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

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

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

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

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

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

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

The vision of the Mechanical Engineering Department is:

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

Mission Statements of the Mechanical Engineering Department are:

- *To provide extensive theoretical and practical knowledge to the students with well-equipped laboratories and ICT tools through motivated faculty members.*
- *To inculcate aptitude for research, innovation, and entrepreneurial qualities in students.*

- *To acquaint students with ethical, social, and professional responsibilities to adapt to the demands of the working environment.*

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

Graduates will be able,

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

Knowledge and Attitude Profile (WK)

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

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

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

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

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

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

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

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

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

PROGRAM OUTCOMES

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

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

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

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

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

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

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

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

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

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

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

Statements of Program Specific Outcomes (PSOs)

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

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

B. Tech. (Mechanical) Sem.-III

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C201	Thermodynamics-Principles	4	0	-	60	40	-		-	100	4	-	-	4
2	C202	Mechanics of Fluids	4	2	-	60	40	25	-	25	150	4	1	-	5
3	C203	Manufacturing Technology@	3	2	-	60	40	25	-	25	150	3	1	-	4
4	C204	Strength of Machine Components	3	2	1	60	40	25#	-	-	125	3	1	1	5
5	C205	Mechanisms of Machines*	4	2	-	60	40	25	25	-	150	4	1	-	5
6	C206	Python Programming-I	-	2	-	-	-	25	-	-	25	-	1	-	1
7	C207	Vocational Course-I $	-	2	-	-	-	25	25	-	50	-	1	-	1
		Total	**18**	**12**	**1**	**300**	**200**	**150**	**50**	**50**	**750**	**18**	**6**	**1**	**25**
8	C208	Social Activity-I**	-	-	-	-	-	-		-	-	-	-	-	2

*End Sem. Examination of 4 Hrs.; Industry Taught Course-I; $Automobile Servicing-I; **Add-on Course

B. Tech. (Mechanical) Sem.-IV

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C209	Thermodynamics-Applications	4	2	-	60	40	-	50	-	150	4	1	-	5
2	C210	Theory of Machines	3	2	1	60	40	-	25	-	125	3	1	1	5
3	C211	Science of Engineering Materials	4	-	-	60	40	-	-	-	100	4	-	-	4
4	C212	Entrepreneurship Development Skills@	3	-	-	60	40	-	-	-	100	3	-	-	3
5	C213	Machine Design & Analysis-I*	4	2	-	60	40	-	25	-	125	4	1	-	5
6	C214	Solid Modelling	-	2	-	-	-	25	-	25	50	-	1	-	1
7	C215	Python Programming-II	-	2	-	-	-	25	-	25	50	-	1	-	1
8	C216	Vocational Course-II$	-	2	-			25	25	-	50	-	1		1
		Total	**18**	**12**	**1**	**300**	**200**	**75**	**125**	**50**	**750**	**18**	**6**	**1**	**25**
9	C217	MOOC-I**						-			-		-		2

*End Sem. Examination of 4 Hrs.; Industry Taught Course-II; $Automobile Servicing-II; + End sem. Exam of 100 marks; ** Add-on Course

B. Tech. Mechanical
Sem.-III

Designation of Course	Thermodynamics- Principles		
Course Code	C201		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

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

Course Contents

Unit-I	First Law of Thermodynamics	(08 Hrs.)
Introduction of thermodynamics, Review of basic definitions (State, Process, Cycle, Path, Quasi-static process, path function and point function, Equilibrium), energy and work transfer, zeroth law of thermodynamics, statement of first law of thermodynamics, Joule's experiment, Limitations of first law of thermodynamics. Reversibility and Irreversibility, Applications of the first law to flow and non-flow processes and cycles. Steady flow energy equation and its application to different devices (Boiler, Diffuser, Turbine, Compressor, Condenser, throttling process), PMM-I.		
Unit-II	**Second Law of Thermodynamics, Entropy, and Availability**	**(08 Hrs.)**
Heat engine, refrigerator, and heat pump, Kelvin-Planck's statement & Clausius statement, equivalence of Kelvin-Planck's and Clausius statements, perpetual motion machine of the second kind (PMM-II), Carnot cycle & Carnot heat engine. **Entropy:** Clausius Theorem, Entropy as a property, second law analysis for entropy, Clausius inequality, principle of increase of entropy, irreversibility, Temperature – Entropy relation, Third law of thermodynamics. **Availability:** High- and low-grade energy, available and unavailable energy, loss of available energy due to heat transfer through a finite temperature difference.		
Unit-III	**Properties of Pure Substances and Vapor Processes**	**(08 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**	**(08 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**	**(08 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**	**(08 Hrs.)**
Solid- Biomass, Coal types, liquid: petrol, diesel, bio-oil, their Application, Gas: Biogas, 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.		

Term Work

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

1. First law of thermodynamics applied to the steady flow energy equation.
2. Study of different types of steam calorimeters.
3. Determination of dryness fraction using any commercially available test rig.
4. Determination of calorific value using a bomb calorimeter.
5. Study of Boy's gas calorimeter.
6. Study and demonstration of exhaust gas analysis by using any commercially available test rig.
7. Demonstration of the smoke meter
8. Study of the Orsat apparatus.
9. Study and Demonstration of Flash Point.
10. Study and Demonstration of Pour Point.

Assignment:

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

3. Steady flow energy equation with applications
4. Concept of the second law of thermodynamics, entropy.
5. Vapor processes.
6. Rankine cycle and vapor power cycle.
7. Air standard cycles.
8. Combustion of fuels.

Textbooks

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

Reference Books

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

Project-Based Learning

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

1. To demonstrate the steady flow energy equation for engineering applications such as heat exchangers, turbo machinery, boilers, etc.
2. To demonstrate the first law of thermodynamics by using Joule's experiment.
3. To demonstrate the first law of thermodynamics through real-life applications such as heating of water using a cook stove, operation of a boiler, operation of turbo machinery, etc.
4. To demonstrate the second law of thermodynamics through a real-life application. (Kelvin-Planck's statement)
5. Demonstration of the second law of thermodynamics through a real-life application. (Clausius statement)
6. To demonstrate Boyle's law.
7. To demonstrate Charles's law.
8. To prepare a chart on the identification of gas/vapor 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	Mechanics of Fluids		
Course Code	**C202**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work and Practical	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	1. Engineering Mathematics 2. Engineering Physics 3. Engineering Mechanics
Course Objectives: -	To provide knowledge about 1. Properties of fluids, concepts of fluid statics, kinematics & dynamics 2. Concepts of laminar & turbulent fluid flows 3. Flow around immersed bodies and boundary layer flow 4. Dimensional analysis
Course Outcomes: -	On completion of the course, students will be able to– 1. Analyze the properties of fluids and evaluate concepts of fluid statics. 2. Apply fluid kinematics principles to solve real-world fluid motion problems. 3. Analyze fluid dynamics phenomena and predict outcomes in practical scenarios. 4. Evaluate laminar flow and flow around immersed bodies, and design solutions for related engineering problems. 5. Apply principles of flow through pipes to analyze and optimize engineering systems. 6. Analyze boundary layer flow and perform dimensional analysis to model and interpret fluid mechanics phenomena.

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, Rheological diagram, Surface Tension, Capillarity, Compressibility, Vapor pressure, Classification of fluid. **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, Buoyancy and stability of floating and submerged bodies, Metacentric height.		
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), velocity in two-dimensional flow, stream function and velocity potential function.		
Unit-III	**Fluid Dynamics**	**(08 Hrs.)**
Linear momentum Equation using differential Approach, Introduction to Navier-Stokes Equation, Euler equation of motion. Derivation of Bernoulli's equation along a streamline, application of Bernoulli's equation to Pitot tube, Venturimeter, Orifice meter, Triangular Notch & Rectangular Notch (Without considering the Velocity of Approach, Concept of HGL, and THL or TEL.		
Unit-IV	**Laminar Flow & Flow around Immersed Bodies**	**(08 Hrs.)**
Definition, relation between pressure and shear stresses, laminar flow through a round pipe, and fixed parallel plates. Introduction to CFD Methodology (Elementary Treatment). Forces on immersed bodies: - Lift and		

Drag, Classification of Drag, Flow around circular cylinder and Airfoil, Development of lift on Airfoil.		
Unit-V	**Flow Through Pipes**	**(08 Hrs.)**
Energy losses through pipe-Major and Minor losses, Pipes in series and parallel, Darcy-Weisbach equation, Moody diagram, Syphon, Transmission of power, Compound pipe, and Dupuit's equation. Water hammer in pipes. Cavitation in pipes. Numericals based on the above contents.		
Unit-VI	**Boundary Layer Flow & Dimensional Analysis**	**(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. **Dimensional Analysis:** Dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham pi Theorem, Important dimensionless numbers, Model analysis (Reynolds, Froude, and Mach).		

Term Work

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

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

Assignment:

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

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

Textbooks

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

Unit Test –

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

Designation of Course	ITC-I: Manufacturing Technology		
Course Code	C203		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
	Internal Assessment	40 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites:-	The student should have basic knowledge of 1. Manufacturing Processes. 2. Machining Processes.
Course Objectives:-	The student should 1. To acquire the 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:-	On completion of the course, students will be able to – 1. Analyze pattern making and mold making techniques for various manufacturing applications. 2. Compare and select appropriate casting processes for specific products based on their requirements. 3. Differentiate and apply hot working and cold working processes in manufacturing operations. 4. Demonstrate and perform various lathe machine operations to manufacture jobs accurately. 5. Demonstrate and perform drilling and milling machine operations to produce desired components. 6. Identify and apply various grinding and plastic molding machines to create components with specified shapes.

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. Moulding sand and core sands, Sand control Test, Core and core making –Introduction, Core making Procedure, Types of cores, Core print, Core boxes. Mould and mould making- Moulding Methods, Moulding processes, Design of Gating System.		
Unit-II	**Sand Casting and Die Casting Practice**	**(06 Hrs.)**
Sand Casting Practice: Melting furnaces and their selection, Cupola furnace, Induction melting furnaces, Advantages, Limitations, applications, pouring practice and equipment, Ladle technology, Strike out, Fettling, Cleaning and Surface preparation of castings, Defects in castings. Die Casting Practice: Pressure and gravity die casting, Shell mould casting, Investment casting, Continuous casting, centrifugal casting, Applications, Merits, and limitations.		
Unit-III	**Hot and Cold Working Processes**	**(06 Hrs.)**
Hot Working Processes: Principle of 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, forging, extrusion- forward, backward impact. Roll Forging, tube drawing, wire drawing, spinning, shot peening, high-energy rate forming, and Stresses in wire drawing operations		
Unit-IV	**Theory of Metal Cutting**	**(06 Hrs.)**

Introduction, function, types, construction, accessories, operations, thread cutting, single and multi-start thread cutting, different tools, tool materials, Tool Geometry- Single Point cutting tool, Tool		
Wear and Tool Life, Mechanics of Metal cutting- Merchant's Circle Diagram, concept of speed, feed, depth of cut. Introduction to Boring Machines- general arrangement and nature of work done.		
Unit-V	**Drilling and Milling Machines**	**(06 Hrs.)**
Drilling Machines: Fundamentals of the drilling process, twist drill geometry, tool holders, Types of drilling machines, and drilling operations. Types of drills, reaming process. Milling Machines: Fundamentals of the milling process, cutter types and geometry, Operations performed on milling machines. Dividing head, methods of indexing.		
Unit-VI	**Abrasive Machining Processes, Plastics & Plastic Moulding**	**(06 Hrs.)**
Abrasive Machining Processes: Abrasive machining, abrasives -types, size, and geometry, Grinding, grinding wheels, wheel marking, wheel selection. Wheel mounting. Types of grinding machines, grinding faults, Honing, lapping, super finishing, buffing, and burnishing process. Plastics & Plastic Moulding: Moulding characteristics of plastic, Moulding process- compression, transfer, and injection blow moulding. Mould design- Materials and construction, bulk factor, shrinkage, moulding parameters, moulding machines, extruders.		

Assignments:

1. Pattern and Mould Making.
2. Sand Casting and Die Casting Practice.
3. Hot Working Processes and Cold Working Processes.
4. Turning, boring related process.
5. Drilling Machines.
6. Milling Machines.
7. Abrasive Machining Processes and Superfinishing Processes.
8. Plastics & Plastic Moulding.

Textbooks:

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

Reference Book

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

Project-Based Learning:

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

1 To develop a pattern of any component using different types of material.
2 To develop a core part by using different types of materials.
3 To develop a demonstration model of a gating system for any mechanical component.
5 To develop a demonstration model of the Cupola furnace

6 To develop a demonstration model of pouring equipment.
7 Preparing a flowchart for the investment casting process
8 To develop a demonstration model of centrifugal casting
9 To develop a demonstration model of the wire drawing process
10 To develop a demonstration model of a mechanical press
11 To develop a demonstration model of the short penning process
12 To develop a demonstration model of different types of rolling mills
13 Case study on different types of tools for thread cutting operations
14 To prepare a chart on the concept of single point cutting tools & their geometry
15 To develop a demonstration model of a mini bench tapping machine
16 To develop a demonstration model of milling mechanisms for vertical/horizontal movement
17 To develop a demonstration model of the indexing mechanism
19 To develop a demonstration model of a plastic molding machine
20 To develop a demonstration model of a buffing machine
21 To develop a demonstration model of an abrasive belt grinder

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	**C204**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Assignments Internal	40 Marks	
Tutorial: - 01 Hours/ Week	Term Work	25 Marks	01
	Tutorial	-	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Mechanics 3. Engineering Science
Course Objectives:-	1. Interpret simple and principal stress and strain 2. Able to find principal stresses on any oblique plane by analytical and graphical methods. 3. Able to draw shear force and bending moment diagrams and find the slope and deflection of the beam 4. Able to draw bending stress and shear stress diagrams at different cross sections in I, C, and T section beams. 5. Able to find stresses in the shaft in torsional, combined torsional and bending, and combined torsional and axial loading. 6. Able to solve problems on strain energy and Euler's column.
Course Outcomes:-	On completion of the course, students will be able to: 1. Analyze and evaluate the concept of simple stress and strain, and calculate them for a simple component. 2. Analyze, interpret, and determine the principal stresses analytically and graphically using Mohr's circle, and evaluate stresses on any oblique plane inclined to the principal plane. 3. Analyze and construct shear force and bending moment diagrams for any loading condition on a simply supported beam and a cantilever beam, and justify design implications based on the diagrams. 4. Examine and compute slope and deflection for any loading condition on simply supported and cantilever beams using Macaulay's double integration method, and assess structural performance. 5. Analyze and draw bending stress and shear stress diagrams for I, C, and T sections of the beam, and evaluate stress distribution for design considerations. 6. Analyze and apply column theory and strain energy concepts, and select and justify appropriate approaches for various loading conditions.

Course Contents

Unit-I	**Simple Stress and Strain**	**(06 Hrs.)**
Load, Direct or normal stress, Direct strain, Sign convention for direct stress and strain, Elastic materials, Hooke's law, Modulus of elasticity - Young's modulus, Tensile test, Ductile materials, Brittle materials, Poisson's ratio, Application of Poisson's ratio to a two-dimensional stress system, Shear stress, Shear strain, Modulus of rigidity, Relationship Between E, G and K, Double shear, Allowable working stress -factor of safety, Load factor, Thermal stresses,		
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, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory.		
Unit-III	**Shear Force and Bending Moment Diagram, Slope and Deflection**	**(06 Hrs.)**

Types of supports and beams, shear force (S.F.), bending moment (B.M.), S.F. and B.M. sign convention, S.F. and B.M. diagrams for beams carrying different loading conditions. Points of contraflexure, Relationship between S.F., B.M., and intensity of loading. Introduction, Simple bending theory, Neutral axis, Section modulus, second moment of area, Relationship between loading, S.F., B.M. Slope and deflection, Double integration method, Macaulay's method for all loading conditions.		
Unit-IV	**Stresses in Beams, Thin and Thick Cylinders**	**(06 Hrs.)**
Bending stresses: Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections (rectangular, T, C) 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 shear stresses, shear connection between flange and web. Concept of shear center, Stresses, and deformation in Thin Cylindrical and Spherical shells are subjected to internal pressure.		
Unit-V	**Torsion**	**(06 Hrs.)**
Simple torsion theory, Polar second moment of area, Shear stress and shear strain in shafts, Section modulus, Torsional rigidity. Principal stresses, Strain energy in torsion, Variation of data along shaft length-torsion of tapered shafts, Power transmitted by shafts. Stresses in solid circular shaft- Torsional load only, bending load only, combined torsional and bending, Combined Torsion and axial loading.		
Unit-VI	**Euler's Columns and Strain Energy**	**(06 Hrs.)**
Concept of buckling of columns, derivation of Euler's formula for buckling load for columns with hinged ends, concept of equivalent length for various end conditions, limitations of Euler's formula, Rankine's formula, and safe load on columns. Strain energy: Strain energy due to axial load (gradual, sudden, and impact), Strain energy due to self-weight.		

Term Work

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

1. Tension test for ductile materials
2. Tension test for brittle materials
3. Compression test for ductile materials
4. Compression test for brittle materials
5. Shear test for ductile materials
6. Shear test for brittle materials
7. Torsion test for ductile materials
8. Torsion test for brittle materials
9. Impact Test- IZOD and Charpy
10. Strain Gauge and Rosette Theory
11. Testing of hardness by Rockwell
12. Graphical simulation of
    a. Shear force and bending moment diagrams with different end conditions.
    b. Slope and deflection.
    c. Principal stresses through graphical and analytical methods.

List of Assignments

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

1. Simple stress and strain.
2. Principal stress and strain.
3. Shear force and Bending moment diagram and slope, and deflection
4. Stresses in beams, thick and thin cylinders
5. Torsion
6. Euler's column and strain energy method

List of Tutorials

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

1. Stresses in simple bar, Elastic modulus, and two-dimensional stress systems.
2. Normal, tangential, and resultant stresses on any oblique plane inclined to the normal plane by analytical and graphical methods.
3. Shaft diameter and factor of safety by using theories of failure.
4. Shear and bending moments on the cantilever and simply supported beam and draw SFD and BMD.
5. Slope and deflection at any section between beams by using Macaulay's method.
6. Stresses in the beam and draw the shear stress diagram and bending stress diagram.
7. Shaft diameter and stresses when the shaft is subjected to torsion, bending, combined torsional and bending, and combined torsional and axial loads.
8. Euler's column theory and strain energy.

Textbooks

1. A textbook of strength of materials by R. K. Bansal

Reference Books

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

Project-Based Learning

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

1. To prepare a demonstration model of a cantilever beam for the study of deflection in it.
2. To prepare a demonstration model of a simply supported beam for the study of deflection in it.
3. Preparing a demonstration model of a fixed beam for the study of deflection in it.
4. To prepare a demonstration model of an Overhang beam for the study of deflection in it.
5. To prepare the chart on the relation between E, G, and K with derivation.
6. To prepare a demonstration model for studying strain energy with consideration of various conditions, like impact load, sudden load, and gradual load.
7. To prepare the chart on various concepts used in Principal Stresses& planes.
8. To prepare the chart on Mohr's Circle method using graphically & analytically.
9. To prepare the chart on Rules and guidelines for drawing SFD & BMD.
10. To prepare the chart on finding bending stress for cross-sections.
11. To prepare the chart on finding bending stress for T cross-sections.
12. To prepare the chart on finding bending stress for C cross-sections.
13. To prepare the chart on concepts used in solid & hollow shafts.
14. To prepare the chart and demonstration model of Euler's formula for buckling load.

Unit Tests

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

Designation of Course	Mechanisms of Machines		
Course Code	C205		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Physics 3. Engineering Mechanics
Course Objectives:-	1. To make the students conversant with the kinematic analysis of mechanisms applied to real-life and industrial applications. 2. To develop the competency to analyze the velocity and acceleration in mechanisms using analytical and graphical approaches. 3. To develop the competency to analyze the friction clutches, Brakes, dynamometer, and flywheel.
Course Outcomes:-	On completion of the course, students will be able to– 1. Analyze the fundamental concepts of lower pair mechanisms and apply them in real-life and industrial applications. 2. Evaluate forces acting on a reciprocating engine using graphical and analytical methods by applying the basic concepts of kinematic analysis. 3. Analyze the velocity and acceleration of planar mechanisms graphically using the relative velocity-acceleration method, ICR method, and the Coriolis component of acceleration. 4. Apply the principles of friction in the design and operation of clutches. 5. Analyze the effects of friction to determine performance parameters in brakes and dynamometers. 6. Evaluate turning moment diagrams and flywheel performance by calculating the coefficient of fluctuation of speed and energy.

Course Contents

Unit-I	**Mechanisms with Lower Pair**	**(08 Hrs.)**
Introduction, Pantograph, Straight line mechanisms- Exact and Approximate, Hook Joint, Double Hook Joint, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism. Theory and analysis of the Compound Pendulum, Concept of equivalent length of simple pendulum, Bifilar suspension, Trifilar suspension.		
Unit-II	**Inertial Forces in Reciprocating Parts**	**(08 Hrs.)**
Analytical method for displacement, velocity, and acceleration analysis of the slider crank Mechanism. Klein's construction. Dynamics of Reciprocating Engines: Two mass statically and dynamically equivalent systems, Correction couple, static and dynamic force analysis of reciprocating engine mechanism, Torque Exerted on crankshaft.		
Unit-III	**Kinematic Analysis of Mechanisms: Graphical Methods**	**(08 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. Coriolis component of acceleration. Instantaneous Centre of Rotation (ICR) Method (limit to only 6 link mechanisms)- Kennedy's Theorem, Body and space centrode.		
Unit-IV	**Friction Clutches**	**(08 Hrs.)**
Friction: Friction in the turning pair, the friction circle, the friction axis, and friction in the slider crank mechanism.		

Pivot and collar friction. Friction clutches- design considerations, Classification of Clutches, torque transmitting capacity of – Single plate and multi-plate clutch, cone clutch, and centrifugal clutch		
Unit-V	**Breaks and Dynamometers**	**(08 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 – Prony brake, rope brake, belt transmission.		
Unit-VI	**Turning Moment Diagrams and Flywheel**	**(08 Hrs.)**
Introduction, Turning Moment Diagrams for different types of Engines, Fluctuations of Energy and Speed of Crankshaft, Coefficient of fluctuation of Energy and speed. Flywheel-Introduction, Coefficient of fluctuation of speed, Energy stored in flywheel, dimensions of flywheel rim, Flywheel in punching press.		

Term Work

The following experiments shall be performed.

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

Assignment

Numerical and/or theory questions on each unit from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

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.

Textbooks

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

Project-Based Learning

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

1. To develop a demonstration model of the Pantograph mechanism

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

Unit Tests

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

Designation of Course	Python Programming-I		
Course Code	**C206**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: - 04 Hours/ Week	Term Work and Practical	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:-	Basics of C and C^{++}Programming
Course Objectives:-	The students should be able to 1. Readily use the Python programming language 2. Use various data types and control structures. 3. Interpret and begin to implement code
Course Outcomes:-	On completion of the course, students will be able to– 1. Install and run Python and demonstrate its basic functionalities**.** 2. Analyze and implement flow control structures in Python programs. 3. Utilize and manipulate complex data types effectively. 4. Design and implement functions for modular programming. 5. Employ various Python modules to solve programming problems. 6. Apply the NumPy module for numerical computing and data analysis.

Course Contents

Unit-I	**Python introduction**	**(08 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**	**(08 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**	**(08 Hrs.)**
Numbers, Type Conversion and Mathematics, List, Tuple, Strings, Sets, Dictionary		
Unit-IV	**Python Functions**	**(08 Hrs.)**
Function Arguments, Recursion, Anonymous/Lambda Function, Global, Local, and Nonlocal variables, Global Keyword		
Unit-V	**Python Modules**	**(08 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**	**(08 Hrs.)**
Python Matrix, Add Two Matrices, Transpose a Matrix, and 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 practice branching and looping techniques in Python.
   Topics: If-else statements, loops, and while loops.
3. Python Functions Exercise
   Practice how to create a function, nested functions, and use the function arguments.

Effectively in Python by solving different questions.
Topics: Function's arguments, built-in functions.

4. Python String Exercise
   Solve Python String exercise to learn and practice String operations and manipulations.
5. Python Data Structure Exercise
   Practice widely used Python types such as List, Set, Dictionary, and Tuple operations in Python
6. Python List Exercise
   This Python list exercise aims to help Python developers learn and practice list operations.
7. Python Dictionary Exercise
   This Python dictionary exercise aims to help Python developers learn and practice dictionary operations.
8. Python Tuple Exercise
   This exercise aims to help Python developers learn and practice tuple operations.

Text Books

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

Reference Books

1. Python Programming using problem-solving Approach by Reema Thareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
2. Data Structures and Algorithms in Python by Michael T Goodrich and Roberto Tamassia, and Michael S Goldwasser, Wiley Publisher (2016)
3. Fundamentals of Python First Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1st edition (6th February 2009)

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	Vocational Course I: Automobile Servicing- I		
Course Code	C207		
Teaching Scheme	Examination Scheme		Credits Allotted
	Term Work and Oral	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:	1. Inclination for taking up Two-Wheeler Repairs and Service as a self-employment occupation 2. Knowledge of Mechanical Engineering System
Course Objectives: -	1. To perform skilled mechanical work in diagnosing, repairing, and maintaining all major vehicle systems of two-wheeler vehicles 2. To provide knowledge on the automotive industry and job-related activities as an automotive service technician. 3. To work safely and responsibly within all shop standards and environmental guidelines.
Course Outcomes: -	On completion of the course, students will be able to– 1. Analyze the suspension system of a two-wheeler and apply knowledge to diagnose, repair, and maintain it. 2. Examine the braking and steering systems of a two-wheeler and perform diagnosis, repair, and maintenance effectively. 3. Evaluate the transmission system of a two-wheeler and execute diagnosis, repair, and maintenance of the clutch and gearbox. 4. Analyze the engine system of a two-wheeler and apply techniques to diagnose, repair, and maintain it. 5. Interpret and inspect the ignition system of a two-wheeler and implement procedures to diagnose, repair, and maintain it. 6. Assess the electrical system and other accessories of a two-wheeler and perform diagnosis, repair, and maintenance tasks.

Course Contents

Unit-I	**Suspension System in Two-Wheelers**	**(08 Hrs.)**
Safety, Hand Tools and Equipment, Nomenclature of different parts of the vehicle and their locations, Introduction & Function of various parts & System of Two-Wheeler **Suspension System:** Introduction, Objectives of suspension, Basic requirements, Function of suspension springs, Types of suspension springs, Suspension system troubleshooting.		
Unit-II	**Brake and Steering Systems**	**(08 Hrs.)**
Brake System: Principle, Braking requirements, Types of brakes, Drum brakes, Disk brakes, Mechanical Brakes, Hydraulic brakes, Brake fluid, Disc brake pads, Braking system troubleshooting. **Steering:** Steering system & its use, inspect and adjust rake of front fork, dismantle trailing link, adjust heavy-duty thrust races.		
Unit-III	**Transmission System in Two-Wheelers**	**(08 Hrs.)**
Gear Box: Function of transmission, Necessity of transmission, Types of transmission, Manual transmission, sliding mesh gear box, constant mesh gear box, synchromesh gear box, **Clutch:** Definition, Requirements of clutch, Principle of friction clutches, Dry friction clutches (Single plate clutch, Multiplate clutch, Centrifugal clutch), Preliminary inspection of clutch, clutch adjustment, Clutch overhaul, clutch troubleshooting. Chain & chain Drive, sprocket (chain, sprocket, shafts)		
Unit-IV	**Engine System of Two-Wheelers**	**(08 Hrs.)**
Basic engine terminology, Types of engine, Constructional details, working of 2-stroke and 4-stroke engine, Classification of 2-stroke & 4-Stroke Engine & their difference, Engine servicing, Repairing method of Engine, engine removal, engine installation, General theory of Carburetion & Silencer.		
Unit-V	**Ignition Systems of Two-Wheelers**	**(08 Hrs.)**

Ignition System: Function, Requirement of an ignition system, Types of ignition systems, Battery ignition, Magneto ignition, Electronic ignition, Components of battery and electronic ignition system,		
Testing and servicing of ignition system components, Ignition system troubleshooting, and Kick-starting system of 2 wheelers.		
Unit-VI	**Electrical Systems and Accessories in Two-Wheelers**	**(08 Hrs.)**
Electrical and electronic components used in auto electrical, auto electrical parts wiring, battery inspection and maintenance, testing of battery voltage, testing of electrical parts such as head lamp, horn, side indicator, brake light, etc. Use of the ECM bike scanner.		

List of Experiments-

1. **Introduction:** Importance of safety and general precaution, Elementary First Aid, Identify the parts &general servicing of Two-Wheeler, washing, cleaning, oiling, greasing, and lubricating.
2. **Suspension Work:** Servicing of suspension, changing bush, checking shock absorbers. Cleaning, Checking, and oil filling of shock absorbers. Cleaning & checking the wheel bearings and greasing.
3. **Break Work:** Adjusting brake pedal play, servicing the brake system, cleaning, checking, greasing, and assembling. Inspecting the shoes and wheel drums and changing brake lining. Repairing and maintenance of the hydraulic disc brake used in Motorcycles.
4. **Transmission:** Adjusting clutch lever free play, removing clutch assembly from the Two-wheeler, cleaning and inspecting parts. Replacing defective parts. Fitting clutch assembly. Repair work of the Automatic clutch and automatic transmission used in a motor vehicle
5. Checking, adjusting, and replacing defective parts (chain, sprocket, shafts) in power transmission from engine to driving wheel.
6. **Engine Work:** Dismantling the unserviceable engine, cleaning and inspecting the parts, checking the engine bore, piston rings, connecting rod, bearings, crankshaft, assembling all the parts, and measuring the gaps. Engine Timing setting and Valve Timing setting of the 4-S Engine. Dismantling a four-stroke engine of a two-wheeler, cleaning, inspecting, and assembling parts.
7. Dismantling the air cleaner, cleaning, inspecting, cleaning the fuel tank, servicing the carburetor, rectifying causes for engine not starting, and high fuel consumption.
8. Starting engine, tuning for slow speed, checking smoke, and setting for exhaust gas emission measurement as per norms.
9. **Ignition System:** Dismantling the C.B. point, cleaning the electronic Ignition system & inspecting and replacing the pitted points. Making a wiring harness and checking different Electrical circuits used in Two-wheelers.
10. **Steering work:** Inspect and adjust rake of front fork, dismantle trailing link, and adjust heavy-duty thrust races.
11. **Electrical accessories repair:** Tracing the A.C./D.C electrical circuit in a two-wheeler, checking the horn, headlight, indicator, and replacing them if necessary.
12. Practice on how to read a job card, General Servicing & road testing of Two-Wheeler.

Textbooks

1. Automobile Mechanics, A.K. Babu, S. C. Sharma, T.R. Banga, Khanna Publishing House

Reference Books

1. Automobile Engineering by Kirpal Singh, Standard Publishers Distributors.
2. Automotive Engines, A.K. Babu, Khanna Publishing House

B. Tech. Mechanical
Sem.-IV

Designation of Course	Thermodynamics Applications		
Course Code	**C209**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Mechanical Engineering System. 2. Thermodynamic principles
Course Objectives:-	1. Steam generator and its performance analysis. 2. Reciprocating air compressors, Gas turbines & jet propulsion. 3. Various systems and phenomena of combustion in I.C. Engine, and Performance analysis of I.C. Engine.
Course Outcomes:-	On completion of the course, students will be able to– 1. Explain the construction and working of steam generators and analyze their performance. 2. Explain the construction and working of reciprocating air compressors and evaluate their performance. 3. Describe the fundamentals of gas turbines, analyze their performance, and assess applications of gas turbines and jet propulsion. 4. Explain the systems of I.C. engines, including ignition, cooling, lubrication, and governing. 5. Illustrate the phenomenon of combustion in S.I. and C.I. engines. 6. Define terms related to I.C. engine testing and analyze their performance characteristics.

Course Contents

Unit-I	**High-Pressure Boilers and Performance of Boilers**	**(08 Hrs.)**
Classification of boilers, Features of high-pressure boiler, construction and working of high-pressure boilers, Fluidized bed combustion, boiler mountings and Accessories. Boiler performance calculations- Equivalent evaporation, Boiler efficiency, Energy balance, boiler controls, Boiler draught.		
Unit-II	**Reciprocating Air Compressors**	**(08 Hrs.)**
Uses of compressed air, classification, constructional details of single-stage reciprocating compressor, computation of work done, isothermal work done, isothermal efficiency, effect of clearance, volumetric efficiency, FAD, theoretical and actual indicator diagrams, method of improving volumetric efficiency. Need for multi-staging, multistage compressor, work done, volumetric efficiency, condition for maximum efficiency, intercooling, actual indicator diagram		
Unit-III	**Gas Turbines & Jet Propulsion**	**(08 Hrs.)**
Theory and fundamentals of gas turbine, Principles, 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 its effect on performance, Closed cycle and Semi-Closed cycle gas turbine plant, Application of gas turbines. **Jet Propulsion:** Introduction, Theory of jet propulsion, Types of jet engines, Energy flow through jet engines, Thrust, Thrust power, Propulsive, Thermal, and overall efficiency, 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 -IV	I. C. Engine Systems	(08 Hrs.)
Fuel supply system for S.I. and C.I. Engines, M.P.F.I. system for modern automobile engines, and CRDI. **Ignition and injection System:** Battery & coil ignition system, Magneto ignition system, electronic ignition system, Advantage over mechanical contact breaker point system. Spark-Advance Mechanisms. **Engine Cooling System**: Necessity of cooling system, effect of overcooling, Air cooling, Water cooling, and Thermostatic radiators. **Lubrication System**: Mist lubrication system, Dry sump lubrication, Wet sump lubrication, Comparison between Wet sump and Dry sump systems, Oil pump **Governing System**: Function of Governor, Quality governing, Quantity governing, Hit & miss governing **Supercharging:** Objects of supercharging, Effects on performance, Limitations, Methods of supercharging & turbocharging, Limitation of turbocharging,		
Unit-V	**Combustion in I.C. engines**	**(08 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-VI	**Performance Characteristics & Testing of I.C. Engines**	**(08 Hrs.)**
Introduction to Indian standards for testing of I.C. Engines, Performance characteristics, Determination of brake power, indicated power, Friction power, Methods to determine power and efficiency, Determination of brake thermal efficiency, Mechanical efficiency, volumetric efficiency, Variables affecting performance of engine, Mean Effective Pressure, SFC, Air consumption, Energy balance. Engine Emissions and their controls.		

Term Work:

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

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

Assignment:

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

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

Textbooks

1. V. P. Vasandani and D. S. Kumar, Heat Engineering, Metropolitan Book Company, New Delhi.

2. R.S. Khurmi and J K Gupta, Textbook of Thermal Engineering, S Chand publications.

Reference Books

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

Project-Based Learning

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

1. To prepare a chart on the performance testing of boilers.
2. To prepare a chart for comparison among various types of boilers.
3. To prepare a chart on the comparison between open and closed cycle gas turbines.
4. To prepare a chart for comparison among various turbo machinery.
5. To prepare a chart on the comparison of different types of jet engines.
6. To prepare a demonstration model of an ignition system.
7. To prepare a demonstration model of the engine cooling system.
8. To prepare a demonstration model of the lubrication system.
9. To prepare a demonstration model of a governing system.
10. To prepare a chart on the different processes of combustion in IC engines.
11. Case study on different IC Engine systems used in cars available in the market.
12. 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

Designation of Course	Theory of Machines		
Course Code	C210		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
Tutorial: - 01 Hour/Week	Term Work and Oral	50 Marks	01
	Tutorial	Internal Evaluation	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Engineering Physics and Mathematics 2. Engineering Mechanics 3. Mechanisms of Machines
Course Objectives:-	1. To develop competency in the interpretation of the theory of spur and helical gears. 2. To develop competence in different types of gear trains. 3. To develop the interpretation of static and dynamic balancing, cam and follower, gyroscopic forces, and moments.
Course Outcomes:-	On completion of the course, students will be able to – 1. Explain and apply the fundamental theory of gears as a basis for gear design. 2. Evaluate the torque-transmitting capacity of various gear trains to serve as a foundation for gearbox design. 3. Apply the principles of balancing to masses in rotating and reciprocating systems, including links, mechanisms, and engines. 4. Analyze and compare the functioning of different types of governors and evaluate their applications in mechanical systems. 5. Analyze the geometry and motion characteristics of cams and followers under various follower motion conditions. 6. Apply and assess the principles of gyroscopic effects and stabilization on different types of transport vehicles.

Course Contents

Unit-I	**Spur Gears**	**(06 Hrs.)**
Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, minimum number of teeth, interference and undercutting, Friction in gears. **Helical gears:** nomenclature, Center Distance		
Unit-II	**Gear Trains**	**(06 Hrs.)**
Types of Gear Trains, analysis of epicyclic gear trains, Holding torque – Simple, compound, and epicyclic gear trains, torque on sun and planetary gear train, compound epicyclic gear train, Bevel epicyclic Gear train. Types of gearboxes.		
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, balancing in multi-cylinder in-line engines, direct and reverse cranks method -radial and 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, Friction, and Insensitiveness.		
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, analysis of circular arc cam with flat face follower. Methods of control pressure angle, radius of curvature, and undercutting. Jump phenomenon of Eccentric cam, Introduction to advanced cam curves (3-4-5 Polynomial cam only)		
Unit-VI	**Gyroscope and Step–Less-Regulation**	**(06 Hrs.)**
Gyroscopes- Gyroscopic forces and Couples, Gyroscopic stabilization for ship and airplanes,		

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)

Term Work

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

1. To draw a conjugate profile for any general type of gear tooth
2. To generate an involute gear tooth profile and to study the effect of undercutting and rack shift using a model.
3. To study various types of gearboxes- constant mesh, sliding mesh, synchromesh gearbox, Industrial gearbox, and differential gearbox.
4. To measure the holding torque of the epicyclic gear train.
5. To find the percentage of slip of the belt material
6. To experiment with balancing rotating parts and finding the unbalanced couple and forces.
7. To perform experiments on various types of Governors to prepare performance characteristics curves, and to find stability and sensitivity.
8. To experiment on the Cam Analysis Machine to find out cam and follower behavior at different follower moments and the jump phenomenon.
9. To draw the cam profiles and study the effect of Different follower motions, and Different follower (roller) dimensions
10. To determine gyroscopic couples on the Motorized Gyroscope.
11. Study of Continuous Variable Transmission and Infinite Variable Transmission.
12. Mini Project based on the contents of the syllabus.

Assignments

Numerical and/or theory questions on each unit from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

Tutorial

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

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

Reference Books

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

Textbooks

4. Rattan S. S., “Theory of Machines”, Tata McGraw-Hill.
5. Ballaney P. L., “Theory of Machines”, Khanna Publishers, Delhi.
6. 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:

12. To prepare a chart for comparison among different types of gears
13. To prepare a chart to interpret the various terminology of spur gears.
14. To prepare a chart to interpret different methods to avoid interference in the spur gear.
15. To develop a mechanical system using a simple gear train.
16. To develop a mechanical system using a compound gear train.
17. To develop a mechanical system using a reversed gear train.
18. To develop a mechanical system using an epicyclic gear train.
19. To prepare a chart comparison among different types of gear trains.
20. To develop a demonstration model of static and dynamic balancing systems.
21. To develop a demonstration model of the balancing of rotating masses.
22. To develop a demonstration model of the balancing of reciprocating masses.
23. Case study on real-life applications of various types of governors.
24. To develop a demonstration model of a Watt Governor/Portal Governor/Proell Governor.
25. To prepare a chart on compression among different types of governors.
26. To prepare a chart to interpret the various terminology of the Cam profile.
27. To prepare a chart on the comparison among different types of followers.
28. To prepare a chart on comparison among different types of follower motions.
29. To develop a demonstration model on real-life applications of gyroscopic effect, such as a Ship, a n Airplane, an automobile, etc.

Unit Tests

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

Designation of Course	Science of Engineering Materials		
Course Code	C211		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: -04 Hours/Week	End Semester Examination	60 Marks	04
	Internal Assessment	40 Marks	
	Total	**100 Marks**	**04**

Course Prerequisites:-	The student should have 1. Basic knowledge of physics and chemistry 2. Basic information on engineering materials 3. Basic knowledge of manufacturing processes
Course Objectives:-	The student should acquire the knowledge of 1. The scope, objective, and application of materials, engineering properties. 2. Material testing to determine the mechanical properties and their applications in mechanical systems. 3. Different methods to change the mechanical properties.
Course Outcomes:-	On completion of the course, students will be able to – 1. Explain the concepts of crystal structure and mechanisms of plastic deformation, and apply these in the processes of annealing and recrystallization. 2. Classify various mechanical testing methods for materials and evaluate material properties to ensure suitability for engineering applications. 3. Interpret equilibrium phase diagrams and correlate them with the resulting properties of materials in different phases. 4. Summarize different types of heat treatment processes and apply them in multidisciplinary engineering applications. 5. Compare the properties of alloy steels, cast irons, and tool steels, and select appropriate materials for multidisciplinary applications. 6. Explain the concept of powder metallurgy and apply it in the manufacturing of engineering components.

Course Contents

Unit-I	**Plastic Deformation, Recrystallization, and Strengthening Mechanism**	**(08 Hrs.)**
Mechanism of plastic deformation, Critical resolved shear stress, Deformation of single crystal and polycrystalline metals, Mechanism of plastic deformation at high temperature, effect of grain size, Work Hardening, Cold and hot working, Annealing and re-crystallization, strengthening Mechanism,		
Unit-II	**Mechanical Testing of Metals**	**(08 Hrs.)**
Study of destructive testing: Tensile test, 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, Cupping test, **Non-destructive testing** such as Liquid dye penetration test, Magnaflux test, Eddy current test, Ultrasonic testing, and Radiography testing.		
Unit-III	**Equilibrium Diagrams**	**(08 Hrs.)**
Related terms and their definitions, Hume-Rothery's rule of solid solubility, solidification, Dendritic growth, cooling curves, Plotting of Equilibrium diagrams, Lever rule, Coring, Isomorph's system, Eutectic system, Partial eutectic and eutectoid system, non-equilibrium cooling and its effects, Fe-Fe3C equilibrium diagram.		
Unit-IV	**Heat Treatment of Steels**	**(08 Hrs.)**
Transformation products of austenite, Martensite transformation & characteristics of martensite, Time – Temperature Transformation curve, Critical Cooling rate, Heat treatment of steels - Annealing, Normalizing, Hardening, Hardenability, Martempering, Austempering, Retained austenite, tempering, Ausforming, Secondary hardening, Quench cracks.		

Unit-V	Cast Irons, Alloy Steels & Tool Steels	(08 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, heat treatment of tool steels.		
Unit-VI	**Powder Metallurgy**	**(08 Hrs.)**
Introduction, Advantages and limitations of powder metallurgy, Production of metal powder, Characteristics of powder, Powder conditioning, Powder Compacting, Hot compacting methods, Sintering and sintering furnaces, Production of powder metallurgical parts such as self-lubricating bearings, ferrites, electric contact materials, Carbide cutting tools, etc.		

Term Work

Term work shall consist of the following experiments

1. Preparation of polystyrene/phenol-formaldehyde/urea-formaldehyde resin.
2. To determine the molecular weight/radius of macromolecule polystyrene/ polyvinyl alcohol by viscosity measurement.
3. Estimation of the percentage of Iron in Plain Carbon Steel by the Volumetric Method.
4. Study of corrosion of metals in a medium of different pH.
5. Determination of the rate of corrosion of aluminum in acidic and basic media.
6. Determination of the percentage of Ca in the given cement sample
7. Preparation of phenol-formaldehyde resin/ urea-formaldehyde.
8. Estimation of copper in brass solution.
9. Determination of the rate of corrosion of aluminum in acidic and basic media.
10. To obtain a metallic coating on the base metal by using the Electroplating and Electroless plating methods.

Assignment

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

1. Mechanism of Plastic Deformations
2. Mechanism of recrystallization
3. Tensile test, Hardness testing
4. Calculations of a phase and its percentages
5. Heat treatment of steels
6. Cast iron applications
7. Stainless steels
8. Heat treatment of tool steels
9. Production of powder productions
10. Production of powder metallurgical parts

Textbooks

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

Reference Books

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

New Delhi.
7. Engineering Chemistry (16th Edition) Jain, Jain, DhanpatRai Publishing Company, 2013.

Project-Based Learning

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

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

Unit Test

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

Designation of Course	ITC-II: Entrepreneurship Development Skills		
Course Code	C212		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
	Internal Assessment	40 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites: -	The student should have 1. Introduction to all engineering subjects 2. Passion to become an entrepreneur. 3. Ambition to create employment.
Course Objectives: -	The student should 1. Acquire knowledge of behavioral sciences and develop a positive attitude. 2. Enjoy the process of learning and develop habits of language skills. 3. Learn success and failure stories. 4. Acquire basic knowledge of Functional Management and leadership lessons.
Course Outcomes: -	On completion of the course, students will be able to – 1. Identify and interpret various personality traits for personal and professional development. 2. Compare, apply, and demonstrate effective communication and interpersonal skills for professional grooming. 3. Develop and practice positive habits through reading, reviewing, and reflecting on life skills books. 4. Analyze and evaluate case studies of various organizations to understand real-world applications of management concepts. 5. Explain and articulate the fundamentals of entrepreneurship and its allied elements. 6. Interpret and examine the roles of functional management and the processes involved in running a business organization.

Course Contents

Unit-I	Grooming Personality	(06 Hrs.)
Personality types, attitude, developing a positive attitude, Effects of Personality management aptitude (PMA), Behavior of human beings under challenging conditions, qualities needed at the top level, traits for top executives, enthusiasm, never give up attitude.		
Unit-II	**Developing Skills**	**(06 Hrs.)**
Communication skills, Interpersonal skills, positive reinforcement, recognition, qualities of a leader, who is a leader, behavior of a leader, assume infinite responsibility, requirement for professional success.		
Unit-III	**Reviews and learning from life skill books.**	**(06 Hrs.)**
Books Review and learnings, Seven Habits of Highly Effective People, Rich Dad Poor Dad, Seven divine laws, Power of Positive Thinking, You Can win, Leader without Title, Think and Grow Rich.		
Unit- IV	**Case Studies**	**(06 Hrs.)**
Case studies: their introduction, types of case studies, their relevance and importance, format, and steps of case studies. Mrs. Lata Khare, Mericom, Dangal Girl, M S Dhoni, Helen Keller. Ravindra Jain, Arunima Sinha, Study of a successful athlete, Mohammad Ali, Major Dhyanchand, leadership lessons.		
Unit-V	**Entrepreneurship and its allied elements**	**(06 Hrs.)**
Introduction to Entrepreneurship, working capital, introduction to sales, finance, risks and rewards, interpreting customers, how to develop a market, and the use of social media. Types of marketing, innovation, interpreting statutory requirements, scaling up, managing vendors, managing employees and contractors, and managing banking relations. Ways of raising funds. Interpret functional management.		
Unit-VI	**Functional management and business processes**	**(06 Hrs.)**

Process of sales, Ethics in selling, Sale with integrity, Sale with honesty, law of familiarity, Sale with passion and integrity, upselling, and cross-selling. Cash flow, definition of business, managing payables, managing commitments in tough times.

List of Assignments

1. What are the different types of personalities? What makes them stand out differently from each other? Choose one type of personality and analyze your personality traits.
2. What different behavioral aspects are important to be a good leader? Analyze and prepare the design thinking model for inculcating the behavioral aspects of a leader.
3. Communication is a lubricant to run an organization smoothly. State your suitable reasoning in relation to the statement and prepare the model to implement it in your organization.
4. What are the different interpersonal skills? Why do they play a significant role in developing a business at its peak? Elucidate with suitable examples.
5. Choose a skills book of your choice and prepare a review of it, and implement the learning lessons for your business model.
6. Why are books on life skills important for a businessman? State your reasoning with appropriate examples.
7. What is meant by case studies? What is its relevance in the business world? Choose a topic from the enlisted and prepare a case study on it.
8. What is meant by Entrepreneurship? State the importance of functional management with suitable examples.
9. What are the different business ethics, and how do they help you in developing the appropriate policy for your organization?
10. Illustrate the different business processes and their roles in developing a successful business.

Textbook

1. Dynamics of Entrepreneurial Development & Management -Vasant Desai, Himalaya Publishing House.

Reference Books

1. Principles of Management -P. C. Tripathi, P. N. Reddy; Tata McGraw-Hill, 4th Edition, 2010.
2. Entrepreneurship Development -Small Business Enterprises -Poornima M Chrestomathy Pearson Education – 2006.
3. Communication Skills by Pushpa Lata and Sanjay Kumar, published by Oxford University Press.
4. Developing Communication Skills by Meera Banerjee, published by Oxford University Press
5. The Third Wave: An Entrepreneur's Vision of the Future (Hardcover)by Steve Case
6. Losing the Signal: The Untold Story Behind the Extraordinary Rise and Spectacular Fall of BlackBerry by Jacquie McNish
7. The 16 Personality Types: Profiles, Theory, & Type Development by A.J. Drenth

Project-Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents. A group of students should meet entrepreneurs and complete the case studies.

1. Company history, establishment.
2. Type of Industry
3. Entrepreneur personality & his approach.
4. Behavioral aspects (leadership quality)
5. Communication skills & Interpersonal skills
6. Correlation of reference books: Review and Learnings, Seven Habits of Highly Effective People, Rich Dad Poor Dad, Seven Divine Laws, Power of Positive Thinking, You Can Win, Leader without Title, Think and Grow Rich. With respect to the entrepreneur
7. How the working capital works has developed

8. Functioning of the Production department,
9. Marketing department
10. Financial department

Unit Test –

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

Designation of Course	Machine Design and Analysis-I		
Course Code	**C213**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: -02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

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

Course Contents

Unit-I	**Introduction to Design and Design against Static Load**	**(08 Hrs.)**

Introduction to Design: Need for component design, design process, Introductions to concurrent engineering, Design considerations for casting, forging & machined parts, hot & cold worked parts, and welded assembly, Introduction to design for manufacture & assembly.

Design against Static Load: Modes of failure, Factor of safety, Service factor, stress-strain relationship, shear stress & strain, stress due to bending moment, Eccentric axial loading.

Design of simple machine parts - Cotter joint, Knuckle joint, and Levers, curved beam.

Unit -II	**Shafts, Keys, and Coupling**	**(08 Hrs.)**

Introduction, Transmission Shafts, Shaft Design on Strength Basis, Shaft Design on Torsional Rigidity Basis, ASME Code for Shaft Design, Design of Hollow Shaft on Strength Basis, Design of Hollow Shaft on Torsional Rigidity Basis, Flexible Shafts

Keys– saddle, sunk, feather, woodruff, square, flat, Kennedy key, key design, Types of keys, splines.

Couplings- types of couplings, Design of rigid and flexible couplings.

Unit-III	**Power Screws and Mechanical Spring**	**(08Hrs.)**

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, Trapezoidal and Acme Threads, Collar Friction Torque, Overall Efficiency, Coefficient of Friction, Design of Screw and Nut, Design of Screw Jack, Differential and Compound Screws, Re-circulating Ball Screw.

Mechanical Spring: Types of Springs, Terminology of Helical Springs, Styles of End, Stress, and Deflection Equations, Series and Parallel Connections, Design of Helical Springs, Concentric Springs,

Helical Torsion Springs, Surge in Spring, Multi-Leaf Spring, Nipping of Leaf Springs, Shot Peening		
Unit-IV	**Design for Fluctuating Loads**	**(08 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 and infinite life, Soderberg, Goodman, Modified Goodman& Gerber criteria.		
Unit-V	**Threaded Joints**	**(08 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, Eccentric Load on Base plate, Torque Requirement for Bolt Tightening, Dimensions of Fasteners, Design of Turnbuckle.		
Unit-VI	**Welded and Riveted Joints**	**(08 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, Welded Joint Subjected to Bending Moment and Torsional Moment, Welding Symbols **Riveted Joints**- Types of Rivet Heads and Riveted Joints, Rivet Materials, Types of Failure, Strength Equations, Efficiency of Joint, Caulking and Fullering, Eccentrically Loaded Riveted Joint		

Term work

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

1. Symbolic representation of common machine components using Auto-CAD.
2. Design of machine components such as knuckle joint, cotter joint, and lever (anyone) using CAD software.
3. Design of the coupling system using CAD software.
4. Design of screw jack using CAD software.

Assignment

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

1. Static loading
2. Design of shafts
3. Power screw
4. Mechanical springs
5. Design of fluctuating load
6. Design of threaded joints
7. Design of welded
8. Riveted joints.

Note: The Design Data Book should be used extensively.

Project-Based Learning

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

1. To develop an Industrial/real-life application demonstration model of different types of Joints. (Cotter joint and Knuckle joint)
2. To observe the system where transmission of power takes place through a shaft, Keys, 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 a design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also, to prepare the bill of materials.

3. To develop a demonstration model of different types of couplings.
4. To develop a demonstration model of different types of keys.
5. To observe the system where transmission of power takes place through power Screws. (e.g., Lead screw of lathe, feed screws of machine tools, Clamping screws, Toggle Jack screw, etc.) Get the required information regarding effort, clamping force, etc., and select suitable materials design of the screw, nut, and different simple components in assembly. To prepare a design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also, to prepare a bill of materials.
6. To develop demonstration models of different types of springs.
7. To develop demonstration models of different types of threaded joints.
8. To develop demonstration models of different types of fasteners.
9. To develop demonstration models of different types of welded joints.
10. To develop demonstration models of different types of riveted joints.

Textbooks

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

Reference Books

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

Unit Tests

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

Designation of Course	Solid Modelling		
Course Code	C214		
Teaching Scheme:	Examination Scheme		Credits Allotted
Practical:- 04 Hours/Week	Term Work and Practical	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites: -	1. Computer-Aided Drafting and Visualization 2. Computer-Aided Machine Drawing
Course Objectives: -	1. To introduce students to the basic concepts of CAD modelling. 2. To develop skills in the Reading and Interpretation of Engineering Drawings. 3. To familiarize students with SolidWorks Software to create 2D and 3D models, assemblies, Drafting, and Sheet metal modelling.
Course Outcomes: -	On completion of the course, students will be able to – 1. Interpret and apply the fundamental concepts of CAD modelling in the design of mechanical components. 2. Develop accurate 3D models of machine components using SolidWorks Software. 3. Construct and analyze the assembly of machine components using SolidWorks Software. 4. Design and generate complex surface models of automobile components using SolidWorks Software. 5. Create detailed engineering drawings and generate Bills of Materials (BOMs) using SolidWorks Software. 6. Analyze and model sheet metal components by applying the principles of sheet metal design in SolidWorks Software.

Course Contents

Unit-I	Introduction to CAD	(08Hrs.)
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		
Unit-II	**Basic Part Modelling**	**(08 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-III	**Assembly Modelling**	**(08 Hrs.)**
Introduction to Assembly Modelling & Approaches, Using Advanced Mates and Mechanical Mates, Manipulating Components, Creating Patterns, Creating Exploded Views.		
Unit-IV	**Surface Modelling**	**(08 Hrs.)**
Surface Modelling tools: Creating Extrude, Revolve, Swept, Loft, Boundary surface. Inserting Planar Surface, Offset Surface, and Radiate Surface. Extending a surface, Surface fill, Ruled Surface, Trimming Surface, Mid surface, Replace Face, delete face, Un-trim surface, Knit surface, Thickening a Surface, Move Face.		
Unit-V	**Drafting of Mechanical Systems**	**(08 Hrs.)**
Generating Views, Creating Dimensions, Inserting Annotations, and Bill of Materials.		
Unit-VI	**Sheet Metal Modelling**	**(08 Hrs.)**
Constructing the base flange and miter Flange, addition of an Edge Flange, closing corner, adding a Jog, unfolding the bends, adding a hem, and vent.		

Term Work

Term work shall consist of A-3/A4 size printouts of the problems solved in practicals using Solid Works Software.

1. Sketcher drawings

2. Part modelling
3. Parametric Modelling
4. Assembly Modelling
5. Exploded view of Assembly
6. Surface Modelling
7. Drafting of Mechanical Systems
8. Sheet metal modelling

Text Books

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

Reference Books

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

End Semester Practical/Oral examination:

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

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

Designation of Course	Python Programming-II		
Course Code	C215		
Teaching Scheme	Examination Scheme		Credits Allotted
Practical:- 04 Hours/ Week	Term Work and Practical	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:-	1. Soft Computing I 2. Soft Computing II 3. Python Programming-I
Course Objectives:-	The students should be able to 1. Readily use the Python file handling 2. Use an array to solve engineering problems. 3. Interpret data visualization techniques
Course Outcomes:-	On completion of the course, students will be able to – 1. Apply file handling techniques to read, write, and manipulate data effectively. 2. Analyze the concept of arrays and their implementation in problem-solving. 3. Develop programs to perform various array manipulation operations. 4. Utilize random number generation methods for simulation and data analysis tasks. 5. Implement visualization using *matplotlib* modules for data representation. 6. Design and evaluate visualization techniques to interpret and communicate data insights effectively.

Course Contents

Unit -I	**Python Files**	**(08 Hrs.)**
Python File I/O, Directory and Files Management, Errors and Built-in Exceptions, Exception Handling Using try, except, and finally statements, Custom Exceptions		
Unit -II	**NumPy Array**	**(08 Hrs.)**
Create a NumPy and array Object, Dimensions in Arrays, 0-D Arrays, 1-D Arrays, 2-D Arrays, 3-D arrays, Access Array Elements, Access 2-D Arrays, Access 3-D Arrays, Negative Indexing		
Unit -III	**NumPy Slicing Arrays**	**(08 Hrs.)**
Array Slicing, Slicing 2-D Arrays, Shape of an Array, Array Reshaping, Iterating Arrays, Iterating 2-D Arrays, Joining NumPy Arrays, Splitting NumPy Arrays, Sorting Arrays		
Unit -IV	**NumPy Random**	**(08 Hrs.)**
Pseudo Random and True Random, Generate Random Number, Generate Random Float, Generate Random Array, Generate Random Number from Array, Normal Distribution, Visualization of Normal Distribution, Binomial Distribution, Poisson Distribution, Uniform Distribution, Exponential Distribution		
Unit -V	**Matplotlib**	**(08 Hrs.)**
Install matplotlib, Pyplot API, Figure Class, Axes Class, Multiplot, Subplots () Function, Formatting Axes, Setting Limits, Setting Ticks and Tick Labels		
Unit -VI	**Two-Dimensional and Three-Dimensional Visualization**	**(08 Hrs.)**
Bar Plot, Histogram, Pie Chart, Scatter Plot, Pie Chart, Contour Plot, 3D Contour Plot, 3D Wireframe plot, 3D Surface plot		

Term Work

1. Read and write the given text file (1exercises)
2. Python NumPy Exercise (2exercises)
3. Practice NumPy questions such as Array manipulations, numeric ranges, Slicing, indexing, Searching, Sorting, and splitting, and more.

4. Random Data Generation Exercise (2exercises)
5. Practice and learn the various techniques to generate random data in Python.
6. Python Matplotlib Exercise (3exercises)
7. Practice Data visualization using Python Matplotlib. Line plot, Style properties, multi-line plot, scatter plot, bar chart, histogram, Pie chart, Subplot, stack plot.

Textbooks:

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

Books of Reference

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 Roberto Tamassia, and Michael S Goldwasser, Wiley Publisher (2016)
3. Fundamentals of Python First Programmes by Kenneth A Lambert, Copyrighted material, Course Technology Inc., 1st edition (6th February 2009)

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	Vocational Course I: Automobile Servicing- I		
Course Code	C217		
Teaching Scheme	Examination Scheme		Credits Allotted
	Term Work and Oral	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:	Basic knowledge of automobile engineering and servicing
Course Objectives: -	1. To perform skilled mechanical work in diagnosing, repairing, and maintaining all major vehicle systems of a four-wheeler 2. To provide knowledge on the automotive industry and job-related activities as an automotive service technician. 3. To work safely and responsibly within all shop standards and environmental guidelines.
Course Outcomes: -	On completion of the course, students will be able to – 1. Identify various types of tools and workshop equipment and demonstrate their proper use for servicing and maintenance operations. 2. Disassemble, inspect, and reassemble engine components, cooling systems, and transmission units of different vehicles by applying appropriate service techniques. 3. Analyze, dismantle, and reassemble the fuel supply system, steering mechanism, wheel balancing, and wheel alignment to evaluate functional performance. 4. Test, dismantle, and reassemble the battery, ignition, and starting systems to diagnose faults and restore operational efficiency. 5. Perform tyre inspection, repair, and execute auto body repair, denting, and painting operations by adhering to standard workshop practices. 6. Inspect, troubleshoot, and overhaul electrical wiring harnesses, lighting, ignition, electronic, and air-conditioning systems to ensure reliable performance and safety.

Course Contents

Unit-I	Introduction to Four-wheeler Servicing:	(08 Hrs.)

Familiarization with the workshop manual. Practice how to read a job card. Identification of different types of vehicles. Identification of Vehicle Identification Number, Chassis No. & Engine no identification of different types of engine components, Lubrication and Maintenance Schedule

Necessity for routine maintenance, Importance of service manuals, Specification of engines- petrol and diesel vehicles(a) Engine (b) Clutch (c) Gear Box (d) Propeller shaft (e) Universal joints (f) Differential (g) Axles and hubs (h) Suspension system (i) Steering system (j) Tyre (k) Chassis (l) Brake-drum and disc Battery (m) Self-starter (n)Dynamo, checking of compression and vacuum, Car wash – before & after servicing using different types of nozzles Check/replenish / top up – lubricating oil, engine coolant, power steering hydraulic oil, wind screen wiper water. Replace – air cleaner, oil filter & fuel filter. Use Grease on parts / through greasing points (if necessary).

Unit-II	Engine Servicing, Cooling, and Power Transmission	(08 Hrs.)

Engine Service: Introduction, Engine removal, cylinder head, Valve and Valve mechanism, piston connecting rod assembly, cylinder block, crankshaft and main bearing, engine reassembly.

Engine tuning: Meaning and scope of engine tuning. Necessity of engine tuning, Engine analysis, and tuning with the help of a diagnostic computer, and Diesel engine injection timing checking.

Engine cooling systems: Necessity, Methods of cooling, Radiator, Cooling system troubleshooting.

Power Transmission: Remove & refit vehicle body parts (bonnet, front bumper & door). Check/replenish/top up brake fluid, transmission oil. Adjust the Hand brake and replace the hand brake cable. Adjust clutch and brake pedal plays Replace propeller shaft, wheel hub bearings & brake pads.

Unit-III	Engine Fuel Supply System, Steering, wheel Balancing and Alignment	(08 Hrs.)

Petrol and Diesel Engine Fuel Supply System: Fuel Supply Systems, Fuel pump, Fuel injection, Fuel pump testing, troubleshooting and service, Fuel supply system troubleshooting, Fuel filters and air cleaners. Maintenance Schedule of diesel engine fuel injector, hot plugs, rotary and reciprocating type of fuel injection pump, fuel injection pump of single cylinder engines, hoses & pipelines, priming unit, tanks.

Front Axle and Steering: Introduction, Front axle, steering geometry, Steering mechanism, power steering, steering adjustment, Steering troubleshooting.

Wheel Balancing: Remove the tyre from the vehicle. Check the tyre & rim and check for runout. Fit the tyre assembly to the vehicle.

Wheel alignment bearings, ball joints, control arms, bushings and sway bars, shock absorbers, struts & and power steering. Identify components, the brief working principle & operation of the computerized wheel

Aligner Procedure to make the aligner ready to check wheel alignment. Procedure for taking readings, interpreting alignment readings, and rectifying steering geometry with wheel aligner – take a printout. Procedures for the test drive to confirm the repairs.

Unit-IV	**Battery, Ignition, and Starting System**	**(08 Hrs.)**

Battery and Ignition System: Remove and refit the head lamp assembly. Check the power plug and inspect H.T. cables. Clean, Check, and Adjust spark plug. Cleaning and topping up of a lead acid battery, testing the battery with a hydrometer, a battery tester, and connecting the battery to a charger for battery charging.

Starting System: Starting motor, starting drives, electronic starter control, **i**dea of engine starting-system circuit. Testing the starting system and troubleshooting.

Ignition System: Idea of Battery-and-coil ignition circuit and its working. Compression ignition of diesel engines.

Unit-V	**Tyre Repairer/Inspection, Auto Body Repair, Denting & Painting**	**(08 Hrs.)**

Tyre Repairer/Inspection: Removal & re-fitting of wheel from light & heavy vehicles. Measurement of tread wear. Dismantling the tyre & tube, checking for punctures, assembling, and inflating it to the correct pressure. Vulcanizing of tubes & tyres. Repair a tubeless tyre puncture. Air inflation with a nitrogen gas inflator according to the manufacturer's recommendation. Practice on Tyre rotation as per the vehicle manufacturer's recommendation.

Auto body repair: Identification of different types of body, chassis and drive lines, Identification of location of parts and panels, Practice on operating the air compressor, Practice on periodical maintenance of air compressor Inspect and decide whether it can be repaired or replaced Remove and refit body panels, doors, floors, wheel boxes and fenders Practice on removing and refitting wind shield glasses.

Auto body painting: Consumable's clothing safety, Practice on removing paint from the damaged area Practice on mixing and Using body filler Practice on sanding (block) Practice on mixing and Using putty Practice on Using primer Practice on feather edge sanding and masking Base coat application Surface cleaning and degreasing Second and third coat application Preheating the vehicle and cooling Cutting, scuffing, rubbing and polishing.

Unit-VI	**Modern Electric and Hybrid Vehicles**	**(08 Hrs.)**

Introduction to electric and hybrid electric vehicles, History of hybrid and electric vehicles, Social and environmental importance of electric and hybrid electric vehicles, Electrical basics, Motor and generator basics, Electric and Hybrid Electric Drive Trains, Basic concept of electric and hybrid traction, Introduction to various electric and hybrid electric drive train topologies, Advantages, and disadvantages.

Power Flow: Power flow control in electric and hybrid electric drive train topologies.

Electric Drive Components: Electric drive components used in electric and hybrid vehicles, including Electric motor requirements, Direct Current (DC) motors (Brushed and Brushless), Power converters, and Drive controllers.

List of Experiments-

1. To follow standard operating procedures for using workshop tools and equipment for fault diagnosis or to troubleshoot problems in a vehicle.
2. To interpret the auto component manufacturer specifications related to the various components/ aggregates in the vehicle (including major aggregates like engine, gearbox, transmission systems, propeller shaft, etc.)
3. Service, repair, and overhaul of the steering system.
4. To Service, repair, and overhaul of suspension system.
5. Service, repair, and overhaul tyres.
6. To Service, repair, and overhaul wheels.
7. To repair and overhaul diesel Engines and their fuel system.
8. To repair and overhaul petrol Engines and their fuel system.
9. To Service, repair, and overhaul of cooling system and radiator
10. To Service, repair, and overhaul of emission and exhaust system.
11. To Service, repair, and overhaul gearbox, drive-train assembly, and transmission systems (manual, automatic, etc.)
12. To repair and overhaul of brake system.
13. To repair and overhaul of clutch assembly.
14. Repair and overhaul of the electronic control unit

15. To Repair and overhaul of electrical wire harness, lighting, ignition, electronic, and air- conditioning systems, etc.

Textbooks

1. Automobile Mechanics, A.K. Babu, S. C. Sharma, T.R. Banga, Khanna Publishing House

Reference Books

1. Automobile Engineering by Kirpal Singh, Standard Publishers Distributors.
2. Automotive Engines, A.K. Babu, Khanna Publishing House

Rules and Regulations

- **Rules regarding the conduction of Internal Assessment (IE):**
  Internal Assessment (IA) will comprise 40 marks. Out of this, 20 marks will be for Unit Tests, and 20 marks will be for Project-Based Learning. Two Unit Tests, each of 20 marks, will be conducted: The average of marks obtained in these two-unit tests will be considered as UT marks. Roll numbers allotted to the students shall be the examination numbers for the conduct of unit tests.

- **Rules Regarding ATKT, Standard of Passing and Award of Class of Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune**

  A.T. K. T.
  1. A candidate who is granted a term for B.Tech. Semester I, III, V, VII will be allowed to keep the term for his/her B.Tech. Semester-II, IV, VI, VIII examinations respectively, even if he/she appears and fails or does not appear at the B.Tech. Semester I, III, V, VII examinations respectively.
  2. A candidate shall be allowed to keep the term for the B.Tech. Semester-III course if he/she has a backlog of any number of Heads of passing at B.Tech. Semester I & II taken together.
  3. A student shall be allowed to keep the term for the B.Tech. Semester-V of the respective course if he/she has no backlog of B. Tech. Semester I & II, and he/she has a backlog of any number of Heads of passing at B. Tech. Semester-III & IV taken together.
  4. A student shall be allowed to keep the term for the B. Tech. Semester-VII of the respective course if he/she has no backlog of B. Tech. Semester I, II, III, IV, and he/she has a backlog of any number of Heads of passing at B. Tech. Semester V & VI taken together.

Standard of Passing:

1. Internal Assessment (IE):

- ✓ There will not be a separate passing head of 16 marks out of 40 marks for Internal Assessment (IA; the overall passing of 40% marks for the combined 100 marks will be imposed. However, the End Semester University Examination of 60 marks should have a separate passing of 40% marks.
- ✓ To grant the term, it is mandatory to appear for all the Unit tests conducted each semester.

2. Overall Passing:

- ✓ The candidate must obtain a minimum Grade Point of 5.0 (40% marks) in the End.
- ✓ Semester University Examinations, and in the combined End Semester + Internal Assessment
- ✓ A student who fails in the End Semester Examinations of a course must reappear only in the End Semester Examinations as a backlog candidate and clear that hurdle to pass.
- ✓ **Award of the Class for the Degree, considering CGPA:**
- ✓ A student who has completed the minimum credits specified for the programme shall be declared to have passed the programme. The result will be in terms of letter grade only and is based on the CGPA of all courses studied and passed. The Criteria for the Award of Honors at the end of the Programme are as follows. (Same as CBCS 2014 Course Curriculum).

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

Rules for Credits of MOOC courses, Social Activities, and Publication of Research Paper:

1. If a candidate completes a **MOOC/NPTEL course** in a particular semester **relevant to the courses in that semester**, he/ she will be allotted **TWO** credits after producing the certificate of completion of the respective course.

   Students shall register to MOOCs which are offered by any of the following agencies:

   a. SWAYAM: www.swayam.gov.in

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

   c. Course Era: www.coursera.org

   d. edX online learning: www.edx.org

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

   f. Udemy: www.udemy.com

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

2. If a candidate completes his/her duties in NSS/Social Activities, he/she will be allotted **TWO** credits after producing the certificate of completion of the respective course/ activity from the relevant authorities.
3. If a candidate publishes a research paper in UGC approved CARE journals, he/she will be allotted **TWO** credits after producing the certificate of publication of the respective paper.
4. These credits will be given only after the authentic document is verified by the Head of the Department, and a separate marksheet is submitted by the Head of the Department along with the subject examiner.