC	Co-curricular Courses
EC	Extra-Curricular Course
EE	Electrical Engineering
ES	Engineering Science Course
SEE	Semester End Examination
GE	General Elective Course
ID	Inter-disciplinary Course
L	Lecture
MD	Multidisciplinary Course
MI	Minor Course
MJ	Major (Core) Course
MOOC	Massive Open Online Course
O	Oral
OE	Open Elective Course
P	Practical
PC	Practical Courses
PE	Programme Elective Courses
RP	Research I Project Course
SE	Skill Enhancement Course
T	Tutorial
TW	Term Work
UH	Course Related to Universal Human Values
VAC	Value Added Course
VE	Vocational Enhancement Course
VS	Vocational Skill Courses

Programme Code:

Commencement/ Revised Year	Faculty Code (Engg. & Tech.)	Programme Type (UG)	Programme Number (Mech.)	Programme Code
23	11	2	11	2311211

Course Code:

Type of Course	Faculty Code	Programme Number	Sem/Year	Course Number	Course Code
MJ	11	11	3	01	MJ1111301

Designation of Course	Manufacturing Technology (Course Code: MJ1111301)		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:-03Hours/Week	Semester-End Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work and Practical	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites:	The student should have basic knowledge of 1. Mechanical Engineering Systems. 2. Machining Processes.
Course Objectives:	The student should 1. To acquire knowledge of Foundry Technology. 2. To acquire knowledge of hot working and cold working processes. 3. To acquire the knowledge of lathe, drilling, milling, and abrasive machining.
Course Outcomes:	The students should be able to– 1. Explain the principles of pattern making and mold making and demonstrate their application in casting preparation. 2. Differentiate among various casting processes and select the most appropriate process for a given product. 3. Compare hot working and cold working processes and apply suitable deformation processes for specific manufacturing requirements. 4. Identify different operations on a lathe machine and perform machining operations to produce the required component. 5. Interpret the operations on drilling and milling machines and execute them to manufacture the desired job profile. 6. Classify various grinding and plastic molding machines and apply appropriate processes to produce components of the required geometry.

Course Contents

Unit-I	**Pattern and Mould Making**	**(06 Hrs.)**
Introduction to casting, Foundry Layout, Foundry departments and sections, Pattern and pattern making, Design and allowances for patterns, Color codes for patterns, Storage of patterns. Mouldings and core sands, Sand control Test, Core and core making–Introduction, Core making Procedure, Types of cores, Core print, Core boxes. Mould and mould making- Moulding Methods, Moulding processes, Design of Gating System.		
Unit-II	**Sand Casting and Die Casting Practice**	**(06 Hrs.)**
Sand Casting Practice: Melting furnaces and their selection, Cupola furnace, Induction melting furnaces, Advantages, Limitations, applications, pouring practice and equipment, Ladle technology, Strike out, Fettling, Cleaning and Surface preparation of castings, Defects in castings. **Die Casting Practice:** Pressure and gravity die casting, Shell mold casting, Investment casting, Continuous casting, centrifugal casting, Applications, Merits, and limitations.		
Unit-III	**Hot and Cold Working Processes**	**(06 Hrs.)**
Hot Working Processes: Principle-rolling, forging-drops, press, upset. Rolling, forging-extrusion, drawing, spinning, Angle of Contact of rolling, effect of hot working. **Cold Working Processes:** Cold rolling, swaging, forges extrusion-forward back ward impact. Roll forging, tube drawing, wire drawing, spinning, shot peening, high-energy rate forming, and Stresses in wire drawing operations		

Unit-IV	**Theory of Metal Cutting**	**(06 Hrs.)**
Introduction, function, types, construction, accessories, operations, thread cutting, single and multi-start thread cutting, different tools, tool materials, Tool Geometry- Single Point cutting tool, Tool Wear and Tool Life, Mechanics of Metal cutting-Merchant's Circle Diagram, concept of speed, feed, depth of cut. Introduction to Boring Machines- general arrangement and nature of work done.		

Unit-V	**Drilling and Milling Machines**	**(06 Hrs.)**
Drilling Machines: Fundamentals of the drilling process, twist drill geometry, tool holders, Types of drilling machines, and drilling operations. Types of drills, reaming process. **Milling Machines:** Fundamentals of the milling process, cutter types and geometry, Operations performed on milling machines. Dividing head, methods of indexing.		
Unit-VI	**Abrasive Machining Processes, Plastics & Plastic Moulding**	**(06 Hrs.)**
Abrasive Machining Processes: Abrasive machining, abrasives -types, size, and geometry, Grinding, grinding wheels, wheel marking, wheel selection. Wheel mounting. Types of grinding machines, grinding faults, Honing, lapping, super finishing, buffing, and burnishing process. **Plastics & Plastic Moulding:** Moulding characteristics of plastic, Moulding process- compression, transfer, and injection blow moulding. Mould design- Materials and construction, bulk factor, shrinkage, Moulding parameters, moulding machines, extruders.		

List of Experiments: (Any Eight)

1. Moulding and core sand testing (Clay content test, moisture content test, etc).
2. Strength of Green sand mould and green sand core.
3. Mold Making Practice.
4. Job on drilling, reaming, and tapping.
5. Casting of the component by using green sand molding / die casting.
6. Individual job at the center Lathe.
7. Study of the dividing indexing mechanism on the milling machine.
8. Gear cutting job on the Milling Machine.
9. Study and demonstration of Grinding Machines.
10. Job on the Grinding Machine.
11. Job on Plastic Molding Machine.

Text Books:

1. O. P. Khanna, A textbook of Foundry Technology, Dhanpat Rai and Sons
2. P. C. Sharma, Production Engineering, S. Chand Publications
3. R. K. Jain, Production Technology, Khanna Publishers

Reference Book

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw-Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technology, Vol-II, McGraw-Hill Education (India) Private Limited
3. G. R. Nagpal, Tool Engineering and Design, Khanna Publishers
4. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai &Co.
5. Hajra Chaudhari, Workshop Technology, Vol.-II
6. Roy A. Lindberg, Process &Materials of Manufacture, PHI
7. E. P. DeGrmo, J. T. Blackand A. Kosher, Material and Process in Manufacturing, PHI

8. HMT Handbook, Production Technology, TMH

Project-Based Learning:

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1 To develop a pattern of any component using different types of material.
2 To develop a core part by using different types of materials.
3 To develop a demonstration model of a gating system for any mechanical component.
4 To develop a demonstration model of the Cupola furnace
5 To develop a demonstration model of pouring equipment.
6 To prepare a flow chart for the investment casting process
7 To develop a demonstration model of centrifugal casting
8 To develop a demonstration model of the wire drawing process
9 To develop a demonstration model of a mechanical press
10 To develop a demonstration model of the short penning process
11 To develop a demonstration model of different types of rolling mills
12 Case study on different types of tools for thread cutting operations
13 To prepare a chart on the concept of single-point cutting tools& their geometry
14 To develop a demonstration model of a mini bench tapping machine
15 To develop a demonstration model of milling mechanisms for vertical/horizontal movement
16 To develop a demonstration model of the indexing mechanism
17 To develop a demonstration model of a plastic molding machine
19 To develop a demonstration model of a buffing machine
20 To develop a demonstration model of an abrasive belt grinder

Unit Test–

Unit Test-I	Unit I, II, III

Designation of Course	Mechanics of Fluids (Course Code: MJ1111302)		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: 03 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial: 01 Hour/ Week	Internal Assessment	40 Marks	
Practical: 02 Hours/ Week	Term Work and Practical	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	1. Engineering Mathematics 2. Engineering Physics 3. Engineering Mechanics
Course Objectives: -	To provide knowledge about 1. Properties of fluids, concepts of fluid statics, kinematics & dynamics 2. Concepts of laminar & turbulent fluid flows 3. Flow around immersed bodies and boundary layer flow 4. Dimensional analysis
Course Outcomes: -	On completion of the course, students will be able to– 1. Analyze the fundamental properties of fluids and evaluate concepts of fluid statics to analyze practical engineering problems. 2. Examine the principles of fluid kinematics and apply kinematic relationships to analyze practical flow problems. 3. Apply the concepts of fluid dynamics and analyze engineering problems using energy, momentum, and flow equations. 4. Analyze the concepts of laminar flow and flow around immersed bodies and evaluate associated engineering problems involving drag, lift, and flow characteristics. 5. Apply the principles of flow through pipes and analyze practical fluid flow problems involving losses. 6. Examine the principles of boundary layer theory and analyze engineering problems related to boundary layer growth, separation, and flow control, flow measurement, and similarity laws

Course Contents

Unit-I	**Properties of Fluids & Fluid Statics**	**(08 Hrs.)**
Properties of Fluid: - Definition of fluid, concept of continuum, Density, Specific Weight, Specific Gravity, Dynamic Viscosity, Kinematic Viscosity, Newton's law of viscosity, types of fluid, Surface Tension, Capillarity, Compressibility. **Fluid Statics:** Hydrostatic law, Pascal's Law, Pressure at a point, Total Pressure, Centre of pressure, Liquid pressure on a plane (Horizontal, Vertical, Inclined) & Curved surfaces, Archimedes' Principle.		
Unit-II	**Fluid Kinematics**	**(08 Hrs.)**
Description of fluid motion- Eulerian and Langragian approach, Types of flow (steady, unsteady, uniform, non-uniform, laminar, turbulent, One, Two and Three dimensional, compressible, incompressible, rotational, Irrotational), Continuity equation in Cartesian co-ordinates, flow net, Control volume, Material derivative and acceleration, Visualization of flow field (Stream, Path and Streak line), stream function and velocity potential function.		
Unit-III	**Fluid Dynamics**	**(08 Hrs.)**
Linear momentum equation using differential approach, Introduction to Navier-Stokes Equation, Euler equation of motion. Derivation of Bernoulli's equation along a streamline, application of Bernoulli's equation to Pitot tube, Venturimeter, Orifice meter. Introduction to CFD Methodology.		

Unit-IV	Laminar Flow & Flow around Immersed Bodies	(08 Hrs.)
Definition, relation between pressure and shear stresses, and laminar flow through a round pipe. Forces on immersed bodies: -Lift and Drag, Classification of Drag, Flow around circular cylinder and airfoil, Development of lift on airfoil.		
Unit-V	**Flow Through Pipes**	**(08 Hrs.)**
Energy losses through pipe-Major and Minor losses, Pipes in series and parallel, Darcy-Weisbach equation, Moody diagram, Concept of HGL and THL or TEL. Syphon, Transmission of power, Water hammer in pipes		
Unit-VI	**Boundary Layer Flow & Dimensional Analysis**	**(08 Hrs.)**
Boundary Layer Flow: Boundary layer, Laminar and Turbulent flow, Velocity distribution, Development of boundary layer on a flat plate, Boundary layer thickness-displacement, Momentum and Energy, Laminar sub layer, Separation of boundary layer, and Methods of controlling, Introduction to compressible fluid flow. **Dimensional Analysis:** Dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham pi Theorem, Important dimensionless numbers.		

Term Work

Term work shall consist of the following **eight** experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Study of Pressure Measuring Devices.
2. Measurement of Viscosity using Redwood Viscometer.
3. Stability of Floating Bodies and Optimum Loading Capacity.
4. Verification of Modified Bernoulli's Equation.
5. Calibration on Venturi meter.
6. Calibration of the Orifice meter.
7. Laminar and Turbulent Flow by Reynolds's Apparatus.
8. Discharge over Notches.
9. Study of Minor Losses due to Pipe Fitting.

Assignment:

Numerical and/or theory questions on the following topics from previous year's question papers of GATE/ESE Mechanical Engineering Examinations.

1. Fluid statics
2. Fluid kinematics.
3. Venturimeter & orifice meter.
4. Laminar flows and flows around immersed bodies.
5. Flow through pipes and Dimensional analysis.
6. Boundary conditions for the velocity profiles.

Textbooks & Reference Books:

1. Dr. R.K. Bansal, A Textbook of Fluid Mechanics and Hydraulic Machines", Laxmi Publication Pvt. Ltd., New Delhi.
2. R.K. Rajput, A Textbook of Fluid Mechanics and Hydraulic Machines, S. Chand & Company Ltd., New Delhi.
3. Streeter V. L. and Wylie E. B. Fluid Mechanics McGraw-Hill International Book Co.
4. Yunus Cengel, John Cimbala, Fluid Mechanics, Tata McGraw-Hill, New Delhi.

1. Streeter & Wylie, Fluid Mechanics, Tata McGraw-Hill.
2. Frank White, Fluid Mechanics, McGraw-Hill.
3. Dr. P.N. Modi and Dr. S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House.
4. Garde R. J. and Mirajgaonkar, Engineering Fluid Mechanics, Nem Chand & Bros, Roorkee, SCITECH, Publication (India) Pvt. Ltd.

Project-Based Learning:

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To demonstrate Pascal's law through real-life applications such as a hydraulic jack, a hydraulic press, a hydraulic lift, etc.
2. To demonstrate Archimedes's Principle through real-life application.
3. To prepare an experimental setup for the measurement of the viscosity of different oils.
4. To demonstrate different types of fluid flow through Reynolds' experiment.
5. To prepare a chart on real-life applications of different types of fluid flows and their characteristics.
6. To measure the flow velocity using a Pitot tube.
7. To prepare a chart on real-life applications of fluid flow measuring devices.
8. To develop a demonstration model for turbulent and laminar flow.
9. To develop a demonstration model of a simple viscous damper for earthquake resistance.
10. To prepare a chart for industrial applications of Pascal's law.

Unit Test –

Unit Test-I	Unit- I, II, III

Designation of Course	Thermodynamics Principles (Course Code: MJ1111303)		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 00 Hours/ Week	Internal Assessment	40 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites:	1. Engineering Mathematics. 2. Engineering Physics.
Course Objectives: -	To provide knowledge about 1. Laws of thermodynamics & their applications. 2. Properties of pure substances & vapor processes. 3. Fuels and concepts of combustion.
Course Outcomes: -	On completion of the course, students will be able to– 1. Explain the concepts of the First Law of Thermodynamics and apply them to analyze energy interactions in thermodynamic systems. 2. Explain the Second Law of Thermodynamics, entropy, and availability, and analyze their implications in engineering processes. 3. Apply thermodynamic property relations of steam to evaluate the performance of various vapor processes. 4. Apply steam properties to analyze and compare different vapor power cycles. 5. Interpret and analyze various air-standard cycles to determine their performance parameters. 6. Explain the types of fuels and combustion concepts and analyze exhaust gas composition for performance and emission characteristics**.**

Course Contents

Unit-I	**First Law of Thermodynamics**	**(06 Hrs.)**
Introduction of thermodynamics, Review of basic definitions (State, Process, Cycle, Path, Quasi-static process, path fiction and point function, Equilibrium), energy and work transfer, zeroth law of thermodynamics, statement of first law of thermodynamics, Joule's experiment, Limitations of first law of thermodynamics. Reversibility and Irreversibility, Applications of the first law to flow and non-flow processes and cycles. Steady flow energy equation and its application to different devices (Boiler, Diffuser, Turbine, Compressor, Condenser, throttling process), PMM-I.		
Unit-II	**Second Law of Thermodynamics, Entropy, and Availability**	**(06 Hrs.)**
Heat engine, refrigerator, and heat pump, Kelvin-Planck's statement & Clausius statement, equivalence of Kelvin-Planck's and Clausius statements, perpetual motion machine of the second kind (PMM-II), Carnot cycle & Carnot heat engine. **Entropy:** Clausius Theorem, Entropy as a property, second law analysis for entropy, Clausius inequality, principle of increase of entropy, irreversibility, Temperature – Entropy relation, Third law of thermodynamics. **Availability:** High- and low-grade energy, available and unavailable energy, loss of available energy due to heat transfer through a finite temperature difference.		
Unit-III	**Properties of Pure Substances and Vapor Processes**	**(06 Hrs.)**

Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-v, T-s and Mollier diagram for steam, use of P-V, T-S, H-S diagrams for Pure substance, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling, and combined). Non-flow and steady flow vapor processes, constant Pressure Process, constant volume Process, constant temperature Process, Isentropic Process, Polytrophic Process, Hyperbolic Process, work transfer & heat transfer.		
Unit-IV	**Vapor Power Cycles**	**(06 Hrs.)**
Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle, Relative efficiency, Performance parameters of vapor power cycle, Effect of operating variables on Rankine cycle (Superheating, Boiler pressure, condenser pressure).		
Unit-V	**Air Standard Cycles**	**(06 Hrs.)**
Analysis of Air standard cycle, Efficiency and Mean Effective Pressure, Carnot Cycle, Otto Cycle, Diesel cycle, Dual cycle, Comparison of cycles, Atkinson Cycle, Ericsson Cycle, Brayton cycle, Sterling Cycle		
Unit-VI	**Fuels and Introduction to Combustion**	**(06 Hrs.)**
Solid- Biomass, Coal types, liquid: petrol, diesel, bio-oil, their Application, Gas: Bio-gas, low calorific value gases, LPG, CNG, and their application. Properties of fuels, Mass fraction, mole fraction, combustion equation, theoretical air, excess and deficient air, stoichiometric and actual air to fuel ratio, Measurement of calorific value of fuels, analysis of products of combustion, gravimetric and volumetric analysis, and their conversions, method to determine flue gas analysis - CO, CO_2, O_2, HC, NO_x, smoke.		

Text Books

1. V. P. Vasandani and D. S. Kumar, Heat Engineering, Metropolitan Book Company, New Delhi.
2. R.S. Khurmi and J K Gupta, Textbook of Thermal Engineering, S Chand publications.

Reference Books

1. P. K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Publications.
2. Y. A. Cengel & M.A. Boles, Thermodynamics -An engineering approach, Tata McGraw-Hill Publications.
3. Rayner Joel, Engineering Thermodynamics, ELBS Longman.
4. R. K. Rajput, Engineering Thermodynamics, Laxmi Publications.
5. Kothandarman & S. Domkundwar, "Thermal Engineering" Dhanpat Rai and Sons.
6. P. L. Ballaney, Thermal Engineering, Khanna Publications.

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To demonstrate the steady flow energy equation for engineering applications such as heat exchangers, turbo machinery, boilers, etc.
2. To demonstrate the first law of thermodynamics by using Joule's experiment.
3. To demonstrate the first law of thermodynamics through real-life applications such as heating of water using a cook stove, operation of a boiler, operation of turbo machinery, etc.
4. To demonstrate the second law of thermodynamics through a real-life application. (Kelvin-Planck's statement)
5. Demonstration of the second law of thermodynamics through real-life application. (Clausius statement)
6. To demonstrate Boyle's law.
7. To demonstrate Charles's law.

8. To prepare a chart on the identification of gas/vapour processes in various real-life applications, such as boiler, steam turbine, gas turbine, IC engine cylinder, etc.
9. To prepare a chart on comparison among different air standard cycles for given conditions.
10. To determine calorific values of different types of solid and liquid fuels.

Unit Test

Unit Test-I	Unit- I, II, III

Designation of Course	**Strength of Machine Components (Course Code: MJ1111304)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:-03Hours/Week	End Semester Examination	60 Marks	03
	Internal Assessment	40 Marks	
	Total	**100Marks**	**03**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Mechanics 3. Engineering Science
Course Objectives:-	1. Interpret simple and principal stress and strain 2. Able to find principal stresses on any oblique plane by analytical and graphical methods. 3. Able to draw shear force and bending moment diagrams and find the slope and deflection of the beam 4. Able to draw bending stress and shear stress diagrams at different cross-sections section I and T-section beams. 5. Able to find stresses in the shaft in torsional, combined torsional and bending, and combined torsional and axial loading. 6. Able to solve problems on strain energy and Euler's column.
Course Outcomes:-	On completion of the course, students will be able to 1. Interpret the concepts of simple stress and strain and analyze them to determine stresses and strains in simple components. 2. Explain principal stress concepts and Mohr's circle (analytical and graphical methods) and apply them to determine stresses on oblique planes. 3. Interpret shear force and bending moment relationships and analyze beams to construct SFD and BMD for various loading conditions. 4. Explain pure bending and shear stress theories and evaluate bending and shear stress distributions for I- and T-section beams. 5. Explain torsion in shafts and apply torsional relations to design shaft diameters under various loading conditions. 6. Explain column theory and strain energy principles and analyze columns and members to evaluate load-carrying capacity under different loading conditions.

Course Contents

Unit-I	**Simple Stress and Strain**	**(06 Hrs.)**
Load, Direct or normal stress, Direct strain, Sign convention for direct stress and strain, Elastic materials, Hooke's law, Modulus of elasticity - Young's modulus, Tensile test, Ductile materials, Brittle materials, Poisson's ratio, Application of Poisson's ratio to a two-dimensional stress system, Shear stress, Shear strain, Modulus of rigidity, Relationship Between E, G and K, Allowable working stress-factor of safety, Thermal stresses in plane and composite members.		
Unit-II	**Principal Stresses, Theories of Failure**	**(06 Hrs.)**

Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses, and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses.
Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory.

Unit-III	Shear Force and Bending Moment Diagram; Slope and Deflection	(06 Hrs.)
Types of supports and beams, shear force (S.F.), bending moment (B.M.), S.F. and B.M. sign convention, S.F. and B.M. diagrams for beams carrying different loading conditions. Points of contraflexure. Introduction, Simple bending theory, Neutral axis, Section modulus, slope and deflection for S.S.B. and C.B., Double integration method (Macaulay's method) for S.S.B. and C.B.		
Unit-IV	**Bending and Shear Stress in a Beam**	**(06 Hrs.)**
Bending stresses: Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections (I and T) with respect to centroidal and parallel axes, bending stress distribution diagrams, moment of resistance, and section modulus. **Shear stress:** Concept, derivation of shear stress distribution formula, shear stress distribution diagrams for common symmetrical sections, maximum and average shear stresses.		
Unit-V	**Torsion**	**(06 Hrs.)**
Simple torsion theory, Polar second moment of area, Shear stress and shear strain in shafts, Section modulus, Torsional rigidity. Strain energy in torsion, Power transmitted by shafts. Stresses in solid circular shaft- Torsional load, combined torsion and bending loads.		
Unit-VI	**Euler's Columns and Strain Energy**	**(06 Hrs.)**
Concept of buckling of columns, derivation of Euler's formula for buckling load for a column with hinged ends only, concept of equivalent length for various end conditions, limitations of Euler's formula, Rankin's formula, safe load on columns. Strain energy: Strain energy due to axial load (gradual, sudden, and impact), Strain energy due to self-weight.		

Textbooks

1. A textbook of Strength of Materials by R. K. Bansal

Reference Books

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Publication
2. J. E. Shigley, Mechanical Engineering Design, McGraw-Hill
3. R. Subramanian Strength of Materials
4. S Ramamrutham, Strength of Materials
5. R. K Rajput, Strength of Materials

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To prepare a demonstration model of a cantilever beam for the study of deflection in it.
2. To prepare a demonstration model of a simply supported beam for the study of deflection in it.
3. To prepare a demonstration model of an Overhang beam for the study of deflection in it.
4. To prepare the demonstration model on the relation between E, G, and K (Stress- strain)
5. To prepare a demonstration model for studying strain energy with consideration of various conditions, like impact load, sudden load, and gradual load.
6. To prepare the demonstration model on concepts used in Principal Stresses & planes.

7. To prepare the demonstration model for concept use in Mohr's Circle method. (Programming simulation)
8. To prepare the demonstration model on finding bending stress for I cross-sections. (Programming simulation)
9. To prepare the demonstration model on the concept used in solid &hollow shafts. (Programming simulation)
10. To prepare the demonstration model of Euler's formula for buckling load. (Programming simulation)

Unit Tests

Unit Test-I	Unit I,II, III

Designation of Course	**Mechanisms of Machines (Course Code: MJ1111305)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Physics 3. Engineering Mechanics
Course Objectives:-	1. To make the students conversant with the kinematic analysis of mechanisms applied to real-life and industrial applications. 2. To develop the competency to analyze the velocity and acceleration in mechanisms using analytical and graphical approaches. 3. To develop competency to analyze the friction clutches, Brakes, dynamometer, and flywheel.
Course Outcomes:-	1. Interpret fundamental concepts of lower-pair mechanisms and apply them to real-life and industrial applications. 2. Interpret the basic principles of kinematic analysis and evaluate forces in reciprocating engine mechanisms using graphical and analytical methods. 3. Interpret the concepts of velocity and acceleration in planar mechanisms and analyze motion using relative velocity–acceleration methods, instantaneous centers, and the Coriolis component of acceleration. 4. Interpret the principles of friction and apply them to the design and functional analysis of clutches. 5. Apply frictional principles to analyze performance parameters in brakes and dynamometers. 6. Interpret the fundamentals of turning moment diagrams and flywheel dynamics and evaluate the coefficient of fluctuation of speed and energy.

Course Contents

Unit-I	**Mechanisms with Lower Pair**	**(06 Hrs.)**
Introduction, Pantograph, Straight line mechanisms- Exact and Approximate, Hook Joint, Double Hook Joint, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism. Theory and analysis of the Compound Pendulum, Concept of equivalent length of simple pendulum, Bifilar suspension, Trifilar suspension.		
Unit-II	**Inertial Forces in Reciprocating Parts**	**(06 Hrs.)**
Analytical method for displacement, velocity, and acceleration analysis of slider crank mechanisms. **Dynamics of Reciprocating Engines:** Two mass statically and dynamically equivalent systems, Correction couple, static and dynamic force analysis of reciprocating engine mechanism.		
Unit-III	**Kinematic Analysis of Mechanisms: Graphical Methods**	**(06 Hrs.)**

Relative Velocity Method: Relative velocity of a point on a link, Angular velocity of a link, Sliding velocity, Velocity polygons for simple mechanisms. **Relative Acceleration Method:** Relative acceleration of a point on a link, Angular acceleration of a link, Acceleration polygons for simple mechanisms. **Instantaneous Centre of Rotation (ICR) Method** (limit to only 6 link mechanisms)- Kennedy's Theorem, Body and space centrode.		
Unit-IV	**Friction Clutches**	**(06 Hrs.)**
Friction: Friction in the turning pair, friction circle, friction axis, and friction in the slider crank mechanism. Pivot and collar friction. **Friction clutches-** design considerations, Classification of Clutches, torque transmitting capacity of – Single plate and multi-plate clutch, cone clutch, and centrifugal clutch.		
Unit-V	**Brakes and Dynamometers**	**(06 Hrs.)**
Brakes-Introduction, Classification of brakes, material for brake lining, types of brakes, braking torque of - shoe brakes, internal shoe brake, disc brake. **Dynamometer-**Types of dynamometers, brake power of absorption and transmission type dynamometers – pronny brake, rope brake.		
Unit-VI	**Turning Moment Diagrams and Flywheel**	**(06 Hrs.)**
Introduction, Turning Moment Diagrams for different types of Engines, Fluctuations of Energy and Speed of Crankshaft, Coefficient of fluctuation of Energy and speed. **Flywheel-**Introduction, Coefficient of fluctuation of speed, Energy stored in flywheel, dimensions of flywheel rim, Flywheel in punching press.		

Term Work

The following experiments shall be performed.

1. Compound Pendulum
2. Bifilar Suspension Method and Trifilar Suspension Method
3. Hook Coupling Experiment
4. Velocity and acceleration analysis using Graphical methods by the Polygon method.
5. Velocity and acceleration analysis using Graphical methods by Klein's construction
6. Velocity analysis using Graphical methods by ICR.
7. Velocity and acceleration analysis using Graphical methods, i.e., polygons involving the Coriolis component.
8. To determine the Coriolis Component of Acceleration at various speeds of rotation and water flow rates.
9. To measure the torque transmitting capacity of the friction clutch experimentally, or to study different types of friction Clutches.
10. To study the various types of Brakes and dynamometers with their practical applications.
11. Study of Turning Moment diagrams and to calculate the experimental and theoretical moment of inertia of different types of flywheels.
12. Mini project based on the contents of the Syllabus.

Reference Books

1. Thomas Bevan, "Theory of Machines", CBS Publishers & Distributors, Delhi.
2. Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw-Hill, Inc.
3. Ghosh Amitabh and Malik A.K., "Theory of Machines and Mechanisms", East-West Press.
4. Hall A.S., "Kinematics and Linkages Design", Prentice-Hall.
5. Erdman, A. G. & Sandor, G.N., "Mechanism design, Analysis and synthesis", Vol 1, Prentice–

Hall of India.

Text Books

1. Rattan S. S., “Theory of Machines”, Tata McGraw-Hill.
2. Ballaney P. L., “Theory of Machines”, Khanna Publishers, Delhi.
3. R. S. Khurmi, “Theory of Machines, S Chand Publication.

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To develop a demonstration model of the Pantograph mechanism
2. To develop a demonstration model of the Ackerman steering gear mechanism.
3. To develop a demonstration model of the Davis steering gear mechanism.
4. To develop demonstration models of an exact straight-line motion mechanism.
5. To develop a demonstration model to understand the Coriolis Effect.
6. To prepare a chart on the comparison of different types of clutches with their application.
7. Case study on the real-life application of clutches used in automobiles.
8. To develop a demonstration model of the Prony brake dynamometer
9. Case study on real-life application of Brakes used in an automobile.
10. To prepare a chart for comparison among different types of dynamometers.
11. To develop a demonstration model of a flywheel energy storage system.

Unit Tests

Unit Test-I	Unit I, II, III

Designation of Course	**Python Programming (Course Code: SE1111306)**		
Course Code			
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Practical	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisites: -	Basics of C and C^{++}Programming
Course Objectives: -	The students should be able to 1. Readily use the Python programming language 2. Apply various data types and control structures. 3. Interpret and begin to implement code
Course Outcomes: -	Upon completion of the course, students will be able to 1. Interpret the process of installing and running Python and create basic Python programs. 2. Interpret and construct flow control structures to solve computational problems. 3. Interpret and use complex data types to store and manipulate data effectively. 4. Interpret and apply user-defined and built-in functions to modularize Python programs. 5. Interpret and utilize various Python modules to extend program capabilities. 6. Interpret and apply NumPy operations for numerical computing and data manipulation.

Course Contents

Unit-I	**Python introduction**	**(04 Hrs.)**
Learn to install and run Python on your computer, Keywords and Identifiers, Statement, Indentation and Comments, Variables, Constants and Literals, Data Types, Type Conversion and Type Casting, Input, Output and Import.		
Unit-II	**Python Flow Control**	**(04 Hrs.)**
Learn to install and run Python on your computer, Keywords and Identifiers, Statement, Indentation and Comments, Variables, Constants and Literals, Data Types, Type Conversion and Type Casting, Input, Output and Import.		
Unit-III	**Datatypes**	**(04 Hrs.)**
Numbers, Type Conversion and Mathematics, List, Tuple, Strings, Sets, Dictionary.		
Unit-IV	**Python Functions**	**(04 Hrs.)**
Function Arguments, Recursion, Anonymous/Lambda Function, Global, Local, and Nonlocal variables, Global Keyword.		
Unit-V	**Python Modules**	**(04 Hrs.)**
Modules in Python, import modules in Python, import statement, Import with renaming, from import statement, Import all names, Python Module Search Path.		
Unit-VI	**NumPy Module**	**(04 Hrs.)**
Python Matrix, Add Two Matrices, Transpose a Matrix, Multiply two matrices.		

Term Work

1. Basic Exercise for Beginners
   Practice and quickly learn Python's necessary skills by solving simple questions andProblems.
   Topics: Variables, Operators, Loops, String, Numbers, List
2. Python Loop Exercise Python loop exercise aims to help developers practice branching and looping techniques in Python.
   Topics: If-else statements, loops, and while loops.
3. Python Functions Exercise
   Practice how to create a function, nested functions, and use the function arguments effectively in Python by solving different questions.
   Topics: Function's arguments, built-in functions.
4. Python String Exercise
   Solve Python String exercise to learn and practice String operations and manipulations.
5. Python Data Structure Exercise
   Practice widely used Python types such as List, Set, Dictionary, and Tuple operations in Python
6. Python List Exercise
   This Python list exercise aims to help Python developers learn and practice list operations.
7. Python Dictionary Exercise
   This Python dictionary exercise aims to help Python developers learn and practice dictionary operations.
8. Python Tuple Exercise
   This exercise aims to help Python developers learn and practice tuple operations.

Text Books

1. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher,
2. Timothy A. Budd, "Exploring Python", McGraw-Hill Education (India) Private Ltd., 2015.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

Reference Books

1. Python Programming using problem solving Approach by Reema Thareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
2. Data Structures and Algorithms in Python by Michael T Goodrich and Robertto Thamassia, Micheal S Goldwasser, Wiley Publisher (2016)
3. Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1st edition (6th February2009)

Supplementary Resources:

1. http://www.w3schools.com
2. http://docs.python.org
3. http://www.tutorialspoint.com
4. http://www.learnpython.org

Designation of Course	Massive open online courses (MOOC) (Course Code: AE1111307)		
Teaching Scheme: ---	**Examination Scheme**		**Credits Allotted**
		--	--
	Total	--	**02**

The students shall be encouraged to complete two MOOCs during their B. Tech. Mechanical programme. Students shall register to MOOCs which are offered by any one the following agencies:

(i) SWAYAM: www.swayam.gov.in

(ii) NPTEL: www.onlinecourse.nptel.ac.in

(iii) Course Era: www.coursera.org

(iv) edX online learning: www.edx.org

(v) MIT Open Course ware: www.ocw.mit.edu

(vi) Udemy: www.udemy.com

(vii) IIT Bombay Spoken Tutorial: www.spoken-tutorial.org

(viii) Artificial Intelligence - C DAC Pune: https://futureskillsprime.in/

(ix) AR- VR - CDAC Pune: https://futureskillsprime.in/
https://tinyurl.com/jx93jwft

Student shall take prior approval from the department before registering for a given MOOCs. Students shall complete MOOCs during their tenure of a given B. Tech. Programme. Students shall submit a passing certificate of MOOCs to obtain two credits per MOOC. The credits obtained for MOOC will be reflected in the mark sheet of Semester VIII.

Designation of Course	Value Aided Course (VAC) -I: Computer-Aided Drafting (Course Code: VA1111308)		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory: 2 Hrs./Week	**IA**	100	02
	Total	100	02

Course Prerequisites: -	1. Computer-Aided Drafting and Visualization 2. Computer-Aided Machine Drawing
Course Objectives: -	1. To introduce students to the basic concepts of CAD modelling. 2. To develop the skills in Reading and Interpretation of Engineering Drawings. 3. To familiarize students with SolidWorks Software to create 2D and 3D models, Assembly, Drafting, and Sheet metal modelling.
Course Outcomes: -	The students will be able to 1. Interpret the fundamentals of engineering drawing and use basic AutoCAD commands to create accurate 2D sketches. 2. Construct orthographic and isometric projections of objects, including sectional views, using AutoCAD. 3. Interpret and apply BIS conventions and conventional representations to illustrate standard machine elements in technical drawings. 4. Create fully defined sketches in SolidWorks by using sketch tools, constraints, and dimensioning within the CAD interface. 5. Develop 3D part models using feature-based modelling tools such as extrude, revolve, sweep, loft, fillet, chamfer, shell, rib, and patterns. 6. Integrate multiple modelling features to generate complete part models and evaluate them for geometric correctness and design intent.

Course Contents

Unit-I	**Fundamentals of CAD**	**(04 Hrs.)**
Introduction to Engineering Drawing, Types of lines and Dimensioning, Layout and size of drawing sheets, Scales. Introduction to AutoCAD, AutoCAD initial setting, and AutoCAD commands, Basic Drawing Commands, Modify Tools, and Dimensioning,		
Unit-II	**Orthographic and Isometric Projections**	
Orthographic Projections of a given Pictorial view by the first angle projection method only, Sectional orthographic Projection. Orthographic Drawing using AutoCAD. Principles of Isometric Projections-Isometric Scale, Isometric Axes, Isometric Projections, and Isometric Drawing by using AutoCAD.		
Unit-III	**Fundamentals of Machine Drawing and Conventional Representation**	**(04 Hrs.)**
Introduction to Machine Drawing and its importance, Code of Practice for Engineering Drawing, BIS specifications – Materials, Welding Joint and symbols, riveted joints, pipe joints, keys, and screwed fasteners. Conventional Representation of dimensioning and sectioning, breaks in pipes and shafts, Screw Threads, springs, gears, foundation bolts, Common features, and machine components.		
Unit-IV	**Introduction to CAD**	**(04 Hrs.)**

Introduction to CAD and CAE Features of SolidWorks, Various products available in SolidWorks for Product Design, Simulation, Communication, SolidWorks Graphical User Interface - Feature manager design tree, Callouts, Handles, Confirmation corner, mouse buttons, keyboard shortcuts, Command Manager. Sketch Entities, Sketch Tools, Block, Relation, and Dimensioning, fully defined, over-defined, under under-defined drawing.		
Unit-V	**Basic Part Modelling**	**(04 Hrs.)**
Part Modelling Tools, Creating Extrude features, Creating Revolve features, Creating Swept features, Creating Loft features. Creating Reference, creating curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern, and advanced modelling tools. Part Modelling Tools, creating curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern, and advanced modelling tools.		
Unit-VI	**Part Modelling - I**	**(04 Hrs.)**
Introduction to Assembly Modelling & Approaches, Applying Advanced Mates and Mechanical Mates, Manipulating Components, Creating Pattern, Creating Explode Views. Generating Views, Creating Dimensions, Inserting Annotations and Bill of Materials.		

Term Work

Term work shall consist of A-2/A4 size printouts of the problems solved in practicals using Solid Works Software.

1. Introduction to CAD drawing
2. Sketcher drawings
3. Part modelling
4. Assembly Modelling
5. Exploded view of Assembly
6. Drafting of Mechanical Systems

Text Books

1. Kuang-Hua Chang, "Motion Simulation and Mechanism Design with SOLIDWORKS Motion 2018", SDC Publishers, 2018

Reference Books

1. Ibrahim Zeid and R. Siva-Subramaniam – "CAD/CAM- Theory and Practice", Tata McGraw-Hill Publishing Co., 2009.
2. Rao P. N., "CAD/CAM", Tata McGraw-Hill.
3. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", Second edition, Addison–Wesley, 2000.
4. Martenson, E. Michael, "Geometric Modelling", John Wiley & Sons, 1995.
5. Ronald E. Barr, Davor Juricic, Thomas J. Krueger, "Engineering & Computer Graphics Workbook Using SolidWorks 2014", SDC Publication, 2014.
6. John Willis, Sandeep Dogra, "SOLIDWORKS 2019: A Power Guide for Beginners and Intermediate Users", published by CADArtifex, 2019.

B. TECH. MECHANICAL: SEMESTER- IV

Designation of Course	**Science of Engineering Materials (Course Code: MJ1111401)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: -03 Hours/Week	End Semester Examination	60 Marks	03
Term Work:-2 Hours/Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	
	ORAL	25 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites:-	The student should have 1. Basic knowledge of physics and chemistry 2. Basic information on engineering materials 3. Basic knowledge of manufacturing processes
Course Objectives:-	The student should acquire the knowledge of 1. The scope, objective, and application of materials, engineering properties. 2. Material testing to determine the mechanical properties and their applications in mechanical systems. 3. Different methods to change the mechanical properties.
Course Outcomes:-	After completing the course, the students will be able to— 1. Explain the principles of plastic deformation, annealing, and recrystallization, and apply these concepts in mechanical engineering applications. 2. Analyze and evaluate various mechanical properties of engineering materials for appropriate material selection. 3. Explain the fundamental concepts of equilibrium diagrams and apply them to select alloys for specific engineering applications. 4. Explain different heat treatment processes for steels and apply them to modify material properties as required in engineering practice. 5. Explain the characteristics of alloy steels, tool steels, and stainless steels and select suitable materials for mechanical engineering applications. 6. Explain the fundamentals of powder metallurgy and apply the process in the manufacturing of engineering components.

Course Contents

Unit-I	**Plastic Deformation, Recrystallization, and Strengthening Mechanism**	**(06 Hrs.)**
Mechanism of plastic deformation, Critical resolved shear stress, Deformation of single crystal and polycrystalline metals, Mechanism of plastic deformation at high temperature, effect of grain size, Work Hardening, Cold and hot working, Annealing, and recrystallization,		
Unit-II	**Mechanical Testing of Metals**	**(06 Hrs.)**
Study of destructive testing, Engineering stress and true stress strain, evolution of properties, Numerical-based Tensile test, Hardness testing such as Brinell, Rockwell, Vickers, and Micro hardness test, Impact test, Fatigue test, Creep test. **Non-destructive testing** such as Liquid dye penetration test, Magnaflux test, Eddy current test, Ultrasonic testing, and Radiography testing.		
Unit-III	**Equilibrium Diagrams**	**(06Hrs.)**
Related terms and their definitions, Hume-Rothery's rule of solid solubility, solidification, Dendritic growth, cooling curves, Plotting of Equilibrium diagrams, Lever rule, Coring, Isomorph's system, Eutectic system,		

Partial eutectic and eutectoid system, non-equilibrium cooling and its effects, study of Fe-Fe3C equilibrium diagram. steel classifications

Unit-IV	**Heat Treatment of Steels**	**(06 Hrs.)**
Transformation products of austenite, Martensite transformation & characteristics of martensite, Time – Temperature Transformation curve, Critical Cooling rate, Heat treatment of steels - Annealing, Normalizing,		
Hardening, Martempering, Austempering, Retained austenite, tempering, Surface hardening heat treatment.		
Unit-V	**Cast Irons, Alloy Steels & Tool Steels**	**(06 Hrs.)**
Classification of alloying elements, Types of cast irons, Properties of different cast irons, Effect of alloying elements on properties, Specifications of steels, Various alloy steels, Stainless steels – Classification, Applications & properties, Tool Steels – Classification, Applications & properties		
Unit-VI	**Powder Metallurgy**	**(06 Hrs.)**
Introduction, Advantages and limitations of powder metallurgy, Production of metal powder, Characteristics of powder, Powder conditioning, Powder Compacting, Hot compacting methods, Sintering and sintering furnaces, Production of powder metallurgical parts such as self-lubricating bearings, ferrites, electric contact materials, Carbide cutting tools, etc		

List of Practical:

1. Tensile test to determine strength and other mechanical properties
2. Hardness test: Brinell and Vickers, or Rockwell hardness test
3. Impact test to determine the Impact strength of Materials
4. Study of Fatigue Strength
5. Study of the Erichsen Cupping test to determine the cupping depth of sheet metal
6. Study of the Magnetic Particle test
7. Study of the Liquid Penetrating Test
8. Study of Ultrasonic Test
9. Heat Treatment of Steels
10. Study of the microstructure of Plain carbon steels

Text Books

1. Material Science and Physical Metallurgy, Dr.V.D. Kodgere, Everest Publication, Pune.
2. "Material Science and Metallurgy", O P Khanna, Khanna Publication, Delhi
3. "Material Science and Engineering", R K Rajput, S K Kataria and Sons Publication, Delhi

Reference Books

1. "Physical Metallurgy", S H Avner, Tata McGraw-Hill Publication, Delhi
2. "Physical Metallurgy" Raghwan V, PHI Learning Pvt. Ltd, Delhi
3. Polymer Science, V. R. Gowarikar, N. V. Viswanathan, Jayadev Sreedhar, Wiley Eastern Limited
4. Polymer Science and Technology (2nd Edition), P. Ghosh, Tata McGraw-Hill, 2008
5. Polymers: Chemistry & Physics of Modern Materials (2nd edition) J.M.G. Cowie, Blackie Academic & Professional, 1994.
6. Engineering Chemistry by Dr. A. K. Pahari and Dr. B. S. Chauhan, Laxmi Publications (P) Ltd, New Delhi.
7. Engineering Chemistry (16th Edition) Jain, Jain, DhanpatRai Publishing Company, 2013.

Project-Based Learning

Following is the list of Topics for project-based Based Learning (Not Limited to) based on the

syllabus contents:

1. To develop a demonstration model of crystal structure.
2. To prepare a chart on different materials and their recrystallization temperatures.
3. To develop a tensile test specimen as per the standards and find its U T S and Y S
4. To find the hardness of any one component by Brinell or Rockwell hardness testing machine
5. To identify flaws and defects in different materials by any NDT methods
6. Case study on case hardening of any mechanical component
7. To perform annealing on any mechanical component
8. To perform hardening operation by either oil quenching or water quenching on any mechanical component.
9. To prepare a chart on properties of different cast irons by using a microscope, hardness testing, or spark testing.
10. To prepare a flowchart on the processing of tool steels
11. To develop a demonstration model of the manufacturing of metal powder by the atomization technique
12. To develop a demonstration model of different types of powder compacting methods
13. To prepare a flow chart of the production process of carbide tools, ferrites, clutch plates, and elastic contact materials.
14. To prepare a flow chart of any mechanical component manufactured by the powder metallurgy technique

Unit Test

Unit Test-I	Unit- I, II, III

Designation of Course	**Theory of Machines (Course Code: MJ1111402)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - 01 Hour/Week	Internal Assessment	40 Marks	
	Tutorial	Internal Evaluation	01
	Total	**100 Marks**	**04**

Course Prerequisites:-	1. Engineering Physics and Mathematics 2. Engineering Mechanics 3. Mechanisms of Machines
Course Objectives:-	1. To develop competency in understanding of theory of spur and helical gears. 2. To develop competency in different types of gear trains. 3. To develop an understanding of static and dynamic balancing, cam and follower, gyroscopic forces, and moments.
Course Outcomes:-	The students should be able to– 1. Interpret gear theory and apply it to the design of gear systems. 2. Analyze torque-transmitting capacity in gear trains and apply it to gearbox design. 3. Apply the principles of balancing of masses to links, mechanisms, and engine components. 4. Interpret the working of different types of governors and apply them to suitable applications. 5. Analyze the motion characteristics of various cam–follower systems and evaluate their performance for different follower motions. 6. Apply the principles of gyroscopic effects and stabilization to the analysis of transport vehicles.

Course Contents

Unit-I	**Spur Gears**	**(06 Hrs.)**
Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, minimum number of teeth, interference and undercutting, Friction in gears. **Helical gears:** nomenclature, Center Distance		
Unit-II	**Gear Trains**	**(06 Hrs.)**
Types of Gear Trains, analysis of epicyclic gear trains, Holding torque – Simple, compound and epicyclic gear trains, torque on sun and planetary gear train, compound epicyclic gear train, Bevel epicyclic Gear train.		
Unit-III	**Balancing**	**(06 Hrs.)**
Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, direct and reverse crank's method, radial / V-engines.		
Unit-IV	**Governors**	**(06 Hrs.)**
Introduction, Classification, Centrifugal Governor, Terminology, Watt Governor, Porter Governor, Proell Governor, Hartnell Governor, Wilson-Hartnell Governor. Sensitiveness, Stability, Isochronous, Hunting. Effort and Power of the Governor, Controlling Forces		
Unit-V	**Cam and Follower**	**(06 Hrs.)**

Types of cams and followers, analysis of standard motions to the follower, Determination of cam profiles for different follower motions, Jump phenomenon of Eccentric cam, Introduction to advanced cam curves (3-4-5 Polynomial cam only)		
Unit-VI	**Gyroscope and Step–Less-Regulation**	**(06 Hrs.)**
Gyroscopes- Gyroscopic forces and Couples, Gyroscopic stabilization for ship and Airplane, Stability of four-wheel drive vehicle moving on curved path, Stability of a two-wheel vehicle. **Continuous Variable Transmissions -** Geometry, Velocity and torque analysis of Faceplate variators, Conical variators, Spheroidal and cone variators, Variators with axially displaceable cones, PIV drives. (Theoretical Treatment Only)		

Tutorial

Numerical and/or theory questions on the following topics from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

1. Spur Gears
2. Gear Trains
3. Balancing
4. Gyroscope
5. Cam and Follower
6. Governors

Text Books

1. Rattan S. S., "Theory of Machines", Tata McGraw-Hill.
2. Ballaney P. L., "Theory of Machines", Khanna Publishers, Delhi.
3. R. S. khurmi, "Theory of Machines', S Chand Publication.

Reference Books

1. Thomas Bevan, "Theory of Machines", CBS Publishers & Distributors, Delhi.
2. Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw-Hill, Inc.
3. Ghosh Amitabh and Malik A.K., "Theory of Machines and Mechanisms", East-West Press.
4. Hall A.S., "Kinematics and Linkages Design", Prentice-Hall.
5. Hartenberg and Denavit, "Kinematic Analysis and Synthesis of Mechanisms".
6. Erdman, A. G. & Sandor, G.N., "Mechanism design, Analysis and synthesis", Vol 1, Prentice–Hall of India.

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To prepare a chart for comparison among different types of gears
2. To prepare a chart to understand the various terminology of spur gears.
3. To prepare a chart to understand different methods to avoid interference in the spur gear.
4. To develop a mechanical system using a simple gear train.
5. To develop a mechanical system using a compound gear train.
6. To develop a mechanical system using a reversed gear train.
7. To develop a mechanical system using an epicyclic gear train.
8. To prepare a chart comparison among different types of gear trains.
9. To develop a demonstration model of static and dynamic balancing systems.
10. To develop a demonstration model of the balancing of rotating masses.
11. To develop a demonstration model of the balancing of reciprocating masses.

12. Case study on real life applications of various types of governors.
13. To develop demonstration model of a Watt Governor/Portal Governor/Proell Governor.
14. To prepare a chart on compression among different types of governors.
15. To prepare a chart to understand various terminology of Cam profile.
16. To prepare a chart on comparison among different types of followers.
17. To prepare a chart on comparison among different types of follower motions.
18. To develop a demonstration model on real life applications of gyroscopic effect such as Ship, an areophane, automobile, etc.

Unit Tests

Unit Test-I	Unit-I, II, III

Designation of Course	**Thermodynamics Applications (Course Code: MJ1111403)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Oral	25 Marks	
	Total	150 Marks	04

Course Prerequisites:	1. Mechanical Engineering System. 2. Thermodynamic principles
Course Objectives:	To provide knowledge about 1. Steam generator and its performance analysis. 2. Reciprocating air compressors, Gas turbines & jet propulsion. 3. Various systems and phenomena of combustion in I.C. Engine, and Performance analysis of I.C. Engine.
Course Outcomes:	After completing this course, the students will be able to: 1. Explain the construction and working of steam generators and evaluate their performance. 2. Explain the construction and working of reciprocating air compressors and evaluate their performance. 3. Explain the fundamentals of gas turbines, assess their performance, and appraise their applications in gas turbine systems and jet propulsion. 4. Explain the construction and functioning of I.C. engine subsystems such as ignition, cooling, and lubrication. 5. Explain the combustion phenomena in spark-ignition and compression-ignition engines and analyze factors influencing combustion. 6. Explain the key terms related to I.C. engine testing and assess engine performance using appropriate test parameters.

Course Contents

Unit 1	**High-Pressure Boilers and Performance of Boilers**	**(6 Hrs.)**
Classification of boilers, Features of high-pressure boiler, construction and working of high-pressure boilers, Fluidized bed combustion, boiler mountings and Accessories. Boiler performance calculations-Equivalent evaporation, Boiler efficiency, Energy balance, boiler controls, Boiler draught.		
Unit 2	**Reciprocating Air Compressors**	**(6 Hrs.)**
Uses of compressed air, classification, constructional details of single-stage reciprocating compressor, work done, effect of clearance, volumetric efficiency, theoretical and actual indicator diagrams, method of improving volumetric efficiency. Need for multi-staging, multistage compressor, work done, volumetric efficiency, condition for maximum efficiency, intercooling, and actual indicator diagram.		
Unit 3	**Gas Turbines & Jet Propulsion**	**(6 Hrs.)**

Theory and fundamentals of gas turbine, Principles, Classification, Assumptions for simple gas turbine cycle analysis, Work ratio, Concepts of maximum and optimum pressure ratio, Actual cycle, Effect of operating variable on thermal efficiency, Regeneration, Intercooling. Reheating and its effect on performance, Application of gas turbines.

Jet Propulsion: Introduction, Theory of jet propulsion, Types of jet engines, Energy flow through jet engine, Turbojet, Turboprop, Turbofan and Ducted fan engines, Pulse jet and Ram jet engines, Application of jet engines, Methods of thrust augmentation, Introduction to rocket engines.

Unit 4	**I. C. Engine Systems**	**(6 Hrs.)**

Fuel supply system for S.I. and C.I. Engines, M.P.F.I. system for modern automobile engines, and CRDI. **Ignition and injection System:** Battery & coil ignition system, Magneto ignition system, Electronic ignition system, Advantage over mechanical contact breaker point system. Spark-Advance Mechanisms. **Engine Cooling System**: Necessity of cooling system, effect of overcooling, Air cooling, Water cooling, Thermostatic radiators. **Lubrication System**: Mist lubrication system, Dry sump lubrication, Wet sump lubrication, Comparison between Wet sump and Dry sump systems, Oil pump. **Supercharging:** Objects of supercharging, Effects on performance, Limitations, Methods of supercharging & turbocharging, Limitations of turbocharging,

Unit 5	**Combustion in I.C. engines**	**(6 Hrs.)**

Combustion in S.I. Engines: Valve timing Diagram for S.I. engine, Ignition Limit, Stages of combustion, Effect of engine variables on ignition lag & flame propagation, Abnormal combustion: Theories, Effects & Controlling measures, Combustion chambers for S.I. engines.

Combustion in C.I. Engines: Valve timing Diagram for C.I. engine, Air-fuel ratio for C.I. engines, Stages of combustion, Ignition delay & factors influencing delay period, Diesel knock & its control, Combustion chambers for C.I. engines.

Unit 6	**Performance Characteristics & Testing of I. C. Engines**	**(6 Hrs.)**

Introduction to Indian standards for testing of I.C. Engines, Performance characteristics, Determination of brake power, indicated power, Friction power, Methods to determine power and efficiency, Determination of brake thermal efficiency, Mechanical efficiency, volumetric efficiency, Variables affecting performance of engine, Mean Effective Pressure, SFC, Air consumption, Energy balance, Engine Emission and their controls.

Term Work:

1. Study and demonstration of boiler mountings.
2. Study and demonstration of boiler Accessories.
3. Trial on a steam power plant.
4. Test on reciprocating air compressor.
5. Performance test on rotary air compressor.
6. Trial on multi-cylinder petrol engine – Morse Test.
7. Trial on multi-cylinder diesel engine.
8. Study of superchargers & turbochargers
9. Study of governing systems used in I.C. Engines.
10. Study of I. C. Engine emission norms.
11. Visit to Boiler House
12. Visit to an Automobile service station.

Assignment:

Numerical and/or theory questions on the following topics from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

1. Boiler performance.
2. Single and multistage reciprocating air compressors
3. Gas turbine performance
4. I C engine systems
5. I C engine combustion
6. Performance of I C engines.

Text Books

1. V. P. Vasandani and D. S. Kumar, Heat Engineering, Metropolitan Book Company, New Delhi.
2. R.S. Khurmi and J K Gupta, Textbook of Thermal Engineering, S Chand publications.

Reference Books:

1. R. K. Rajput, Thermal Engineering, Laxmi Publications
2. Y. Cengel & Boles, "Thermodynamics -An engineering approach", Tata McGraw Hill Publications
3. S. Domkundwar, "Thermodynamics & Heat Engines" Dhanpat Rai and Sons
4. P. K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill Publications
5. P. L. Ballany, "Thermal Engineering", Khanna Publications
6. Ganesan V, "Internal Combustion Engines", Tata McGraw-Hill Publishing House
7. R. K. Rajput, "Internal Combustion Engines", Laxmi Publications.
8. M. L. Mathur & R. P. Sharma, "A Course in I. C. Engines", Dhanpat Rai & Sons
9. V. M. Domkundwar, "A Course in I. C. Engines", Dhanpat Rai & Co.
10. Shrinivasan, "Automobile Engines", Tata McGraw-Hill Publishing House – CBS Publication

Project-Based Learning

Following is the list of Topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To prepare a chart on the performance testing of boilers.
2. To prepare a chart on the comparison of various types of boilers.
3. To prepare a chart on the comparison between open and closed cycle gas turbines.
4. To prepare a chart for comparison among different types of jet engines.
5. To prepare a chart on Battery & coil ignition system, Magneto ignition system, and Electronic ignition system.
6. To prepare a demonstration model of high pressure boiler.
7. To prepare a demonstration model of boiler mounting or a boiler accessory.
8. To prepare a demonstration model of a reciprocating compressor.
9. To prepare a demonstration model of an ignition system.
10. To prepare a demonstration model of Gas Turbines & Jet Propulsion.
11. To prepare a demonstration model of the engine cooling system.
12. To prepare a demonstration model of a lubrication system.

13. To prepare a demonstration model of the governing system.
14. To prepare a chart on the different processes of combustion in IC engines.
15. Case study on different IC Engine systems used in cars available in the market.
16. To prepare a chart on various performance characteristics of IC engines.

Unit Test -

Unit Test-I	Unit- I, II, III

HYBRID AND ELECTRIC VEHICLES

(Course Code: MJ1111404)

Designation of Course	**Hybrid and Electric Vehicles**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- --Hours/ Week	Term Work	-- Marks	--
	Oral/Practical	-- Marks	
	Total	**100 Marks**	**03**

Course Prerequisites: -	The students should know of 1. Basics of Internal combustion engines, 2. Electrical and electronics engineering
Course Objectives:-	To study the basic concepts of 1. Hybrid electric vehicles, vehicle performance, and their drive trains. 2. Electric vehicle architecture design and different energy storage systems.
Course Outcomes: -	The students should be able to– 1. Explain the fundamentals of hybrid and electric vehicles and evaluate their performance under various operating conditions. 2. Explain the concepts and configurations of hybrid electric drive trains and assess their suitability for different applications. 3. Analyze electric vehicle architectures and propose appropriate design choices based on functional requirements. 4. Classify different types of energy storage systems and compare their characteristics for vehicular applications. 5. Explain the construction and working principles of electric drives and evaluate their performance for electric mobility. 6. Explain energy management strategies and examine the Indian and global electric mobility scenario to derive technological insights.

Course Contents

Unit I	**Introduction of Internal Combustion Engines**	**(06 Hrs.)**
Introduction, Classification of I.C. Engines, Engine Components, Terminology of I.C. engine, four stroke S.I. Engines, Valve timing diagram for four stroke S.I. Engine, Four stroke C.I. Engines, Valve timing diagram for four stroke C.I. Engine, Comparison of four stroke S.I. and C.I. Engines.		
Unit II	**Introduction to Hybrid, Electric Vehicles**	**(06 Hrs.)**
History, Components of Electric Vehicle, Comparison with Internal combustion Engine: Benefits and Challenges, EV classification and their electrification levels, EV Terminology. Configurations of Electric Vehicles: Performance of Electric Vehicles		
Unit III	**Drive Trains**	**(06 Hrs.)**
Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains, Torque-Coupling Parallel Hybrid Electric Drive Trains, Speed-Coupling Parallel Hybrid Electric Drive Trains.		
Unit IV	**Electric Vehicle Architecture Design**	**(06 Hrs.)**

Types of Electric Vehicle and components, Electrical protection and system requirement, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle (PHEV, Fuel cell electric vehicle (FCEV), Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles.		
Unit V	**Types of Storage Systems**	**(06 Hrs.)**
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery-based energy storage and its analysis, Fuel Cell-based energy storage and its analysis, Super Capacitor-based energy storage and its analysis, Flywheel-based energy storage and its analysis, Hybridization of different energy storage devices.		
Unit VI	**Electric Drive Trains and Global Scenario**	**(06 Hrs.)**
Basic concept of electric traction, introduction to various electric drive-train topologies, and power flow control in electric drive-train topologies. Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives. Technology Scenario, Market Scenario, Policies and Regulations, Payback and commercial model, Polices in India.		

Project-Based Learning

Following is the list of Topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To prepare a chart on the Components of an Electric Vehicle.
2. To prepare a demonstration model of electric Vehicle terminology.
3. To prepare a demonstration model of Series Hybrid Electric Drive Trains.
4. To prepare a demonstration model of Parallel Hybrid Electric Drive Trains.
5. To prepare a demonstration model of a Photovoltaic solar-based electric Vehicle design / Battery Electric vehicle (BEV)
6. To prepare a chart on Types of Storage Systems
7. Preparing a demonstration model of Storage Systems
8. To prepare a demonstration model of the Configuration and control of DC Motor drives/Induction Motor drives/ Permanent Magnet Motor drives.
9. To prepare a chart on energy management strategies used in hybrid and electric vehicles.
10. Preparing a chart on the comparison of different energy management strategies

Textbooks:

1. R. K. Rajput, Thermal Engineering, Laxmi Publications
2. R. K. Rajput, “Internal Combustion Engines”, Laxmi Publications.
3. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
4. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003

Reference Books:

1. James Larminie, J. Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay, and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
3. Chris MI, M. Abul, and David Wenzhong Gao “Hybrid Electrical Vehicle Principles and

Application with Practical Perspectives."

Unit Tests

Unit Test-I	Unit- I, II, III

Designation of Course	**Machine Design and Analysis-I (Course Code: MJ1111405)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: -02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites: -	1. Computer-Aided Drafting and Visualization 2. Computer-Aided Machine Drawing 3. Strength of Machine Components
Course Objectives: -	1. To study basic concepts of machine design. 2. To design and analyze different types of machine elements 3. To design of machine component for finite and infinite life and subjected to fluctuating load.
Course Outcomes: -	On completion of the course, students will be able to – 1. Explain the fundamental concepts of machine design and evaluate the dimensions of simple mechanical components. 2. Apply the fundamental design principles for shafts, keys, and couplings, and evaluate the associated forces and required dimensions. 3. Explain the design principles of power screws and analyze their performance for various engineering applications. 4. Explain the concept of fluctuating loads and analyze the design of components subjected to variable loading conditions. 5. Explain the design considerations of fasteners and threaded joints and analyze their behavior under different loading conditions. 6. Explain the design concepts of welded joints and evaluate their suitability and performance under different loading conditions.

Course Contents

Unit-I	**Introduction to Design and Design against Static Load**	**(06 Hrs.)**
Introduction to Design: Need for component design, generalized design process, design consideration for casting, machine parts, welded assembly, Introduction to design for manufacture & assembly. Design of simple machine parts - Cotter joint, Knuckle.		
Unit -II	**Shafts, Keys, and Coupling**	**(06 Hrs.)**
Introduction, Transmission Shafts, Shaft Design on Strength Basis, Shaft Design on Torsional Rigidity Basis, ASME Code for Shaft Design **Keys**– Types of keys -Saddle, Sunk, feather, woodruff, square, flat, Kennedy key, key design. Coupling and its classification, Design of rigid flange and bush pin type flexible coupling		
Unit-III	**Power Screws**	**(06 Hrs.)**
Power Screws, Forms of Threads, Multiple Threaded Screws, Terminology of Power Screw, Torque Requirement—Lifting Load, Torque Requirement—Lowering Load, Self-locking Screw, Efficiency of Square Threaded Screw, Efficiency of Self-locking Screw, Overall Efficiency, Coefficient of Friction, Design of Screw Jack.		
Unit-IV	**Design for Fluctuating Loads**	**(06 Hrs.)**

Stress concentration factor and its Reduction, Stress concentration factor for various machine parts, Cyclic stresses, Fatigue and endurance limit, Notch sensitivity, Cumulative Damage in Fatigue, Design for finite, Soderberg, Goodman,

Unit-V	**Threaded Joints**	**(06 Hrs.)**
Basic Types of Screw Fastening, Cap Screws & Setscrews, Bolt of Uniform Strength, Locking Devices, Terminology of Screw Threads, ISO Metric Screw Threads, Bolt under tension, Eccentrically Loaded Bolted Joints in Shear, Eccentric Load Perpendicular to Axis of Bolt, Torque Requirement for Bolt Tightening.		
Unit-VI	**Welded Joints**	**(06 Hrs.)**
Welded Joints- Welding Processes, Strength of Butt and Fillet Joints, Strength of Parallel Fillet Welds, Strength of Transverse Fillet Welds, Axially Loaded Unsymmetrical Welded Joints, Eccentric Load in the Plane of Welds, Welding Symbols.		

Term work

Term work shall consist of the following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Symbolic representation of common machine components using Auto-CAD.
2. Design of machine components such as knuckle joint, cotter joint, and lever (anyone) using CAD software.
3. Design of the coupling system using CAD software.
   Couplings- types of couplings, Design of rigid and flexible couplings.
4. Design of screw jack using CAD software.
5. Design of Mechanical Spring.
   Types of Springs, Terminology of Helical Springs, Styles of End, Stress and Deflection Equations, Series and Parallel Connections, Design of Helical Springs, Multi-Leaf Spring,
6. Riveted Joints
   Types of Rivet Heads and Riveted Joints, Rivet Materials, Types of Failure, Strength Equations, Efficiency of Joint, Caulking and Fullering,

Note: The Design Data Book should be used extensively.

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To develop an Industrial/real-life application demonstration model of different types of Joints. (Cotter joint and knuckle joint)
2. To observe the system where transmission of power takes place through a shaft, Keys, and couplings, like Transmission of power from the motor to the pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the shaft, key, and coupling. To prepare a design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also, to prepare the bill of materials.
1. To develop a demonstration model of different types of couplings.
2. To develop a demonstration model of different types of keys.
3. To observe the system where transmission of power takes place through power Screws. (e.g., Lead screw of lathe, feed screws of machine tools, Clamping screws, Toggle Jack screw, etc.)

Get the required information regarding effort, clamping force, etc., and select suitable materials for designing the screw, nut, and different simple components in assembly. To prepare a design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also, to prepare the bill of materials.

4. To develop demonstration models of different types of springs.
5. To develop demonstration models of different types of threaded joints.
6. To develop demonstration models of different types of fasteners.
7. To develop demonstration models of different types of welded joints.
8. To develop demonstration models of different types of riveted joints.

Textbooks

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw-Hill Publication Co. Ltd.
2. R. S. Khurmi and J.K. Gupta "Machine Design", S Chand Publication.
3. Shigley J. E. and Mischke C. R., "Mechanical Engineering Design", McGraw-Hill Publication Co. Ltd.
4. Spotts M. F. and Shoup T.E., "Design of Machine Elements", Prentice Hall International.

Reference Books

1. Black, P.H., and O. Eugene Adams, "Machine Design", McGraw-Hill Book Co. Inc.
2. Willium C. Orthwein, "Machine Components Design", West Publishing Co. and Jaico Publications House.
3. Hall A. S., Holowenko A. R., and Laughlin H. G., "Theory and Problems of Machine Design", Schaum's Outline Series.
4. Sharma C. S. and Purohit Kamlesh, "Design of Machine Elements", PHI Learning Pvt. Ltd.
5. D. K. Aggarwal & Sharma P. C., "Machine Design", S.K. Kataria and Sons
6. Gope P. C., "Machine Design: Fundamentals and Applications", PHI Learning Pvt. Ltd.
7. "Design Data- P. S. G." College of Technology, Coimbatore.
8. V. B. Bhandari, "Design Data Book", Tata McGraw-Hill Publication Co. Ltd.

Unit Tests

Unit Test-I	Unit I, II, III

Designation of Course	Solid Modelling (Course Code: MJ1111406)		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Practical:- 02 Hours/Week	Term Work and Practical	25 Marks	01
	Total	**25 Marks**	**01**

Course Prerequisites: -	1. Computer-Aided Drafting and Visualization 2. Computer-Aided Machine Drawing
Course Objectives: -	1. To introduce students to the basic concepts of CAD modelling. 2. To develop the skills in Reading and Interpretation of Engineering Drawings. 3. To familiarize students with SolidWorks Software to create 2D and 3D models, assemblies, Drafting, and Sheet metal modelling.
Course Outcomes: -	On completion of the course, students will be able to– 1. Interpret and explain the fundamental concepts of CAD modelling. 2. Develop accurate 2D sketches of machine components using SolidWorks Software. 3. Construct parametric 3D models of machine components using SolidWorks Software. 4. Create complete 3D assembly models of machine components using SolidWorks Software. 5. Assemble machine components and *evaluate* the fit, motion, and constraints using SolidWorks Software. 6. Generate detailed engineering drawings and prepare a comprehensive Bill of Materials (BOM) using SolidWorks Software.

Course Contents

Unit-I	**Introduction to CAD**	**(02Hrs.)**
Introduction to CAD and CAE Features of SolidWorks, Various products available in SolidWorks for Product Design, Simulation, Communication, SolidWorks Graphical User Interface - Feature manager design tree, Callouts, Handles, Confirmation corner, mouse buttons, keyboard shortcuts, Command Manager.		
Unit-II	**Basic Part Modelling**	**(02 Hrs.)**
Sketch Entities, Sketch Tools, Block, Relation, and Dimensioning, fully defined, over-defined, under under-defined drawing.		
Unit-III	**Part Modelling - I**	**(02 Hrs.)**
Part Modelling Tools, Creating Extrude features, Creating Revolve features, Creating Swept features, Creating Loft features. Creating Reference, creating curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern, and advanced modelling tools.		
Unit-IV	**Part Modelling - II**	**(02 Hrs.)**
Part Modelling Tools, creating curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern, and advanced modelling tools.		
Unit-V	**Assembly Modelling**	**(02 Hrs.)**
Introduction to Assembly Modelling & Approaches, Applying Advanced Mates and Mechanical Mates, Manipulating Components, Creating Patterns, and Creating Explode Views.		
Unit-VI	**Drafting of Mechanical Systems**	**(02 Hrs.)**
Generating Views, Creating Dimensions, Inserting Annotations, and Bill of Materials.		

Term Work

Term work shall consist of A-2/A4 size printouts of the problems solved in practical using Solid Works Software.

1. Introduction to CAD drawing
2. Sketcher drawings
3. Part modelling
4. Assembly Modelling
5. Exploded view of Assembly
6. Drafting of Mechanical Systems

Text Books

1. Kuang-Hua Chang, "Motion Simulation and Mechanism Design with SOLIDWORKS Motion 2018", SDC Publishers, 2018

Reference Books

1. Ibrahim Zeid and R. Siva-Subramaniam – "CAD/CAM- Theory and Practice", Tata McGraw-Hill Publishing Co., 2009.
2. Rao P. N., "CAD/CAM", Tata McGraw-Hill.
3. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", Second edition, Addison–Wesley, 2000.
4. Martenson, E. Michael, "Geometric Modelling", John Wiley & Sons, 1995.
5. Ronald E. Barr, Davor Juricic, Thomas J. Krueger, "Engineering & Computer Graphics Workbook Using SolidWorks 2014", SDC Publication, 2014.
6. John Willis, Sandeep Dogra, "SOLIDWORKS 2019: A Power Guide for Beginners and Intermediate Users", published by CAD Artifex, 2019.

End Semester Practical/Oral examination:

1. Practical examination duration is two hours, based on the Term work.
2. Questions provided for practical examination should contain a minimum of five and not more than ten parts.
3. Evaluation of practical examination to be done based on the performance of students' work in the laboratory.

***Oral examination should also be conducted to check the knowledge of conventional and SolidWorks drawing.**

Bharati Vidyapeeth
(Deemed to be University)
College of Engineering, Pune

B. Tech. Sem. IV **Course Designation: - Indian Knowledge System** **(Course Code: AC1113407)**		
TEACHING SCHEME:	**EXAMINATION SCHEME:**	**CREDITS ALLOTTED:**
Theory: 02	End Semester Examination: --	Credits: 02
Practical: 00	Internal Assessment: 50 Marks	
Tutorial: 00		
		Total Credit: 02

Course Objectives:	
1.	To sensitize the students about Indian culture and civilization, including its Knowledge System and Tradition.
2.	To help students interpret the knowledge, art, and creative practices, skills, and values in the ancient Indian system
3.	To help study the enriched scientific Indian heritage.
4.	To introduce the contribution from the Ancient Indian system & tradition to modern science & Technology

Course Outcomes:	On completion of the course, students will be able to – 1. Explain and interpret the fundamental concepts of the Indian Knowledge System and their relevance in contemporary contexts. 2. Analyze and evaluate India's contributions to philosophy and literature, highlighting their enduring significance. 3. Examine and illustrate India's involvement in mathematics and astronomy, demonstrating its impact on global scientific development. 4. **Assess** and compare India'**s** role in medicine and yoga, emphasizing traditional practices and their modern applications. 5. Critically appraise India's influence on Sahitya, identifying key texts, themes, and cultural implications. 6. Interpret and differentiate among various concepts of Indian Shastra, establishing connections with modern knowledge frameworks.

UNIT – I	**Introduction to the Indian Knowledge System**	**(04 Hours)**
	Definition, Concept, and Scope of IKS, IKS-based approaches on Knowledge Paradigm, IKS in ancient India, and in modern India	
UNIT – II	**Philosophy and Literature**	**(04 Hours)**

	Contributions by Maharishi Vyas, Manu, Kanad, Pingala, Parasar, Banabhatta, Nagarjuna, and Panini in Philosophy and Literature	

UNIT - III	**Mathematics and Astronomy**	**(04 Hours)**
	Contribution of Aryabhatta, Mahaviracharya, Bodhayan, Bhashkaracharya, Varahamihira and Brahmgupta in Mathematics and Astrononmy	
UNIT - IV	**Medicine and Yoga**	**(04 Hours)**
	Major contributions of Charak, Susruta, Maharishi Patanjali and Dhanwantri in Medicine and Yoga	
UNIT -V	**Sahitya**	**(04 Hours)**
	Introduction to Vedas, Upvedas, Upavedas (Ayurveda, Dhanurveda, Gandharvaveda) Puran and Upnishad) and shad darshan (Vedanta, Nyaya.Vaisheshik, Sankhya, Mimamsa, Yoga, Adhyatma, and Meditation)	
UNIT - VI	**Shastra**	**(04 Hours)**
	Introduction to Nyaya, vyakarana, Krishi, Shilp, Vastu, Natya and Sangeet	
Reference Books		

1. Textbook on IKS by Prof. B Mahadevan, IIM Bengaluru
2. Kapur K and Singh A.K (Eds) 2005). Indian Knowledge Systems, Vol. 1. Indian Institute of Advanced Study, Shimla. Tatvabodh of sankaracharya, Central chinmay mission trust, Bombay, 1995.
3. The Cultural Heritage of India. Vol.I. Kolkata: Ramakrishna Mission Publication, 1972.
4. Nair, Shantha N. Echoes of Ancient Indian Wisdom. New Delhi: Hindology Books, 2008.
5. Dr. R. C. Majumdar, H. C. Raychaudhuri and Kalikinkar Datta: An Advanced History of India (Second Edition) published by Macmillan & Co., Limited, London, 1953.
6. Rao, N. 1970. The Four Values in Indian Philosophy and Culture. Mysore: University of Mysore.
7. Avari, B. 2016. India: The Ancient Past: A History of the Indian Subcontinent from c. *7000* BCE to CE 1200. London: Routledge.
8. Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan,
9. History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha et al. National Academy of Sciences, India, and The Ramkrishan Mission Institute of Culture, Kolkata (2014).
10. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).
11. Vedic Physics by Keshav Dev Verma, Motilal Banarsidass Publishers (2012).
12. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010).
13. Kapoor, Kapil, Avadesh Kr. Singh (eds.) *Indian Knowledge Systems* (Two Vols), IIAS, Shimla, 2005

Designation of Course	**Social Activities (Course Code: CC1111408)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - - Hours/ Week	End Semester Examination	-- Marks	02
Practical: -- Hours/Week	Internal Assessment	-- Marks	
	Term Work and Oral	-- Marks	-
	Total	**-- Marks**	**02**

Course Contents

Students should participate in at least **TWO** activities from the list below.

1. Volunteer work
2. Community clean-up events
3. Fundraising for charitable organizations
4. Hosting awareness campaigns
5. Participating in marches or protests for social justice
6. Organizing food or clothing drives for those in need
7. Advocacy for environmental conservation
8. Peer support groups for mental health or addiction recovery
9. Organizing blood drives or bone marrow registry events
10. Visiting nursing homes or shelters to spend time with residents or animals
11. Participating in cultural exchange programs
12. Supporting initiatives for gender equality and women's rights
13. Creating art installations or performances that address social issues
14. Participating in political activism and lobbying for policy change.
15. Participating in NSS Social Activities.

**Social Activities are not limited to those listed above*

Course Structure and Syllabus for

Minor Degree Programme: 3D Printing

(CBCS 2023 Course) As per NEP 2020 Guidelines

Sr. No	Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	PR	OR	Total	TH	Pr /Or	Tut	Total
1.	MI1111301	Sem.- III Materials & Manufacturing Processes for 3D Printing	3	2	0	60	40	25	-	25	125	3	1	-	4
2.	MI1111401	Sem.- IV Modelling for 3D Printing	3	2	0	60	40	25	-	25	125	3	1	-	4
3.	MI1111501	Sem.- V 3D Printing Technology & Processes	3	2	0	60	40	25	-	25	125	3	1	-	4
4.	MI1111601	Sem.- VI Design for Additive Manufacturing	3	2	0	60	40	25	-	25	125	3	1	-	4
5.	MI1111602	Sem.- VI **Project**	-	4	-	-	-	50	-	50	100	-	4	-	4
		Total	**12**	**12**	**0**	**240**	**160**	**150**	**0**	**150**	**700**	**12**	**8**	**0**	**20**

Designation of Course	**Materials and Manufacturing Processes for 3D Printing (Course Code: MI1111301)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: -03 Hours/Week	End Semester Examination	60 Marks	03
Term Work:-2 Hours/Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites:-	The student should have basic knowledge of 1. Knowledge of basic concepts of Physics and Chemistry 2. Basic knowledge of Engineering materials and their properties 3. Basic knowledge of cutting tools
Course Objectives:-	The student should acquire the knowledge of 1. To acquire the knowledge of Material science and power metallurgy. 2. To acquire the knowledge of lathe, drilling, milling, and abrasive machining. 3. To acquire the knowledge of CNC Technology
Course Outcomes:-	On completion of the course, students will be able to – 1. Analyse the fundamentals of engineering materials and evaluate their characteristics. 2. Explain the concept of powder metallurgy and apply it to manufacture engineering components. 3. Compare various casting processes and select the most suitable process for a specific product. 4. Examine different operations of the lathe, drilling, and milling machines and employ them to create a given job. 5. Analyse various grinding and plastic moulding machines and utilise them to produce the required shape. 6. Evaluate various additive manufacturing processes and apply them for the effective manufacturing of components.

Course Contents

Unit-I	**Study of Engineering materials and their properties**	**(06 Hrs.)**
Classification of Engineering materials, Introduction to ferrous and non-ferrous materials, Study of plastics and polymers, elastomers rubbers. Ceramic materials, study of composite materials. Mechanical properties of different materials.		
Unit-II	**Introduction to Powder Metallurgy**	**(06 Hrs.)**
Introduction to Powder Metallurgy, Advantages and limitations of powder metallurgy, Production of metal powder, Characteristics of powder, Powder conditioning, Powder Compacting, Hot compacting methods, Sintering and sintering furnaces,		
Unit-III	**Casting Processes**	**(06 Hrs.)**
Introduction to casting, Pattern and pattern making, Core and core making-–Introduction, Core making Procedure, Types of cores, Core print, Core boxes. Mould and mould making- Moulding Methods. Sand Casting, Pressure and gravity die casting, Shell mould casting, Investment casting, Continuous casting, centrifugal casting, Applications, Merits, and limitations.		
Unit-IV	**Machining Processes**	**(06 Hrs.)**

Lathe Machines: Introduction, function, types, construction, accessories, operations. Drilling Machines: Fundamentals of drilling process Milling Machines: Fundamentals of milling process, cutters-types and geometry, Operations performed on milling machines. Evolution of CNC		
Principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines, and CNC controllers. CNC Programming: Coordinate system, structure of a part program, G & M Codes.		
Unit-V	**Abrasive Machining Processes, Plastics & Plastic Moulding**	**(06 Hrs.)**
Abrasive Machining Processes: Abrasive machining, abrasives -types, size, and geometry, Grinding, grinding wheels. Types of grinding machines, **Plastics & Plastic Moulding:** Moulding characteristics of plastic, Moulding process- compression, transfer, and injection blow moulding. Mould design- Materials and construction, bulk factor, shrinkage, moulding parameters, moulding machines, extruders.		
Unit-VI	**Additive Manufacturing**	**(06 Hrs.)**
Introduction to Additive manufacturing, Different types of Additive manufacturing processes, 3D Printing technology, FDM and SLA processes, working principle, Applications, introduction to Stereo lithography Apparatus, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Overview & Introduction of AM.		

Project-Based Learning

Students can do the following small working models as PBL.

1. Anyone casting the component from non-ferrous alloys and doing the different types of machining on it.
2. Take raw materials and do the different machining operations to produce the finished product.
3. Prepare a green compact from metallic powder and do sintering to produce a component using from powder metallurgy technique
4. Prepare plastic mounding component from raw materials
5. Prepare the 3D printing component by use of FDM or SLA processes.

List of Practicals:

1. Testing of mechanical properties such as Tensile strength
2. Testing of Hardness and Impact Strength
3. Demonstration and Practical on powder compacting processes
4. Demonstration and Practical Casting Processes
5. Study on lathe and other machining processes
6. Demonstration and Practical on milling and drilling
7. Demonstration and Practical on grinding operations
8. Demonstration and Practical on plastic molding.
9. Demonstration and Practical on 3D printing

Text Books

1. "Material Science and Engineering", R K Rajput, S K Kataria, and Sons Publication, Delhi.
2. P. C. Sharma, Production Engineering, S. Chand Publications
3. R. K. Jain, Production Technology, Khanna Publishers
4. P.Radhakrishnan, V.Raju, CAD/CAM/CIM, New Edge International Publishers.

Reference Books

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw-Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technology, Vol. II, McGraw-Hill Education (India) Private Limited
3. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
4. E. P. DeGrmo, J. T. Black, and A. Kosher, Material and processes in manufacturing, PHI
5. Additive Manufacturing Technologies (Authors: Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani)
6. "Material Science and Physical Metallurgy", Dr. V. D. Kodgere, Everest Publication, Pune.
7. "Physical Metallurgy", S H Avner, McGraw-Hill Publication.
8. "Material science and metallurgy", O P Khanna, Khanna Publication, Delhi.

Unit Test

Unit Test-I	Unit- I, II, III

Designation of Course	**Modelling for 3D Printing (Course Code: MI1111401)**		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory :- 03 Lecture	Theory Exam	60 Marks	03
Practical:- 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites: -	1. Solid Modeling 2. Machine design and Analysis 3. Computer-Aided Machine Drawing
Course Objectives: -	1. To introduce students to the basic concepts of 3D printing. 2. To develop skills in Reading and interpreting Engineering Drawings for 3D printing. 3. To familiarize students with SolidWorks Software to create 2D and 3D models, Assembly, Drafting, and Sheet metal modelling are required for 3D printing.
Course Outcomes: -	On completion of the course, students will be able to: 1. Analyze and interpret the concepts of additive manufacturing and 3D printing. 2. Analyze the fundamental principles of machine component design to support engineering decision-making. 3. Apply and evaluate geometric dimensioning and tolerancing concepts in preparing machine drawings for 3D printing. 4. Analyze and develop detail and assembly drawings as per engineering standards. 5. Create accurate 2D drawings of machine components using SolidWorks software. 6. Create 3D models of machine components using SolidWorks software and analyze the data preparation requirements for 3D printing.

Course Contents

Unit-I	**Introduction to 3D Printing**	**(06 Hrs.)**
Introduction to 3D printing, Definition, 3D Printer, 3D Printing Technology, Process of 3D printing, Applications of 3D Printing, 3D Printing examples, 3D Printing advantages Additive manufacturing, Photopolymerization, 3D slicing, STL file configuration,		
Unit-II	**Design of a component for 3D printing**	**(06 Hrs.)**
Introduction to machine design, Design procedure, Design consideration for casting, forging, and machining, Design for manufacture and assembly. Selection of material.		
Unit-III	**Geometric Dimensioning and Tolerancing (GD & T)**	**(06 Hrs.)**
Limit, Fit and tolerances: Introduction, fundamental tolerances, deviations, methods of placing limit dimensions, types of fits with symbols and applications, Geometric tolerance on drawing.		
Unit-IV	**Assembly and Details Drawing**	**(06 Hrs.)**
Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details, and vice versa. Types of drawing: Machine drawing, production drawing, drawing for a catalogue. Drawing standards.		
Unit-V	**Drawing for 3D printing using CAD software**	**(06 Hrs.)**
Sketch Entities, Sketch Tools, Block, Relation, and Dimensioning, fully defined, over-defined, under under-defined drawing. Part Modelling Tools, Features: Extrude, Revolve, Swept, Loft. Creating Reference, curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern, and advanced modelling tools.		

Unit-VI	Part Modelling using CAD software	(06 Hrs.)
Part Modelling Tools, creating curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern, and advanced modelling tools. **Data Preparation for 3D Printing:** 3D Printing interfaces, STL interface Specification, Creating STL file, Repair of STL files, STL data Manipulation-Advantages and limitations of STL file format. Part orientation and support generation-Model Slicing and Contour Data organization, Direct and adaptive slicing: Identification of peak features-Tool Path generation		

Project Based Learning:

Students are encouraged to do mini projects or a working models by using the above knowledge.

Term Work

Term work shall consist of:

1. Case study on 3D printing technology, Type of 3D Printer.
2. Detail assignment on basic design concepts.
3. Problems based on limits, fit, and tolerances.
4. Detail to assembly drawing of simple machine components.
5. Assembly to detail drawing of simple machine components.
6. Sketcher drawings using Solid Modeling software
7. Part modelling using Solid Modeling software.
8. Data preparation for 3D printing for a simple machine component.

Text Books

1. Kuang-Hua Chang, "Motion Simulation and Mechanism Design with SOLIDWORKS Motion 2018", SDC Publishers, 2018
2. KHURM, R. (2005). Machine design.

Reference Books

1. Ibrahim Zeid and R. Siva-Subramaniam – "CAD/CAM- Theory and Practice", Tata McGraw-Hill Publishing Co., 2009.
2. Kumar, L. J., Pandey, P. M., & Wimpenny, D. I. (Eds.). (2019). 3D printing and additive manufacturing technologies (Vol. 311). Singapore: Springer.
3. Rao P. N., "CAD/CAM", Tata McGraw-Hill.
4. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", Second edition, Addison–Wesley, 2000.
5. Martenson, E. Michael, "Geometric Modelling", John Wiley & Sons, 1995.
6. Ronald E. Barr, Davor Juricic, Thomas J. Krueger, "Engineering & Computer Graphics Workbook Using SolidWorks 2014", SDC Publication, 2014.
7. John Willis, Sandeep Dogra, "SOLIDWORKS 2019: A Power Guide for Beginners and Intermediate Users", published by CAD Artifex, 2019.

***Oral examination should also be conducted to check the knowledge of conventional and SolidWorks drawing.**

Course Structure and Syllabus for

Minor Degree Programme: Energy Engineering

(CBCS 2023 Course) As per NEP 2020 Guidelines

Sr. No	Course Code	Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	PR	OR	Total	TH	Pr /Or	Tut	Total
1.	MI1111302	Sem.- III Fundamentals of Energy Engineering	3	2	0	60	40	25	-	25	125	3	1	-	4
2.	MI1111402	Sem.- IV Non-Renewable Energy Technologies	3	2	0	60	40	25	-	25	125	3	1	-	4
3.	MI1111502	Sem.- V Renewable Energy Technologies	3	2	0	60	40	25	-	25	125	3	1	-	4
4.	MI1111602	Sem.- VI Energy Audit and Management	3	2	0	60	40	25	-	25	125	3	1	-	4
5.	MI1111603	Sem.- VI Project	-	4	-	-	-	50	-	50	100	-	4	-	4
		Total	**12**	**12**	**0**	**240**	**160**	**150**	**0**	**150**	**700**	**12**	**8**	**0**	**20**

Designation of Course	**Fundamentals of Energy Engineering (Course Code: MI1111302)**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites:	1. Engineering Mathematics. 2. Engineering Physics.
Course Objectives: -	To provide knowledge about 1. Laws of thermodynamics & their applications. 2. Properties of pure substances & vapor processes. 3. Fuels and concepts of combustion.
Course Outcomes: -	On completion of the course, students will be able to– 1. Explain and evaluate the concepts of the first law of thermodynamics and its engineering applications. 2. Explain and assess the second law of thermodynamics, entropy, and availability for thermodynamic analysis. 3. Apply and differentiate the properties of steam for various vapor processes. 4. Apply and evaluate the properties of steam for different power cycles. 5. Examine and analyze various air-standard cycles for performance assessment. 6. Examine the different types of fuels and combustion concepts, and analyze exhaust gas composition.

Course Contents

Unit-I	**Laws of Thermodynamics**	**(06 Hrs.)**
Thermodynamics-introduction, energy and work transfer, zeroth law of thermodynamics, statement of first law of thermodynamics, Joule's experiment, Applications of first law to flow and non-flow processes. Steady flow energy equation and its applications to different devices. Perpetual Motion Machine of the first kind (PMM-I). Limitations of the first law of thermodynamics. Kelvin-Planck's statement & Clausius' statements for the 2nd law of thermodynamics, Heat engine, refrigerator, and heat pump, Perpetual Motion Machine of the second kind (PMM-II), Carnot cycle & Carnot heat engine.		
Unit-II	**Properties of Fluids and Gas Processes**	**(06 Hrs.)**
Definition of fluid, fluid properties *viz.* mass density, specific weight, specific volume, specific gravity, viscosity, vapor pressure, compressibility, elasticity, surface tension, and capillarity. Equation of state. Non-flow and steady flow gas processes, Constant pressure process, Constant volume process, Constant temperature process, Isentropic process, Polytrophic process, Hyperbolic process, work transfer & heat transfer during various processes.		
Unit-III	**Introduction to Heat Transfer**	**(06 Hrs.)**
Statement and explanation of Fourier's law of heat conduction. Conducting and insulating materials and their properties. Composite slab, Electrical analogy. Newton's law of cooling, Natural and forced convection- applications. Types of fins. Heat exchangers classification and applications. Stefan Boltzmann's law. Concept of shape factor.		
Unit-IV	**Energy-producing devices**	**(06 Hrs.)**

Internal Combustion Engines: Two stroke, Four Stroke Cycles, Construction and working of C.I. and S.I. Engines. Modern trends in IC engines. Impulse momentum principle, Impact of jet, Hydraulic turbines: Impulse & reaction water turbines. Steam turbines and gas turbines: Impulse & reaction. Steam generators. (Theoretical study using schematic diagrams)

Unit-V	**Energy Absorbing Devices**	**(06 Hrs.)**
Vapor compression and vapor absorption refrigeration systems, household refrigerators, and window air conditioners. Reciprocating and rotary compressors and pumps, Blowers, Fans (Theoretical study using schematic diagrams)		
Unit-VI	**Introduction to energy technologies**	**(06 Hrs.)**
Renewable and nonrenewable, solar flat plate collectors, Wind, Geothermal, Wave, Tidal, Hydro power, Bio-gas, Bio-Diesel, Nuclear power. (Theoretical study using schematic diagrams), Current Energy Scenario.		

Text Books

1. V. P. Vasandani and D. S. Kumar, Heat Engineering, Metropolitan Book Company, New Delhi.
2. R.S. Khurmi and J K Gupta, Textbook of Thermal Engineering, S Chand publications.

Reference Books

1. P. K. Nag, Engineering Thermodynamics, Tata McGraw-Hill Publications.
2. Y. A. Cengel & M.A. Boles, Thermodynamics -An engineering approach, Tata McGraw-Hill Publications.
3. Rayner Joel, Engineering Thermodynamics, ELBS Longman.
4. R. K. Rajput, Engineering Thermodynamics, Laxmi Publications.
5. Kothandarman& S. Domkundwar, "Thermal Engineering" Dhanpat Rai and Sons.
6. P. L. Ballaney, Thermal Engineering, Khanna Publications.

Project-Based Learning

Topics for project-based learning based on the syllabus contents

1. Preparing a demonstration model of a Heat Pump
2. Preparing a demonstration model of a refrigerator
3. Preparing a demonstration model of a Heat Exchanger.
4. Preparing a demonstration model of the types of fin
5. Preparing a demonstration model of I.C. Engines
6. Preparing a demonstration model of a Steam Turbine
7. Preparing a demonstration model of a Gas Turbine
8. Preparing a demonstration model of the Impulse Turbine
9. Preparing a demonstration model of the Francis Turbine
10. Preparing a demonstration model of the Kaplan Turbine
11. Preparing a demonstration model of the Vapor Absorption refrigeration system
12. Preparing a demonstration model of the Vapor Compression refrigeration system
13. Preparing a demonstration model of a window air conditioning system

List of Practical:

1. To demonstrate the steady flow energy equation for engineering applications such as heat Exchangers, turbo machinery, boilers, etc.
2. To determine the viscosity of fluid.
3. To demonstrate the second law of thermodynamics through a real-life application. (Kelvin-Planck's statement)
4. Demonstration of the second law of thermodynamics through real real-life application. (Clausius statement)
5. Demonstration of a stroke and a stroke engine
6. Demonstration of pumps and compressors
7. Study of domestic refrigerator & window air-conditioner
8. Study and trial on the bomb calorimeter
9. Trial on Vapor Compression Refrigeration Systems

Unit Test

Unit Test-I	Unit- I, II, III

Designation of Course	Non-Renewable Energy Technologies (Course Code: MI1111402)		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work & Oral	50 Marks	01
	Total	**150 Marks**	**04**

Course Prerequisites :-	1. Mechanical Engineering System. 2. Thermodynamic principles 3. Thermodynamic Applications
Course Objectives: -	1. To explain the concepts of different types of Power Plants 2. To study and analyze different types of Steam Condensers, Cooling Towers.
Course Outcomes: -	On completion of the course, students will be able to – 1. Analyze the fundamentals and operating principles of boilers. 2. Examine and explain the functional components and processes of a thermal power plant. 3. Evaluate the fundamental working cycles and performance aspects of gas power plants. 4. Assess the principles, safety considerations, and operational characteristics of nuclear power plants. 5. Analyze the design features, classifications, and performance parameters of heat exchangers. 6. Evaluate the economic factors, cost components, and performance indicators involved in power plant economics.

Unit No. -I	**Boiler, Mountings and Accessories**	**(6 Hrs.)**
Introduction, Classification of boilers, Features of Low- and high-pressure boilers, construction and working of boilers, Fluidized bed combustion, boiler mountings and Accessories. Heat balance analysis.		
Unit No.-II	**Steam Power Plant:**	**(6 Hrs.)**
Introduction, Steam Power Plant, Thermal Power Plant, Construction and Working, Role of thermal power plant in current power generation scenario, Selection of site for thermal power plant. Basic Rankine cycle.		
Unit No. -III	**Gas Power Plant**	**(6 Hrs.)**
Introduction, Components of Gas Turbine Power plants, Simple gas turbine power Plant, Classification of Gas turbines, Advantages of Gas turbine, Brayton cycle, Jet Engines		
Unit No.-IV	**Nuclear Power Plant**	**(6 Hrs.)**
Basic Principles of Nuclear Energy, Nuclear Reactor, Nuclear Power Plants, Nuclear Power-Radioactivity, Working of a nuclear power plant, PWR, BWR, and gas cooled reactors, Advantages and Disadvantages of Nuclear Power Plant.		
Unit No. -V	**Heat Exchangers used in Power Plants and Instrumentation**	**(6 Hrs.)**

Classification of Heat Exchangers, Types of Condensers, Types of Cooling Towers, Construction and Working, Advantages and Disadvantages. Instruments: Drum level Controls, Main Steam Temperature Control, Combustion Control, Measuring Instruments (Temperature, pressure, Velocity, Fluid flow)		
Unit No.-VI	**Power Plant Economics**	**(6 Hrs.)**
Power Plant Economics - Cost of electric energy, fixed and operating costs, energy rates, types tariffs, economics of load sharing, Load Curves, Load duration Curves, types of load and their characteristics, performance and operational characteristics of power plants,		
comparison of various power plants, Energy, Economic and Environmental issues of Power plants, Emission norms for power plants.		

Term work:

1. Study of Different types of boilers
2. Study of Boiler Mountings and Accessories
3. Study of Steam Power Plant
4. Study of Thermal Power Plant
5. Study of a Nuclear power plant
6. Study of Power Plant Instrumentation.
7. Study of Heat Exchangers used in Power Plant
8. Visit to the power plant.
9. Case Study on Plant Safety and Maintenance
10. Case Study on Economic and Environmental issues of Power plants

Project-Based Learning

Following is the list of Topics for project-based learning (Not Limited to) based on the syllabus Contents:

1. Preparing a chart on a Thermal Power Plant
2. Preparing a chart on Steam Condenser and Cooling Towers
3. Preparing a demonstration model of a Thermal Power Plant
4. Preparing a demonstration model of Gas Power Plants
5. To prepare a demonstration model of the Steam Condenser
6. Preparing a demonstration model of Cooling Towers
7. Case study on Thermal Power Plant
8. Case study on Gas Power Plants

Text Books:

- Modern Power Station Practice, Vol 6, Instrumentation, Controls and Testing, Pergamon Press, Oxford, 1971.
- John V Grimaldi and Rollin H Simonds, Safety Management
- M. M. El Wakil, Power Plant Technology –McGraw-Hill. Int. Edition.
- Domkundwar and Arora, Power Plant Engineering, Dhanpatrai and Sons.

Reference Books

- Grainger John J, and Stevenson Jr. W.D. Power System Analysis, McGraw-Hill Hill 1994
- L. K. Kirchmeyer, Economic Operation of Power Systems, John Wiley and Sons, 1993.
- C. A. Gross, Power System Analysis, John Wiley and Sons, Inc., 1986.
- John Weisman & L.E. Eckart, Modern Power Engineering, Prentice Hall, 1985
- A course on Power Plant Engineering Ramlingam SCITECH Publication
- S. P. Sukhatme, Solar Energy, Tata McGraw-Hill, 3rd Edition, 1996.

- G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 2011
- P. K. Nag, Power Plant Engineering, TMH, 3rd Edition 2002

Unit Test –

Unit Test-I	Unit- I, II, III

B. Tech. – (All branches)

(I) Theory

(A) Theory Examination

Theory examination consists of: (i) End semester examination (ESE), and (ii) Internal assessment (IA).

(i) ESE is of 60 marks for theory courses.

(ii) The existing internal assessment system, totaling 40 marks, currently utilizes two components: a Unit Test and Project-Based Learning (PBL), each allocated 20 marks. To further enhance the teaching-learning experience, the following additional innovative assessment tools will be incorporated into the current framework. These additions are intended to improve the assessment of student learning outcomes and ensure thorough syllabus coverage through engaging and effective methods.

a) Poster presentation

b) Quiz

c) Case study

d) Presentation/Seminar

e) Open-book test

f) Assignment

g) MCQ

h) Modelling

i) Group discussion

j) Role play

k) Term paper/Review

paper Note

1. Each semester shall include two Internal Assessments: Internal Assessment–I and Internal Assessment–II.
2. Internal Assessment–I will be based on Units I, II, and III, while Internal Assessment–II will cover Units IV, V, and VI.
3. It is mandatory to categorize the courses within each discipline into appropriate groups based on their nature. For each group, a set of 2 to 4 suitable assessment tools shall be identified and used for evaluation.
4. The Course Coordinator shall prepare a unit-wise plan for conducting the Internal Assessments

using the selected tools and submit it to the Head of the Department before the commencement of the academic term. A maximum of 2–3 tools may be selected for each course.

5. The Course Coordinator is also responsible for maintaining proper documentation of the Internal Assessments and shall submit the same to the Head of the Department at the end of the semester, if required.

6. All Internal Assessments must be designed, conducted, and evaluated in alignment with the appropriate levels of Bloom's Taxonomy.

(B) Standard of Passing

(i) There is a separate passing of 40% of 60 marks, i.e., 24 marks, for ESE for a given course.

(ii) There is a separate passing of 40% of 40 marks, i.e., 16, for IA for a given course.

(iii) A candidate who fails at ESE in a given course has to reappear only at ESE as a backlog candidate and clear the head of passing. Similarly, a candidate who fails at IA in a given course has to reappear only at IA as a backlog candidate and clear the head of passing

(II) Practical

(A) Practical Examination

Practical examination consists of: (i) Term work, and (ii) Practical/Oral examination for a given course.

(i) Term work (TW): TW marks are as mentioned in the curriculum structure.

(ii) Practical/Oral (PR/OR): PR/OR marks are as mentioned in the curriculum structure.

(B) Conduction of practical/oral examination

(i) A candidate will be permitted to appear for the practical/oral examination only if he/she submits the term work of a given course.

(ii) Practical/oral examinations shall be conducted in the presence of internal and external examiners appointed by the university.

(C) Standard of Passing

(i) A candidate shall pass both TW and PR/OR separately with a minimum of 40% of the total marks of the respective heads.

(III) MOOC and Social Activity Course

(i) If a student completes one MOOC during a programme, he/ she will earn an additional TWO credits, subject to submission of the certificate of completion of the respective courses. A student must complete at least two MOOCs to obtain a degree in each discipline. Students shall register for MOOCs which are offered by any one of the following agencies:

(a) SWAYAM: www.swayam.gov.in

(b) NPTEL: www.onlinecourse.nptel.ac.in

(c) Course Era: www.coursera.org

(d) edX online learning: www.edx.org

(e) MIT Open Course ware : www.ocw.mit.edu

(f) Udemy: www.udemy.com

(g) Spoken tutorial: www.spoken-tutorial.org

(ii) If a student completes a social activity, he/she will earn an additional TWO credits, subject to submission of the certificate of completion of the respective course/ activity from the relevant authorities. A student must complete at least one social activity to obtain a degree in each discipline.

(iii) The additional credits for MOOC and Social Activity will be given only after verification of the authentic document by the Head of the Department, and a separate mark-sheet will be submitted by the Head of the Department along with the course examiner.

(IV) Value Added Course (VAC) and Indian Knowledge System (IKS) Course

(i) The VAC and IKS courses are mandatory and must be passed by students during the designated semester to earn two credits.

(ii) These courses have an internal assessment worth 100 marks, which is distributed as follows: (a) three assignments, each worth 20 marks, and (b) two case studies, presentations, or quizzes, each worth 20 marks. Faculty members have the flexibility to choose between conducting two case studies, two presentations, two quizzes, or any combination thereof.

(V) Minor Programme

(i) A student shall receive a MINOR degree when he/she acquires an additional 20 credits in a given specialization defined by the UG programmes offered at the institute.

(ii) The theory and practical/oral components for a given course are mentioned in the curriculum structure. The theory and examination for a given course are mentioned in Sections I and II.

(iii) The grade point, grade letter, and equivalent marks system for the MINOR programme are mentioned in Section V.

(iv) The MINOR DEGREE programme is OPTIONAL. The interested students may opt MINOR programme.

(v) A student shall complete the MINOR program before his/her graduation.

(VI) A. T. K. T

(i) A student who is granted a term for B. Tech. Semester I, III, V, VII will be allowed to keep the term for his/her B. Tech. Semester-II, IV, VI, VIII examination, respectively, even if he/she appears

and fails or does not appear at the B. Tech. Semester I, III, V, VII examination respectively.

(ii) A student shall be allowed to keep the term for the B. Tech. Semester-III course if he/she has a backlog of any number of Heads of passing at B. Tech. Semester I & II taken together.

(iii) A student shall be allowed to keep the term for the B. Tech. Semester-V of the respective course if he/she has no backlog of B. Tech. Semester I & II, and he/she has a backlog of any number of Heads of passing at B. Tech. Semester-III & IV taken together.

(iv) A student shall be allowed to keep the term for the B. Tech. Semester VII of the respective course if he/she has no backlog of B. Tech. Semester I, II, III, IV, and he/she has a backlog of any number of Heads of passing at B. Tech. Semester-V & VI taken together.

(VII) Grade Point, Grade Letter, and Equivalent Marks

The student must obtain a minimum Grade Point of 5.0 (40% marks) in ESE and also in combined ESE + IA. A student who fails in ESE of a course must reappear only in ESE as a backlog student and clear that hurdle of passing.

Award of the Class for the Degree considering CGPA: A student who has completed the minimum credits specified for the programme shall be declared to have passed in the programme. The CGPA will be computed for every year of all the courses of that year. The grade will be awarded according to the CGPA of every year.

Range of CGPA	Final Grade	Performance Descriptor	Equivalent range of Marks (%)
9.50 ≤ CGPA ≤10.00	O	Outstanding	80 ≤ Marks ≤ 100
9.00 ≤ CGPA ≤ 9.49	A+	Excellent	70 < Marks <80
8.00 ≤ CGPA ≤ 8.99	A	Very Good	60 < Marks < 70
7.00 ≤ CGPA ≤ 7.99	B+	Good	55 < Marks < 60
6.00 ≤ CGPA ≤ 6.99	B	Average	50 < Marks < 55
5.00 ≤ CGPA ≤ 5.99	C	Satisfactory	40 ≤ Marks < 50
CGPA below 5.00	F	Fail	Marks Below 40

NOTE:

Amendment in Internal assessment tools:

From the A.Y. 2025-26, the Internal Assessment for B.Tech. Sem. I will be as per the above guidelines.