COURES STRUCTURE & SYLLBUS

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, infrastructure to meet needs of profession & society.*
- *To provide an environment conducive to innovation, creativity, research and entrepreneurial leadership.*
- *To practice and promote professional ethics, transparency and accountability for 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 &up gradation of curricula.*
- *Up gradation of laboratories, library & communication facilities.*
- *Collaboration with industry and research & development organizations.*
- *Sharing of knowledge, infra-structure and resources.*
- *Training, extension, testing and consultancy services.*
- *Promoting interdisciplinary research.*

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 working environment.*

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

Graduates will be able,

- *To fulfill need 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.*

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. ***Engineering knowledge****: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.*
2. ***Problem analysis****: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.*
3. ***Design/development of solutions****: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.*
4. ***Conduct investigations of complex problems****: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.*
5. ***Modern tool usage****: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.*
6. ***The engineer and society****: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.*
7. ***Environment and sustainability****: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.*
8. ***Ethics****: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.*
9. ***Individual and team work****: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.*
10. ***Communication****: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.*

11. ***Project management and finance****: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.*
12. ***Life-long learning****: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.*

Statements of Programme Specific Outcomes (PSOs)

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

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

PSO3: *Apply concepts of mechanical engineering to asses' societal, environmental, health and safety issues with professional ethics.*

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 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	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.	*VAC	VA1111308	VAC-I	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	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
ESE	End Semester 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
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

Designation of Course	Manufacturing Technology (Course Code: MJ1111301)

Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:-03Hours/Week	End Semester 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 the 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. **Understand** the pattern making and mold making. 2. **Understand** the **v**arious casting processes and **apply** the best casting process for a specific product. 3. **Understand** the hot working and cold working processes and **apply** the min Manufacturing. 4. **Understand** different operations on lathe machine and **apply** them to create the job. 5. **Understand** different operations on drilling, milling machines and **Apply** them to create the job. 6. **Understand**variousgrindingmachinesandplasticmoldingmachinesand**apply** Them for create the shape.

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's, Ladle technology, Strike out, Fettling, Cleaning and Surface preparation of castings, Defects in castings.
Die Casting Practice: Pressureandgravitydiecasting,Shellmouldcasting,Investmentcasting, 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, Stresses in wiredrawing 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 drilling process, twist drill geometry, tool holders, Types of drilling machines, drilling operations. Types of drills, reaming process. **Milling Machines:** Fundamentals of milling process, cutters-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, 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 greens sand core.
3. Mold Making Practice.
4. Job on drilling, reaming, tapping.
5. Casting of component by using green sand molding / Die casting.
6. Individual job on center Lathe.
7. Study of dividing indexing mechanism on milling machine.
8. Gear cutting job on Milling Machine.
9. Study and demonstration of Grinding Machines.
10. Job on 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- Vol1,McGrawHillEducation(India)Private Limited
2. P.N.Rao,ManufacturingTechnologyp,Vol-II,McGrawHillEducation(India)PrivateLimited
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.BlackandA.Kosher,Materialandprocessesinmanufacturing,PHI

8. HMT Handbook, Production Technology, TMH

Project Based Learning:

Followingisthelistoftopicsforprojectbasedlearning(NotLimitedto)basedonthesyllabus 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 gating system for any mechanical component.
4 To develop a demonstration model of Cupola furnace
5 To develop a demonstration model of pouring equipment's.
6 To prepare a flow chart for investment casting process
7 To develop a demonstration model of centrifugal casting
8 To develop a demonstration model of wire drawing process
9 To develop a demonstration model of mechanical press
10 To develop a demonstration model of 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 concept of single point cutting tools& its geometry
14 To develop a demonstration model of mini bench tapping machine
15 Todevelopademonstrationmodelofmillingmechanismsforvertical/horizontalmovement
16 To develop a demonstration model of indexing mechanism
17 To develop a demonstration model of plastic molding machine
19 To develop a demonstration model of buffing machine
20 To develop a demonstration model of abrasive belt grinder

Unit Test–

Unit Test-I	Unit-I, II,III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Mechanics of Fluids (Course Code: MJ1111302)**		
Course Code	**C202**		
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. **Understand** properties of fluids and analyze concepts of fluid statics. 2. **Understand** concepts related to fluid kinematics and analyze practical problems. 3. **Understand** concepts related to fluid dynamics and analyze practical problems. 4. **Understand** concepts related to laminar flow, flow around immersed bodies and analyze practical problems. 5. **Understand** concepts related to flow through pipes, dimensional analysis and **analyze** practical problems. 6. **Understand** concepts related to boundary layer theory andanalyze practical problems.

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-Stoke's 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, laminar flow through 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 & Dimensional Analysis**	**(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 **Dimensional Analysis:** Dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham pi Theorem, Important dimensionless numbers.		
Unit-VI	**Boundary Layer Flow**	**(08 Hrs.)**
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.		

Term Work

Term work shall consist of 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 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 following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

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

Text 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.

Reference Books:

1. Streeter V. L. and Wylie E. B. Fluid Mechanics McGraw Hill International Book Co.
2. Yunus Cengel, Jhon Cimbala, Fluid Mechanics, Tata McGraw Hill, New Delhi.

3. Streeter & Wylie, Fluid Mechanics, Tata McGraw Hill.
4. Frank White, Fluid Mechanics, McGraw Hill.
5. Dr. P.N. Modi and Dr. S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House.
6. 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 application such as hydraulic jack, hydraulic press, hydraulic lift, etc.
2. To demonstrate Archimedes's Principle through real life application.
3. To prepare an experimental setup for measurement of viscosity of different oils.
4. To demonstrate different types of fluid flow through Reynold's experiment.
5. To prepare a chart on real life application of different types of fluid flows and its characteristics.
6. To measure the flow velocity using Pitot tube.
7. To prepare a chart on real life application on fluid flow measuring devices.
8. To develop demonstration model for turbulent and laminar flow.
9. To develop demonstration model of 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
Unit Test-II	Unit- IV, V, VI

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. **Understand** concepts of first law of thermodynamic and its application. 2. **Understand** concepts second law of thermodynamics, entropy and availability. 3. **Apply** the knowledge of Properties of steam for different vapor Processes. 4. **Apply** the knowledge of properties of steam for different power cycles. 5. **Understand** the different air standard cycles and **analyze** it. 6. **Understand** the different type of fuels, concepts of combustion and analyze exhaust gas composition.

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 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 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 Rankin 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.

7. **Project Based Learning**

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

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

7. To demonstrate Charles's law.
8. To prepare a chart on 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
Unit Test-II	Unit- IV, V, VI

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. Understand simple and principal stress and strain 2. Able to find principal stresses on any oblique plane by analytical and graphical method. 3. Able to draw shear force and bending moment diagram and find slope and deflection of beam 4. Able to draw bending stress and shear stress diagram at different cross section I and T section beam. 5. Able to find stresses in shaft in torsional, combined torsional and bending, 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. **Understand** the concept of simple stress and strain and **apply** to find it for simple component. 2. **Understand** the concept of principal stress and analytical and graphical by Mohr's circle; and **apply** it to find stresses on any oblique plane inclined to normal plane. 3. **Understand** the concept of shear force and bending moment and **apply** it to find shear force diagram and bending moment diagram for any loading condition on simply supported beam and cantilever beam. 4. **Understand** the concept of pure bending and shear and **apply** it to find bending stress and shear stress diagram of I and T section of beam. 5. **Understand** the concept of Torsion in shaft and **apply** it to find shaft diameter for different loading condition. 6. **Understand** the concept of column theory and strain energy and **apply** it for loading condition.

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 contra flexure. 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 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 stresses:** Concept, derivation of shear stress distribution formula, shear stress distribution diagrams for common symmetrical sections, maximum and average shears 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 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 text book of strength of material 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 Material
4. S Ramamrutham, Strength of Material
5. R. K Rajput, Strength of Material

Project Based Learning

Followingisthelistoftopicforprojectbasedlearning(NotLimitedto)basedonthesyllabus contents:

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

7. To prepare the demonstration model on 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 concept use 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
Unit Test-II	Unit-IV,V,VI

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 kinematic analysis of mechanisms applied to real life and industrial applications. 2. To develop the competency to analyse the velocity and acceleration in mechanisms using analytical and graphical approach. 3. To develop the competency to analyse the friction clutches, Brakes, dynamometer and flywheel.
Course Outcomes:-	1. **Understand** the fundamental concept of Lower pair mechanisms and **apply** to real life and industrial applications. 2. **Understand** the basic concept of kinematic analysis and **evaluate** forces acting on reciprocating engine by graphical and analytical method. 3. **Understand** the concept of velocity and acceleration of any planar mechanism and **analyze** it graphically by using relative velocity - acceleration method and ICR method, Coriolis component of acceleration. 4. **Understand** the concept of friction and apply it in application of clutches. 5. **Apply** the concept of friction to **analyse** different parameter in Brakes and Dynamometer 6. **Understand** the fundamental concept of Turning moment diagram and flywheel; and **evaluate** coefficient fluctuation speed and energy.

Course Contents

Unit-I	**Mechanisms with Lower Pair**	**(06Hrs.)**
Introduction, Pantograph, Straight line mechanisms- Exact and Approximate, Hook Joint, Double Hook's Joint, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism. Theory and analysis of Compound Pendulum, Concept of equivalent length of simple pendulum, Bifilar suspension, Trifiler suspension.		
Unit-II	**Inertial Forces in Reciprocating Parts**	**(06Hrs.)**
Analytical method for displacement, velocity and acceleration analysis of slider cranks Mechanism. **Dynamics of Reciprocating Engines:** Two mass statically and dynamically equivalent system, 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 turning pair, friction circle, friction axis, friction in 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 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 Coriolis component.
8. To determine Coriolis Component of Acceleration at various speeds of rotation and water flow rates.
9. To measure torque transmitting capacity of friction clutch experimentally or To study of 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 type of Flywheel.
12. Mini-project based on contents of 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 demonstration model of Pantograph mechanism
2. To develop demonstration model of Ackerman steering gear mechanism.
3. To develop demonstration model of Davis steering gear mechanism.
4. To develop demonstration models of exact straight line motion mechanism.
5. To develop demonstration model to understand Coriolis Effect.
6. To prepare chart on comparison among different types of clutches with their application.
7. Case study on real life application of clutches used in automobile.
8. To develop demonstration model of Prony brake dynamometer
9. Case study on real life application of Brakes used in automobile.
10. To prepare chart on comparison among different types of dynamometer.
11. To develop demonstration model of flywheel energy storage system.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

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 structure. 3. Understand and begin to implement code
Course Outcomes: -	Upon completion of the course, students will be able to 1. **Understand** how to install and run python and create. 2. **Understand** flow control. 3. **Understand** complex datatypes. 4. **Understand** and **Apply** functions. 5. **Understand** various modules. 6. **Understand** and **Apply** Num Pymodule.

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 and

problems. Topics: Variables, Operators, Loops, String, Numbers, List

2. Python Loop Exercise

This Python loop exercise aims to help developers to practice branching and Looping techniques in Python.
Topics: If-else statements, loop, and while loop.

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 to learn and practice list operations.
7. Python Dictionary Exercise
   This Python dictionary exercise aims to help Python developers to learn and practice dictionary operations.
8. Python Tuple Exercise
   This exercise aims to help Python developers to 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", Mc-Graw 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 a 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-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 Visualisation 2. Computer Aided Machine Drawing
Course Objectives: -	1. To introduce students to the basicconcepts of CAD modelling. 2. To develop the skills in Reading and Interpretation of Engineering Drawings. 3. To familiarize students with SolidWorks Software to Crate 2D and 3D model, Assembly, Drafting and Sheet metal modelling.
Course Outcomes: -	The students will be able to 1. **Understand** the concepts of CAD modelling and **Creating** 2D sketches of machine components AUTOCAD Software. 2. **Creating** 3D drawing machine components using SolidWorks Software. 3. **Creating** 3D drawing for Assembly of machine components using SolidWorks Software.

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 given Pictorial view by first angle projection method only, Sectional orthographic Projection. Orthographic Drawing by using AutoCAD. Principles of Isometric Projections-Isometric Scale, Isometric Axes, Isometric Projections, and Isometric Drawing by using AutoCAD.		
Unit-III	**Fundamental 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 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 practical's 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. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
5. Ronald E. Barr, DavorJuricic, 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 User", 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 of 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 its applications in mechanical systems. 3. Different methods to change the mechanical properties.
Course Outcomes:-	The students should be able to 1. **Understand** basics of plastic deformation, annealing, re- crystallization and apply in mechanical engineering applications. 2. **Understand and evaluate** different types of mechanical properties. 3. **Understand and apply** fundamental concept of equilibrium diagrams in selections of alloys for different applications. 4. **Understand and apply** the different types of heat treatment processes on steels. 5. **Understand**the different types of alloy steels, tool steels and stainless steels and its applications in mechanical engineering. 6. **Understand** the concept of powder metallurgy and **apply** in manufacturing of components.

Course Contents

Unit-I	**Plastic Deformation, Recrystallization and Strengthening Mechanism**	**(06 Hrs.)**
Mechanism of plastic deformation, Critical resolve 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 re- crystallization,		
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 penetrate test, Magnaflux test, Eddy current test, Ultrasonic testing and Radiography testing.		
Unit-III	**Equilibrium Diagrams**	**(06Hrs.)**
Related terms and their definitions, Hume Ruther'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- Fe3 C 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 metals 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's:

1. Tensile test to determine strength and other mechanical properties
2. Hardness test Brinell and Vickers or Rocwell hardness test
3. Imact test to determine the Impact strength of Materials
4. Study of Fatigue strength
5. Study of Erichsen Cupping test for determine the cupping depth of sheet metal
6. Study of Magnetic Particle test
7. Study of Liquid penetrate test
8. Study of Ultrasonic Test
9. Heat Treatment of Steels
10. Study of 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 Micro hill Publication, Delhi
2. "Physical Metallurgy" Raghwan V, PHI Learning Pvt. Ltd,Delhi
3. Polymer Science, V. R. Gowarikar, N. V. Viswanathan, jayadevSreedhar, 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 Learning (Not Limited to) based on the syllabus contents:

1. To develop demonstration model of crystal structure.
2. To prepare a chart on different material and its 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 Brinel 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 microscope, hardness testing or spark testing.
10. To prepare a flowchart on processing of tool steels
11. To develop demonstrations model of manufacturing of metal powder by atomization technique
12. To develop demonstrations model of different type of powder compacting methods
13. To prepare a flow chart of production process of carbide tools, ferrites, clutch plates and elastic contact materials.
14. To prepare a flow chart of any mechanical component manufactured by powder metallurgy technique

Unit Test

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

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 gear. 2. To develop competency in different types of gear train. 3. To develop understanding of static and dynamic balancing, cam and follower, gyroscopic forces; and moments.
Course Outcomes:-	1. **Understand** the gear theory which will be the **Apply** for the gear design. 2. **Understand** torque transmitting capacity in gear trains which will be **Apply** the for gear box design. 3. **Apply** the principles of balancing of masses to various links, mechanisms and engines 4. **Understand** and **Apply** the concept of different types of governor and its applications. 5. **Analyse** various types of cam and followers with different kinds of follower motion. 6. **Apply** the principles of gyroscopic effects and stabilization on various 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 under cutting, 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 cranks 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 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 stabilisation for ship and Aeroplane, 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 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 on comparison among different types of gears
2. To prepare a chart to understand various terminology of spur gear.
3. To prepare a chart to understand different methods to avoid interference in spur gear.
4. To develop a mechanical system using simple gear train.
5. To develop a mechanical system using compound gear train.
6. To develop a mechanical system using reverted gear train.
7. To develop a mechanical system using epicyclic gear train.
8. To prepare a chart comparison among different types of gear trains.
9. To develop demonstration model of static and dynamic balancing systems.
10. To develop demonstration model of balancing of rotating masses.
11. To develop demonstration model of 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 charton 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 demonstration model on real life applications of gyroscopic effect such as Ship, aeroplane,automobile, etc.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

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 principals
Course Objectives:	To provide knowledge about 1. Steam generator and their performance analysis. 2. Reciprocating air compressors, Gas turbines & jet propulsion. 3. Various systems and phenomenon of combustion in I.C. Engine; and Performance analysis of I.C. Engine.
Course Outcomes:	On completion of the course, students will be able to– 1. **Understand** construction working of steam generators and **analysis** their performance. 2. **Understand** construction working of Reciprocating air compressors and **analysis** their performance. 3. **Understand** fundamentals of gas turbine, **analysis** their performance and application of gas turbines & jet propulsion. 4. **Understand** I.C. Engine systems viz. ignition, cooling and lubrication. 5. **Understand** phenomenon of combustion in S.I and C.I. Engine. 6. **Understand** terms related to I.C. Engine testing and **analysis** their performance.

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, Fluidize 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 of multi staging, multistage compressor, work done, volumetric efficiency, condition for maximum efficiency, intercooling, actual indicator diagram.		
Unit 3	**Gas Turbines & Jet Propulsion**	**(6 Hrs.)**

Theory and fundamentals of gas turbine, Principals, Classification, Assumption 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 their 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, 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 lubrications, Comparison between Wet sump and Dry sump systems, Oil pump. **Supercharging:** Objects of supercharging, Effects on performance, Limitations, Methods of supercharging & turbocharging, Limitation 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 break 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 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 Automobile service station.

Assignment:

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

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

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

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 have knowledge of 1. Basic 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: -	Students should be able to 1. Understand basics of hybrid and electric vehicle and analysis their performance. 2. Understand concept of hybrid electric drive trains 3. Understand electric vehicle architecture design 4. Understand different types of storage systems 5. Understand construction and working of electric drives and analyze their performance. 6. Understand Energy Management Strategies and Indian /global Scenario

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, 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 Components of Electric Vehicle.
2. To prepare demonstration model of electric Vehicle terminology.
3. To prepare demonstration model of Series Hybrid Electric Drive Trains.
4. To prepare demonstration model of Parallel Hybrid Electric Drive Trains.
5. To prepare demonstration model of Photovoltaic solar based electric Vehicle design / Battery Electric vehicle (BEV)
6. To prepare a chart on Types of Storage Systems
7. To prepare demonstration model of Storage Systems
8. To prepare demonstration model of 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. To prepare a chart on comparison of different energy management strategies

Textbooks:

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

Reference Books:

1. James Larminie, J. Lowry, “Electric Vehicle Technology Explaned”, 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. Mehrdad Ehsani, Yimin Gao,Sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles Fundamentals, Theory and Design”
4. 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
Unit Test-II	Unit- IV, V, VI

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 analysis different types of machine elements 3. To design of machine component for finite and infinite life and subjected to fluctuating load.
Course Outcomes: -	1. **Understand** the basic concept of machine design and **evaluate** dimensions of simple components. 2. **Understand** the fundamental concepts for design of shaft, keys and coupling and **evaluate** forces and dimensions. 3. **Understand** the concept of designing of Power Screws and **analyze** it for various applications. 4. **Understand** the basic concept of fluctuating loads and **Analyze** design of components under fluctuating loads. 5. **Understand** the concept of fasteners and threaded joints; and **analyze** when it is subjected to different loading conditions. 6. **Understand** the Design concept of welded and **analyze** when it is subjected to 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, machined 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**	**(06Hrs)**
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 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 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: 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 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 shaft, Keys, coupling, like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the shaft, key, and coupling. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also, to prepare 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 selecting suitable materials design screw, nut, and different simple components in assembly. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also, to prepare 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 PurohitKamlesh, "Design of Machine Elements", PHI LearingPvt. 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 LearingPvt. 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
Unit Test-II	Unit-IV, V, VI

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 Visualisation 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 Crate 2D and 3D model, Assembly, Drafting and Sheet metal modelling.
Course Outcomes: -	The students will be able to 1. **Understand** the concepts of CAD modelling. 2. **Creating**2D sketches of machine components using SolidWorks Software. 3. **Creating** 3D drawing machine components using SolidWorks Software. 4. **Creating** 3D drawing for Assembly of machine components using SolidWorks Software. 5. **Creating** Assembly of machine components using SolidWorks Software. 6. **Creating** detail drawing and generating Bill of Material 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 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 Pattern, 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's 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. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
5. Ronald E. Barr, DavorJuricic, 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 User", published by CADArtifex, 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 minimum five and not more than ten parts.
3. Evaluation of practical examination to be done based on the performance of students work in 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: **SUBJECT: - 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 student to understand the knowledge, art and creative practices, skills, and values in ancient Indian system
3.	To help to study the enriched scientific Indian heritage.
4.	To introduce the contribution from Ancient Indian system & tradition to modern science & Technology

Course Outcomes: After learning this course students will be able to understand

1	Concepts of Indian Knowledge System
2	India's contribution in Philosophy and Literature
3	India's involvement in Mathematics and Astronomy
4	India's role in Medicine and Yoga
5	India's influence in Sahitya
6	Concepts of Indian Shastra

UNIT – I	**Introduction to 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. Histrory 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).
12. Vedic Physics by Keshav Dev Verma, Motilal Banarsidass Publishers (2012).
13. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010).
14. 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.	MI1111701	Sem.- VII **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 concept of Physics and chemistry 2. Basic knowledge of Engineering materials and its 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:-	The students should be able to– 1. **Understand** basics of Engineering material and its characteristics **2. Understand** the concept of powder metallurgy and apply in manufacturing of components. 3. **Understand** the **v**arious casting processes and **apply** the best casting process for a specific product. 4. **Understand** different operations of Lathe, Drilling and Milling machine and **apply** them to create the job. 5. **Understand** various grinding machines and plastic moulding machine and **apply** them for create the shape. 6. **Understand** the **v**arious additive manufacturing and **apply** them for manufacturing of components.

Course Contents

Unit-I	**Study of Engineering materials and its 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 metals powder, Characteristics of powder, Powder conditioning, Powder Compacting, Hot compacting methods, Sintering and sintering furnaces,		
Unit-III	**Casting Processes**	**(06Hrs.)**
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 Technology,

principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines , 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,3 D 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 Base Learning

Student can do following small working models as PBL

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

List of Practical's:

1. Testing of mechanical properties such as Tensile strength
2. Testing od 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 Technologyp, 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.DKodgere, 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
Unit Test-II	Unit- IV, V, VI

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 the skills in Reading and Interpretation of Engineering Drawings for 3D printing. 3. To familiarize students with SolidWorks Software to Crate 2D and 3D model, Assembly, Drafting and Sheet metal modelling required for 3D printing.
Course Outcomes: -	The students will be able to 1. **Understand** the concepts of Additive manufacturing and 3D printing. 2. **Understand** the basic concept of machine component design. 3. **Understand** concept of geometric dimensioning and tolerancing, and **apply** in machine drawing for 3D printing. 4. **Understand** the concept of detail and assembly drawing. 5. **Creating** 2D drawing of machine component using SolidWorks Software. 6. **Creating 3D d**rawing of machine component using SolidWorks Software and **Understand** the concepts for data preparation 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 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 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 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

PBL

Student can do small mini project or working model by using 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 limit, 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. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
6. Ronald E. Barr, DavorJuricic, 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 User", published by CADArtifex, 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 minimum five and not more than ten parts.
3. Evaluation of practical examination to be done based on the performance of students work in laboratory.

***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.	MI1111702	Sem.- VII **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. **Understand** concepts of first law of thermodynamic and its application. 2. **Understand** concepts second law of thermodynamics, entropy and availability. 3. **Apply** the knowledge of Properties of steam for different vapor Processes. 4. **Apply** the knowledge of properties of steam for different power cycles. 5. **Understand** the different air standard cycles and **analyze** it. 6. **Understand** the different type of fuels, concepts of combustion 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 first kind (PMM-I). Limitations of first law of thermodynamics. Kelvin-Planck's statement & Clausiu's statements for 2nd law of thermodynamics, Heat engine, refrigerator and heat pump, Perpetual Motion Machine of 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 system, house hold refrigerator, window air conditioner. 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 collector, 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. To prepare demonstration model of Heat Pump
2. To prepare demonstration model of refrigerator
3. To prepare demonstration model of Heat Exchanger.
4. To prepare demonstration model of types of fin
5. To prepare demonstration model of I. C. Engines
6. To prepare demonstration model of Steam Turbine
7. To prepare demonstration model of Gas Turbine
8. To prepare demonstration model of Impulse Turbine
9. To prepare demonstration model of Fransis Turbine
10. To prepare demonstration model of Kaplane Turbine
11. To prepare demonstration model of Vapour Absorption refrigeration system
12. To prepare demonstration model of Vapour Compression refrigeration system
13. To prepare demonstration model of window air conditioning system

List of Practical:

1. To demonstrate steady flow energy equation for engineering applications such as heat

exchangers, turbo machinery, boiler, etc.

2. To determine viscosity of fluid.
3. To demonstrate second law of thermodynamic through real life application. (Kelvin-Planck's statement)
4. Demonstration second law of thermodynamic through real life application. (Clausius statement)
5. Demonstration of Two stroke and four stroke engine
6. Demonstration of pumps and compressor
7. Study of domestic refrigerator & window air-conditioner
8. Study and trial on Bomb calorimeter
9. Trial on Vapour Compression Refrigeration systems

Unit Test

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

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 principals 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 Condenser, Cooling Towers.
Course Outcomes:-	On completion of the course, students will be able to– 1. **Understand** fundamentals of Boilers 2. **Understand** fundamentals of Thermal Power Plant 3. **Understand** fundamentals of Gas Power Plants 4. **Understand** fundamentals of Nuclear power plants. 5. **Understand** fundamentals of heat exchangers 6. **Understand** study fundamentals of Power Plant Economics.

Unit No. -I	**Boiler , Mountings and Accessories**	**(6 Hrs)**
Introduction, Classification of boilers, Features of Low and high pressure boiler, construction and working of boilers, Fluidize 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 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-Radio activity, 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 Tower, 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 Nuclear power plant
6. Study of Power plant Instrumentation.
7. Study of Heat Exchangers used in Power Plant
8. Visit to 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. To prepare a chart on Thermal Power Plant
2. To prepare a chart on Steam Condenser and Cooling Towers
3. To prepare demonstration model of Thermal Power Plant
4. To prepare demonstration model of Gas Power Plants
5. To prepare demonstration model of Steam Condenser
6. To prepare demonstration model of Cooling Towers
7. Case study on Thermal Power Plant
8. Case study on Gas Power Plants

Text Books:

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

Reference Books

1. Grainger John J, and Stevenson Jr. W.D. Power System Analysis, McGraw Hill 1994
2. L. K. Kirchmeyer, Economic Operation of Power Systems, John Wiley and Sons, 1993.
3. C. A. Gross, Power System Analysis, John Wiley and Sons, Inc.1986.
4. John Weisman & L.E. Eckart, Modern Power Engineering, Prentice Hall, 1985
5. A course on Power Plant Engineering Ramlingam SCITECH Publication
6. S. P. Sukhatme, Solar Energy, Tata McGraw Hill, 3rdEdition 1996.
7. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 2011
8. P. K. Nag, Power plant Engineering, TMH, 3rd Edition 2002

Unit Test –

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI