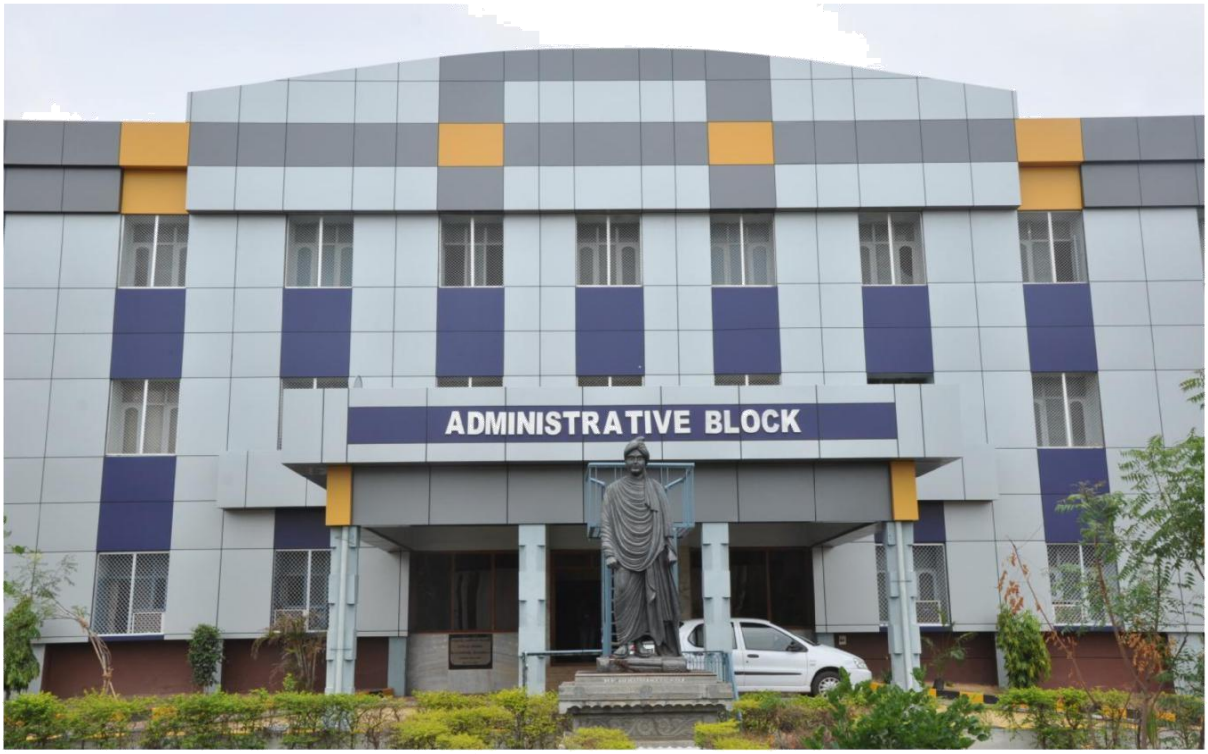

Scheme – 2023

Department of Mechanical Engineering

G. Pulla Reddy Engineering College (Autonomous): Kurnool

Accredited by NBA of AICTE and NAAC of UGC

Affiliated to JNTUA, Anantapuramu

Scheme and Syllabus for

B.Tech in Mechanical Engineering

(With Effect from the Batch Admitted in 2023-24)

MECHANICAL ENGINEERING
FOUR YEAR B.TECH. DEGREE COURSE
SCHEME OF INSTRUCTION AND EXAMINATION

V Semester **Scheme 2023**

S. No.	Category	Title	L/D	T	P	Credits	CIA	End Exam Marks	Total Marks
1	PC	Machining Processes	3	0	0	3	30	70	100
2	PC	Design of Machine Elements	3	0	0	3	30	70	100
3	PC	Metrology and Measurements	3	0	0	3	30	70	100
4	ES	Introduction to Quantum Technologies and Applications	3	0	0	3	30	70	100
5	PE	Professional Elective - I	3	0	0	3	30	70	100
6	OE	Open Elective -I	3	0	0	3	30	70	100
7	PC	Thermal Engineering Lab	0	0	3	1.5	30	70	100
8	PC	Theory of Machines Lab	0	0	3	1.5	30	70	100
9	SEC	Machine Tools & Metrology Lab	0	1	2	2	30	70	100
10	ES	Tinkering Lab	0	0	2	1	30	70	100
11		Evaluation of Community Service Internship	-	-	-	2			100
		Total	**18**	**1**	**10**	**26**			

L/D : Lecture/Design/Drawing T/P : Tutorial / Practical PC : Professional Core
CIA : Continuous Internal Assessment PE : Professional Elective OE : Open Elective
SEC : Skill Enhancement Course ES : Engineering Sciences

MACHINING PROCESSES (MP)

V Semester: Mechanical Engineering | **Scheme:** 2023

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
ME301	PC	3	0	0	3	30	70	100

Sessional Exam Duration: 2 Hrs | **End Exam Duration:** 3 Hrs

Course Outcomes: At the end of the course, students will be able to

CO1:	Explain cutting tool geometry and solve simple problems on cutting forces and tool life using Merchant's theory and Taylor's equation.
CO2:	Describe the construction and working of lathe, drilling, and boring machines.
CO3:	Demonstrate the working mechanisms of shaper, slotter, planer and milling machine and apply indexing methods to perform milling operations like gear cutting.
CO4:	Explain grinding and finishing operations, including wheel specifications and maintenance.
CO5:	Explain the principles of jigs and fixtures design and select suitable non-traditional machining processes.

UNIT – I

Introduction to Metal Cutting: Classification of metal cutting operations, Nomenclature of Single point cutting tool, mechanics of metal cutting, mechanism of chip formation, types of chips, oblique and orthogonal cutting - Merchant's Theory of metal cutting, Merchant's circle diagram for forces. Simple problems on Force calculations. Tool wear, Tool life Taylor's Tool life equation. Simple problems on tool life. Cutting tool materials.

UNIT – II

Lathe: Introduction, types of lathes, Lathe specifications, Parts of a lathe, Lathe accessories and Attachments, Lathe operations.

Drilling: Introduction, Types of Drilling machines, Upright drilling machine, Radial drilling machine, Drilling machine operations.

Boring: Introduction, Types of Boring machines, Principal parts of Horizontal boring machine, Vertical boring machine and Jig boring machine.

UNIT – III

Shaper: Introduction, Principal parts of a shaper, Shaper size, Shaper mechanisms, Crank and slotted link mechanism, Whitworth quick return mechanism, Hydraulic shaper mechanism, Shaper Operations.

Planner: Planning machine parts, Open and cross belt dry mechanism, Planner operations

Slotter: Slotting Machine Parts, Slotter size, Slotter operations

Milling Machines : Introduction, Types of Milling machines, Principal parts of Column and knee type milling machine, Milling machine operations Dividing heads – Plain or Simple dividing head, Universal dividing head. Indexing methods, Direct or Rapid indexing, Plain or simple indexing, Compound indexing and Differential indexing. Simple problems on Indexing.

UNIT – IV

Grinding and Surface Finishing Machines: Introduction, Kinds of Grinding, Classification of Grinding machines, Grinding wheel specification, Glazing and loading in wheels, Dressing and trueing of grinding wheels. Honing, Honing machines, Lapping, Lapping machines and super finishing**,** Buffing.

UNIT – V

Jigs and Fixtures: Introduction, Classification of jigs and fixtures, design principles, location and clamping, types of clamping, 3-2-1 principle, applications of jigs and fixtures.

Modern Machining processes: Electrical Discharge Machining (EDM),Wire cut Electrical Discharge Machining (WEDM), Electro Chemical Machining (ECM), Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma Arc Machining (PAM), Ultrasonic Machining (USM), and Abrasive Jet Machining (AJM)

Text Books:

1. S K Hajra Choudhury and Nirjhar Roy, Elements of Work shop technology Volume II, (Machine Tools) Media Promoters & Publishers, New Delhi
2. P N Rao, Manufacturing Technology, Metal cutting and Machine tools, TMH Publishers, New Delhi
3. P C Sharma, A text book of Production Technology (Manufacturing Processes), S.Chand Publishers, New Delhi.

Reference Books:

1. Amitabha Ghose and Asok Kumar Malik, Manufacturing Science, EWP Publishers, New Delhi.
2. R K Jain, Production Technology, Khanna Publishers, New Delhi.
3. S Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, Pearson Publishers, New Delhi.
4. V K Jain, Advanced Machining Processes, Allied Publishers, New Delhi.

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

DESIGN OF MACHINE ELEMENTS (DME)

V Semester: Mechanical Engineering | **Scheme:** 2023

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
ME302	PC	3	0	0	3	30	70	100

Sessional Exam Duration: 2 Hrs | **End Exam Duration:** 3 Hrs

Course Outcomes: At the end of the course, students will be able to

CO1:	Apply design principles for components subjected to static and dynamic loads, analyze and design for fatigue failure using relevant criteria.
CO2:	Design of bolted and welded joints, considering factors such as different types of loads, including eccentric loading scenarios.
CO3:	Design of power transmission shafts and couplings for fluctuating loads, and selecting appropriate couplings such as flange, bushed pin, and universal couplings.
CO4:	Design of sliding and rolling contact bearings.
CO5:	Design of springs and spur gears.

UNIT – I

Introduction, Design for Static and Dynamic Loads

Mechanical Engineering Design: Design process, design considerations, Codes and standards of designation of materials, Selection of materials.

Design for Static Loads: Modes of failure, Design of components subjected to axial, Bending, Torsional and impact loads. Theories of failure for static loads.

Design for Dynamic Loads: Endurance limit, Fatigue strength under axial, Bending and torsion, Stress concentration, Notch sensitivity. Types of fluctuating loads, Fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

UNIT – II

Design of Bolted and Welded Joints

Design of Bolted Joints: Threaded fasteners, Preload of bolts, Various stresses induced in the bolts. Torque requirement for bolt tightening, Gasketed joints and Eccentrically loaded bolted joints.

Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion. Eccentrically loaded welded joints.

UNIT – III

Power Transmission Shafts and Couplings

Power Transmission Shafts: Design of shafts subjected to bending, Torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

Couplings: Design of flange and bushed pin couplings, Universal coupling.

UNIT – IV

Design of Bearings

Design of Sliding Contact Bearings: Lubrication modes, Bearing modulus, McKee's equations, Design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, Equivalent bearing load, Load-life relationships, Load factor, Selection of bearings from manufacturer's catalogue.

UNIT – V

Design of Springs and Gears

Springs: Design of helical compression, Tension, Torsion and Leaf springs.

Design of Gears: Spur gears, Beam strength, Lewis equation, Design for dynamic and Wear loads.

Text Books:

1. R L Norton, Machine Design an Integrated approach, Pearson Education, New Delhi.
2. V B Bhandari, Design of Machine Elements, Tata McGraw Hill, New Delhi.
3. R K Jain, Machine Design, Khanna Publications, New Delhi.

Reference Books:

1. J E Shigley, Mechanical Engineering Design, Tata McGraw Hill, New Delhi
2. M F Spotts and T E Shoup, Design of Machine Elements, Prentice Hall (Pearson Education), London.
3. K Mahadevan and K Balaveera Reddy, Design data handbook, CBS Publications, New Delhi.
4. N C Pandya and C S Shah, Machine design, Charotar Publishing House Pvt. Ltd, Gujarat.

Online Learning Resources:

1. https://www.yumpu.com/en/document/view/18818306/lesson-3-course-name-design-of- machine-elements-1-nptel
2. https://www.digimat.in/nptel/courses/video/112105124/L01.html
3. https://dokumen.tips/documents/nptel-design-of-machine-elements-1.html
4. http://www.nitttrc.edu.in/nptel/courses/video/112105124/L25.html

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

METROLOGY AND MEASUREMENTS (MMT)								
V Semester: Mechanical Engineering					**Scheme: 2023**			
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
ME303	**PC**	**3**	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration: 2 Hrs					**End Exam Duration: 3 Hrs**			

Course Outcomes: At the end of the course the student will be able to	
CO1:	Apply measurement standards, limits, fits, and gauge design using Taylor's principle and standard systems.
CO2:	Measure angles and screw thread parameters using precision instruments and evaluate errors in thread profiles.
CO3:	Perform gear and surface finish measurements, and evaluate components using CMM with understanding of error sources.
CO4:	Understand and apply various transducers for measurement of physical quantities, including LVDT, piezoelectric, and photoelectric types.
CO5:	Apply strain gauge techniques and transducers to measure force, torque, and acceleration accurately.

UNIT – I

Standards of Measurements: Line standards, End standards and Wavelength standards. **Limits, Fits and Gauges:** Tolerances, limits and Fits, Basic types fits, Interchangeable and Selective assemblies, Systems of limits and fits as exemplified in British, International and Indian standards for Plain work, Limit gauging –Plug, Ring and Snap gauges, Taylor's principle of limit gauges. Problems on limits, fits and design of GO and NOGO gauges.

UNIT – II

Angular Measurement: Bevel protractor, Clinometer, Angle dekkor, Sine bar, Spirit level, Applications of Slip gauges, Rollers and Balls in testing of tapers.

Screw Thread Measurement: Terminology of screw threads, effect of pitch errors and angle errors, concept of virtual effective diameter, Measurement of major, minor and effective diameter.

UNIT – III

Measurement of Gears: Terminology of gear tooth, Tooth to tooth pitch measurement, Profile checking, Tooth thickness measurement and Parkinson gear tester.

Measurement of Surface Finish: Significance of surface finish, Order of geometrical errors occurring during machining, Magnitude, Sampling length, Methods of measuring surface finish- Stylus probe instruments, Tomlinson surface meter and Taylor – Hobson Talysurf surface meter.

Coordinate Measuring Machines: CMM construction, Possible sources of error in CMM, Specifications of coordinate measuring machines, Advantages of CMM.

UNIT – IV

Transducers: Introduction, Classification and description, Sensitivity, Mechanical transducers, Electrical transducers, Variable resistance transducers, Variable inductance transducers, Capacitive transducers, LVDT, Piezoelectric and photo electric transducers.

UNIT – V

Measurement of Force, Torque, Acceleration: Basic force measurement methods - Elastic load cells, Elastic strain gauge load cells, Hydraulic and Pneumatic load cells, Torque measurement, Types of torsion meters, Piezo-electric accelerometer, Seismic accelerometer, Strain gauge accelerometer.

Strain Gauges and Measurement: Strain measuring techniques, Requirement of strain

gauges, Resistance strain gauges, Strain gauges alloys and materials, Bonded and Un bonded strain gauges, Bonding techniques, Temperature compensation in strain gauges.

Text Books:

1. R K Jain, Engineering Metrology, Khanna Publishers, New Delhi.
2. N V Raghavendra, L Krishnamurthy, Engineering Metrology and Measurements, Oxford University Press, New Delhi.
3. I C Guptha, A text book of Engineering Metrology, Dhanpat rai Publications.
4. M Mahajan, A text book of Metrology, Dhanpat rai and Co.

Reference Books:

1. K L Narayana, Engineering Metrology, Scitech Publications.
2. P C Sharma, A textbook of Production Engineering, S. Chand Publishers, New Delhi.
3. ASME, Hand Book of Industrial Metrology, PHI Publication, New Delhi.
4. D S Kumar, Mechanical Measurements and Control, Metropolitan Books, New Delhi.

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

INTRODUCTION TO QUANTUM TECHNOLOGIES AND APPLICATIONS (IQTA) (Qualitative Treatment)								
V Semester: Common for all Branches						**Scheme: 2023**		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
ESCM03	**ES**	**3**	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration: 2 Hrs						**End Exam Duration: 3 Hrs**		

Course Outcomes : At the end of the course the student will be able to	
CO1:	Explain core quantum principles in a non-mathematical manner
CO2:	Compare classical and quantum information systems.
CO3:	Identify theoretical issues in building quantum computers.
CO4:	Discuss quantum communication and computing concepts.
CO5:	Recognize applications, industry trends, and career paths in quantum technology

UNIT – I

Introduction to Quantum Theory and Technologies: The transition from classical to quantum physics, Fundamental principles explained conceptually: Superposition, Entanglement, Uncertainty Principle, Wave-particle duality, Classical vs Quantum mechanics – theoretical comparison, Quantum states and measurement: nature of observation, Overview of quantum systems: electrons, photons, atoms, The concept of quantization: discrete energy levels, Why quantum? Strategic, scientific, and technological significance, A snapshot of quantum technologies: Computing, Communication, and Sensing, National and global quantum missions: India's Quantum Mission, EU, USA, China

UNIT – II

Theoretical Structure of Quantum Information Systems: What is a qubit? Conceptual understanding using spin and polarization, Comparison: classical bits vs quantum bits, Quantum systems: trapped ions, superconducting circuits, photons (non-engineering view),Quantum coherence and decoherence – intuitive explanation, Theoretical concepts: Hilbert spaces, quantum states, operators – only interpreted in abstract, The role of entanglement and non-locality in systems, Quantum information vs classical information: principles and differences, Philosophical implications: randomness, determinism, and observer role

UNIT – III

Building a Quantum Computer – Theoretical Challenges and Requirements: What is required to build a quantum computer (conceptual overview)?, Fragility of quantum systems: decoherence, noise, and control, Conditions for a functional quantum system: Isolation, Error management, Scalability, Stability, Theoretical barriers:

Why maintaining entanglement is difficult, Error correction as a theoretical necessity, Quantum hardware platforms (brief conceptual comparison),Superconducting circuits, Trapped ions, Photonics, Vision vs reality: what's working and what remains elusive, The role of quantum software in managing theoretical complexities

UNIT – IV

Quantum Communication and Computing – Theoretical Perspective: Quantum vs Classical Information, Basics of Quantum Communication, Quantum Key Distribution (QKD),Role of Entanglement in Communication, The Idea of the Quantum Internet – Secure Global Networking, Introduction to Quantum Computing, Quantum Parallelism (Many States at Once),Classical vs Quantum Gates, Challenges: Decoherence and Error Correction, Real-World Importance and Future Potential

UNIT – V

Applications, Use Cases, and the Quantum Future: Real-world application domains: Healthcare (drug discovery),Material science, Logistics and optimization, Quantum sensing and precision timing, Industrial case studies: IBM, Google, Microsoft, PsiQuantum, Ethical, societal, and policy considerations, Challenges to adoption: cost, skills, standardization, Emerging careers in quantum: roles, skillsets, and preparation pathways, Educational and research landscape – India's opportunity in the global quantum race

Text Books:

1. Michael A Nielsen and Isaac L Chuang, Quantum Computation and Quantum Information, Cambridge University Press, Cambridge.
2. Eleanor Rieffel and Wolfgang Polak, Quantum Computing: A Gentle Introduction, MIT Press, Cambridge.
3. Chris Bernhardt, Quantum Computing for Everyone, MIT Press, Cambridge.

Reference Books:

1. David McMahon, Quantum Computing Explained, Wiley.
2. Phillip Kaye, Raymond Laflamme and Michele Mosca, An Introduction to Quantum Computing, Oxford University Press.
3. Scott Aaronson, Quantum Computing Since Democritus, Cambridge University Press.
4. Alastair I M Rae, Quantum Physics: A Beginner's Guide, Oneworld Publications.
5. Eleanor G Rieffel and Wolfgang H Polak, Quantum Computing: A Gentle Introduction, MIT Press.
6. Leonard Susskind, Art Friedman, Quantum Mechanics: The Theoretical Minimum, Basic Books.
7. Bruce Rosenblum and Fred Kuttner, Quantum Enigma: Physics Encounters Consciousness, Oxford University Press.
8. Giuliano Benenti, Giulio Casati and Giuliano Strini, Principles of Quantum Computation and Information, Volume I: Basic Concepts, World Scientific Publishing
9. K.B. Whaley et al., Quantum Technologies and Industrial Applications: European Roadmap and Strategy Document, Quantum Flagship, European Commission.
10. Department of Science & Technology (DST), Government of India, National Mission on Quantum Technologies & Applications – Official Reports and Whitepapers, MeitY/DST Publications.

Online Learning Resources:

1. https://www.coursera.org/learn/quantum-mechanics
2. https://nptel.ac.in/courses/106106232

Question Paper Pattern:

Qualitative Treatment

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

THERMAL ENGINEERING LAB (THE (P))								
V Semester: Mechanical Engineering						**Scheme:** 2023		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
ME304	**PC**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
		0	**0**	**3**	**1.5**	**30**	**70**	**100**
End Exam Duration: 3 Hrs								
Course Outcomes : On successful completion of the course, the students will be able to								
CO1:	Analyze IC engine operations through valve timing diagram and determine fuel properties like flash and fire points.							
CO2:	Evaluate the performance characteristics of four-stroke diesel engines using hydraulic, mechanical, and electrical loading, and determine the friction power of an MPFI engine.							
CO3:	Perform retardation and heat balance tests to analyze engine efficiency and losses.							
CO4:	Analyze the performance characteristics of compressor, blower and wind turbine.							
CO5:	Understand the working of boiler operation and identify engine components, and exhaust emissions in IC engine.							

LIST OF EXPERIMENTS

1.	a) Draw the Valve Timing Diagrams of four stroke Engine b) Determining the Flash and Fire Point of a given oil using Pensky apparatus
2.	Performance test on 10 H.P, two-cylinder diesel engine using Hydraulic loading
3.	Performance test on 5 H.P, single cylinder diesel engine with D.C. generator loading
4.	Evaluation of Engine friction by conducting Morse test on MPFI Engine
5.	Retardation test on 5 H.P, single cylinder diesel engine using mechanical loading
6.	Heat Balance test on 5 H.P., single cylinder diesel engine with electrical loading
7.	Performance test on Two stage reciprocating air compressor
8.	Performance test on Blower rig
9.	Determine the theoretical power coefficient of a laboratory model wind turbine using wind tunnel
10.	Study of Boilers
11.	Dismantling/Assembly of Engines to identify the parts and their positions in an engine.
12.	Conduct exhaust gas Emission Test for measuring CO, CO_2, HC and NOx of an IC Engine.

Experiments beyond the curriculum:

1.	Load test on 5 H.P diesel engine fuelled with blend of Biodiesel subjected to D.C. generator loading
2.	Test on Vortex tube

Note: Student has to perform at least 10 experiments from the above lists.

THEORY OF MACHINES LAB (TOM(P))

V Semester: Mechanical Engineering | **Scheme:** 2023

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
ME305	PC	0	0	3	1.5	30	70	100

End Exam Duration: 3 Hrs

Course Outcomes: At the end of the course students will be able to

CO1:	Balance rotating masses in different planes and draw the characteristic curves of governors.
CO2:	Measure the critical speed of the shaft with fixed end conditions.
CO3:	Measure vibration characteristics of spring mass system, rotor system and damped system.

LIST OF EXPERIMENTS

1. a) Determination of Radius of Gyration of Connecting Rod
   b) Displacement, Velocity & Acceleration analysis of Cam & Follower
2. Longitudinal Vibrations of Spring-Mass System
3. Performance characteristic curves of Watt and Porter Governers using Universal Governor apparatus
4. Performance characteristic curves of Proell and Hartnell Governers using Universal Governor apparatus
5. Static and Dynamic balancing of rotating masses
6. Verification of magnitude of gyroscopic couple & applied couple on motorized gyroscope
7. Study of Damped and Un-damped Torsional Vibrations
8. Torsional Vibrations of Single and Two Rotor System
9. Verification of Dunkerley's Rule
10. Determination of Critical speed or Whirling speed of shaft

Experiments beyond the curriculum:

1. Determine the natural frequencies of a rectangular plate with free-free boundary conditions
2. Draw the mode shapes of a rectangular plate with free-free boundary conditions

Note: Student has to perform at least 10 experiments from the above lists

Virtual labs:

1. https://dom-nitk.vlabs.ac.in/
2. https://va-coep.vlabs.ac.in/
3. https://mdmv-nitk.vlabs.ac.in/

MACHINE TOOLS & METROLOGY LAB (MTM(P))

V Semester: Mechanical Engineering | **Scheme:** 2023

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
SCME01	SEC	0	1	2	2	30	70	100

End Exam Duration: 3 Hrs

Course Outcomes: At the end of the course students will be able to

CO1:	Perform step turning, taper turning, eccentric turning and thread cutting on cylindrical work piece using lathe machine.
CO2:	Perform drilling, shaping and slotting operations on work piece using relevant machine tools.
CO3:	Prepare single point cutting tools using Tool and cutter grinder.
CO4:	Measure the taper angle of external and internal taper.
CO5:	Determine the elements of screw threads and gear elements using metrology equipment.

LIST OF EXPERIMENTS

1.	To perform Step turning and Taper turning by compound swivel method on Lathe
2.	To perform Eccentric turning on Lathe.
3.	Right hand thread cutting and Left hand thread cutting on Lathe.
4.	To perform Drilling, reaming, tapping and counter sinking on Drilling machine.
5.	Making Square rod from round rod using shaper.
6.	a) Making of a Single point cutting tool by cup grinding wheel on tool cutter grinder. b) Key way cutting on slotting machine.
7.	Measurement of angle of Taper plug gauge and Ring gauge.
8.	Measurement of taper angle of an object using Sine bar.
9.	Measurement of parameters of Screw Threads.
10.	Measurement of Gear parameters.
11.	Measurement of co-ordinates of Jig plate
12.	a) To find small angles and length measurement on objects using Tool Makers micro Scope. b) To find small angles and length measurement on objects using Profile Projector
13.	Measurement of surface roughness using surface roughness tester

Note: Student has to perform at least 10 experiments from the above lists

Online Learning resources:

1. https://www.youtube.com/watch?v=sG6GCfX7L3c&pp=ygUeTWFjaGluZSBUb29scyAgbGFiIGV4cGVyaW1lbnRz
2. https://www.youtube.com/watch?v=mafthRhz1iM&pp=ygUeTWFjaGluZSBUb29scyAgbGFiIGV4cGVya W1lbnRz
3. https://www.youtube.com/watch?v=5—saqoYBE&list=PLrcSDk_gQ7jiQCfWEzw93ZMaxHkg2v-CC
4. https://www.youtube.com/watch?v=m60m2TcbTgc&pp=ygUZbWV0cm9sb2d5IGxhYiBleHBlcmltZW50cw

TINKERING LAB (TL(P))								
V Semester: Common for all branches						**Scheme:** 2023		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
ESCM02	**ES**	**L**	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
		0	**0**	**2**	**1**	**30**	**70**	**100**

End Exam Duration: 3 Hrs

Course Outcomes: At the end of the course students will be able to

CO1:	The students will be able to experiment, innovate, and solve real-world challenges.

LIST OF EXPERIMENTS

1.	Make your own parallel and series circuits using breadboard for any application of your choice.
2.	Demonstrate a traffic light circuit-using breadboard.
3.	Build and demonstrate automatic Street Light using LDR.
4.	Simulate the Arduino LED blinking activity in Tinkercad.
5.	Build and demonstrate an Arduino LED blinking activity using Arduino IDE.
6.	Interfacing IR Sensor and Servo Motor with Arduino.
7.	Blink LED using ESP32.
8.	LDR Interfacing with ESP32.
9.	Control an LED using Mobile App.
10.	Design and 3D print a Walking Robot
11.	Design and 3D Print a Rocket.
12.	Build a live soil moisture-monitoring project, and monitor soil moisture levels of a remote plan in your computer dashboard.
13.	Demonstrate all the steps in design thinking to redesign a motor bike.

References:

1.	https://aim.gov.in/pdf/equipment-manual-pdf.pdf
2.	https://atl.aim.gov.in/ATL-Equipment-Manual/
3.	https://aim.gov.in/pdf/Level-1.pdf
4.	https://aim.gov.in/pdf/Level-2.pdf
5.	https://aim.gov.in/pdf/Level-3.pdf

List of Professional Elective - I Courses

1. Tool Design
2. Nano Technology
3. Mechanical Behavior of Materials
4. Work Study and Ergonomics
5. Internal Combustion Engines & Gas Turbine

TOOL DESIGN (TD)

V Semester: Mechanical Engineering — **Scheme: 2023**

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
ME311	PE-I	3	0	0	3	30	70	100

Sessional Exam Duration: 2 Hrs — **End Exam Duration: 3 Hrs**

Course Outcomes: At the end of the course the student will be able to

CO1:	Apply Merchant's theory and cutting mechanics to analyze forces, tool wear, and tool life in metal cutting.
CO2:	Explain tool materials, cutting fluids, and evaluate machining parameters for economic production.
CO3:	Demonstrate the design principles of single-point cutting tools, twist drills, and milling cutters based on functional requirements.
CO4:	Describe press working operations and identify key design factors for dies and press tools.
CO5:	Demonstrate the principles and design considerations of jigs and fixtures.

UNIT – I

Metal Cutting: Classification of metal cutting operations, Mechanics of metal cutting, Tool signature, Oblique and orthogonal cutting, Review of Merchant's theory of metal cutting, Two component tool dynamometer.

Tool Wear and Tool Life: Sources of heat in metal cutting, Heat dissipation and distribution to chip, Tool and work piece, Methods of evaluating temperature at tool-chip interface. Machinability, Factors affecting machinability, Mechanism of tool wear and various types of tool wear-crater wear and flank wear. Introduction to tool life, Taylor's tool life equation, Efects of tool geometry, Feed, Depth of cut, Cutting speed on tool life.

UNIT – II

Cutting Tool Materials: Essential requirements of a tool material, tool materials - HCS, HSS, Cast alloys, Carbides, Ceramic tools, Diamond tool bits.

Cutting Fluids: Essential requirements of a good cutting fluid, types of cutting fluids and their relative applications.

Economics of Machining: Introduction, economic tool life, derivations on optimal cutting speed to – maximum production, maximum profit and minimum cost criteria.

UNIT – III

Design of Cutting Tools: Design of single point cutting tool, elements of twist drill and its design considerations, Design of milling cutters.

UNIT – IV

Press Working: Press working terminology, press operations - punching, blanking and other types of press working operations, drawing and deep drawing, bending and forging, Design considerations for forging and bending dies.

Press Tools: types of cutting dies and their working, design considerations for press tools-centre of pressure, scrap strip layout, press tonnage capacity, etc.

UNIT – V

Jigs & fixtures: Fundamental ideas and principles of Jigs and Fixtures. Design of drill jigs and fixtures for turning, drilling, milling, broaching and grinding operations. Locating and clamping devices of jigs and fixtures. Indexing devices and types. Different types of jigs & fixtures. Design of a jig and fixtures for the given component by using Computer Aided Design

Text Books:

1. Ranganath B J, Tool Engineering Design, Vikas publishing house pvt.ltd, New Delhi.
2. Cyril Donaldson, H Le Cain George, V C Goold and Joyjeet Ghose, Tool Design, McGraw

	Hill Education, New Delhi.
3.	Ashok Kumar Singh, Metal Cutting and Tool Design, Vayu Education of India, New Delhi.
4.	P H Joshi, Jigs and Fixtures, McGraw Hill Education, New Delhi.
Reference Books	
1.	Amerego E J and Brown R H , The Machining of Metals, Prentice Hall, New Jersey.
2.	N K Mehta, Metal Cutting and Design of Cutting Tools - Jigs and Fixture, McGraw Hill Education, New Delhi.
Question Paper Pattern:	

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

NANO TECHNOLOGY (NT)								
V Semester: Mechanical Engineering					**Scheme: 2023**			
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
ME312	**PE-I**	**3**	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration: 2 Hrs					**End Exam Duration: 3 Hrs**			

Course Outcomes: At the end of the course, students will be able to

CO1:	Understand the fundamentals of nano science and nanotechnology, including the history, classification and analyze the structural aspects of nanomaterials.
CO2:	Knowledge of the synthesis and fabrication techniques used in nano science, and methods for realizing semiconductor nanostructures.
CO3:	Advanced characterization techniques used for analysing the structural, morphological, and electronic properties of nanomaterials.
CO4:	Explore carbon nanomaterials properties and wide-ranging applications.
CO5:	Familiarize with the diverse applications of nanotechnology, with emphasis on nanostructured thin films and quantum dots.

UNIT – I

Introduction: History of nano science, Definition of nano meter, Nano materials, Nano technology. Classification of nano materials. Crystal symmetries, Crystal directions, Crystal planes. Band structure.

Properties Of Materials: Mechanical properties, Electrical properties, Dielectric properties, Thermal properties, Magnetic properties, Opto electronic properties. Effect of size reduction on properties, Electronic structure of nano materials.

UNIT – II

Synthesis and Fabrication: Synthesis of bulk polycrystalline samples, Growth of single crystals. Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis, Hydro thermal growth, Thin film growth, PVD and CVD; Top Down Approach – Ball milling, Micro fabrication, Lithography.

UNIT – III

Characterization Techniques: X-Ray diffraction and Scherrer method, Scanning electron microscopy, Transmission electron microscopy, Scanning probe microscopy, Atomic force microscopy, Piezoresponse microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, Diffuse reflectance spectra, Photoluminescence spectra, Raman spectroscopy

UNIT – IV

Semiconductor Nanostructures and Manufacturing: Overview of semiconductor nanomaterials, Quantum wells, wires, and dots; Bandgap engineering in nanostructures, Epitaxial growth methods: MBE, MOCVD; Photolithography, Nanoimprint lithography, Etching techniques, Integration of semiconductor nanostructures in devices.

UNIT – V

Applications of Nano Technology: Applications in material science, Biology and medicine, surface science, Energy and environment. Applications of nano structured thin fins, Applications of quantum dots.

Text Books:

1. M S Ramachandra Rao and Shubra Singh, Nano science and nano technology, Wiley publishers
2. Risal Singh and Shipra Mital Gupta, Introduction to Nanotechnology, Oxford Higher Education

Reference Books:

1. Charles P Poole and Frank J Owens, Introduction to Nano Technology, Wiley publishers
2. Jermy J Ramsden, Nanotechnology, Elsevier publishers
3. A K Bandyopadhyay, Nano Materials, New Age
4. M A Shah, K A Shah, Nanotechnology the Science of Small, Wiley Publishers.

Online Learning Resources:

1. https://youtube.com/playlist?list=PLyqSpQzTE6M8682dGkNTN8936vSY4CbqZ&si=8S682KjXK7_xITpT
2. https://youtu.be/OLa8DQkKlyU?si=I6R1Of59MArQyPUb
3. https://youtu.be/u1ojNgPCHGs?si=mlIgQm4OdwZnHUo3

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

MECHANICAL BEHAVIOUR OF MATERIALS (MBM)

V Semester: Mechanical Engineering | **Scheme: 2023**

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
ME313	PE-I	3	0	0	3	30	70	100

Sessional Exam Duration: 2 Hrs | **End Exam Duration: 3 Hrs**

Course Outcomes: At the end of the course the student will be able to

CO1:	Dictate the elastic behaviour of engineering materials, recall Hooke's law and apply the dislocation theory, forces on and between dislocations.
CO2:	Distinguish strengthening mechanisms and strain aging mechanisms
CO3:	List various modes of fracture and the basic mechanism of ductile and brittle fracture, Identify importance of Griffith's theory, and also the factors effecting DBTT.
CO4:	Explain fatigue behaviour and testing. Differentiate HCF/LCF, thermo mechanical fatigue.
CO5:	Explain stages in creep curve. Evaluate and predict the metallurgical factors affecting creep and creep different testing.

UNIT – I

Elastic and Plastic Behavior: Elastic behavior of materials – Hooke's law, plastic behavior: dislocation theory – Burger's vectors and dislocation loops, dislocations in FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, slip and twinning.

UNIT – II

Strengthening Mechanisms: Cold Working, Grain Size Strengthening, Solid Solution Strengthening, Martensitic Strengthening, Precipitation Strengthening, Dispersion Strengthening, Fibre Strengthening, Examples. Yield Point Phenomenon, Strain aging and Dynamic strain aging.

UNIT – III

Fracture and Fracture Mechanics: Types of Fracture, Basic Mechanism of Ductile and Brittle Fracture, Griffith's Theory of Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Factors Affecting DBTT, Determination of DBTT. Fracture Mechanics-Introduction, Modes of Fracture, Stress Intensity Factor, Strain Energy Release Rate, Fracture Toughness and Determination of KIC.

UNIT – IV

Fatigue Behaviour and Testing: Stress Cycles, S-N Curves, Effect of Mean Stress, Factors Affecting Fatigue, Structural Changes Accompanying Fatigue, Cumulative Damage, HCF / LCF, Thermo-mechanical Fatigue, Application of Fracture Mechanics to Fatigue Crack Propagation-Paris law- Fatigue Testing Machines.

UNIT – V

Creep Behavior and Testing: Creep Curve, Stages in Creep Curve and Explanation, Structural Changes during Creep, Creep Mechanisms, Metallurgical Factors Affecting Creep, High Temperature Alloys, Stress Rupture Testing, Creep Testing Machines.

Text Books:

1. G E Dieter, Mechanical Metallurgy, McGraw Hill, New Delhi
2. H E Davis, G E Troxell and G E W Hauck, The Testing Of Engineering Materials‖, McGraw Hill.

Reference Books:

1. Wulff, The Structure and Properties of Materials, Vol. III — Mechanical Behavior of

Materials‖, John Wiley and Sons.

2. R W K, Honey Combe Plastic Deformation of Materials‖, Edward Arnold Publishers.

3. A V K Suryanarayana, Testing of Metallic Materials‖, Prentice Hall India, New Delhi.

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

WORK STUDY AND ERGONOMICS (WSE)

V Semester: Mechanical Engineering						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
ME314	PE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes: At the end of the course, students will be able to

CO1:	Remember the basic concepts of productivity, work content and work study.
CO2:	Understand the concept of method study, principles of motion economy and work sampling.
CO3:	Understand the basic work measurement techniques and to gain knowledge of measurement of work and rating
CO4:	Analyse the basic concepts of Ergonomics and demonstrate a sound knowledge of Ergonomics in engineering applications
CO5:	Apply the knowledge of Man-Machine Interfaces and design of displays and controls in engineering systems

UNIT – I

Productivity and Work Study: Definition of productivity, Task of management, Productivity of materials, land, Building, Machine and power, Factors affecting the productivity, Work content, Basic work content, Excess work content, How manufacturing job is made up, Work content due to excess product and process, Ineffective time due to short comings on part of the management.

Definition, Objective and scope of Work Study: Work study and management, Work study and work.

UNIT – II

Method Study: Definition, Objective and scope of method study, Activity recording and tools, Flow Process Chart, Flow diagram, String Diagram, Travel Chart, Multiple Activity Chart.

Principles of Motion Economy: Introduction, Classification of movements.

Micromotion study, Therbligs

Work Sampling: Need, Confidence levels, and sample size determination, Conducting study with problems.

UNIT – III

Time study: Definition, time study equipment, Selection of job, Steps in time study. Breaking jobs into elements.

Recording information. Rating: Systems of rating, Standard rating, Standard performance, scales of rating. Allowances: Standard time determination, Predetermined motion time study (PMTS), factors affecting rate of working, Problems on allowances.

UNIT – IV

Introduction to Ergonomics: Human factors and ergonomics, Psychology, bio mechanics, Industrial design, graphics design, Anthropometry Morphology of design and its relationship with cognitive abilities of human being.

Physical Ergonomics: Human anatomy, and some of the anthropometric, Physiological and bio mechanical characteristics as they relate to physical activity.

Cognitive: Mental processes, such as perception, Memory, Reasoning, and motor response, Mental workload, and Decision-making.

Organizational Ergonomics: Optimization of socio-technical systems, including their

organizational structures, policies, processes. Communication, work design, cooperative work.

Environmental Ergonomics: Human interaction with the environment- Characterized by climate, temperature, pressure, vibration, light.

UNIT – V

Man-Machine Interaction; Man-Machine interaction cycle, Man-machine interfaces, Display factors that control choice of display, visual displays- qualitative displays; moving pointer displays, moving scale displays, digital displays Indicators, auditory displays, tactile displays. Factors affecting effectiveness of displays. Quantitative displays, check- reading displays, representational displays. Types of controls and their integration with displays.

Design Guidelines for Displays and Controls: Viewing distance, Illumination, Angle of view, reach etc., General design checklist for displays and controls. Standards for ergonomics in engineering and design, displays and controls.

Text Books:

1. Introduction to Work Study, ILO.
2. Mark S Sanders and Ernest J McCornick, Human Factor in Engineering and Design, McGraw-Hill Book Co., Inc., New York.

Reference Books:

1. S Dalela and Sourabh, Work Study and Ergonomics. Standard publishers.
2. Wesley Woodson, Peggy Tillman and Barry Tillman, Human Factors Design Handbook, McGraw-Hill.
3. Ralph M Barnes, Motion and Time Study, Wiley International.
4. Mark S Sanders and Ernest J McCormick, Human Factors in Engineering Design.

Online Learning Resources:

1. https://youtu.be/b05FPBjFH6A?si=dWB1YOLOmSMRBSX7
2. https://youtube.com/playlist?list=PLLy_2iUCG87BbIF6sF5sy_ZZLFoUcnncb&si=n1NAnNAnFTti9vtK
3. https://youtube.com/playlist?list=PLuF8VVHesRxXBZzQpQSzvJI7eM_SduxwR&si=j2vyTNYybgvXrDiy

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

INTERNAL COMBUSTION ENGINES AND GAS TURBINES (ICGT)								
V Semester: Mechanical Engineering					**Scheme: 2023**			
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
ME315	**PE-I**	**3**	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration: 2 Hrs					**End Exam Duration: 3 Hrs**			

Course Outcomes : At the end of the course the student will be able to	
CO1:	Solve problems on engine performance parameters.
CO2:	Understand the combustion process, carburetion, emissions of engines.
CO3:	Understand the working of superchargers, turbo charging and sensors.
CO4:	Analyze the basic operation of a gas turbine and its component.
CO5:	Apply the basic concepts of rocket propulsion to solve related problems.

UNIT – I

IC Engines: Introduction, Engine performance parameters, Calculation of engine power and efficiencies, Performance characteristics, Heat balance calculation, Measurement of friction power and brake power

UNIT – II

Carburetion: Air-fuel mixtures and its requirements, Principle of carburetion, Working of simple carburetor, Basic principle of mechanical and electronic fuel injection

Combustion: Stages of combustion in SI engines and CI engines

Emissions: Basic categories of engine emissions, causes of HC, CO, and NOx emissions and control methods

UNIT – III

Engine Electronics: Introduction, Engine management system, Position displacement and speed sensing sensors, Temperature and Intake air flow measurement

Supercharging: Introduction, Advantages and limitations, Types of superchargers, Turbo charging.

UNIT – IV

Gas Turbines : Simple Gas Turbine, Ideal cycle, essential components, Open and closed cycle arrangements, Requirements of working medium, Applications of Gas Turbines, Comparison of Gas Turbines with reciprocating engines, Work output and efficiency of a simple Gas Turbine cycle, Optimum pressure ratio for maximum specific output, Gas Turbines with regeneration, Reheating and inter cooling

UNIT – V

Jet Propulsion: Introduction to Propeller engines and Gas Turbine engines, Working principle of Ramjet engine, Pulse jet engine, Turboprop engine and Turbojet engine, Thrust and thrust equation, Specific thrust, Parameters affecting flight performance, Introduction to Rocket propulsion, Classification of Rockets and principle of Rocket propulsion

Text Books:

1. V Ganesan, Internal Combustion Engines, TMH Publishers, New Delhi.
2. V Ganesan, Gas Turbines, TMH Publishers, New Delhi.

Reference Books:

1. H N Gupta, Fundamentals of internal combustion engines, Prentice hall, New Delhi.
2. P K Nag, Power Plant Engineering, McGraw hill, New Delhi.
3. S L Soma Sundaran, Gas dynamics and Jet Propulsion, NAI Publishers, New Delhi.
4. P L Ballaney, Thermal Engineering, Khanna Publishers, New Delhi.

5. Sarvanamutto and GFC Rogers, Gas Turbine Theory, Pearson Education, New Delhi.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/112/103/112103262/

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

List of Open Elective - I Courses

1. Green Buildings
2. Construction Technology and Management
3. Electrical Safety Practices and Standards
4. Sustainable Energy Technologies
5. Electronic Circuits
6. Java Programming
7. Foundations of Artificial Intelligence
8. Ethical Hacking
9. Mathematics for Machine Learning and AI
10. Materials Characterization Techniques
11. Chemistry of Energy Systems
12. English for Competitive Examinations
13. Entrepreneurship and New Venture Creation

GREEN BUILDINGS (GB)

V Semester: All Branches						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE501	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Understand the importance of green buildings, their necessity, and sustainable features
CO2:	Analyze various green building practices, rating systems, and their impact on environmental sustainability.
CO3:	Apply principles of green building design to enhance energy efficiency and incorporate renewable energy sources.
CO4:	Evaluate HVAC systems, energy-efficient air conditioning techniques, and their role in sustainable building design.
CO5:	Assess material conservation techniques, waste reduction strategies, and indoor air quality management in green buildings.

UNIT – I

Introduction to Green Building: Necessity of Green Buildings, Benefits of Green Buildings, Green Building Materials and Equipment in India, Key Requisites for Constructing a Green Building, Important Sustainable Features for Green Buildings.

UNIT – II

Green Building Concepts and Practices: Indian Green Building Council, Green Building Movement in India, Benefits Experienced in Green Buildings, Green Building Rating Systems, Residential Sector, Market Transformation

Green Building Opportunities and Benefits: Opportunities of Green Buildings, Green Building Features, Material and Resources, Water Efficiency, Optimum Energy Efficiency, Typical Energy-Saving Approaches in Buildings, LEED India Rating System, and Energy Efficiency.

UNIT – III

Green Building Design: Introduction, Reduction in Energy Demand, Onsite Sources and Sinks, Maximizing System Efficiency, Steps to Reduce Energy Demand and Use Onsite Sources and Sinks, Use of Renewable Energy Sources, Eco-Friendly Captive Power Generation for Factories, Building Requirements.

UNIT – IV

Air Conditioning: Introduction, CII Godrej Green Business Centre, Design Philosophy, Design Interventions, Energy Modeling, HVAC System Design, Chiller Selection, Pump Selection, Selection of Cooling towers, Selection of Air Handling Units, Pre-Cooling of Fresh Air, Interior Lighting Systems, Key Features of The Building, Eco-Friendly Captive Power Generation for Factories, Building Requirements.

UNIT – V

Material Conservation: Handling of Non-Process Waste, Waste Reduction During Construction, Materials With Recycled Content, Local Materials, Material Reuse, Certified Wood, Rapidly Renewable Building Materials and Furniture.

Indoor Environment Quality and Occupational Health: Air Conditioning, Indoor Air Quality, Sick Building Syndrome, tobacco Smoke.

Text Books:

1. Handbook on Green Practices published by Indian Society of Heating Refrigerating and

Air conditioning Engineers, 2009.

2. Green Building Hand Book by Tomwoolley and Samkimings, 2009.

Reference Books:

1. Complete Guide to Green Buildings by Trish riley

2. Standard for the design for High Performance Green Buildings by Kent Peterson, 2009

3. Energy Conservation Building Code–ECBC-2020, published by BEE

4. Alternative Building Materials and Technologies – By K S Jagadeesh, B V Venkata Rama Reddy & K S NanjundaRao – New Age International Publishers

5. Non-conventional Energy Resources – By D S Chauhan and S K Sreevasthava – New Age International Publishers

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/105/102/105102195/

2. https://igbc.in/resources

3. https://www.grihaindia.org/

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

CONSTRUCTION TECHNOLOGY AND MANAGEMENT (CTM)

V Semester: All Branches Except CE						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE502	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Understand project management fundamentals, organizational structures, and leadership principles in construction.
CO2:	Solve and formulate network analysis in CPM and PERT networks.
CO3:	Understand the structure of organization and resource allocation
CO4:	Evaluate various contract types, contract formation, and legal aspects in construction management
CO5:	Assess safety management practices, accident prevention strategies, and quality management systems in construction

UNIT – I

Introduction: Management Objectives and Functions; Stages of Project Management - Types of Organization, Organizational Chart of a Construction Company – Team of Construction Unit - Manager's Duties and Responsibilities.

Construction Planning and Scheduling: Objectives and importance of planning and scheduling – Methods of Planning and Scheduling.

UNIT – II

Network Techniques in Construction management: Elements of network – Network techniques – Breakdown structures – Representation and specifying of activities and events – Rules for Network.

Critical Path Method (CPM): Introduction – Difference between CPM and PERT – Time estimates – Float – Critical path – Network analysis and computation problems.

UNIT – III

Program Evaluation and Review Technique (PERT): Introduction, time estimates, slack, critical path – Network analysis and computation problems.

Cost–Time Analysis in Net Work Planning: Importance of time – Project cost analysis innetwork planning – Updating – Resources allocation.

UNIT – IV

Tenders and Contracts: Type of tenders – Principles of tendering – Notice inviting tender – Contracts definition – Essentials – Types – Documents – Conditions of contracts.

Arbitration: Definition – Arbitrator – Arbitration agreement – Qualification of arbitrator – Advantages of arbitration.

UNIT – V

Safety Management: Implementation and Application of QMS, ISO 9000 Series, Accident Theories, Cost of Accidents, Problem Areas in Construction Safety, Fall Protection, Incentives, Zero Accident Concepts, Planning for Safety.

Text Books:

1. Construction Project Management, SK. Sears, GA. Sears, RH. Clough, John Wiley and Sons, 6th Edition, 2016.
2. Construction Project Scheduling and Control by Saleh Mubarak, 4th Edition, 2019
3. Pandey, I.M (2021) Financial Management 12th edition. Pearson India Education Services Pvt. Ltd.

Reference Books:

1.	Brien, J.O. andPlotnick, F.L., CPMin Construction Management, Mcgraw Hill, 2010.
2.	Punmia, B.C., andKhandelwal, K.K., Project Planning and control with PERT and CPM, Laxmi Publications, 2002.
3.	Construction Methods and Management: Pearson New International Edition 8 th Edition Stephens Nunnally.
4.	Rhoden, M and Cato B, Construction Management andOrganisational Behaviour, Wiley-Blackwell, 2016.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/105/104/105104161/
2. https://archive.nptel.ac.in/courses/105/103/105103093/

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

ELECTRICAL SAFETY PRACTICES AND STANDARDS (ESPS)

V Semester: All Branches Except EEE					Scheme: 2023			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE503	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs					End Exam Duration: 3 Hrs			

Course Outcomes : At the end of the course, students will be able to

CO1:	Understanding the Fundamentals of Electrical Safety
CO2:	Identifying and Applying Safety Components
CO3:	Analyzing Grounding Practices and Electrical Bonding
CO4:	Applying Safety Practices in Electrical Installations and Environments
CO5:	Evaluating Electrical Safety Standards and Regulatory Compliance

UNIT – I

Introduction To Electrical Safety: Fundamentals of Electrical Safety-Electric Shock-physiological effects of electric current - Safety requirements –Hazards of electricity- Arc - Blast- Causes for electrical failure.

UNIT – II

Safety Components: Introduction to conductors and insulators- voltage classification - safety against over voltages- safety against static electricity-Electrical safety equipment's - Fire extinguishers for electrical safety.

UNIT – III

Grounding: General requirements for grounding and bonding- Definitions- System grounding-Equipment grounding - The Earth - Earthing practices- Determining safe approach distance-Determining arc hazard category.

UNIT – IV

Safety Practices: General first aid- Safety in handling hand held electrical appliances tools-Electrical safety in train stations-swimming pools, external lighting installations, medical locations-Case studies.

UNIT – V

Standards For Electrical Safety: Electricity Acts- Rules & regulations- Electrical standards-NFPA 70 E-OSHA standards-IEEE standards-National Electrical Code 2005 – National Electric Safety code NESC-Statutory requirements from electrical inspectorate

Text Books:

1. Massimo A.G.Mitolo, "Electrical Safety of Low-Voltage Systems", McGraw Hill, USA, 2009.
2. Mohamed El-Sharkawi, "Electric Safety - Practice and Standards", CRC Press, USA, 2014.

Reference Books:

1. Kenneth G.Mastrullo, Ray A. Jones, "The Electrical Safety Program Book", Jones and Bartlett Publishers, London, 2nd Edition, 2011.
2. Palmer Hickman, "Electrical Safety-Related Work Practices", Jones & Bartlett Publishers, London, 2009.
3. Fordham Cooper, W., "Electrical Safety Engineering", Butterworth and Company, London, 1986.
4. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, "Electrical Safety Hand book", McGraw-Hill, New York, USA, 4th edition, 2012.

Online Learning Resources:

1. https://onlinecourses.swayam2.ac.in/nou25_ec08/preview

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

SUSTAINABLE ENERGY TECHNOLOGIES (SET)

V Semester: All Branches Except ME						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE504	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Understand the importance of solar radiation and solar PV modules.
CO2:	Describe the storage methods in PV systems
CO3:	Explain the solar energy storage for different applications
CO4:	Illustrate the principles of wind energy, and bio-mass energy.
CO5:	Attain knowledge in geothermal energy, ocean energy and fuel cells.

UNIT – I

Solar Radiation: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems and coordinates of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems.

Solar PV Modules and PV Systems: PV Module Circuit Design, Module Structure, Packing Density, Interconnections, Mismatch and Temperature Effects, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module, Solar PV Systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

UNIT – II

Storage in PV Systems: Battery Operation, Types of Batteries, Battery Parameters, Application and Selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV System.

UNIT – III

Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation.

Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

UNIT – IV

Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

Bio-Mass: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

UNIT – V

Geothermal Energy: Origin, Applications, Types of Geothermal Resources, Relative Merits. **Ocean Energy**: Ocean Thermal Energy; Open Cycle & Closed Cycle OTEC Plants, Environmental Impacts, Challenges.

Fuel Cells: Introduction, Applications, Classification, Different Types of Fuel Cells Such as Phosphoric Acid Fuel Cell, Alkaline Fuel Cell, PEM Fuel Cell, MC Fuel Cell.

Text Books:

1. Sukhatme S.P. and J.K.Nayak , Solar Energy – Principles of Thermal Collection and

Storage, TMH, 2009

2. Khan B.H , Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi,2006

3. Twidell & Weir, Renewable Energy Sources , Taylor and Francis / 2nd Special Indian Edition,2006

4. G.N Tiwari and M.K.Ghosal , Fundamentals of Renewable Energy Sources, Alpha Science International Limited, 2007

Reference Books:

1. D.Yogi Goswami, Frank Krieth& John F Kreider , Principles of Solar Engineering , Taylor & Francis,2015

2. Ashok V Desai ,Non-Conventional Energy , New Age International (P) Ltd,1990

3. R. Ramesh & K. Uday Kumar,Renewable Energy Technologies, Narosa Publishing,1997

4. G.D Roy , Non-conventional Energy Source, Standard Publishers,2004

5. Anjaneyulu & Francis , Energy Resources Utilization and Technologies , BS Publications/2012.

6. Frank Krieth & John F Kreider, Principles of Solar Energy, Hemisphere Publications.2000

Online Learning Resources:

1. https://nptel.ac.in/courses/112106318

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

ELECTRONIC CIRCUITS (EC)

V Semester: All Branches Except ECE						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE505	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Illustrate the VI Characteristics of Diode and special purpose diodes, Design rectifiers, wave shaping circuits and describe the behavior of special purpose diodes.
CO2:	Explore the operation, configurations, and biasing of BJTs.
CO3:	Gain knowledge about the operation, analysis, and coupling techniques of BJT amplifiers.
CO4:	Understand the operation, applications and uses of feedback amplifiers and oscillators
CO5:	Analyze the characteristics, configurations, and applications of operational amplifiers.

UNIT – I

Semiconductor Diode and Applications: Introduction, PN junction diode – structure, operation and VI characteristics, Half-wave, Full-wave and Bridge Rectifiers with and without Filters, Positive and Negative Clipping and Clamping circuits (Qualitative treatment only).

Special Diodes: Zener and Avalanche Breakdowns, VI Characteristics of Zener diode, Zener diode as voltage regulator, Construction, operation and VI characteristics of Tunnel Diode, LED, Varactor Diode, Photo Diode

UNIT – II

Bipolar Junction Transistor (BJT): Principle of Operation, Common Emitter, Common Base and Common Collector Configurations, Transistor as a switch and Amplifier, Transistor Biasing and Stabilization - Operating point, DC & AC load lines, Biasing - Fixed Bias, Self Bias, Bias Stability, Bias Compensation using Diodes.

UNIT – III

Single Stage Amplifiers: Classification of Amplifiers - Distortion in amplifiers, Analysis of CE, CC and CB configurations with simplified hybrid model.

Multistage Amplifiers: Different Coupling Schemes used in Amplifiers - RC coupled amplifiers, Transformer Coupled Amplifier, Direct Coupled Amplifier; Multistage RC coupled BJT amplifier (Qualitative treatment only).

UNIT – IV

Feedback Amplifiers: Concepts of feedback, Classification of feedback amplifiers, Effect of feedback on amplifier characteristics, Voltage Series, Voltage Shunt, Current Series and Current Shunt Feedback Configurations (Qualitative treatment only).

Oscillators: Classification of oscillators, Condition for oscillations, RC Phase shift Oscillators, Generalized analysis of LC Oscillators-Hartley and Colpitts Oscillators, Wien Bridge Oscillator.

UNIT – V

Op-amp: Classification of IC'S, basic information of Op-amp, ideal and practical Op-amp, 741 op-amp and its features, modes of operation-inverting, non-inverting, differential. **Applications of Op-amp:** Summing, scaling and averaging amplifiers, Integrator, Differentiator, phase shift oscillator and comparator.

Text Books:

1. Electronics Devices and Circuits, J.Millman and Christos. C. Halkias, 3rd edition, Tata McGraw Hill, 2006.

2. Electronics Devices and Circuits Theory, David A. Bell, 5th Edition, Oxford University press. 2008.

Reference Books:

1. Electronics Devices and Circuits Theory, R.L.Boylestad, LousisNashelsky and K.Lal Kishore, 12th edition, 2006, Pearson, 2006.

2. Electronic Devices and Circuits, N.Salivahanan, and N.Suresh Kumar, 3rd Edition, TMH, 2012

3. Microelectronic Circuits, S.Sedra and K.C.Smith, 5th Edition, Oxford University Press.

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

JAVA PROGRAMMING (JP)

V Semester: CE, EEE, ME and ECE						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE506	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Analyze problems, design solutions using OOP principles, and implement them efficiently in Java.
CO2:	Design and implement classes to model real-world entities, with a focus on attributes, behaviors, and relationships between objects
CO3:	Demonstrate an understanding of inheritance hierarchies and polymorphic behaviour, including method overriding and dynamic method dispatch.
CO4:	Apply Competence in handling exceptions and errors to write robust and fault-tolerant code.
CO5:	Perform file input/output operations, including reading from and writing to files using Java I/O classes, graphical user interface (GUI) programming using JavaFX
CO6:	Choose appropriate data structure of Java to solve a problem

UNIT – I

Object Oriented Programming: Basic concepts, Features of Java , Principles

Program Structure in Java: Introduction, Writing Simple Java Programs, Java Statements

Data Types, **Variables, and Operators:** Introduction, Data Types in Java, Declaration of Variables, Type Casting, Scope of Variable Identifier, Variables, Constants, Scope and Lifetime of variables, Operators, Type conversion and casting

Introduction to Operators: Precedence and Associativity of Operators, Assignment Operator (=), Basic Arithmetic Operators, Increment (++) and Decrement (--) Operators, Ternary Operator, Relational Operators, Boolean Logical Operators, Bit-wise Logical Operators.

Control Statements: Introduction, Control Statements- If Nested loops, Switch Statement, Iteration Statements, while Expression, do–while Loop, for Loop, Nested for Loop

UNIT – II

Classes and Objects: Introduction to Classes: Introduction, Class Declaration and Modifiers, Class Members, Declaration of Class Objects, Assigning One Object to Another, Constructor Methods for Class, , Nested Classes, Final Class and Methods, Passing Arguments by Value and by Reference, Keyword this, finalize and Wrapper classes

Methods: Introduction, Defining Methods, Overloaded Methods, Overloaded Constructor Methods, Class Objects as Parameters in Methods, Access Control, Recursive Methods, , Attributes Final and Static.

UNIT – III

Arrays: Introduction, Declaration and Initialization of Arrays, Memory Storage & Access, Array Operations, Arrays as Vectors. Two dimensional Arrays, Arrays of Varying Lengths, Three dimensional Arrays.

Inheritance: Introduction, Access Control and Types of Inheritance, Multilevel and Hierarchical Inheritance, Final and Super keywords, Method Overriding, Dynamic Method Dispatch, Abstract Classes, Interfaces and Inheritance.

Interfaces: Introduction, Declaration of Interface, Implementation of Interface, , Default Methods in Interfaces, Static Methods in Interface, Functional Interfaces, Annotations.

UNIT – IV

Packages and Java Library :Packages:

Introduction, Defining Package, Importing Packages and Classes into Programs, Access Control, Packages in Java SE, Class Object, Enumeration, class Math, Wrapper Classes, Java util Classes and Interfaces, Formatter Class, Random Class, Formatting for Date/Time in Java

Exception Handling: Introduction, Hierarchy of Standard Exception Classes, Keywords throws and throw, try, catch, and finally Blocks, Multiple Catch Clauses, Class Throw able, Unchecked Exceptions, Checked Exceptions.

Java I/O and File: Java I/O API, standard I/O streams, types, Byte streams.

UNIT – V

String Handling in Java: Introduction, Interface Char Sequence, Class String, Methods for Extracting Characters from Strings, Comparison, Modifying, Searching; Class String Buffer.

Multithreaded Programming: Introduction, Java thread model, Creating a thread-Extending Thread class and Implementing Runnable interface, Thread life cycle, Thread class methods, Thread priorities, Deadlocks in Threads, Thread Synchronization and Inter Thread Communication

Java Database Connectivity: Introduction, JDBC Architecture, Installing My SQL and My SQL Connector/J, JDBC Environment Setup, Establishing JDBC Database Connections, Result Set Interface

Text Books:

1. JAVA one step ahead, Anitha Seth, B.L.Juneja, Oxford.
2. Joy with JAVA, Fundamentals of Object Oriented Programming, Debasis Samanta, Monalisa Sarma, Cambridge, 2023.
3. JAVA 9 for Programmers, Paul Deitel, Harvey Deitel, 4th Edition, Pearson.

Reference Books:

1. The complete Reference Java, 11thedition, Herbert Schildt,TMH
2. Introduction to Java programming, 7th Edition, Y Daniel Liang, Pearson

Online Learning Resources:

1. https://nptel.ac.in/courses/106/105/106105191/
2. https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_0128804645476 18816347 _shared/overview

Question Paper Pattern:

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End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

FOUNDATIONS OF ARTIFICIAL INTELLIGENCE (FAI)

V Semester: CE, EEE and ECE					Scheme: 2023			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE507	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs					End Exam Duration: 3 Hrs			

Course Outcomes : At the end of the course, students will be able to

CO1:	Learn the distinction between optimal reasoning Vs human like reasoning and formulate an efficient problem space for a problem expressed in natural language. Also select a search algorithm for a problem and estimate its time and space complexities.
CO2:	Apply AI techniques to solve problems of game playing, theorem proving, and machine learning.
CO3:	Learn different knowledge representation techniques.
CO4:	Understand the concepts of state space representation, exhaustive search, heuristic search together with the time and space complexities.
CO5:	Comprehend the applications of Probabilistic Reasoning and Bayesian Networks.
CO6:	Analyze Supervised Learning Vs. Learning Decision Trees.

UNIT – I

Introduction to AI: Intelligent Agents, Problem-Solving Agents.

Searching for Solutions: Breadth-first search, Depth-first search, Hill-climbing search, Simulated annealing search, Local Search in Continuous Spaces.

UNIT – II

Games: Optimal Decisions in Games, Alpha–Beta Pruning, Defining Constraint Satisfaction Problems, Constraint Propagation, Backtracking Search for CSPs, Knowledge-Based Agents, Logic- Propositional Logic, Propositional Theorem Proving: Inference and proofs, Proof by resolution, Horn clauses and definite clauses.

UNIT – III

First-Order Logic: Syntax and Semantics of First-Order Logic, Using First Order Logic, Knowledge Engineering in First-Order Logic. Inference in First-Order Logic: Propositional vs. First Order Inference, Unification, Forward Chaining, Backward Chaining, Resolution. **Knowledge Representation:** Ontological Engineering, Categories and Objects, Events.

UNIT – IV

Planning: Definition of Classical Planning, Algorithms for Planning with State Space Search, Planning Graphs, other Classical Planning Approaches, Analysis of Planning approaches. Hierarchical Planning.

UNIT – V

Probabilistic Reasoning: Acting under Uncertainty, Basic Probability Notation Bayes‘ Rule and Its Use, Probabilistic Reasoning, Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Approximate Inference in Bayesian Networks, Relational and First- Order Probability.

Text Books:

1. Artificial Intelligence: A Modern Approach, Third Edition, Stuart Russell and Peter Norvig, Pearson Education.

Reference Books:

1. Artificial Intelligence, 3rd Edition, E. Rich and K. Knight (TMH).
2. Artificial Intelligence, 3rd Edition, Patrick Henny Winston, Pearson Education.
3. Artificial Intelligence, Shivani Goel, Pearson Education.

4. Artificial Intelligence and Expert systems – Patterson, Pearson Education.

Online Learning Resources:

1. https://swayam.gov.in/nd1_noc19_me71/preview

2. https://ai.google/

Question Paper Pattern:

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ETHICAL HACKING (EH)

V Semester: All Branches					Scheme: 2023			
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE508	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs					End Exam Duration: 3 Hrs			

Course Outcomes : At the end of the course, students will be able to

CO1:	Understand the basics of security and ethical hacking.
CO2:	Understand about foot printing and types of attacks in social engineering.
CO3:	Understand about sniffers, hijacking and DoS attacks.
CO4:	Understand the importance of web server hacking, database hacking and SQL Injection.
CO5:	Understand about Wireless technologies, intrusion detection and firewalls.

UNIT – I

Introduction to Ethical Hacking: Introduction, Security fundamentals, Security testing, Hackers and crackers description, Ethical Hackers.

Technical Foundations of Hacking: The Hacking process, Information Security Systems and the Stack.

UNIT – II

Foot printing: Information Gathering Methodology , OS Fingerprinting, Fingerprinting Services, Enumeration, System Hacking.

Social Engineering: Social Engineering, Malware threats, Vulnerability analysis.

UNIT – III

Sniffers: Passive sniffing, Active sniffing, ARP,ARP poisoning and MAC flooding, tools for sniffing, wire shark, sniffing and spoofing countermeasures.

Session Hijacking: Transport layer Hijacking, Application layer Hijacking, Session Hijacking **Tools. Denial of Service:** DoS attack techniques, Distributed DoS, DDoS tools.

UNIT – IV

Web Server Hacking: HTTP protocol, scanning web servers, Banner grabbing and Enumeration, Web server, DoS/ DDoS and DNS attacks.

Database Hacking: Introduction to SQL and SQL injection and categories, Finger printing, UNION Exploitation technique, Boolean in SQL injection attacks, Out-of band exploitation, exploring the time-delay SQL injection technique, Stored procedure SQL injection and mitigations, SQL injection hacking tools.

UNIT – V

Wireless Technologies, Mobile Security: Mobile device operation and security, Wireless LAN's- Basics, Wireless LAN frequencies and signalling, Wireless LAN security.

IDS: Intrusion Detection and Prevention Systems. Firewalls and Honey pots.

Text Books:

1. Micheal Gregg, "Certified Ethical Hacker (CEH) Cert Guide", Pearson education, 2020.

Reference Books:

1. EC-Council, "Ethical Hacking and Counter measures (CEH)",CENGAGE Learning, 2020
2. Sai Satish, "Hacking Secrets Part-1", Indian Servers, 2018.
3. David Litchfield, Chris Anley "The Database Hackers Handbook: Defending Database Servers", Wiley.

Online Learning Resources:

1. https://www.coursera.org/courses?query=ethical%20hacking
2. https://onlinecourses.nptel.ac.in/noc22_cs13/preview
3. https://www.geeksforgeeks.org/ethical-hacking-tutorial/

Question Paper Pattern:

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MATHEMATICS FOR MACHINE LEARNING AND AI (MMLA)

V Semester: All Branches						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE509	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Apply linear algebra concepts to ML techniques like PCA and regression
CO2:	Analyze probabilistic models and statistical methods for AI applications.
CO3:	Implement optimization techniques for machine learning algorithms.
CO4:	Utilize vector calculus and transformations in AI-based models.
CO5:	Develop graph-based AI models using mathematical representations.

UNIT – I

Linear Algebra for Machine Learning: Review of Vector spaces, basis, linear independence, Vector and matrix norms, Matrix factorization techniques, Eigen values, eigenvectors, diagonalization, Singular Value Decomposition (SVD) and Principal Component Analysis (PCA).

UNIT – II

Probability and Statistics for AI: Probability distributions: Gaussian, Binomial, Poisson. Bayes' Theorem, Maximum Likelihood Estimation (MLE), and Maximum a Posteriori (MAP).Entropy and Kullback-Leibler (KL) Divergence in AI, Cross entropy loss, Markov chains.

UNIT – III

Optimization Techniques for ML: Multivariable calculus: Gradients, Hessians, Jacobians. Constrained optimization: Lagrange multipliers and KKT conditions. Gradient Descent and its variants (Momentum, Adam) Newton's method, BFGS method.

UNIT – IV

Vector Calculus & Transformations: Vector calculus: Gradient, divergence, curl. Fourier Transform & Laplace Transform in ML applications

UNIT – V

Graph Theory for AI: Graph representations: Adjacency matrices, Laplacian matrices. Bayesian Networks & Probabilistic Graphical Models. Introduction to Graph Neural Networks (GNNs).

Text Books:

1. Mathematics for Machine Learning by Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Cambridge University Press, 2020.
2. Pattern Recognition and Machine Learningby Christopher Bishop, Springer.

Reference Books:

1. Gilbert Strang, Linear Algebra and Its Applications, Cengage Learning, 2016.
2. Jonathan Gross, Jay Yellen, Graph Theory and Its Applications, CRC Press, 2018.

Online Learning Resources:

1. https://ocw.mit.eduhttps://
2. https://cs229.stanford.edu/
3. https://deepai.org

Question Paper Pattern:

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question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

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MATERIALS CHARACTERIZATION TECHNIQUES (MCT)

V Semester: All Branches						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE510	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Analyze the crystal structure and crystallite size by various methods
CO2:	Analyze the morphology of the sample by using a Scanning Electron Microscope
CO3:	Analyze the morphology and crystal structure of the sample by using Transmission Electron Microscope
CO4:	Explain the principle and experimental arrangement of various spectroscopic techniques
CO5:	Identify the construction and working principle of various Electrical & Magnetic Characterization technique

UNIT – I

Structure analysis by Powder X-Ray Diffraction: Introduction, Bragg's law of diffraction, Intensity of Diffracted beams, Factors affecting Diffraction, Intensities, Structure of polycrystalline Aggregates, Determination of crystal structure, Crystallite size by Scherer and Williamson-Hall (W-H) Methods, Small angle X-ray scattering (SAXS) (in brief).

UNIT – II

Microscopy technique -1 –Scanning Electron Microscopy (SEM): Introduction, Principle, Construction and working principle of Scanning Electron Microscopy, Specimen preparation, Different types of modes used (Secondary Electron and Backscatter Electron), Advantages, limitations and applications of SEM.

UNIT – III

Microscopy Technique -2 - Transmission Electron Microscopy (TEM): Construction and Working principle, Resolving power and Magnification, Bright and dark fields, Diffraction and image formation, Specimen preparation, Selected Area Diffraction, Applications of Transmission Electron Microscopy, Difference between SEM and TEM, Advantage and Limitations of Transmission Electron Microscopy

UNIT – IV

Spectroscopy techniques: Principle, Experimental arrangement, Analysis and advantages of the spectroscopic techniques – (i) UV-Visible spectroscopy (ii) Raman Spectroscopy, (iii) Fourier Transform infrared (FTIR) spectroscopy, (iv) X-ray photoelectron spectroscopy (XPS).

UNIT – V

Electrical & Magnetic Characterization techniques: Electrical Properties analysis techniques (DC conductivity, AC conductivity) Activation Energy, Effect of Magnetic field on the electrical properties (Hall Effect). Magnetization measurement by induction method, Vibrating sample Magnetometer (VSM) and SQUID.

Text Books:

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods – Yang Leng – John Wiley & Sons (Asia) Pvt. Ltd. 2013.
2. Microstructural Characterization of Materials - David Brandon, Wayne D Kalpan, John Wiley & Sons Ltd., 2008

Reference Books:

1. Fundamentals of Molecular Spectroscopy – IV Ed. – Colin Neville BanwellandElaine M. McCash, Tata McGraw-Hill, 2008.

2. Elements of X-ray diffraction – Bernard Dennis Cullity& Stuart R Stocks, Prentice Hall , 2001 – Science.

3. Practical Guide to Materials Characterization: Techniques and Applications - Khalid Sultan – Wiley – 2021.

4. Materials Characterization Techniques -Sam Zhang, Lin Li, Ashok Kumar -CRC Press - 2008

Online Learning Resources:

1. https://nptel.ac.in/courses/115/103/115103030/

2. https://nptel.ac.in/content/syllabus_pdf/113106034.pdf

3. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mm08/

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

CHEMISTRY OF ENERGY SYSTEMS (CES)

V Semester: All Branches						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE511	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Solve the problems based on electrode potential, Describe the Galvanic Cell, Differentiate between Lead acid and Lithium ion batteries, Illustrate the electrical double layer
CO2:	Describe the working Principle of Fuel cell, Explain the efficiency of the fuel cell, Discuss about the Basic design of fuel cells, Classify the fuel cell
CO3:	Differentiate between Photo and Photo electro chemical Conversions, Illustrate the photochemical cells, Identify the applications of photochemical reactions, Interpret advantages of photo electron catalytic conversion.
CO4:	Apply the photovoltaic technology, Demonstrate about solar energy and prospects Illustrate the Solar cells, Discuss about concentrated solar power
CO5:	Differentiate Chemical and Physical methods of hydrogen storage, Discuss the metal organic framework, Illustrate the carbon and metal oxide porous structures, Describe the liquification methods.

UNIT – I

Electrochemical Systems: Galvanic cell, Nernst equation, standard electrode potential, application of EMF, electrical double layer, polarization, Batteries- Introduction, Lead-acid, Nickel- cadmium, Lithium ion batteries and their applications.

UNIT – II

Fuel Cells: Fuel cell- Introduction, Basic design of fuel cell, working principle, Classification of fuel cells, Polymer electrolyte membrane (PEM) fuel cells, Solid-oxide fuel cells (SOFC), Fuel cell efficiency and applications.

UNIT – III

Photo and Photo electrochemical Conversions: Photochemical cells Introduction and applications of photochemical reactions, specificity of photo electrochemical cell, advantage of photoelectron catalytic conversions and their applications.

UNIT – IV

Solar Energy: Introduction and prospects, photovoltaic (PV) technology, concentrated solar power (CSP), Solar cells and applications

UNIT – V

Hydrogen Storage: Hydrogen storage and delivery: State-of-the art, Established technologies, Chemical and Physical methods of hydrogen storage, Compressed gas storage, Liquid hydrogen storage, Other storage methods, Hydrogen storage in metal hydrides, metal organic frameworks (MOF), Metal oxide porous structures, hydrogel , and Organic hydrogen carriers.

Text Books:

1. Physical chemistry by Ira N. Levine
2. Essentials of Physical Chemistry, Bahl and Bahl and Tuli.
3. Inorganic Chemistry, Silver and Atkins

Reference Books:

1. Fuel Cell Hand Book 7th Edition, by US Department of Energy (EG&G technical services And corporation)

2.	Hand book of solar energy and applications by ArvindTiwari and Shyam.
3.	Solar energy fundamental, technology and systems by Klaus Jagar et.al.
4.	Hydrogen storage by Levine Klebonoff

Question Paper Pattern:

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End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

ENGLISH FOR COMPETITIVE EXAMINATIONS (ECE)								
V Semester: All Branches						**Scheme: 2023**		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
OE512	**OE-I**	**3**	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration: 2 Hrs						**End Exam Duration: 3 Hrs**		

Course Outcomes : At the end of the course, students will be able to	
CO1:	Identify the basics of English grammar and its importance
CO2:	Explain the use of grammatical structures in sentences
CO3:	Demonstrate the ability to use various concepts in grammar and vocabulary and their applications in everyday use and in competitive exams
CO4:	Analyze an unknown passage and reach conclusions about it
CO5:	Choose the appropriate form of verbs in framing sentences
CO6:	Develop speed reading and comprehending ability thereby perform better in competitive exams

UNIT – I

Grammar - I: Nouns-classification-errors, Pronouns-types-errors, Adjectives-types-errors, Articles-definite indefinite, Degrees of Comparison, Adverbs-types- errors, Conjunctions-usage Prepositions-usage, Tag Questions, types-identifying errors- Practice

UNIT – II

Grammar - II: Verbs-tenses- structure-usages- negatives- positives- time adverbs, Sequence of tenses--If Clause, Voice-active voice and passive voice, reported Speech, Agreement-subject and verb Modals-Spotting Errors-Practices

UNIT – III

Verbal Ability: Sentence completion-Verbal analogies-Word groups-Instructions, Critical reasoning-Verbal deduction-Select appropriate pair, Reading Comprehension-Paragraph-Jumbles-Selecting the proper statement by reading a given paragraph.

UNIT – IV

Reading Comprehension and Vocabulary: Competitive Vocabulary :Word Building – Memory techniques, Synonyms, Antonyms, Affixes-Prefix &Suffix, One word substitutes, Compound words, Phrasal Verbs, Idioms and Phrases, Homophones, Linking Words, Modifiers, Intensifiers - Mastering Competitive Vocabulary, Cracking the unknowing passage-speed reading techniques- Skimming & Scanning-types of answering–Elimination methods

UNIT – V

Writing for Competitive Examinations: Punctuation- Spelling rules- Word order-Sub Skills of Writing- Paragraph meaning-salient features-types - Note-making, Note-taking, summarizing-precise writing- Paraphrasing Expansion of proverbs- Essay writing-types

Text Books:

1. Wren & Martin, English for Competitive Examinations, S.Chand & Co, 2021.
2. Objective English for Competitive Examination, Tata McGraw Hill, New Delhi, 2014

Reference Books:

1. Hari Mohan Prasad, Objective English for Competitive Examination, Tata McGraw Hill, New Delhi, 2014.
2. Philip Sunil Solomon, English for Success in Competitive Exams, Oxford 2016
3. Shalini Verma , Word Power Made Handy, S Chand Publications
4. Neira, Anjana Dev & Co. Creative Writing: A Beginner's Manual. Pearson Education

India, 2008.

5. Abhishek Jain,Vocabulary Learning Techniques Vol.I&II,RR Global Publishers 2013.

6. Michel Swan, Practical English Usage,Oxford,2006.

Online Learning Resources:

1. https://www.grammar.cl/english/parts-of-speech.htm
2. https://academicguides.waldenu.edu/writingcenter/grammar/partsofspeech
3. https://learnenglish.britishcouncil.org/grammar/english-grammar-reference/active-passive-voice
4. https://languagetool.org/insights/post/verb-tenses/
5. https://www.britishcouncil.in/blog/best-free-english-learning-resources-british-council
6. https://www.careerride.com/post/social-essays-for-competitive-exams-586.aspx

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ENTREPRENEURSHIP AND NEW VENTURE CREATION (ENVC)

V Semester: All Branches						Scheme: 2023		
Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
OE513	OE-I	3	0	0	3	30	70	100
Sessional Exam Duration: 2 Hrs						End Exam Duration: 3 Hrs		

Course Outcomes : At the end of the course, students will be able to

CO1:	Understand the concept of entrepreneurship, analyze its role in economic development, and develop a creative mindset for starting a business.
CO2:	Understand customer problems, validate them with potential customers, and evaluate customer segments and personas.
CO3:	Evaluate customer needs through jobs-to-be-done analysis and develop value propositions using prototypes and MVPs.
CO4:	Apply lean business models, financial and sales plans to design a venture with suitable funding and marketing channels.
CO5:	Analyze scaling aspirations and venture components to develop an investor-ready pitch

UNIT – I

Entrepreneurship Fundamentals and Context: Meaning and concept, attributes and mindset of entrepreneurial and entrepreneurial leadership, role models in each and their role in economic development. An understanding of how to build entrepreneurial mindset, skill sets, attributes and networks while on campus.

UNIT – II

Problem & Customer Identification: Understanding and analyzing the macro-Problem and Industry perspective - technological, socioeconomic and urbanization trends and their implication on new opportunities - Identifying passion –identifying and defining problem using Design thinking principles –Analyzing problem and validating with the potential customer - Understanding customer segmentation, creating and validating customer personas.

UNIT – III

Solution Design, Prototyping & Opportunity Assessment and Sizing: Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customer's needs and create a strong value proposition - Understanding prototyping and Minimum Viable product (MVP) - Developing a feasibility prototype with differentiating value, features and benefits - Assess relative market position via competition analysis - Sizing the market and assess scope and potential scale of the opportunity.

UNIT – IV

Business & Financial Model, Go-To-Market Plan: Introduction to Business model and types, Lean approach,9 block lean canvas model, riskiest assumptions to Business models. Importance of Build - Measure – Lean approach. Business planning: components of Business plan- Sales plan, People plan and financial plan. Financial Planning: Types of costs, preparing a financial plan for profitability using financial template, understanding basics of Unit economics and analyzing financial performance. Introduction to Marketing and Sales, Selecting the Right Channel, creating digital presence, building customer acquisition strategy. Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity Map the Start-up Life-cycle to Funding Options.

UNIT – V

Scale Outlook and Venture Pitch Readiness: Understand and identify potential and aspiration for scale vis-a-vis your venture idea. Persuasive Storytelling and its key components. Build an Investor ready pitch deck.

Text Books:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha. Entrepreneurship, McGrawHill, 11th Edition.(2020)
2. Ries, E.The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business, (2011).

Reference Books:

1. Simon Sinek,Start with Why, Penguin Books limited. (2011)
2. Brown Tim,Change by Design Revised & Updated: How Design Thinking
3. Transforms Organizations and Inspires Innovation, Harper Business.(2019)
4. Namita Thapar(2022) The Dolphin and the Shark: Stories on Entrepreneurship, Penguin Books Limited

Online Learning Resources:

1. https://wadhwanifoundation.org/initiatives/entrepreneurship/

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