



Marathwada Shikshan Prasarak Mandal's

DEOGIRI INSTITUTE OF ENGINEERING AND MANAGEMENT STUDIES

(An Autonomous Institute)

Affiliated to Dr. Babasaheb Ambedkar Technological University, Lonere, Raigad | B.Tech. | M.Tech.

Affiliated to Dr. Babasaheb Ambedkar Marathwada University, CSN | MBA

Approved by AICTE/UGC-Govt. of India & DTE-Govt. of Maharashtra

Deogiri College Campus, Railway Station Road, Chhatrapati Sambhajnagar- 431 005 (M.S.)

DTE CODE : 2114

☎ 0240-2367567, 2367577

🌐 www.dietms.org

✉ director@dietms.org

Department of Mechanical Engineering

MTech MECHANICAL ENGINEERING PROGRAM STRUCTURE (2025-27)

Course Category		I	II	III	IV	Total Credits
Program Courses	Program Core Course (PCC)	12	04	04		24
	MOOC		04			
	Program Elective Course (PEC)	06	06			12
Vocational and Skill Education Courses (VSE)	Seminar	01				02
	PG Lab	01				
Humanities, Social Science and Management (HSSM)	Indian Knowledge System (IKS)		02			02
Experiential Learning Courses (EL)	Research Methodology		03			34
	Mini Project		01			
	Project			10	20	
Open Elective Courses (OE)	Open Elective (OE)			03		03
Multi-Disciplinary Minor Courses (MDM)	Multi-Disciplinary Minor (MDM)			03		03
Liberal Learning Courses (LLC)	Co-Curricular Courses (CC)				AU	Audit
Total Credits		20	20	20	20	80

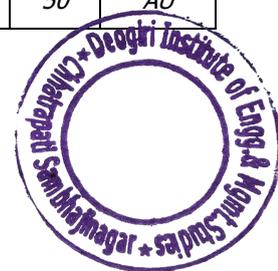


SEMESTER I												
Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	
PCC	PM251001	Advanced Thermal Engineering	4			4	10	10	20	60	100	4
PCC	PM251002	Machining and Forming Processes	4			4	10	10	20	60	100	4
PCC	PM251003	Mechanical Design Analysis	4			4	10	10	20	60	100	4
PEC	PM2511--	PEC I	3			3	10	10	20	60	100	3
PEC	PM2511--	PEC II	3			3	10	10	20	60	100	3
VSE	PM251401	Seminar			2	2	15	15		20	50	1
VSE	PM251402	PG Lab			2	2	15	15		20	50	1
Total			18		4	22					600	20

SEMESTER II												
Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	
PCC	PM252004	Advanced Fluid Mechanics and Heat Transfer	4			4	10	10	20	60	100	4
PCC	PM252005	MOOC/SWAYAM	4			4	10	10	20	60	100	4
PEC	PM2521--	PEC III	3			3	10	10	20	60	100	3
PEC	PM2521--	PEC IV	3			3	10	10	20	60	100	3
EL	PG252601	Research Methodology	3			3	10	10	20	60	100	3
IKS	PG252501	Interdisciplinary Perspective on Indian Science and Technology	2			2	10	10	20	60	100	2
EL	PM252602	Mini Project			2	2	15	15		20	50	1
Total			19		2	21					650	20

SEMESTER III												
Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	
PCC	PM253006	Automation in Manufacturing	4			4	10	10	20	60	100	4
OE	PM25335-	Open Elective	3			3	10	10	20	60	100	3
MDM	PM25320-	Multi-Disciplinary Minor	3			3	10	10	20	60	100	3
EL	PM253603	Project I			10	10	25	25		50	100	10
Total			10		10	20					400	20

SEMESTER IV												
Category	Course Code	Name of the Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	PR	Total	CA-I	CA-II	MSE	ESE	Total	
EL	PM254604	Project II			20	20	50	50		100	200	20
Total			2		20	22					200	20
CC	PM254701	Communication Skills and Technical Writing	2			2	25	25			50	AU



Program Elective Courses (PEC)

Semester	Course Category	No. of Credits		Design Engineering	Thermal Engineering	Manufacturing Engineering
SEM I	Program Elective I	3	Course Code	PM251101	PM251102	PM251103
			Course	Advanced Machine Design	Advanced I.C. Engines	Additive Manufacturing
	Program Elective II	3	Course Code	PM251104	PM251105	PM251106
			Course	Finite Element Analysis	Sustainable Power Generation Systems	Manufacturing Planning and Control
SEM II	Program Elective III	3	Course Code	PM252107	PM252108	PM252109
			Course	CAD-CAE	Alternative Fuels for I.C. Engines	Process Control Automation
	Program Elective IV	3	Course Code	PM252110	PM252111	PM252112
			Course	Product Design and Development	Computational Fluid Dynamics	Advanced Machine Tool Design

Open Electives (OE)

Semester	Course Category	No. of Credits	Course Code	Course
SEM III	Open Elective	3	PM253351	Intellectual Property Rights
			PM253352	Robotics and Automation
			PM253353	Engineering Economics

Multi-Disciplinary Minor (MDM)

Semester	Course Category	No. of Credits	Course Code	Course
SEM III	Multi-Disciplinary Minor	3	PM253201	Design of Mechatronic Systems
			PM253202	Product Life Cycle Management
			PM253203	Electric and Hybrid Vehicles

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EST. 2009



CO-PO Mapping

CO-PO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
C01	3	1										1	1	
C02	3	2										1	2	1
C03	3	3	2									1	3	2
C04	3	3	2	3			1					1	3	2
C05	3	3	3	3			1					1	3	3

Assessment

CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

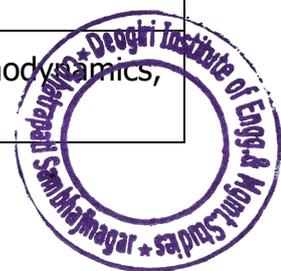
Course Contents

Unit 1	Reactive Systems Degree of Reaction, Reaction Equilibrium, Law of Mass Action, Heat of Reaction and Temperature Dependence, Thermal Ionization of Gases, Gibbs Function, Fugacity and Activity, Equilibrium Shifts with Temperature or Pressure, Heat Capacity of Reacting Gases, Combustion, Enthalpy and Internal Energy, Adiabatic Flame Temperature, Absolute Entropy and Third Law, Second Law Analysis, Chemical Exergy, Fuel Cells	7 Hrs
Unit 2	Vapour Power Cycles: Simple and Actual Rankine Cycles, Comparison with Carnot Cycle, Reheat and Regenerative Cycles, Reheat-Regenerative Cycle, Binary Vapour Cycles, Thermodynamics of Coupled Cycles, Process Heat and By-Product Power, Exergy Analysis, Working Fluid Characteristics, Steam Power Plant Efficiencies	7 Hrs
Unit 3	Steam Turbines: Classification and Overview, Impulse and Reaction Turbines, Velocity and Pressure Compounding, Blade Velocity Diagrams, Turbine Efficiencies and Energy Losses, Turbine Bleeding and Reheat Factor, Governing Methods (Throttle, Nozzle, By-Pass), Special Turbines: Back-Pressure, Extraction, Low-Pressure	7 Hrs

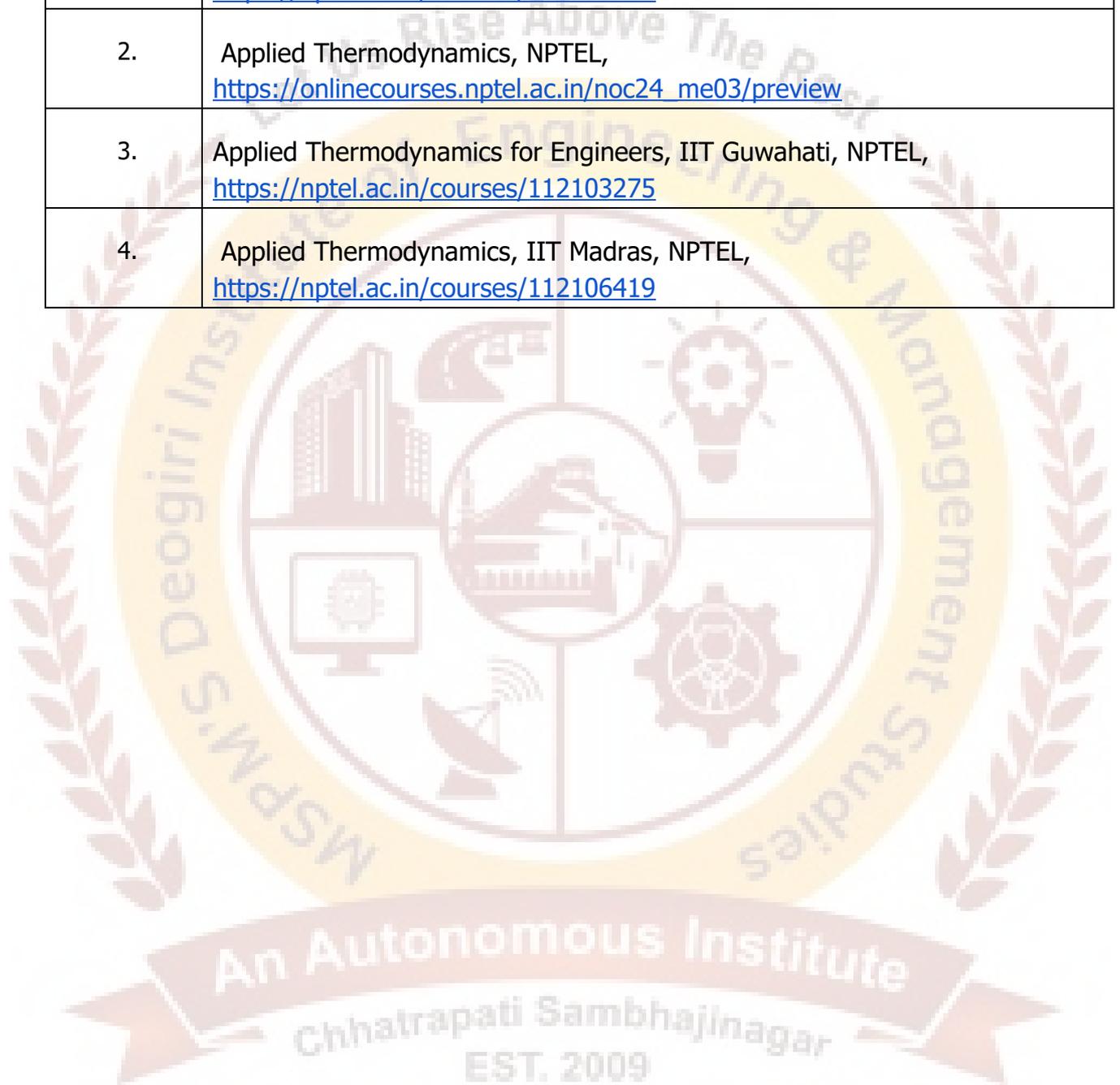


Unit 4	Gas Power Cycles: Air Standard Efficiency, The Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Combustion Cycle, Comparison of Otto, Diesel, and Dual Combustion Cycles, Efficiency Versus Compression Ratio, Atkinson Cycle, Ericsson Cycle, Brayton Cycle	7 Hrs
Unit 5	Gas Turbines and Propulsion: Closed Cycle and Open Cycle Plants, Advantages of a Gas Turbine Plant, Disadvantages of a Gas Turbine Plant, Analysis of GT Plant, Closed-Cycle Gas Turbine, Semi-Closed Cycle GT Plant, Performance of Gas Turbine Power Plants, Components of a Gas Turbine Plant, Gas Turbine Fuels, Gas Turbine Materials, Jet Propulsion System, Propulsive Devices for Aircrafts and Missiles, Turbojet Engine with Afterburner, Turbo-Prop Engine, Bypass Turbo-JET Engine, Athodyds, Ramjets, Pulsejets, Rocket Propulsion, Nuclear Rockets	7 Hrs
Unit 6	Gas Compressors: Reciprocating Compressors: Classification, Work and Efficiency, Clearance Volume, Volumetric Efficiency, Free Air Delivery, Single-Stage and Multi-Stage Compression, Cylinder Dimensions, Compression Processes, Rotary Compressors: Roots Blower, Vane, Lysholm Screw, Centrifugal and Axial Compressors, Differences Between Centrifugal and Axial Compressors, Air Motors, Blowers and Fans, Applications in Industries, Design Considerations and Efficiency Improvement	7 Hrs

Sr.No.	Textbooks
1.	P.K. Nag, Basic and Applied Thermodynamics, McGraw-Hill India, 2 nd Edition
2.	Mehrzad Tabatabaian and R.K. Rajput, Advanced Thermodynamics, Mercury Learning and Information
3.	R.K. Rajput, Thermal Engineering, S. Chand & Co.
4.	Mahesh Rathore, Thermal Engineering, Tata McGraw-Hill
Reference Books	
1.	Van Wylen, G.J., Sonntag, R.E., Fundamentals of Classical Thermodynamics, Wiley
2.	S.M. Yahya, Turbines, Compressors and Fans, McGraw-Hill India,
3.	Moran, M.J., Shapiro, H.N., Fundamentals of Engineering Thermodynamics, Wiley
4.	Van Wylen, G.J., Sonntag, R.E., Fundamentals of Classical Thermodynamics, Wiley



5.	S.M. Yahya, Turbines, Compressors and Fans, McGraw-Hill India,
	Web Resources
1.	Basic Thermodynamics: Classical and Statistical Approaches, NPTEL, https://nptel.ac.in/courses/104106107
2.	Applied Thermodynamics, NPTEL, https://onlinecourses.nptel.ac.in/noc24_me03/preview
3.	Applied Thermodynamics for Engineers, IIT Guwahati, NPTEL, https://nptel.ac.in/courses/112103275
4.	Applied Thermodynamics, IIT Madras, NPTEL, https://nptel.ac.in/courses/112106419



Course Title: Machining and Forming Processes		
Course Code: PM251002		Course Category: PCC
Teaching Scheme	Examination Scheme	
Lectures: 04 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite: Basic knowledge of manufacturing processes, engineering materials, mechanics of materials, heat transfer, and fundamentals of machine tools.		
Course Description: This course provides advanced knowledge of machining and metal forming processes, emphasizing process mechanics, material behavior, tool–work interactions, heat generation, and surface integrity. It covers conventional and non-traditional machining, bulk and sheet metal forming, high-speed and precision manufacturing, as well as process modeling and optimization using analytical, numerical, and experimental approaches. The course prepares students to analyze, design, and improve modern manufacturing processes for industrial and research applications.		
Course Objectives: By the end of this course, students will be able to:		
<ol style="list-style-type: none"> 1. To develop an advanced understanding of the mechanics of machining and forming processes. 2. To analyze the influence of material properties, tool geometry, and process parameters on machinability and formability. 3. To study heat generation, tool wear, surface integrity, and product quality in manufacturing processes. 4. To explore conventional, non-traditional, and modern high-speed/precision machining and forming methods. 5. To apply analytical, numerical, and experimental techniques for modeling, simulation, and optimization of machining and forming operations. 		

Course Outcomes:		
COs	After completion of the course: Student should be able to	Bloom's Level
CO1	Recall key concepts of machining, forming, grinding, advanced processes, CNC, and programming.	L1
CO2	Explain chip formation, plastic deformation, grinding, CNC operations, and process applications.	L2
CO3	Apply theories to calculate forces, set process parameters, and write CNC part programs.	L3
CO4	Analyze effects of strain rate, temperature, tool wear, vibrations, and economics on processes.	



CO5	Evaluate and compare machining and forming methods for efficiency and suitability.	L5
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CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2
CO 1	3	2	-	-	1	-	-	-	-	1	-	2	1	
CO 2	3	3	2	2	2	-	-	-	1	2	-	2	2	1
CO 3	3	3	3	2	3	1	-	-	1	2	2	2	3	2
CO 4	3	3	2	3	3	1	1	-	2	2	2	3	3	3

Assessment

CA-1 (a)	Subjective Test / Open book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

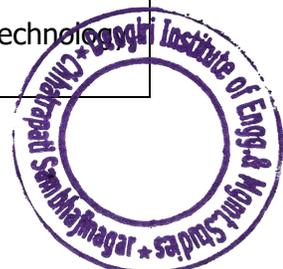
Course Contents

Unit 1	Advanced Machining Theory and Material Removal Mechanisms: Material removal mechanism, parametric analysis, mechanisms of chip formation, shear angle relations, and theoretical determination of cutting forces in orthogonal cutting; analysis of turning, drilling, and milling operations.	6 Hrs
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Unit 2	Advanced Forming Processes: Theory of plastic deformation, strain hardening, effect of temperature, composition, and strain rates on metal forming, recovery, recrystallization, and grain growth; characteristics and applications of hot working and cold working. Process principles and details of electro-magnetic forming, explosive forming, electro-hydraulic forming, stretch forming, contour roll forming, blow molding, thermoforming, rotational molding, compression molding, and transfer molding.	8 Hrs
Unit 3	Mechanics of Grinding and Finishing Operations: Mechanics of grinding, design considerations for grinding, finishing operations, economics of abrasive machining and finishing operations; dynamometry; thermal aspects of machining; tool wear; economics of machining; processing of polymers, ceramics, and composites; cutting tool materials and cutting fluids.	6 Hrs
Unit 4	Advanced Machining Processes and Micro/Nano Manufacturing: Details of USM, AJM, ECM, EDM, LBM, and EBM, their advantages, limitations, and applications; micromachining of MEMS devices, solid free form fabrication of devices, nanoscale manufacturing, additive manufacturing processes, VP, self-replicating machines, direct manufacturing, and rapid tooling.	10 Hrs
Unit 5	CNC Machines and Part Programming: CNC machines, operating principles, encoders, servo motors, CNC part programming fundamentals (G and M Codes), interpolation systems, methods of CNC part programming, APT language, motion commands, CNC part programming using CAD/CAM, and computer-automated part programming.	10 Hrs
Unit 6	Machine Tool Dynamics and Advanced Machining Techniques: Machining centers, machine tool structures, vibrations and chatter in machining operations, high-speed machining, hard machining, ultra-precision machining, and machining economics.	8 Hrs

Sr.No.	Textbooks
1.	Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering & Technology, Pearson, Prentice Hall.



2.	George E. Dieter, Mechanical Metallurgy, McGraw-Hill.
3.	Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley, 7th Edition, 2020.
4.	E. Paul DeGarmo, J. T. Black, Ronald A. Kohser, Materials and Processes in Manufacturing, Wiley, 11th Edition, 2011.
5.	P. N. Rao, Manufacturing Technology: Foundry, Forming and Welding, McGraw-Hill Education, 5th Edition, 2013.
Reference Books	
1.	Amstead, B. H., Ostwald, P. F., Begeman, M. L., Manufacturing Processes, Wiley, 9th Edition, 1987.
2.	V. Astashev, K. Babitsky, Ultrasonic Processes and Machines, Springer, 2010.
3.	Robert C. Creese, M. Adithan, R. C. G. Pabla, Introduction to Manufacturing Processes and Materials, Taylor & Francis, 2016.
4.	HMT, Production Technology, Tata McGraw-Hill, 2001.
5.	S. Kalpakjian, Manufacturing Processes for Engineering Materials, Pearson, 6th Edition, 2013.
Web Resources	
1.	S. P. Sukhatme, U. N. Gaitonde, Heat and Mass Transfer, NPTEL, IIT Bombay, 2007. (https://nptel.ac.in/courses/112101097)
2.	Somnath Roy, Fundamentals of Heat Transfer, NPTEL/SWAYAM, IIT Kharagpur, 2025. (https://onlinecourses.nptel.ac.in/noc25_me171/preview)
3.	V. Kumaran, Transport Processes I: Heat and Mass Transfer, NPTEL/SWAYAM, IISc Bangalore, 2022. (https://nptel.ac.in/courses/103108123)



Course Title: Mechanical Design Analysis		
Course Code: PM251003		Course Category: PCC
Teaching Scheme	Examination Scheme	
Lectures: 04 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite:		
<ol style="list-style-type: none"> 1. Engineering Mathematics. 2. Mechanics of Materials (Strength of Materials). 3. Theory of Machines. 4. Basics of Engineering Graphics and CAD. 		
Course Description:		
<p>The "Mechanical Design Analysis" course provides an advanced study of failure mechanisms, impact dynamics, thermal stresses, and optimum design techniques for mechanical components. It integrates fundamentals of fracture mechanics, fatigue analysis, and the behavior of composite materials with reliability-based design approaches.</p> <p>The course emphasizes practical and theoretical aspects of power transmission system design, including gear drives and bearing selection. Students learn analytical and optimization methods essential for creating robust, efficient, and innovative mechanical designs. This knowledge equips students to address complex engineering challenges in research and industry settings effectively.</p>		
Course Objectives:		
<ol style="list-style-type: none"> 1. To develop advanced technical knowledge in failure analysis, fracture mechanics, and fatigue design for mechanical components. 2. To introduce optimization techniques for the development of efficient and reliable mechanical designs. 3. To familiarize students with design principles involving composite materials and power transmission elements such as gears and bearings. 4. To prepare students to apply modern design and analysis methods for solving complex engineering problems in research and industry. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Recall and explain fundamental principles of failure analysis, fracture mechanics, and fatigue design.	L1
CO2	Understand and explain the mechanics of impact stresses, thermal stresses, and material behavior under various conditions.	L2
CO3	Apply analysis methods to solve design problems involving contact stresses, reliability, and power transmission components.	L3
CO4	Analyze mechanical systems for failure modes, optimization, and performance evaluation under thermal and dynamic loads.	L4
CO5	Evaluate design alternatives involving composite materials and gear systems for safety, reliability, and efficiency.	L5



CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO1	3	2	1	-	-	-	-	-	-	1	-	1	1	1
CO2	3	3	2	1	-	-	-	-	-	-	-	1	2	1
CO3	3	3	3	2	2	-	-	-	-	-	-	1	3	2
CO4	3	3	3	3	2	-	-	-	-	-	1	1	3	3
CO5	3	2	3	3	2	1	1	-	-	-	1	2	3	3

Assessment	
CA-1 (a)	Subjective Test / Open book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	Fundamentals of Failure and Fracture Mechanics: Failure Analysis, Limit design, Fundamentals of fracture mechanics. Fatigue designing for finite life, contact stresses and surface failures, oil films and their effects.	8 Hrs
Unit 2	Impact Mechanics and Stress Waves: Energy methods, longitudinal stress waves in elastic media, impact on beams, torsional impact on shafts, and longitudinal impacts on helical springs.	6 Hrs
Unit 3	Thermal Properties and Stresses: Effect of short-term and long-term properties of materials on design, creep, and stress relaxation. Elementary analysis of thermal stresses, thermal fatigue.	8 Hrs
Unit 4	Principles of Optimum Design: Basic concepts, introduction to various techniques of optimization, and optimum design of simple mechanical components.	6 Hrs
Unit 5	Design with Composite Materials and Reliability: Polymers and F.R.P. as materials for mechanical components. Reliability-based design: Definition, normal, exponential, and Weibull distributions, system reliability, and reliability based on strength.	



Unit 6	Analysis and Design of Power Transmission Systems: Analysis and design of power transmission systems and elements such as: Spur, helical, bevel, and worm gear drives, speed reducers and gearboxes, epicyclic gear drives, selection of ball and roller bearings.	12 Hrs
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Sr.No.	Textbooks
1.	M. F. Spotts" Mechanical Design Analysis", Prentice Hall.
2.	Joseph Edward Shigley & Charles R. Mischke, "Mechanical Engineering Design", Mc. Graw Hill (1989).
3.	Bhandari, V. B., Design of Machine Elements, McGraw Hill Education, 4th Edition, 2017
4	Norton, R. L., Machine Design: An Integrated Approach, Pearson, 6th Edition, 2013.
Reference Books	
1.	H. Burr & John B.Cheatham, "Mechanical Analysis and Design", Prentice Hall of India (1997).
2.	Kenneth Edwards & Robert B. Makee, "Fundamentals of Mechanical Component Design", McGraw Hill International ed. 1991.
3.	Aaron D. Deutschmanetal," Machine Design" Collier Macmillan Publishers International edition.
Web Resources	
1.	Machine Design II, IIT Madras, NPTEL, https://nptel.ac.in/courses/112106137
2.	NOC: Engineering Fracture Mechanics, IIT Madras, NPTEL, https://nptel.ac.in/courses/112106065

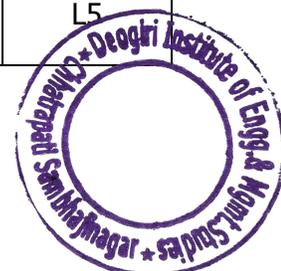
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Course Title: Advanced Machine Design		
Course Code: PM251101		Course Category: PEC I
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First year (Semester I)	ESE	60 Marks
Course Prerequisite: Knowledge of engineering mechanics, strength of materials, basic materials science, fundamentals of machine design, and engineering mathematics.		
Course Description: This course provides a comprehensive understanding of mechanical design principles with emphasis on static load analysis, theories of failure, fatigue, creep, and optimization techniques. It covers the application of composite materials, advanced design considerations for materials and processes, and the significance of safety in design. Through analytical methods, case studies, and design examples, students will gain both theoretical knowledge and practical skills for solving complex engineering problems. The course bridges fundamentals with applications in real-world mechanical systems, enabling students to design efficient and reliable components.		
Course Objectives: By the end of the course, students will be able to:		
<ol style="list-style-type: none"> 1. Demonstrate knowledge of load analysis, theories of failure, fatigue, creep, optimization, and composite materials. 2. Explain the mechanisms of fatigue and creep, and the influence of different factors on material behavior. 3. Apply optimization techniques and design methods to mechanical components under different loading and material conditions. 4. Analyze the performance of materials and components using theories, design case studies, and computational approaches. 5. Evaluate design alternatives considering safety, materials, manufacturing processes, and reliability. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Define fundamental principles of load analysis, theories of failure, fatigue, creep, optimization, and composite materials.	L1
CO2	Summarize the behavior of materials and components under static, fatigue, and creep conditions, as well as the characteristics of composites.	L2
CO3	Solve problems involving mechanical components and materials using design principles and optimization techniques.	L3
CO4	Analyze the performance of components under different loading conditions, including static, fatigue, creep, and composite stresses.	L4
CO5	Justify design alternatives for safety, manufacturability, and performance, and recommend suitable improvements.	L5



CO-PO Mapping

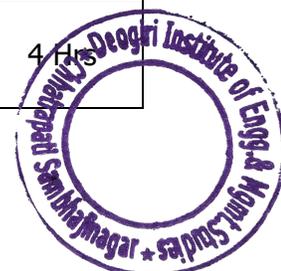
CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO1	3	2										1	1	1
CO2	3	2										1	1	1
CO3	3	3	3									1	3	2
CO4	3	3	2	2								1	3	2
CO5	3	2	3	2		1	1					1	3	3

Assessment

CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

Course Contents

Unit 1	Review of Fundamental Concepts: Load analysis - 2D and 3D static load analysis; Case studies of static load analysis - Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench; Understanding of static failure for ductile and brittle materials; Comparison of experimental data with failure theories; Significance of the theories of failure; Importance of factor of safety in design; Design case studies - Bracket, Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench.	8 Hrs
Unit 2	Fatigue: Introduction, Fatigue strength, factors affecting fatigue behavior, Influence of superimposed static stress, Cumulative fatigue damage, fatigue under complex stresses, Fatigue strength after overstresses, True stress and true strength.	6 Hrs
Unit 3	Creep: Mechanism of creep of material at high temperature, Exponential creep law, hyperbolic sine creep law, stress relaxation, bending etc.	4 Hrs



Unit 4	Optimization: Introduction, multivariable search methods, linear & geometric programming, structural and shape optimization, and simplex method.	5 Hrs
Unit 5	Composite Materials: Composite materials and structures, classical lamination theory, elastic stress analysis of composite material, Fatigue strength improvement techniques, stress concentration around cutouts in composite laminates, stability of composite laminate plates and shells, Hybrid materials, applications.	7 Hrs
Unit 6	Design for Materials and Process of Mechanical Components: Design for brittle fracture, Design for fatigue failure, Design for different machining process, assembly & safety etc.	6 Hrs

Sr.No.	Textbooks
1.	Richard G. Budynas, J. Keith Nisbett – Shigley’s Mechanical Engineering Design – McGraw-Hill
2.	Robert L. Norton – Machine Design: An Integrated Approach – Pearson Education
3.	V.B. Bhandari – Design of Machine Elements – McGraw-Hill
4.	Singiresu S. Rao – Engineering Optimization: Theory and Practice – Wiley.
Reference Books	
1.	Jack A. Collins, Henry R. Busby, George H. Staab – Mechanical Design of Machine Elements and Machines – Wiley.
2.	Marc Meyers, Krishan Chawla – Mechanical Behavior of Materials – Cambridge University Press
3.	Wolé Soboyejo – Mechanical Properties of Engineered Materials – Marcel Dekker Inc
Web Resources	
1.	Machine Design II, IIT Madras, NPTEL, https://nptel.ac.in/courses/112106137
2.	NOC: Engineering Fracture Mechanics, IIT Madras, NPTEL, https://nptel.ac.in/courses/112106065

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Chhatrapati Sambhajinagar
EST. 2009



Course Title: Advanced I.C. Engines		
Course Code: PM251102		Course Category: PEC I
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite: Thermodynamics, IC engines		
<p>Course Description: This course provides a comprehensive understanding of internal combustion (IC) engines, covering fundamental principles, design, and performance analysis. Students will study engine cycles, gas exchange, combustion processes in both spark-ignition and compression-ignition engines, and the mechanisms of pollutant formation and control. Emphasis is placed on heat transfer, fuel supply systems, and modern developments such as electric and hybrid vehicles. The syllabus integrates theoretical foundations with practical applications, enabling students to analyze, design, and evaluate engine systems for improved efficiency and sustainability.</p>		
<p>Course Objectives: By the end of this course, students will be able to:</p> <ol style="list-style-type: none"> 1. Understand the fundamental principles, classification, and operating parameters of IC engines. 2. Analyze engine cycles, combustion processes, and gas exchange phenomena in SI and CI engines. 3. Apply knowledge of heat transfer and fuel supply systems to evaluate engine performance. 4. Examine pollutant formation mechanisms and methods to control emissions in modern engines. 5. Explore advancements in electric and hybrid vehicle technologies, including energy storage and fuel cells. 		

Course Outcomes:		
COs	After completion of the course, the student should be able to	Bloom's Level
CO1	Define engine terminology, combustion parameters, list various factors affecting combustion, emission, and performance of IC engines, basic layouts and components of electric and hybrid vehicles.	L1
CO2	Explain engine cycles, combustion processes, gas exchange phenomena, and emission control methods, and the working principles of electric and hybrid vehicles.	L2
CO3	Solve practical problems related to engine performance, fuel supply systems, and heat transfer in engines.	L3
CO4	Analyze engine systems to identify performance limitations, pollutant formation, and energy efficiency issues.	L4
CO5	Evaluate the Performance Parameters of I.C. Engines and analyze the Performance maps.	L5

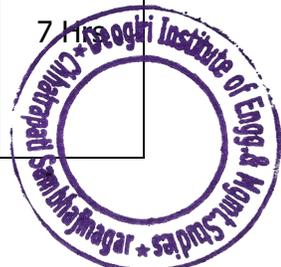


CO-PO Mapping

CO-PO Mapping														
COs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO1	2	1											1	
CO2	2							1					1	
CO3		2						1						1
CO4		2						1						1
CO5					1	2							1	

Assessment	
CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation /etc
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	Introduction to IC Engines and Engine Cycle Analysis: Historical review, engine types, design, and operating parameters. Thermo-chemistry of fuel-air mixtures, engine cycle analysis, ideal models of engine cycles, real engine cycles, differences, and factors responsible for deviation, and computer modeling.	6 Hrs
Unit 2	Gas Exchange and Charge Motion in Engines: Gas exchange processes: volumetric efficiency, flow through ports, altitude compensation, supercharging and turbocharging. Charge motion: mean velocity and turbulent characteristics, various types of combustion chambers in SI and CI engines, swirl, squish, pre-chamber engine flows.	6 Hrs
Unit 3	Combustion in SI and CI Engines: Engine combustion in SI engines: combustion and speed, cyclic variations, ignition, abnormal combustion, fuel factors, MPFI, SI engine testing. Combustion in CI engines: essential features, types of cycle, fuel spray behavior, ignition delay, mixing formation and control, common rail fuel injection system. Performance of engines: evaluation of various performance parameters of IC engines.	7 Hrs



Unit 4	Pollutant Formation and Control: Nature and extent of problems, nitrogen oxides, carbon monoxide, unburnt hydrocarbon, and particulate emissions measurement, exhaust gas treatment, catalytic converter, SCR, particulate traps, emission norms. Modern trends in IC engines: lean burning and adiabatic concepts, rotary engines, modification in IC engines to suit bi-fuels, HCCI, and GDI concepts.	5 Hrs
Unit 5	Engine Heat Transfer and Fuel Supply Systems: Importance of heat transfer, heat transfer and engine energy balance, convective heat transfer, radiation heat transfer, engine operating characteristics, fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG, and hydrogen.	6 Hrs
Unit 6	Electric and Hybrid Vehicles Electric vehicles: layout, advantages, disadvantages, and case studies. Hybrid vehicles: need, layouts, advantages, and disadvantages. Batteries: types, scope of development. Fuel cell technology and case studies.	6 Hrs

Sr.No.	Textbooks
1.	V. Ganeshan, "Internal Combustion Engines", Tata McGraw-Hill Publications, New Delhi, 3rd edition.
2.	J. B. Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill Publications, New York, International Edition, 1988.
	Reference Books
1.	Alternative Fuels, Dr. S. S. Thipse, Jaico Publications.
2.	Ehsani, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", Taylor and Francis Publication
	Web Resources
1.	IC Engines And Gas Turbines, IIT Guwahati, NPTEL, https://nptel.ac.in/courses/112103262

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Chhatrapati Sambhajinagar
EST. 2009



Course Title: Additive Manufacturing		
Course Code: PM251103		Course Category: PEC I
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite: Basic knowledge of CAD modeling, engineering materials, manufacturing processes, mechanical engineering fundamentals, and computer operations.		
Course Description: This course introduces the principles, technologies, and applications of Additive Manufacturing (AM) in modern mechanical engineering. Students will learn about various AM systems, including liquid-based, solid-based, and powder-based processes, as well as geometric modeling, reverse engineering, and rapid tooling techniques. The course covers the preparation of digital models, STL file handling, part orientation, support generation, and slicing for AM. Practical applications in product development, rapid prototyping, and rapid manufacturing are emphasized, providing students with both theoretical understanding and real-world problem-solving skills.		
Course Objectives: By the end of this course, students will be able to: <ol style="list-style-type: none"> 1. Understand the fundamental principles, classifications, and benefits of additive manufacturing technologies. 2. Develop and process digital models for additive manufacturing using CAD, reverse engineering, and STL file techniques. 3. Apply various AM systems and processes, including SLA, FDM, DMLS, SLS, LENS, and 3D printing, for rapid prototyping and manufacturing. 4. Analyze the performance and suitability of AM systems for different materials, design requirements, and applications. 5. Evaluate and propose improvements in AM processes, rapid tooling, and manufacturing methods to optimize product development. 		

Course Outcomes:		
COs	After completion of the course: Student should be able to	Bloom's Level
CO1	Identify fundamental principles, classifications, and benefits of additive manufacturing technologies.	L1
CO2	Illustrate the characteristics, working principles, and processes of different AM systems.	L2
CO3	Implement CAD modeling, STL file processing, and AM techniques to solve practical prototyping and manufacturing problems.	L3
CO4	Examine AM systems, process parameters, and material behavior to optimize part quality and performance.	L4
CO5	Assess the performance of AM processes and recommend improvements in design, tooling, and manufacturing efficiency.	



CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	3	2			1							1	1	1
CO 2	3	2			2							1	2	1
CO 3	3	3			3							1	3	2
CO 4	3	3	2		3							1	3	3
CO 5	3	3	3	3	3							1	3	2

Assessment	
CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	Introduction to Additive Manufacturing: Overview, Historical Development, Need for Additive Manufacturing in Product Development, Classification of AM Technologies, Materials for Additive Manufacturing, Traditional Manufacturing vs. Additive Manufacturing, Tooling, Benefits and Applications	6 Hrs
Unit 2	Geometric Modeling and Reverse Engineering: Basic Concepts of Geometric Modeling, Digitization Techniques, Model Reconstruction, Data Processing for Additive Manufacturing, CAD Model Preparation, Interface Formats, Part Orientation, Support Generation, Model Slicing, Tool Path Generation, AM Data Formats, Reengineering for Digital Representation, STL Format, STL File Problems, Consequences of Building Valid and Invalid Tessellated Models, STL File Repairs, Introduction to Reverse Engineering	6 Hrs



Unit 3	Liquid-Based and Solid-Based AM Systems: Classification of AM Systems, Liquid-Based Systems, Stereolithography Apparatus (SLA) – Principle, Process, Process Parameters, Machine Details, Advantages, Applications, Solid-Based Systems, Fused Deposition Modeling (FDM) – Principle, Process, Process Parameters, Machine Details, Advantages, Applications, Direct Metal Laser Sintering (DMLS) – Principle, Process, Process Parameters, Advantages, Applications	6 Hrs
Unit 4	Powder-Based AM Systems: Selective Laser Sintering (SLS) – Principle, Process, Process Parameters, Machine Details, Advantages, Applications, Three-Dimensional Printing (3DP) – Principle, Process, Advantages, Applications, Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM), Shape Deposition Manufacturing, Laser Deposition, Laminated Object Manufacturing (LOM), Electro-Optical Sintering	6 Hrs
Unit 5	Rapid Casting and Segmental Object Manufacturing: Rapid Casting Using Wax Patterns, Acrylic Patterns, Dense Polystyrene Patterns, Expanded Polystyrene Process, Rapid Manufacturing of Metallic Objects, Visible Slicing Implementation	6 Hrs
Unit 6	Advanced AM Processes and Tooling: Ballistic Particle Manufacturing (BPM), Rapid Tooling Techniques – Vacuum Casting, DMLS, Direct and Indirect Methods, Commercial Software for AM, STL File Generation	6 Hrs

Sr.No.	Textbooks
1.	Chua C.K., Leong K.F., Lim C.S., Rapid Prototyping: Principles and Applications, Third Edition, World Scientific Publishers, 2010.
2.	Frank W. Liou, Rapid Prototyping & Engineering Applications, CRC Press, Taylor & Francis Group.
	Reference Books
1.	A. Gebhardt, <i>Rapid Prototyping</i> . Cincinnati, OH: Hanser Gardner Publications.
2.	L. W. Liou and F. W. Liou, <i>Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development</i> . Boca Raton, FL: CRC Press.
3.	F. W. Liou, <i>Rapid Prototyping & Engineering Applications</i> . Boca Raton, FL: CRC Press, Taylor & Francis Group.
4.	D. T. Pham and S. S. Dimov, <i>Rapid Manufacturing</i> . Berlin: Springer-Verlag.
5.	K. G. Cooper, <i>Rapid Prototyping Technology: Selection and Application</i> . Boca Raton, FL: CRC Press.
	Web Resources
1.	NOC: Navigating the Latest Trends in Additive Manufacturing Landscape, IIT Bombay-Wipro 3D, NPTEL, (https://nptel.ac.in/courses/112101623)
2.	Fundamentals of Additive Manufacturing Technologies (IIT Guwahati), https://nptel.ac.in/courses/112103306



Course Title: Finite Element Analysis		
Course Code: PE251104		Course Category: PEC II
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs./ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite: Knowledge of Strength of Materials and Engineering Mechanics, Basics of Differential Equations and Numerical Methods, Understanding of structural and thermal engineering problems.		
Course Description: This course introduces the Finite Element Analysis (FEA) as a numerical technique for solving a variety of engineering problems. It begins with approximate solution methods and 1D problems, advances to 2D elements and isoparametric formulations, and covers 3D problems including plates, shells, and dynamic applications. The course emphasizes stiffness matrix derivation, convergence, accuracy, and stability analysis, equipping students with the ability to apply FEM to structural, thermal, and mechanical problems.		
Course Objectives:		
<ol style="list-style-type: none"> 1. Provide fundamental understanding of FEM principles and applications. 2. Develop ability to formulate mathematical models for engineering problems. 3. Train students to solve 1D structural and thermal problems using FEM. 4. Enable derivation of stiffness matrices and application of shape functions. 5. Familiarize students with FEM formulations for 2D and 3D engineering applications. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Describe the fundamental principles of the finite element method, linear elasticity, and approximate solution techniques.	L1
CO2	Interpret and construct mathematical models of engineering problems using energy methods and variational principles.	L2
CO3	Apply FEM techniques to formulate and solve 1D structural and thermal problems involving bar, truss, and beam elements.	L3
CO4	Analyze stiffness matrices, shape functions, and isoparametric formulations for 2D and 3D problems, including convergence and patch test.	L4
CO5	Evaluate FEM results for accuracy, convergence, and stability in structural, thermal, and dynamic applications.	L5



CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	1	1											1	1
CO 2	3	3	1		1							1	2	1
CO 3	2	2	1	2	2				2			1	3	2
CO 4	3	2	2	3	2								3	2
CO 5	3	2	2	3	3								3	3

Assessment

CA-1 (a)	Subjective Test, Assignment, etc.
CA-2 (b)	Assignment, Open-Book Test, etc.
MSE (c)	Mid Sem Examination

Course Contents

Unit 1	Introduction to FEM and Structural Analysis Introduction to FEM, structural analysis concepts, approximate solution methods, review of linear elasticity	6 Hrs.
Unit 2	1D Problems in FEM Principles of virtual displacements, minimum potential energy, Rayleigh–Ritz method, exact vs. approximate solutions, bar and beam elements	6 Hrs.
Unit 3	2D Problems – Fundamentals Plane stress and plane strain, triangular elements (CST, LST), quadrilateral elements, boundary conditions, body forces, stress recovery	6 Hrs.
Unit 4	2D Isoparametric Formulation Lagrange and Serendipity shape functions, isoparametric elements, numerical integration, convergence requirements, patch test, reduced integration, nonconforming elements	6 Hrs.



Unit 5	3D Problems Axisymmetric solids, 3D elements, mixed formulations	6 Hrs.
Unit 6	Advanced Topics in FEM Plate bending (Kirchhoff theory), thick plate and shell elements, FEM for dynamic problems, mass properties, introduction to elastic stability of frames and plates	6 Hrs.

Sr.No.	Textbooks
1.	Bruce Irons and Soharab Ahmed, Techniques of Finite Elements, 1st Edition, John Wiley & Sons, 1980.
2.	O. P. Gupta, Finite and Boundary Element Methods in Engineering, 1st Edition, Oxford & IBH Publishing, 1999.
3.	Singiresu S. Rao, The Finite Element Method in Engineering, 6th Edition, Butterworth–Heinemann, 2017.
Reference Books	
1.	Robert D. Cook, David S. Malkus, Michael E. Plesha, and Robert J. Witt, Concepts and Applications of Finite Element Analysis, 4th Edition, John Wiley & Sons, 2001.
2.	C. S. Krishnamurthy, Finite Element Method: Theory and Programming, Revised Edition, Tata McGraw-Hill Education, 1987.
3.	Klaus-Jürgen Bathe, Finite Element Procedures, 1st Edition, Prentice Hall, 1996.
4.	Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, 4th Edition, Prentice Hall of India (PHI), 2012
Web Resources	
1.	Finite Element Analysis, IIT Kharagpur, NPTEL, https://nptel.ac.in/courses/105105041
2.	NOC: Finite Element Method and Computational Structural Dynamics, IIT Roorkee, NPTEL, https://nptel.ac.in/courses/105107209

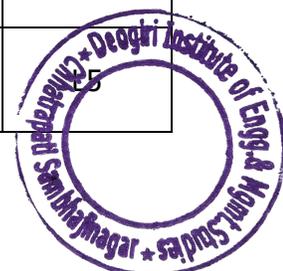
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EST. 2009



Course Title: Sustainable Power Generation Systems		
Course Code: PM251105		Course Category: PEC II
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite: Basic knowledge of thermodynamics, heat transfer, fluid mechanics, and mechanical engineering fundamentals		
Course Description: This course provides a comprehensive study of sustainable power generation systems, covering both conventional and renewable energy technologies. It introduces students to solar thermal, solar photovoltaic, wind, hydro, biomass, hydrogen, geothermal, ocean, wave, and tidal energy systems, along with energy storage methods and energy economics. Emphasis is placed on the theoretical principles, design considerations, performance analysis, and practical applications of these technologies in the context of mechanical engineering. The course equips students with the knowledge to analyze, design, and evaluate sustainable energy systems for modern power generation needs.		
Course Objectives: By the end of this course, students will be able to: <ol style="list-style-type: none"> 1. Understand the fundamental principles of conventional and renewable power generation systems. 2. Explain the design, operation, and performance characteristics of solar, wind, hydro, biomass, hydrogen, geothermal, and ocean energy systems. 3. Apply analytical and computational methods to solve practical problems in renewable energy systems. 4. Analyze the behavior and performance of different energy systems under various operating conditions. 5. Evaluate energy generation and storage systems for efficiency, economic viability, and sustainability, and propose improvements. 		

Course Outcomes:		
COs	After completion of the course: Student should be able to	Bloom's Level
CO1	Recall the fundamental principles, definitions, and classifications of conventional and renewable power generation systems.	L1
CO2	Explain the concepts, working principles, and performance characteristics of different renewable energy systems.	L2
CO3	Solve practical design and performance problems of solar, wind, hydro, biomass, hydrogen, geothermal, and ocean energy systems.	L3
CO4	Analyze the behavior and efficiency of energy generation and storage systems under varying conditions.	L4
CO5	Evaluate the performance and economic feasibility of sustainable power generation systems and suggest improvements.	L5



CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	3	2										1	1	1
CO 2	3	2										1	2	1
CO 3	3	3	1									1	3	2
CO 4	3	3	1	1								1	3	2
CO 5	3	3	2	1								1	3	3

Assessment

CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

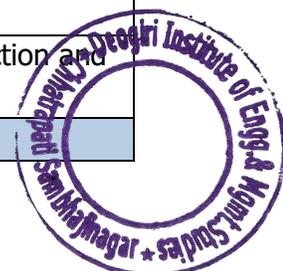
Course Contents

Unit 1	Introduction to Power Generation and Renewable Energy: Global and Indian energy scenario, Overview of conventional power generation technologies, Overview of renewable power generation technologies, Concepts of renewable energy-based power plants, Role of sustainable power generation in energy transition	6 Hrs
Unit 2	Solar Energy Systems: Solar Thermal Power Generation, Fundamentals of solar thermal energy conversion, Flat plate and concentrator solar thermal plants, ORC, RC, Stirling engine, Solar Photovoltaic Power Generation, Fundamentals of PV energy conversion, Standalone PV systems, Grid-connected PV systems, Performance analysis, Design considerations	6 Hrs



Unit 3	Wind and Hydro Power Generation: Wind Power Generation, Introduction to wind turbines, Classification of horizontal and vertical axis turbines, Theory of wind turbines, Component analysis, Wind farm design and performance evaluation, Hydro Power Generation, Micro, mini, and small hydro plants, Hydraulic turbines, Selection and design of pumps and turbines, Design and analysis of hydro power plants	6 Hrs
Unit 4	Biomass, Hydrogen, and Fuel Cell Technologies: Biomass Power Generation, Bioenergy production technologies, Biochemical and thermochemical reactors, Clean power generation, IGCC, Hydrogen Energy and Fuel Cells, Hydrogen production routes, Types of fuel cells, Design principles, Applications, Future prospects, IGFC	6 Hrs
Unit 5	Geothermal, Ocean, Wave, and Tidal Energy: Geothermal Energy, Fundamentals, Classification, Design and analysis of geothermal power plants, Ocean Thermal Energy, Principles, Classification, Design and analysis, Wave and Tidal Energy, Fundamentals, Types, Design and performance evaluation	6 Hrs
Unit 6	Energy Storage and Energy Economics: Energy Storage, Thermal energy storage, Mechanical energy storage, Electro-chemical energy storage, Design and analysis of storage technologies, Energy Economics, Cost analysis, Interest, Accounting rate of return, Payback, Discounted cash flow, Net present value, Internal rate of return, Inflation, Life cycle analysis of energy systems	6 Hrs

Sr.No.	Textbooks
1.	J. Twidell, T. Weir, Renewable Energy Resources, 4th Edition, Taylor and Francis, 2021
2.	G. Boyle (Editor), Renewable Energy: Power for a Sustainable Future, 3rd Edition, Oxford University Press, 2012.
3.	Chetan Singh Solanki, Renewable Energy Technologies: A Practical Guide for Beginners, PHI Learning, 2008
Reference Books	
1.	G. N. Tiwari, Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa, 2002.
2.	J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, 4th Edition, John Wiley, 2013.
3.	R. Gasch, J. Twele, Wind Power Plants: Fundamentals, Design, Construction and Operation, 2nd Edition, Springer, 2012.
4.	P. Breeze, Hydropower, 1st Edition, Elsevier, 2018.
5.	S. C. Bhattacharyya, Energy Economics: Concepts, Issues, Markets and Governance, 2nd Edition, Springer, 2019.
6.	S.P. Sukhatme and J.K. Nayak, Solar Energy: Principles of Thermal Collection and Storage, 3rd Edition, Tata McGraw-Hill, 2010.
Web Resources	



1.	Sustainable Power Generation Systems, IIT Guwahati, NPTEL, https://nptel.ac.in/courses/127103236
2.	Renewable Energy Engineering: Solar, Wind And Biomass Energy Systems, IIT Guwahati, NPTEL. https://nptel.ac.in/courses/103103206



Course Title: Manufacturing Planning and Control		
Course Code: PM251106		Course Category: PEC II
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester I)	ESE	60 Marks
Course Prerequisite: Basics of Production and Operations Management, Fundamentals of Mechanical Engineering, and introductory knowledge of Manufacturing Systems.		
Course Description: This course provides a comprehensive overview of Manufacturing Planning and Control (MPC), covering the fundamental principles and modern practices in production systems. It explores different manufacturing environments such as assembly lines, batch production, cellular manufacturing, and flexible manufacturing systems, along with preplanning, operations planning, and control techniques. The syllabus emphasizes both theoretical foundations, including MRP, JIT, and hierarchical planning, and practical applications, such as simulation, quality control, and ERP integration. The course equips mechanical engineers with the ability to design, plan, and optimize manufacturing systems for improved productivity and efficiency.		
Course Objectives: By the end of this course, students will be able to: <ol style="list-style-type: none"> 1. Understand the fundamental principles and components of various manufacturing systems and MPC techniques. 2. Explain the methods of preplanning, forecasting, capacity planning, and inventory management in production systems. 3. Apply planning, scheduling, and control techniques, including MRP, JIT, FMS, and line balancing, to practical manufacturing scenarios. 4. Analyze manufacturing operations, system behavior, and resource utilization to identify bottlenecks and efficiency gaps. 5. Evaluate manufacturing system performance and propose improvements using modern IT tools such as ERP, EAI, and virtual manufacturing. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Recall the fundamental principles, definitions, and components of manufacturing systems and MPC techniques.	L1
CO2	Explain the characteristics, functions, and interactions of manufacturing systems, planning methods, and control techniques.	L2
CO3	Solve practical manufacturing planning and control problems using MRP, JIT, line balancing, plant layout, and FMS principles.	



CO4	Analyze manufacturing operations, system performance, and resource utilization to identify inefficiencies and bottlenecks.	L4
CO5	Evaluate manufacturing systems and processes, propose improvements, and assess the impact of IT tools and modern practices on productivity and efficiency.	L5

CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	3										1		1	1
CO 2	3	1									1		1	1
CO 3	3	3	2		2						3		3	3
CO 4	3	3	2	3	2		1				3		3	3
CO 5	3	2	3	2	3	1	2				3	2	3	3

Assessment

CA-1 (a)	Subjective Test / Open book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

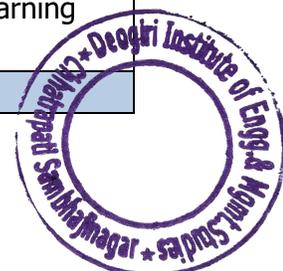
Course Contents

Unit 1	Introduction to Manufacturing Systems: Overview of manufacturing systems, assembly line, repetitive manufacturing, batch manufacturing, objectives of manufacturing planning and control, issues in production planning and control	6 Hrs
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Unit 2	Advanced Manufacturing Systems and Preplanning: Cellular manufacturing, flexible manufacturing systems (FMS), Just-In-Time (JIT) manufacturing, computer-integrated manufacturing (CIM), forecasting, economic analysis, aggregate planning, capacity planning, inventory planning	6 Hrs
Unit 3	Design of Manufacturing Systems: Decision-making in the design of manufacturing systems, group technology (GT), line balancing, plant layout, and types of plant layout	6 Hrs
Unit 4	Operations Planning: Material requirements planning (MRP), MRP II, hierarchical planning systems, JIT systems, sales and operations planning (S&OP), master production scheduling (MPS), MPS design	6 Hrs
Unit 5	Operations Control and Simulation: FMS operation and control, lot sizing decisions, production scheduling, line of balance, quality planning and control, cost planning and control, productivity planning and control, applications of theory of constraints (TOC), simulation analysis of manufacturing systems, case studies	6 Hrs
Unit 6	World-Class Manufacturing and IT Integration: World-class manufacturing systems, ideal manufacturing, intelligent manufacturing, agile manufacturing, enterprise resource planning (ERP), e-business, enterprise applications integration (EAI), virtual manufacturing, demand management, distribution requirements planning (DRP), case studies	6 Hrs

Sr.No.	Textbooks
1.	Bedworth, D. D., Bailey, J. E., Integrated Production Control System – Management, Analysis and Design, John Wiley, 1983.
2.	Elsayed, E. A., Boucher, T. O., Analysis and Control of Production Systems, Prentice Hall, 1985
3.	Chase, R. B., Aquilano, N. J., Jacobs, F. R., Production and Operations Management – Manufacturing and Services, Tata McGraw Hill, 2nd Edition, 1999.
4.	Bestwick, P. F., Lockyer, K., Quantitative Production Management, Pitman Publications, 1982
Reference Books	
1.	Hax, A. C., Candea, D., Production and Inventory Management, Prentice Hall, 1984.
2.	Johnson, L. A., Montgomery, D. C., Operations Research in Production Planning, Scheduling and Inventory Control, John Wiley, 1974.
3.	Krishnaswamy, K. N., Cases in Production Operations Management, PHI Learning Pvt. Ltd., 1998.
4.	Starr, M. K., Miller, D. W., Inventory Control: Theory and Practice, PHI Learning Pvt. Ltd., 1990.
Web Resources	



1.	Production Planning and Control – NPTEL IIT Roorkee NPTEL, https://nptel.ac.in/courses/112107143
2.	Industrial Engineering and Operations Research – NPTEL IIT Guwahati NPTEL https://nptel.ac.in/courses/112103774

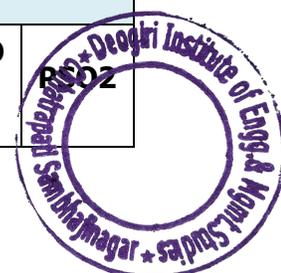


Course Title: Seminar		
Course Code: PM251401		Course Category: VSE
Teaching Scheme	Examination Scheme (As Applicable)	
Practical's/Sessions: 02 Hours/Week	CA-I	15 Marks
	CA-II	15 Marks
Semester: First Year (Semester-I)	ESE	20 Marks
Course Prerequisite:		
<ul style="list-style-type: none"> Basic understanding of core subjects in specialization, Ability access, and interpret scientific literature. Exposure to technical report writing and presentation. 		
Course Description:		
<p>The M.Tech Seminar course is designed to enhance student ability to identify, analyze and present research-oriented or industry-relevant topics related to their field of specialization. It provides a platform to review recent literature, critically analyze methodologies, and effectively communicate technical concepts written and oral forms. The course emphasizes independent learning analytical thinking presentation and interaction with peers and faculty to prepare students for research and professional careers.</p>		
Course Objectives:		
<ol style="list-style-type: none"> To enhance the ability to conduct a comprehensive literature review on a selected research/technical topic. To develop skills in critical analysis, organization, and synthesis of technical information. To improve proficiency in technical report writing and formatting. To strengthen communication skills through oral presentation and discussion. To build confidence in defending technical ideas and responding to queries effectively. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Identify and select a relevant research topic in Mechanical Engineering through a literature survey.	L3–Apply
CO2	Analyze and summarize state-of-the-art developments in the chosen area.	L4 – Analyze
CO3	Prepare a well-structured seminar report following technical writing standards.	L5 – Evaluate
CO4	Deliver an effective oral presentation with clarity and professionalism.	L6- Create
CO5	Demonstrate the ability to answer questions, engage in discussions, and defend ideas confidently.	L5 – Evaluate

CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2



CO 1	3	2	1	3	2	1	1	1	2	2	1	3	3	3
CO 2	3	3	2	3	2	1	1	1	2	2	1	3	2	2
CO 3	2	2	2	1	2	1	1	2	2	3	2	3	3	2
CO 4	1	1	1	2	1	1	1	1	3	3	2	3	1	2
CO 5	1	2	1	2	1	1	1	2	3	3	2	3	2	2

Course Content

The seminar requires each candidate to prepare a report on a topic that they and their supervisor have mutually agreed upon. This topic must be a current problem in the field of Mechanical Engineering and should have a strong research orientation. The candidate is expected to demonstrate a thorough understanding of the recent developments related to their chosen topic. Once the report is complete, the candidate will present it to an examining committee, as well as to other faculty members from the department. The PG coordinator and the Head of the Mechanical Engineering Department will form this committee to evaluate the seminar.

Assessment

Evaluation and Examination

The seminar will be evaluated out of a total of 50 marks, with 30 marks for internal assessment and 20 marks for the semester-end examination. The semester-end examination will be conducted by a committee of three faculty members. Students must submit their completed reports, which should be authenticated by both their guide and the Head of the Department. Each student will individually present their work to the committee, who will then evaluate them and award marks.

CA-I (a)	Review-I: 15 Marks (Concept/knowledge in the topic:10 marks, Literature: 05 marks)
CA-II (b)	Review-II: 15 Marks (Report writing & Presentation: 15 Marks)
ESE (Practical/viva voce (c))	20 Marks (Individual evaluation through viva voce/test:20 marks)
Total (d)	50 Marks



Course Title: PG Lab		Course Category: VSE	
Course Code: PM251402			
Teaching Scheme		Examination Scheme (As Applicable)	
Practicals/Sessions: 02 Hours/Week		CA-I	15 Marks
		CA-II	15 Marks
Semester: First Year (Semester-I)		ESE	20 Marks
Course Prerequisite: Fundamentals of Heat Transfer, Thermodynamics, Fluid Mechanics and Hydraulic Machines, Refrigeration and Air Conditioning, Internal Combustion Engines			
Course Description: This laboratory course provides hands-on experience in advanced experiments related to thermal and fluid sciences. It focuses on heat transfer enhancement, performance evaluation of engines with alternative fuels, refrigeration and air conditioning systems, and pumps at variable speeds, unsteady heat transfer, and blower testing. The course aims to strengthen students' theoretical knowledge through practical experimentation, data analysis, and interpretation in alignment with modern engineering practices.			
Course Objectives:			
<ol style="list-style-type: none"> 1. To provide experimental knowledge of advanced concepts in heat transfer, refrigeration, IC engines, and fluid machinery. 2. To develop ability to conduct, analyze, and interpret experimental data related to real-time thermal and fluid systems. 3. To strengthen problem-solving, research, and innovation skills through laboratory practices. 4. To familiarize students with modern experimental tools, measurement techniques, and performance analysis methods. 			

Course Outcomes:		
COs	After completion of the PG Lab: Students should be able to	Bloom's Level
CO1	Demonstrate understanding of heat transfer, IC engines, RAC systems, pumps, and blowers through experiments.	L2 – Understand
CO2	Conduct experiments using modern test rigs and collect accurate data for analysis.	L3 – Apply
CO3	Analyze performance characteristics of thermal and fluid systems under different operating conditions.	L4 – Analyze
CO4	Interpret results and compare with theoretical models and published literature.	L5 – Evaluate
CO5	Prepare technical reports and present findings with effective communication and teamwork.	L6-Create

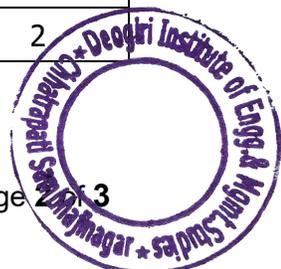


CO-PO Mapping

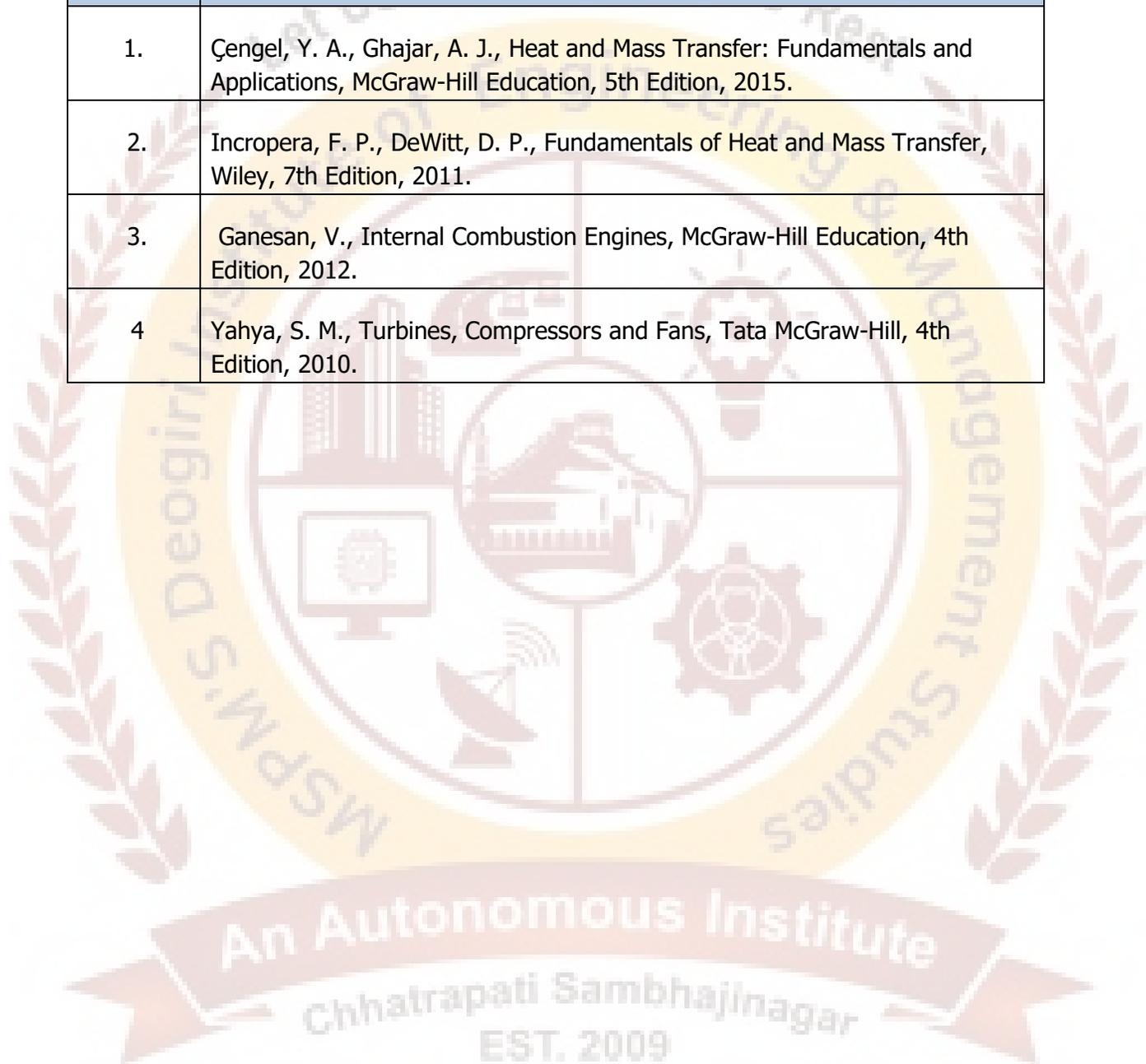
CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	1		1			2					2	1	2	1
CO 2	1			1								1	3	1
CO 3	2					1						2	3	2
CO 4	2	3	2	2	-	-	3	3	2	1	-	2	3	2
CO 5	1		1			2					2	1	1	1

Assessment	
CA-I (a)	Laboratory performance and attendance – 10Maks, Lab records and technical reporting – 15Marks,
CA-II (b)	Experiment conduction, observation, and data collection – 15 Marks Viva-voce (during lab sessions) – 10Marks,
Practical (d)	Particular Experiment number

Sr. No.	List of Experiments/Activities	Hours
1	Heat Transfer Enhancement	2
2	Computerized Single Cylinder Diesel Engine using Alternative Fuel	2
3	Air Conditioning Test-rig	2
4	Centrifugal/Gear Pump at Variable speed	2
5	Unsteady State Heat Transfer	2
6	Blower Test-rig	2

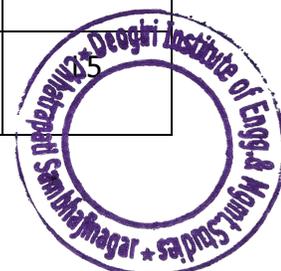


Sr.No.	Textbooks
1.	Lab Manuals and Recent Research Papers related to Thermal/Fluid Systems, Various Authors, Various Publishers, Latest Editions.
Reference Books	
1.	Çengel, Y. A., Ghajar, A. J., Heat and Mass Transfer: Fundamentals and Applications, McGraw-Hill Education, 5th Edition, 2015.
2.	Incropera, F. P., DeWitt, D. P., Fundamentals of Heat and Mass Transfer, Wiley, 7th Edition, 2011.
3.	Ganesan, V., Internal Combustion Engines, McGraw-Hill Education, 4th Edition, 2012.
4	Yahya, S. M., Turbines, Compressors and Fans, Tata McGraw-Hill, 4th Edition, 2010.



Course Title: Advanced Fluid Mechanics and Heat Transfer		
Course Code: PM252004		Course Category: PCC
Teaching Scheme	Examination Scheme	
Lectures: 04 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 04	MSE	20 Marks
Semester: Second Year (Semester III)	ESE	60 Marks
Course Prerequisite: Engineering Mathematics, Thermodynamics, Fluid Mechanics (UG level), Heat Transfer (UG level)		
Course Description: This course provides an in-depth study of advanced fluid mechanics and heat transfer principles relevant to mechanical engineering applications. It covers fluid kinematics, control volume and differential analysis of fluid flow, conduction, convection, and heat transfer with phase change. Emphasis is placed on deriving governing equations, understanding physical interpretations, and solving practical engineering problems. Students will develop the ability to analyze, model, and evaluate fluid and thermal systems in real-world applications.		
Course Objectives: By the end of this course, students will be able to: <ol style="list-style-type: none"> 1. Understand the fundamental principles of fluid mechanics and heat transfer, including conservation laws and governing equations. 2. Develop analytical and mathematical skills to solve complex problems in fluid flow and heat transfer. 3. Apply theoretical concepts to practical engineering scenarios, including laminar flows, conduction, convection, and phase-change processes. 4. Analyze the behavior of fluid and thermal systems under various conditions and predict performance. 5. Evaluate engineering solutions and propose improvements for enhanced fluid and thermal system efficiency. 		

Course Outcomes:		
COs	After completion of the course: Student should be able to	Bloom's Level
CO1	Recall fundamental principles of fluid mechanics, heat transfer modes, and governing equations.	L1
CO2	Describe concepts, governing equations, and characteristics of fluid flow and heat transfer processes.	L2
CO3	Solve practical problems involving fluid flow, conduction, convection, and phase change using appropriate principles and equations.	L3
CO4	Examine fluid and thermal systems to determine their behavior under varying conditions.	L4
CO5	Evaluate the performance of fluid and thermal systems and propose improvements for efficiency and reliability.	



CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	3	1										1	1	1
CO 2	3	1										1	2	1
CO 3	3	2	1									1	3	2
CO 4	3	3	2	1		1	1					1	3	2
CO 5	3	3	3	2		1	1					1	3	3

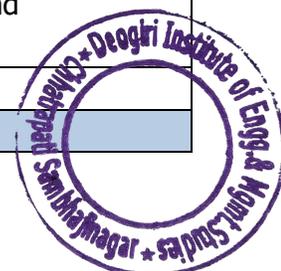
Assessment	
CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	Fluid Kinematics: Principle of Conservation of Mass, Momentum, and Energy, Eulerian and Lagrangian Descriptions of the Flow, Velocity and Acceleration Fields, Material Derivative, Streamlines, Pathlines, Streaklines, Stream Function, Vorticity, Rotationality, Types of Fluid Element Deformation: Translation, Rotation, Linear Strain, Shear Strain, Experimental Fluid Visualization Techniques	8 Hrs
Unit 2	Control Volume Analysis of Fluid Flow: Control Volume Analysis, The Reynolds Transport Theorem (RTT) (Derivation and Physical Interpretation), Conservation of Mass (Derivation of Continuity Equation from RTT), Conservation of Momentum (Derivation of Linear and Angular Momentum Equation from RTT), Conservation of Energy (Derivation of Energy Equation from RTT)	8 Hrs



Unit 3	Differential Analysis of Fluid Flow: Differential Form of Continuity Equation (Derivation and Interpretation), Differential Form of Linear Momentum Equation (Derivation and Interpretation), Navier-Stokes Equation (Derivation and Interpretation), Differential Form of Energy Equation (Only Interpretation and No Derivation), Some Simple Solutions for Laminar, Viscous, Incompressible Flows (Couette Flow, Plane Poiseuille Flow, Hagen-Poiseuille Flow, Taylor-Couette Flow)	8 Hrs
Unit 4	Conduction Heat Transfer: Fourier's Law of Heat Conduction, Multidimensional General Heat Conduction in Cartesian, Cylindrical and Spherical Coordinate Systems, Initial and Boundary Conditions, Thermoelectric Power Generation, Micro- and Nanoscale Conduction, 2D Steady State Conduction: 2D Steady State Conduction in a Rectangular Plate by Separation of Variable Method, The Conduction Shape Factor, Dimensionless Conduction Heat Rate	8 Hrs
Unit 5	Convection Heat Transfer: External Flows: Equations of Conservations of Mass and Momentum, Derivation of Conservation of Energy Equation (First Law of Thermodynamics), Reynolds Transport Theorem for Energy Conservation, Boundary Layer Considerations for Convection, Local and Average Convection Coefficients, Analytical Approach Analysis of Heat Flow in Couette Flow, Analytical Approach Analysis of Heat Transfer in Flow Through Pipe, Analytical Approach Analysis of Forced Convection over Flat Plate, Analysis of Laminar Natural Convection on a Vertical Surface, Combined Forced and Natural Convection Effect	8 Hrs
Unit 6	Heat Transfer with Phase Change: Physical Mechanics of Boiling, Pool Boiling, Boiling Curve, Modes of Boiling (Free Convection Boiling, Transition Boiling, Film Boiling, Correlations of Pool Boiling, Forced Convection Boiling, Mechanism of Condensation, Filmwise Condensation, Dropwise Condensation, Analysis of Laminar Film Condensation on a Vertical Plate, Condensation on Horizontal Tubes, Turbulent Film Condensation	8 Hrs

Sr.No.	Textbooks
1.	Frank M. White, Fluid Mechanics, McGraw-Hill
2.	Munson, Young, and Okiishi, Fundamentals of Fluid Mechanics, Wiley
3.	Philip J. Pritchard, Fox and McDonald's Introduction to Fluid Mechanics, Wiley
4.	Frank P. Incropera, David P. DeWitt, Theodore L. Bergman, Adrienne Lavine, Fundamentals of Heat and Mass Transfer, Wiley
5	J.P. Holman, Heat Transfer, McGraw-Hill
Reference Books	
1.	P. Kundu, I.M. Cohen, and D.R. Dowling, Fluid Mechanics, Academic Press
2.	R.K. Som and G. Biswas, Fluid Mechanics, McGraw-Hill Education
3.	Yunus A. Çengel and Afshin J. Ghajar, Heat and Mass Transfer: Fundamentals and Applications, McGraw-Hill
4.	F. Kreith, R. M. Manglik, M. S. Bohn, Principles of Heat Transfer, Cengage
Web Resources	



1.	Advanced Concepts in Fluid Mechanics, IIT Kharagpur, NPTEL, https://nptel.ac.in/courses/112105218
2.	Fluid Mechanics, IIT Kharagpur, NPTEL, https://nptel.ac.in/courses/112105171
3.	Heat Transfer, IIT Bombay, NPTEL, https://nptel.ac.in/courses/103101137
4.	Fundamentals of Convective Heat Transfer, IIT Guwahati, NPTEL, https://nptel.ac.in/courses/112103297



Course Title: MOOC/SWAYAM		Course Category: PCC	
Course Code: PM252005			
Teaching Scheme		Examination Scheme	
Lectures: 04 hrs/ week	CA-1	10 Marks	
Tutorial: -----	CA-2	10 Marks	
Credits: 04	MSE	20 Marks	
Semester: First Year (Semester II)	ESE	60 Marks	
Course Description:			
This course is part of a curated set of MOOCs offered, with the specific courses selected and approved by the Board of Studies (BoS) to ensure alignment with current academic and industry standards.			



Course Title: CAD-CAE (Computer Aided Design and Computer Aided Engineering)		
Course Code: PM252107		Course Category: PEC III
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs./ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks
Course Prerequisite: Basic knowledge of Engineering Graphics and Engineering Mechanics, Fundamentals of Mathematics and Computational Methods, Awareness of general engineering design processes.		
Course Description: This course introduces the concepts and applications of Computer-Aided Design (CAD) and Computer-Aided Engineering (CAE) in modern product development. It emphasizes geometric modeling techniques (wireframe, surface, solid, and assembly modeling), meshing, and finite element analysis for 1D and 2D heat transfer and fluid mechanics problems. The course also focuses on accuracy and validation of CAE results by correlating computational models with experimental testing.		
Course Objectives:		
<ol style="list-style-type: none"> 1. Provide fundamental knowledge of CAD and CAE in product design and development. 2. Introduce wireframe, surface, solid, and assembly modeling concepts for engineering applications. 3. Develop skills in meshing techniques and applying finite element methods in heat transfer and fluid mechanics problems. 4. Enable students to analyze engineering problems using CAD-CAE tools. 5. Evaluate and validate CAE solutions by comparison with experimental results. 		

Course Outcomes:		
COs	After completion of the course: Student should be able to	Bloom's Level
CO1	Explain the fundamentals of product design, design process, sustainability, and the role of CAD-CAE tools	L1
CO2	Interpret wireframe and surface modeling techniques using parametric representations for engineering applications.	L2
CO3	Apply solid and assembly modeling methods (B-Rep, CSG, feature-based modeling, tolerance modeling) to develop part and assembly models.	L3
CO4	Analyze engineering problems using meshing techniques and finite element formulations for 1D and 2D heat transfer and fluid mechanics problems.	L4
CO5	Evaluate the accuracy and validation of CAE simulations using convergence tests, stress comparison, and experimental correlation.	L5

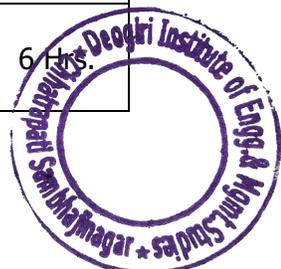


CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	2	1	1		1				1				2	1
CO 2	2	2	1		2								2	2
CO 3	3	2	3	1	2					1			3	2
CO 4	3	3	3	3	3								3	3
CO 5	3	2	2	3	3					1			3	3

Assessment	
CA-1 (a)	Subjective Test, Assignment, etc.
CA-2 (b)	Assignment, Project, Presentation, etc.
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	Design and CAD–CAE Importance of design, design process, embodiment design, parametric design, Industrial design, Human factors in design, sustainability in design, Design for X (DFX), Introduction to CAD and CAE, Applications of CAD and CAE, Hardware and Software in CAD and CAE.	6 Hrs.
Unit 2	Wireframe and Surface Modeling Wireframe modeling, Curves and surfaces: curve representation, parametric representation of analytic and synthetic curves; surface models and representations.	6 Hrs.
Unit 3	Solid Modeling Solid modeling: Boundary representation, CSG, sweep representations, Octree, primitive instancing, cell decomposition, spatial occupancy	6 Hrs.



	enumeration, feature recognition, design by features, tolerance modeling.	
Unit 4	Assembly Modeling Assembly modeling: Representation, mating conditions, representation schemes, generation of assembly sequences.	6 Hrs.
Unit 5	Meshing & 1D–2D FEA (CAE Applications) Mesh topology, data structures, mesh generation algorithms, element types, quality criteria, aspect ratio, node numbering. Applications in heat transfer & fluid mechanics: 1D heat transfer elements, 2D scalar variable problems, 2D heat transfer and fluid mechanics problems.	6 Hrs.
Unit 6	Accuracy & Validation of FEA (CAE) Validation and accuracy of FEA results, computational accuracy: strain energy norm, residuals, reaction forces and moments; convergence tests, stress difference. Correlation with experiments: strain gauging-stress comparison; natural frequency comparison; dynamic response comparison, temperature and pressure distribution.	6 Hrs

Sr.No.	Textbooks
1.	Ibrahim Zeid and R. Sivasubramanian, CAD/CAM: Theory and Practice, 2nd Edition, McGraw-Hill Education, 2009.
2.	Ibrahim Zeid, Mastering CAD/CAM, 1st Edition, McGraw-Hill Education, 2005.
3.	Gerald Farin, Curves and Surfaces for CAGD: A Practical Guide, 5th Edition, Elsevier, 2002 (Reprint 2013).
4.	Michael E. Mortenson, Geometric Modeling, 3rd Edition, Industrial Press, 2006.
	Reference Books
1.	David F. Rogers and J. Alan Adams, Mathematical Elements for Computer Graphics, 2nd Edition, McGraw-Hill Education, 1990.
2.	Singiresu S. Rao, The Finite Element Method in Engineering, 6th Edition, Butterworth–Heinemann, 2017.
3.	Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, 4th Edition, Prentice Hall of India (PHI), 2012.
4.	Bruce Irons and Soharab Ahmed, Techniques of Finite Elements, 1st Edition, John Wiley & Sons, 1980.
	Web Resources
1.	Computer-Aided Design and Manufacturing – NPTEL (IIT Delhi) https://nptel.ac.in/courses/112102101 NPTEL
2.	Computer-Aided Design and Manufacturing I – NPTEL (IIT Delhi) https://nptel.ac.in/courses/112102102 NPTEL
3.	Computer-Aided Engineering Design – NPTEL (IIT Kanpur) https://nptel.ac.in/courses/112104031



Course Title: Alternative Fuels for I.C. Engines		
Course Code: PM252108		Course Category: PEC III
Teaching Scheme	Examination Scheme	
Lectures: 03hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks
Course Prerequisite: Basic knowledge of thermodynamics, combustion, and internal combustion engine fundamentals.		
Course Description: This course introduces students to conventional fuels and the need for alternative fuels in internal combustion (IC) engines. It covers the structure and refining of petroleum, properties of fuels, and performance aspects of spark and compression ignition fuels. The course emphasizes various alternative fuels such as alcohols, LPG, CNG, hydrogen, biogas, producer gas, and biodiesel, including their properties, utilization methods, and required engine modifications. Students will gain insights into the comparative performance, emissions, and environmental implications of conventional and alternative fuels, enabling them to explore sustainable fuel technologies for the future.		
Course Objectives: By the end of this course, students will be able to: <ol style="list-style-type: none"> 1. Explain the structure, refining process, and key properties of petroleum-based fuels. 2. Interpret the characteristics and performance parameters of conventional and alternative fuels for IC engines. 3. Apply knowledge of alternative fuels to evaluate their suitability in single-fuel and dual-fuel engine operations. 4. Analyze the impact of fuel properties and engine modifications on combustion, performance, and emissions. 5. Assess the prospects of alternative fuels in terms of availability, sustainability, and environmental impact, particularly in the Indian context. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Define the fundamental concepts of traditional and alternative petroleum fuels, refining processes, and their key properties.	L1
CO2	Explain the characteristics, production methods, and suitability of different alternative fuels for IC engines.	L2
CO3	Use principles of fuel properties and engine modifications to solve problems related to performance and emissions of engines operating on alternative fuels.	L3



CO4	Examine the behavior of dual-fuel and single-fuel engines under varying fuel types, operating conditions, and combustion characteristics.	L4
CO5	Assess the comparative performance, emissions, and environmental impacts of conventional fuels and alternative fuels, recommending improvements and applications.	L5

CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	3						1					1	1	1
CO 2	3	1				1	2					1	1	1
CO 3	3	3	2				2						3	2
CO 4	3	3	2	2			2						3	2
CO 5	3	2	2			2	3					2	3	3

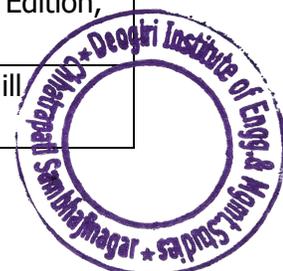
Assessment	
CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

Course Contents

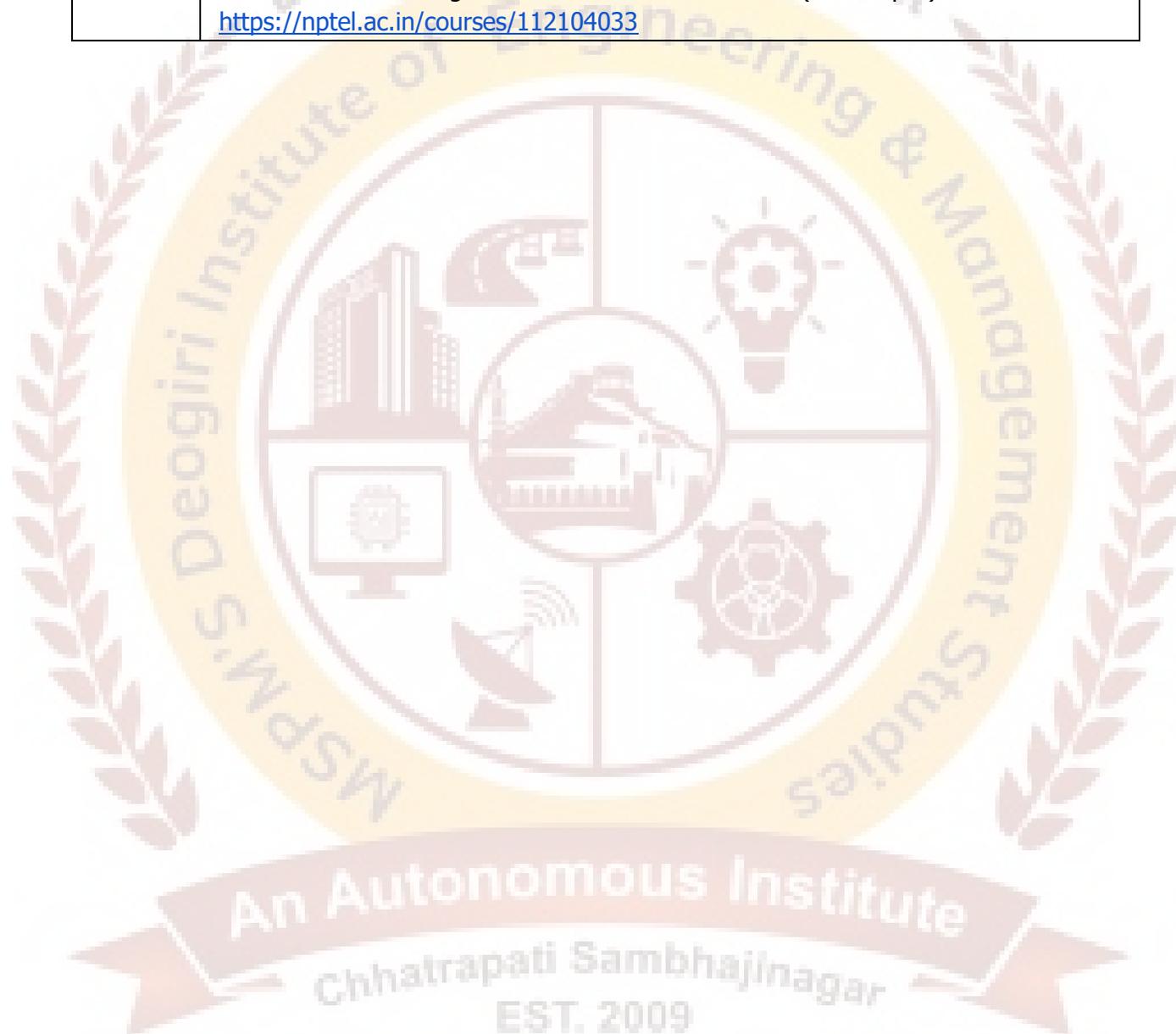


Unit 1	Fuels: Introduction, Structure of petroleum, Refining process, Products of refining process, Fuels for spark ignition, Knock rating of SI engine fuels, Octane number requirement, Diesel fuels, and Numericals.	6 Hrs
Unit 2	Properties of Petroleum Products Specific gravity, Density, Molecular weight, Vapour pressure, Viscosity, Flash point, Fire point, Cloud point, Pour point, Freezing point, Smoke point & Char value, Aniline point, Octane Number, Performance Number, Cetane Number, Emulsification, Oxidation Stability, Acid Value/Number, Distillation Range, and Sulphur content.	6 Hrs
Unit 3	Alternative Fuels for I.C. Engines: Need for alternative fuels such as Ethanol, Methanol, LPG, CNG, Hydrogen, Biogas, and Producer gas and their methods of manufacturing.	6 Hrs
Unit 4	Dual-fuel Engine Need and advantages, the working principle, Combustion in dual fuel engines, Factors affecting combustion in dual fuel engines, Use of alcohols, LPG, CNG, Hydrogen, Biogas, and Producer gas in CI engines in dual fuel mode. Engine modifications required. Performance and emission characteristics of alternative fuels (mentioned above) in the Dual Fuel mode of operation v/s Diesel operation.	6 Hrs
Unit 5	Single Fuel Engines: Properties of alternative fuels, use of alternative fuels in SI engines, Engine modifications required, Performance and emission characteristics of alternative fuels in SI mode of operation v/s gasoline operation. Availability: Suitability & Prospects of these gaseous fuels in the Indian context. Environmental pollution with conventional and alternative fuels, Pollution control methods and packages.	6 Hrs
Unit 6	Biodiesels What are biodiesels? Need for biodiesels, Properties of biodiesels V/s petrol diesel, Performance and emission characteristics of biodiesels v/s Petro diesel operation.	6 Hrs

Sr.No.	Textbooks
1.	R. P. Sharma, M. L. Mathur, A Course in Internal Combustion Engines, D. Rai & Sons.
2.	V. M. Domkundwar, Internal Combustion Engines, Dhanpat Rai & Co., 1st Edition, 1999.
3.	John B. Heywood, Internal Combustion Engines Fundamentals, McGraw-Hill International Edition.



Reference Books	
1.	O. P. Gupta, Elements of Fuels, Furnaces & Refractories, Khanna Publishers, 2000.
2.	Osamu Hirao, Richard Pefley, Present and Future Automotive Fuels, Wiley-Interscience Publication, New York, 1988.
Web Resources	
1.	IC Engines and Gas Turbines – NPTEL/SWAYAM (IIT Guwahati) https://onlinecourses.nptel.ac.in/noc20_me42/preview NPTEL Online Courses+1
2.	Introduction to IC Engines and Air Pollution – NPTEL (IIT Kanpur) https://nptel.ac.in/courses/112104033



Course Title: Process Control & Automation		
Course Code: PM252109		Course Category: PEC III
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: Third Year (Semester V)	ESE	60 Marks
<p>Course Prerequisite: Basic knowledge of Engineering Mathematics (Differential Equations, Laplace Transforms, Matrices), Fundamentals of Process Engineering / Chemical or Mechanical Engineering processes, Basics of Control Theory and Instrumentation.</p>		
<p>Course Description: This course introduces the principles and practices of process control and automation used in modern industries. It covers process modeling, feedback and feedforward control, frequency response analysis, simulation tools, advanced multivariable and plant-wide control strategies. Students will also learn about control system instrumentation, valves, P&ID preparation, and emerging topics such as fuzzy logic and OPC in industrial process control.</p>		
<p>Course Objectives:</p> <ol style="list-style-type: none"> 1. To provide fundamental knowledge of process modeling, instrumentation, and control system hierarchies. 2. To develop understanding of classical and advanced control strategies including PID, cascade, feedforward, and ratio control. 3. To train students in frequency response methods, digital control design, and state feedback control techniques. 4. To enable students to simulate, analyze, and interpret control systems using modern software tools and standards. 5. To introduce advanced concepts such as multi-loop control, decoupling, model predictive control, plant-wide control, fuzzy logic, and OPC for real-time process optimization. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Recall fundamentals of process control, models, controllers, simulations, and plant-wide strategies.	L1
CO2	Explain principles of PID, frequency response, simulations, interactions, and plant monitoring.	L2
CO3	Apply modeling, controller tuning, simulation tools, and multi-loop strategies.	L3
CO4	Analyze process data, control structures, loop interactions, and plant-wide systems.	L4
CO5	Evaluate control methods, simulation results, optimization, fuzzy logic & OPC.	L5



CO-PO Mapping

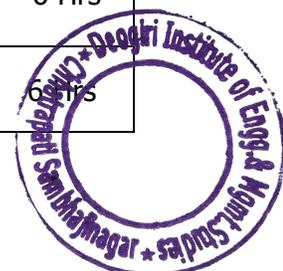
CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	3	2	1	1	1	-	-	-	-	1	-	1	2	1
CO 2	3	3	2	2	2	-	-	-	-	2	-	1	2	2
CO 3	3	3	3	3	3	-	-	-	2	2	-	2	3	3
CO 4	3	3	3	3	2	-	-	-	2	2	-	2	3	3
CO 5	3	3	3	3	3	-	-	-	2	3	-	3	3	3

Assessment

CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

Course Contents

Unit 1	Process Modeling Introduction to Process Control and Process Instrumentation, Hierarchies in process control systems, Theoretical models, Transfer function, State space models, Time series models, Development of empirical models from process data, Chemical reactor modeling, Analysis using softwares	6 Hrs
Unit 2	Feedback & Feedforward Control Feedback controllers, PID design, tuning, troubleshooting, Cascade control, Selective control loop, Ratio control	6 Hrs
Unit 3	Frequency Response	6 Hrs



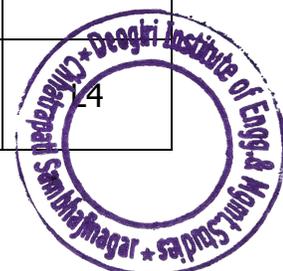
	Control system design based on Frequency response Analysis, Direct digital design, Feed forward and ratio control, State feedback control, LQR problem, Pole placement	
Unit 4	Software Simulations of Control Systems Simulation using softwares, Control system instrumentation, Control valves, Codes and standards, Preparation of P& I Diagrams	6 Hrs
Unit 5	Advanced Process Control Multi-loop and multivariable control, Process Interactions, Singular value analysis, Tuning of multi-loop PID control systems, Decoupling control, Strategies for reducing control loop interactions, Real-time optimization	6 Hrs
Unit 6	Plant Control Model predictive control, Batch Process control, Plant-wide control & monitoring, Plant-wide control design, Instrumentation for process monitoring, Statistical process control, Introduction to Fuzzy Logic in Process Control, Introduction to OPC, Introduction to environmental issues and sustainable development relating to process industries, Comparison of performance of different types of control with examples on softwares	6 Hrs

Sr.No.	Textbooks
1.	Seborg, D. E., T. F. Edgar, D. A. Mellichamp, Process Dynamics and Control, John Wiley, 2004.
2.	Johnson, D. Curtis, Instrumentation Technology (7th Edition), Prentice Hall India, 2002.
3.	Edgar, T. F., D. M. Himmelblau, Optimization of Chemical Processes, McGraw-Hill Book Co., 1988.
Reference Books	
1.	Bob Connel, Process Instrumentation Applications Manual, McGraw-Hill, 1996.
2.	Macari Emir Joe, Michael F. Saunders, Environmental Quality Innovative Technologies, [Publisher not specified].
Web Resources	
1.	Chemical Process Control – NPTEL/SWAYAM (IIT Bombay) https://onlinecourses.nptel.ac.in/noc21_ch38/preview NPTEL Online Courses
2.	Optimization in Chemical Engineering – NPTEL/SWAYAM (IIT Kharagpur) https://onlinecourses.nptel.ac.in/noc23_ch22/preview NPTEL Online Courses
3.	Advanced Process Dynamics – NPTEL/SWAYAM (IIT Kharagpur) https://onlinecourses.nptel.ac.in/noc22_ch60/preview



Course Title: Product Design and Development		
Course Code: PM252110		Course Category: PEC IV
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 0	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 Marks
Course Prerequisite: Basic knowledge of mechanical engineering design, manufacturing processes, and engineering graphics.		
Course Description: This course introduces the principles, methods, and tools involved in modern product design and development. It covers the complete product development process, including product planning, concept generation, selection, functional analysis, industrial design, ergonomics, design for X (DFM, DFA, DFE), value engineering, rapid prototyping, and product economics. The syllabus emphasizes practical applications in mechanical engineering, enabling students to design products that are manufacturable, cost-effective, user-friendly, and innovative. Students will gain the ability to apply systematic design methodologies, use modern design tools, and evaluate product performance.		
Course Objectives: By the end of this course, students will be able to: <ol style="list-style-type: none"> 1. Understand the principles and stages of product design and development. 2. Explain techniques for concept generation, selection, and functional analysis. 3. Apply design for X (DFM, DFA, DFE), value engineering, and ergonomics in product design. 4. Analyze product architecture, industrial design, and human factors for optimized performance. 5. Evaluate prototypes, product economics, and project trade-offs for real-world applications. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Identify fundamental principles, stages, and definitions in product design and development.	L1
CO2	Describe concepts of product planning, functional analysis, industrial design, ergonomics, and value engineering.	L2
CO3	Demonstrate application of DFM, DFA, DFE, rapid prototyping, and design tools to solve practical product design problems.	L3
CO4	Examine product architecture, concept alternatives, and human factors to optimize design performance.	L4



CO5	Assess prototypes, economic feasibility, and design trade-offs to propose improved product solutions.	L5
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CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	2		1								1		1	1
CO 2	2	1	2			1					2		1	2
CO 3	3	2	3		3		2						3	3
CO 4	2	3	3	2	2	2							3	3
CO 5	2	2	3	2			1				3		3	3

Assessment

CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

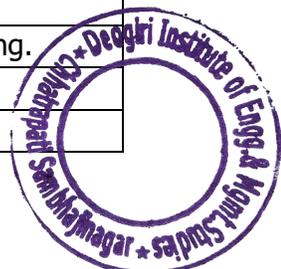
Course Contents

Unit 1	Introduction to Product Design and Development Introduction to course, Characteristics of successful products, Product life cycle, Product policy of an organization, Selection of a profitable product, Product mix, Modern product development process, Innovative thinking, Morphology of design	6 Hrs
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Unit 2	Product Planning and Customer Needs Product planning process, Identifying opportunities, Evaluating and prioritizing projects, Resource allocation, Pre-project planning, Identifying customer needs, Gathering and interpreting raw data, Organizing customer needs, Establishing relative importance of needs	6 Hrs
Unit 3	Concept Generation, Selection, and Testing Concept generation, Brainstorming, Lateral thinking, TRIZ, Ideality and IFR, Problem formulation, Functional analysis, FAST technique, Primary, secondary, tertiary functions, Case studies, Concept selection, Concept screening, Concept scoring, Pugh matrix, Concept testing, Surveys, DFMEA, PFMEA	6 Hrs
Unit 4	Product Architecture, Industrial Design, and Ergonomics Product architecture, Variety and supply chain considerations, Platform planning, Industrial design, Need for industrial design, Industrial design process, Impact of industrial design, Assessing quality of industrial design, Ergonomics, Gross human anatomy, Anthropometry, Man-machine interaction, Comfort criteria, Psychological and physiological considerations, Concepts of size, texture, and color	6 Hrs
Unit 5	Design for X (DFX), Value Engineering, and Design Tools Design for Manufacturing (DFM), Design for Assembly (DFA), Design for Environment (DFE), Design for Service and Quality, Value engineering, Definition, Advantages, Applications, Economic analysis (qualitative and quantitative), Product costing, Product design tools, QFD, CAD, CAM interface, Robust design, Ergonomics in design, Creativity techniques	6 Hrs
Unit 6	Prototyping, Rapid Manufacturing, and Product Economics Prototyping, Basics of prototyping, Principles of prototyping, Technologies, SLA, LOM, SLS, Planning for prototypes, Rapid prototyping, Additive manufacturing, Concurrent engineering, Product development economics, Economic analysis, Base case financial model, Sensitivity analysis, Project trade-offs, Influence of qualitative factors	6 Hrs

Sr.No.	Textbooks
1.	Karl T. Ulrich, Steven D. Eppinger, Product Design and Development, McGraw-Hill Education.
2.	A. K. Chitale, R. C. Gupta, Product Design and Manufacturing, PHI Learning.
3.	R. C. Jindal, Design and Manufacturing of Products, Tata McGraw-Hill.
4.	Paul Trott, Innovation and Product Development, Pearson

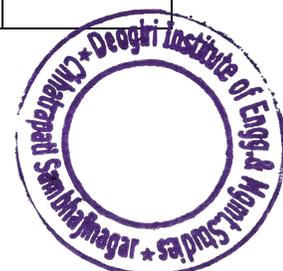


Reference Books	
1.	W. Green, P. W. Jordan (Eds.), Human Factors in Product Design: Current Practice and Future Trends, CRC Press.
2.	N. F. Roozenburg, J. Eekels, Product Design: Fundamentals and Methods (Vol. 2), John Wiley & Sons Inc.
3.	M. S. Sanders, E. J. McCormick, Human Factors in Engineering and Design, McGraw-Hill Book Company.
Web Resources	
1.	Product Design and Manufacturing, NPTEL/SWAYAM, IIT Kanpur https://onlinecourses.nptel.ac.in/noc21_me66/preview
2.	Product Design and Innovation, NPTEL/SWAYAM, IIT Guwahati https://onlinecourses.nptel.ac.in/noc21_de01/preview
3.	Product Design and Development, NPTEL/SWAYAM, IIT Roorkee https://onlinecourses.nptel.ac.in/noc21_me83/preview



Course Title: Computational Fluid Dynamics		Course Category: PEC IV	
Course Code: PM252111			
Teaching Scheme		Examination Scheme	
Lectures: 03 hrs/ week	CA-1	10 Marks	
Tutorial: -----	CA-2	10 Marks	
Credits: 03	MSE	20 Marks	
Semester: First Year (Semester II)	ESE	60 Marks	
Course Prerequisite: Basic knowledge of thermodynamics, heat transfer, fluid mechanics, and engineering calculus.			
Course Description: This course introduces the fundamentals of Computational Fluid Dynamics (CFD) with emphasis on its governing equations, discretization techniques, and numerical solution methods. Students will learn finite difference and finite volume approaches, pressure–velocity coupling algorithms, and basic turbulence modeling. The course blends theoretical foundations with case studies and software demonstrations to highlight CFD’s role in solving real-world engineering problems in fluid flow and heat transfer. By the end, learners will understand both the limitations and practical applications of CFD in mechanical engineering.			
Course Objectives: By the end of this course, students will be able to: <ol style="list-style-type: none"> 1. Explain the fundamental principles and governing equations of fluid flow and heat transfer. 2. Illustrate discretization methods and numerical techniques used in CFD. 3. Apply finite difference and finite volume methods to simple conduction and convection problems. 4. Analyze pressure–velocity coupling and turbulence modeling approaches in CFD solution algorithms. 5. Evaluate CFD applications and case studies to assess accuracy, validation, and practical significance in engineering design. 			

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom’s Level
CO1	Recall fundamental CFD principles, governing equations, discretization concepts, solution algorithms, turbulence modeling, and applications.	L1
CO2	Explain the concepts, characteristics, and methodologies used in CFD for modeling fluid flow and heat transfer.	L2
CO3	Implement CFD principles and numerical methods to solve fluid flow and heat transfer problems using both theoretical and software approaches.	L3
CO4	Analyze CFD solutions and numerical methods to understand system behavior and assess performance under different conditions.	L4
CO5	Evaluate CFD models, solution algorithms, and applications to propose improvements and ensure reliable engineering predictions.	L5



CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	3	1	1	1	1							1	1	1
CO 2	3	2	1	2	2							1	2	1
CO 3	3	3	2	3	3							1	3	2
CO 4	3	3	2	3	3							1	3	2
CO 5	3	3	3	3	3							1	3	3

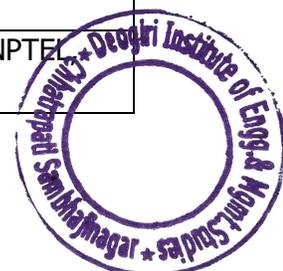
Assessment	
CA-1 (a)	Subjective Test / Open-book test / etc
CA-2 (b)	Model Making / Assignment / Presentation / etc
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	Introduction to CFD and Governing Equations Definition, scope, and applications of CFD in engineering. Advantages and limitations vs. experimental and theoretical methods. Governing equations of fluid flow: Continuity, momentum, and energy. Classification of PDEs (elliptic, parabolic, hyperbolic) and physical relevance. Initial and boundary conditions.	5 Hrs
Unit 2	Fundamentals of Discretization and Numerical Errors Discretization of governing equations, structured vs. unstructured grids, basics of grid generation. Overview of FDM, FVM, and FEM. Numerical errors: Truncation and round-off. Concepts of consistency, stability, and convergence.	6 Hrs



Unit 3	Finite Difference Method (FDM) Basics of FDM. Discretization of first- and second-order derivatives. Explicit and implicit time integration: Forward Euler, Backward Euler. CFL condition and stability. Simple applications: 1D steady/unsteady heat conduction.	5 Hrs
Unit 4	Finite Volume Method (FVM) Concept of control volume approach. Discretization of diffusion (central differencing) and convection terms (upwind, QUICK). Applications in conduction and convection. Comparison of FDM and FVM.	6 Hrs
Unit 5	CFD Solution Algorithms and Turbulence Modeling Pressure-velocity coupling: SIMPLE and PISO algorithms. Time integration for transient flows. Basics of turbulence: RANS equations, closure problem. Turbulence modeling (overview only): $k-\epsilon$, $k-\omega$, Spalart-Allmaras, Reynolds Stress Model (RSM). Introduction to Large Eddy Simulation (LES) and Direct Numerical Simulation (DNS).	7 Hrs
Unit 6	Applications, Case Studies, and Modern Trends Case studies: Flow over airfoils, pipe flows, natural convection. Verification and validation: Grid independence and comparison with analytical/experimental results. Introduction to CFD software (ANSYS Fluent, OpenFOAM). Trends: GPU computing and machine learning in CFD.	7 Hrs

Sr.No.	Textbooks
1.	H.K. Versteeg & W. Malalasekera, An Introduction to Computational Fluid Dynamics – The Finite Volume Method, Pearson
2.	S.V. Patankar, Numerical Heat Transfer and Fluid Flow, ANE Books
3.	J.D. Anderson, Computational Fluid Dynamics – The Basics with Applications, McGraw-Hill
Reference Books	
1.	Atul Sharma, Introduction to Computational Fluid Dynamics – Development, Application and Analysis, Ane Books
2.	Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics: A Practical Approach, Elsevier
3.	A.W. Date, Introduction to Computational Fluid Dynamics, Cambridge University Press
4.	Ferziger & Peric, Computational Methods for Fluid Dynamics, Springer
Web Resources	
1.	Computational Fluid Dynamics, IIT Kharagpur, NPTEL, https://nptel.ac.in/courses/112105254
2.	Computational Fluid Dynamics using Finite Volume Method, IIT Madras, NPTEL, https://nptel.ac.in/courses/112106294
3.	Computational Fluid Dynamics For Incompressible Flows, IIT Guwahati, NPTEL, https://nptel.ac.in/courses/112103289



Course Title: Advanced Machine Tool Design		
Course Code: PM252112		Course Category: PEC IV
Teaching Scheme	Examination Scheme	
Lectures: 03 hrs./ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 03	MSE	20 Marks
Semester: First Year (Semester II)	ESE	60 arks
Course Prerequisite: Fundamentals of Machine Design, Basics of Manufacturing Engineering and Processes, Kinematics and Dynamics of Machinery.		
Course Description: This course focuses on the design and development of advanced machine tools with emphasis on manufacturing engineering applications. Topics include structural design, kinematic systems, spindle and drive design, vibration control, and accuracy requirements. Modern design principles such as CNC systems, mechatronics, and sustainable design are included to align with current manufacturing industry practices. The course integrates theoretical design analysis with practical manufacturing considerations, preparing students for advanced research and industrial applications in machine tool development.		
Course Objectives: By the end of this course, students will be able to:		
<ol style="list-style-type: none"> 1. Provide a deep understanding of the functional and manufacturing requirements of machine tools. 2. Develop knowledge of structural, kinematic, and dynamic considerations in advanced machine tool design. 3. Train students to design critical machine tool components such as spindles, bearings, drives, and guideways. 4. Enable analysis of machine tool performance with respect to vibration, stiffness, and accuracy. 5. Familiarize students with modern control, CNC integration, and sustainable practices in machine tool design. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Describe the manufacturing requirements, functional aspects, and design criteria of modern machine tools.	L1
CO2	Explain the structural, kinematic, and dynamic considerations that influence machine tool design and performance.	L2
CO3	Apply design principles to develop spindles, bearings, guideways, and drive mechanisms for machine tools.	L3
CO4	Analyze vibration, stiffness, accuracy, and thermal stability of machine tool structures using analytical approaches.	L4
CO5	Evaluate machine tool performance in terms of productivity, reliability, and sustainability, incorporating CNC and mechatronic principles.	

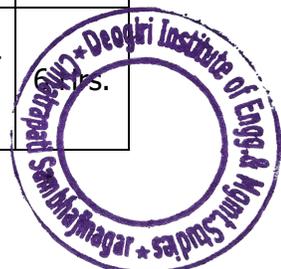


CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	2	1										1	1	1
CO 2	3	2	1		1							1	2	1
CO 3	3	2	2	1	2				2			1	3	3
CO 4	3	2	2	3	2							1	3	2
CO 5	3	2	2	3	3							1	3	3

Assessment	
CA-1 (a)	Subjective Test, Assignment, etc.
CA-2 (b)	Assignment, Test, Project, Open-book Test, etc.
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	Introduction to Advanced Machine Tool Design Functional and manufacturing requirements of machine tools, Classification of machine tools, Performance criteria, Accuracy and productivity considerations, General requirements of machine tool design, Layout of machine tools	6 Hrs.
Unit 2	Structural Design of Machine Tools Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structures, Static and dynamic stiffness, Design of beds and columns, Design of housing models, Techniques in design of machine tool structures, Thermal and static stability considerations, Design for manufacturing aspects	6 Hrs.
Unit 3	Guideways and Power Screws Function and types of guideways, Design of slide-ways, Protective devices for slide-ways, Design of power screws, Antifriction recirculating ball-type lead screws, Linear motion systems, Sliding bearings, Antifriction bearings	6 Hrs.



Unit 4	Spindles and Spindle Supports Materials for spindles, Design of spindles, Design of spindle supports, Sliding bearings, Antifriction bearings, Design considerations for high-speed spindles	6 Hrs
Unit 5	Kinematics, Drives, and Speed/Feed Regulation Kinematic systems in machine tools, Working and auxiliary motions, Machine tool drives: hydraulic, mechanical, electrical, Gearboxes and their design, Stepped regulation of speed, Design of speed boxes, Design of feed boxes,	6 Hrs.
Unit 6	Dynamics, Vibration, and Modern Trends Dynamic behavior of machine tools, Sources of vibration and chatter, Methods of vibration suppression, Dynamic testing, Stability analysis, Cutting process dynamics, Closed-loop systems, CNC systems, Mechatronics integration, Adaptive control, Sustainable machine tool design	6 Hrs.

Sr.No.	Textbooks
1.	N.K. Mehta, Machine Tool Design and Numerical Control, 3rd Edition, Tata McGraw-Hill Education, 2012.
2.	G.C. Sen and A. Bhattacharya, Principles of Machine Tools, 2nd Edition, New Central Book Agency, 2010.
3.	S.K. Basu, D.K. Pal, and S. Som, Design of Machine Tools, Revised Edition, Oxford & IBH Publishing, 2008.
	Reference Books
1.	S. Koenigsberger and J.F. Tlustý, Machine Tool Structures: Stability and Accuracy, Pergamon Press, 1970.
2.	H. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1984.
3.	Yorston & Stublely (CMTI Bangalore), Machine Tool Design Handbook, Latest Reprint, McGraw-Hill Education, 2015
4.	N.K. Mehta, Handbook of Machine Tool Design, Tata McGraw-Hill, 2015.
	Web Resources
1.	Advanced Machining Processes, NPTEL/SWAYAM, IIT Guwahati, 2024 https://onlinecourses.nptel.ac.in/noc24_me154/preview
2.	Advanced Machining Processes (graduate level), NPTEL/SWAYAM, IIT Kanpur, 2024 https://onlinecourses.nptel.ac.in/noc24_me72/preview
3.	Metal Cutting and Machine Tools, NPTEL/SWAYAM, IIT Kharagpur, 2021 https://onlinecourses.nptel.ac.in/noc21_me04/preview

Chhatrapati Sambhajinagar
EST. 2009



Course Title: Research Methodology		Course Category: EL	
Course Code: PG252601			
Teaching Scheme		Examination Scheme	
Lectures: 03 hrs/ week		CA-1	10 Marks
Tutorial: -----		CA-2	10 Marks
Credits: 03		MSE	20 Marks
Semester: First Year (Semester II)		ESE	60 Marks
Course Prerequisite: Basic knowledge of engineering fundamentals, Familiarity with undergraduate-level mathematics and statistics, Ability to use computers and standard engineering software tools			
Course Description: This course introduces postgraduate engineering students to the principles, processes, and practices of research methodology. It emphasizes problem identification, literature review, research design, data collection, analysis, and interpretation. The course also covers ethical practices, mathematical modeling, computational tools, and scientific communication through thesis, research papers, and presentations. It aims to equip students with essential skills to undertake independent research projects and contribute effectively to the advancement of science and technology.			
Course Objectives:			
<ol style="list-style-type: none"> 1. To provide a clear understanding of the fundamentals and process of research in engineering. 2. To develop the ability to identify research problems through literature review and formulate hypotheses. 3. To impart knowledge of research ethics, integrity, and professional responsibility. 4. To familiarize students with research design, data collection, analysis, and interpretation techniques. 5. To introduce mathematical modelling and computational tools relevant to engineering research. 6. To develop effective academic writing and presentation skills for disseminating research outcomes. 			

Course Outcomes:		
Cos	After completion of the course: Student should be able to	Bloom's Level
CO1	Recall the meaning, objectives, and types of research, along with problem identification and hypothesis formulation.	L1
CO2	Demonstrate understanding of ethical issues, research integrity, plagiarism, and intellectual property rights.	L2
CO3	Design appropriate research methodologies, select data collection methods, and apply suitable statistical techniques for analysis.	L3
CO4	Develop and validate mathematical and computational models for engineering applications using appropriate tools/software.	L4
CO5	Write and present research outputs in the form of proposals, reports, papers, and presentations adhering to academic standards.	L5

CO PO Mapping														
Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	2	1	2	1	1			1	1		2		
CO 2	2	2	2	2	2	3			3	2		2		
CO 3	3	3	3	3	3	2				2		2		
CO 4	3	3	3	1	3	1			2	2		2	3	
CO 5	2	2	2	2	2	2			3	2		2		



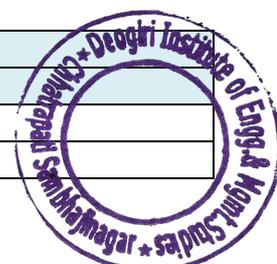
Assessment	
CA-1 (a)	Subjective Test / Open book test / Assignment.
CA-2 (b)	Assignment / Presentation/ Case Study
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	Introduction to Research: meaning, objectives, motivation, types, Research process, Criteria of good research, Importance of literature review in defining a problem, Literature review: primary and secondary sources, Critical literature review, Identifying gap areas from literature and research database, Research problem: selection, necessity and formulation, Technique Involved in Defining a Problem, Hypothesis formation, Problems Encountered by Researchers in India,	6 Hrs
Unit 2	Research Ethics: Ethical considerations in research, Plagiarism, Intellectual Property, Research Integrity, and misconduct, Ethical issues in data collection, experimentation, and analysis, Ethical considerations in publication and peer review, Case studies of ethical dilemmas in engineering research, Conflict of interest, Ethics in Emerging Technologies like AI	6Hrs
Unit 3	Research Design, Experimentation, and Analysis And Data Analysis and Interpretation: Experimental and non-experimental research designs, Sampling techniques, and sample size determination, Data collection methods: Surveys, interviews, and observation, Instrumentation and measurement techniques, Reliability and validity in research, Design of experiments and analysis of results, Data processing and cleaning, Statistical analysis: Descriptive and inferential statistics, Advanced data analysis techniques: Regression, ANOVA, and multivariate analysis, Interpretation of results. Reporting and presenting data	6 Hrs
Unit 4	Mathematical Modeling in Engineering Research, Use of Computer Technology and Software: Introduction to mathematical modeling, Types of models: Deterministic and probabilistic, Model development and validation, Applications of mathematical modeling in mechanical or automotive engineering, Modeling with Ordinary Differential Equations (ODEs), Difference Equations in modeling, Partial Differential Equations (PDEs) in modeling, Case studies and examples, Introduction to computational tools: MATLAB, SPSS, R, Simulation and modeling software: ANSYS, Solid Works, and other CAD tools, Data analysis software: Usage and applications, Big data and machine learning in engineering research	6 Hrs
Unit 5	Writing and Presenting Research: Writing a thesis and project report: Structure and content, Writing progress reports and project updates, Structuring a research paper, Writing research proposals and grants, Writing for journals and conferences, Incorporating references and citations: APA, MLA, IEEE styles, Managing references with citation management software (e.g., End Note, Zotero), Preparing and delivering oral presentations, Creating effective visual aids (charts, graphs, tables), Poster presentations: Design and delivery, The publication process and peer review, Communicating research to non-specialists and stakeholders	6Hrs
Unit 6	Case Studies and Applications: Case studies of successful engineering research, Application of research methodologies to real-life projects, Problem-solving through interdisciplinary approaches, Integration of ethical, technical, and methodological aspects, Emerging trends in engineering research.	6 Hrs

Text/Reference Books

Text Books

1	C. R. Kothari, Research Methodology, New Age Publishers.
2	Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners



3	Herman Tang, Engineering Research: Design, Methods, and Analysis
4	Douglas C. Montgomery, Design and Analysis of Experiments
5	C. Neal Stewart Jr., Research Ethics for Scientists: A Companion for Students

Reference Books

1	Cooper, D.R. & Schindler, P.S. – Business Research Methods, McGraw Hill.
2	Montgomery, D.C. – Design and Analysis of Experiments, Wiley.
3	Krishnaswamy, K.N., Sivakumar, A.I., Mathirajan, M. – Management Research Methodology, Pearson.
4	Deborah Rumsey – Statistics for Dummies, Wiley.

Web Resources

1	MIT OpenCourseWare: Research Methods (https://ocw.mit.edu)
2	NCBI – PubMed Central (https://www.ncbi.nlm.nih.gov/pmc/)
3	https://researcheracademy.elsevier.com/
4	https://link.springer.com/



Course Title: Interdisciplinary Perspective on Indian Science and Technology
Course Code: PG252501 **Course Category: IKS**

Teaching Scheme	Examination Scheme	
Lectures: 02 hrs/ week	CA-1	10 Marks
Tutorial: -----	CA-2	10 Marks
Credits: 02	MSE	20 Marks
Semester: Semester II	ESE	60 Marks

Course Prerequisite: None

Course Description:

The course Interdisciplinary Perspective on Indian Science and Technology introduces students to India's rich contributions in mathematics, astronomy, architecture, metallurgy, textiles, and agriculture. It emphasizes the scientific principles embedded in traditional practices, tracing their historical development and global impact. Students will explore how ancient Indian innovations such as the number system, astronomical instruments, town planning, metallurgy, and sustainable farming shaped modern science and engineering. The course bridges theoretical understanding with practical relevance, enabling appreciation of indigenous knowledge systems and their applications in contemporary contexts.

Course Objectives:

1. To understand the foundational concepts and necessity of the Indian Knowledge System.
2. To identify key historical contributions of Indian scholars in mathematics, astronomy, architecture, metallurgy, textiles, and agriculture.
3. To interpret the scientific principles and techniques underlying traditional Indian practices.
4. To analyze the relevance of IKS in modern scientific and technological contexts.
5. To appreciate the global influence and sustainability of Indian innovations throughout history.

Course Outcomes:

COs	After completion of the course, students should be able to	Bloom's Level
CO1	Recall key concepts, terminologies, historical developments, and contributions in Indian Mathematics, Astronomy, Architecture, Metallurgy, Textiles, and Agriculture.	L1 (Remember)
CO2	Explain the principles, methods, and scientific basis of Indian Knowledge Systems in various domains such as mathematics, astronomy, architecture, metallurgy, textiles, and agriculture.	L2 (Understand)
CO3	Use traditional Indian scientific and technological methods to address contemporary or theoretical problems in relevant fields.	L3 (Apply)
CO4	Examine the relevance, strengths, and limitations of Indian Knowledge Systems in addressing contemporary scientific, environmental, technological, and societal challenges.	L4 (Analyze)



CO-PO Mapping

CO-PO Mapping														
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	1					1						1		
CO 2	2					1						1	1	
CO 3	2	2											1	1
CO 4		1				3	3					2	2	2

Assessment	
CA-1 (a)	Subjective Test / Open-book test / etc.
CA-2 (b)	Model Making / Assignment / Presentation / etc.
MSE (c)	Mid Sem Examination

Course Contents		
Unit 1	<p>Indian Mathematics</p> <p>Necessity of Indian Knowledge System, Defining Indian Knowledge System, Contributions of Indian Mathematicians, Historical Evidence and features of Indian Numerical Number System, The Idea of Zero and Infinity, Decimal System, Representation of Large Numbers, Global Spread and Adoption of Indian Numericals, Arithmetic (Square of a Number, Square Root, Series and Propagation), Geometry (Simple Constructions from Sulba-Sutras, e.g, Right Angle Triangle, The Value of Pi), Trigonometry and Algebra in IKS, Modern Indian Contributions to Mathematics</p>	4 Hrs
Unit 2	<p>Indian Astronomy</p> <p>Historical Development of Indian Astronomy, Astronomy for Timekeeping, Solar and Lunar Motions, The Celestial Coordinate System, Various Regional Indian Calendar Systems, Planetary Model of Aryabhata and Nilakantha, Astronomical Instruments, Various Royal Endeavors for Astronomy (e.g., Jaisingh's Jantar Mantar), Modern Indian Contributions to Astronomy</p>	4 Hrs



Unit 3	Indian Architecture and Town Planning Sthapatya-Veda and Vastu-Shastra, Historical Features of Indian Town Planning, Water Management and Drainage Systems, Town Town Planning of Harappan Cities, Temple Architecture, Features and Examples of Cave, Rock Cut, Nagara, Dravida, Kalinga, Vesara, Deccan, Rajput, Mughal, Indo-Saracenic Architecture Styles, Modern Indian Contributions to Architecture and Town Planning	4 Hrs
Unit 4	Indian Metallurgy Ancient Mining and Ore Extraction Technologies, Mining and Manufacture of Zinc, Copper and its Alloys, Silver, Gold, Mercury and Lead, Iron Extraction from Biotite, Steel Manufacturing, Global Influence of Wootz Steel, Wax Casting, Modern Indian Contributions to Metallurgy	4 Hrs
Unit 5	Indian Textile Textile Traditions in Ancient India, The Variety and Diversity of Indian Textiles, Types of Fabrics and Materials, Cotton and Silk, Weaving Techniques and Looms, Dyeing Process and Natural Colors, Major Textile Centers, Significance of Indian Textile in Historical Global Trade, Fall of Indian Textile in Colonial Era, Modern Indian Contributions to Textile	4 Hrs
Unit 6	Indian Agriculture Importance of Agriculture in Ancient India, Traditional Crops (Grains, Fruits, Vegetables Spices), Significance of Indian Agricultural Products in Historical Global Trade, Significance of Agriculture and Irrigation for the Indian Kings, The Ery System of South India, Traditional Farming Techniques (Land Preparation, Sowing Techniques, Weeding and Pest Management, Harvesting and Storage), Irrigation Techniques and Rainwater Harvesting, Modern Indian Contributions to Agriculture	4 Hrs

Sr.No.	Textbooks
1.	D. M. Bose, S. N. Sen and B. V. Subbarayappa, Eds., A Concise History of Science in India, 2nd Ed., Universities Press, Hyderabad, 2010.
2.	B. Mahadevan, Nagendra Pavana, Vinayak Rajat Bhat, Introduction to Indian Knowledge System: Concepts and Applications, PHI Learning, 2022
3.	Kapil Kapoor, Awadhesh Kumar Singh, Indian Knowledge Systems, D.K. Print World Ltd; First Edition (15 October 2005)
4.	Bhag Chand Chauhan, IKS: The Knowledge system of Bharata, Garuda Prakashan (13 March 2023)
5.	Science in India: A Historical Perspective by B V Subbarayappa, Rupa & Co (2013)
Reference Books	
1.	G. G. Joseph, Indian Mathematics Engaging the World from Ancient to Modern Times, World Scientific, London, 2016
2.	History of Astronomy: A Handbook, Edited by K. Ramasubramanian, Aniket Sule, andbMayank Vahia, SandHI, IIT Bombay, and T.I.F.R. Mumbai, 2016.

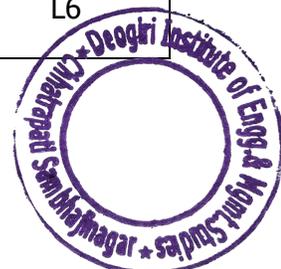


3.	History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ramkrishna Mission Institute of Culture, Kolkata (2014).
4.	Christopher Tadgell, History of Architecture in India, Architecture Design and Technology Press (1990)
5.	Bindia Thapar, Introduction to Indian Architecture, Periplus Asian Architecture Series
Web Resources	
1.	Indian Knowledge System Division, Ministry of Education, Government of India, https://iksindia.org/lectures-and-videos.php



Course Title: Mini Project		
Course Code: PM252602		Course Category: EL
Teaching Scheme	Examination Scheme (As Applicable)	
Practicals/Sessions: 02 Hours/Week	CA-I	15 Marks
	CA-II	15 Marks
Semester: First Year (Semester-II)	ESE	20 Marks
Course Prerequisite:		
<ul style="list-style-type: none"> Basic understanding of core subjects in specialization, Ability to access, and interpret scientific literature. Exposure to technical report writing and presentation. 		
Course Description:		
<p>The Mini Project course provides students with an opportunity to apply theoretical knowledge gained during coursework to a small-scale practical problem in Mechanical Engineering. It enables students to experience the process of identifying a problem, reviewing literature, formulating objectives, and developing solutions using experimental, analytical, or simulation-based approaches. The course emphasizes independent learning, teamwork, critical thinking, innovation, and technical communication.</p>		
Course Objectives:		
<ol style="list-style-type: none"> Develop the ability to identify, analyze, and solve engineering problems using modern tools and techniques. Encourage creativity, innovation, and research aptitude in addressing mechanical engineering challenges. Provide hands-on exposure to design, modeling, analysis, and/or experimental work on a defined problem. Strengthen teamwork, project management, and professional ethics in executing engineering tasks. Enhance technical writing and oral presentation skills through project documentation and seminars. 		

Course Outcomes:		
COs	After completion of the course: Students should be able to	Bloom's Level
CO1	Identify and define a relevant problem in the domain of Mechanical Engineering.	L4
CO2	Conduct literature survey and establish research/technical objectives.	L5
CO3	Apply appropriate engineering methods, tools, and techniques to develop and implement solutions.	L6
CO4	Work independently or in a team, demonstrating project management, ethical practices, and leadership.	L3
CO5	Demonstrate the ability to answer questions, engage in discussions, and defend ideas confidently.	L6



CO-PO Mapping

CO-PO Mapping														
COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO2
CO 1	3	3	1	2		1						1	3	1
CO 2	2	3	1	3	2							2	2	2
CO 3	3	2	3	2	3		1				1		3	3
CO 4						2		3	3	2	3	1		
CO 5									2	3		2		

Course Contents

The mini project is designed to help students identify, analyze, and solve real-world problems in Mechanical Engineering and management. This project also aims to improve their overall skills and capabilities. Each student should choose a topic they are interested in. The project's content must be relevant to emerging areas within the field, address current issues with a research focus, or be based on industrial visits. Students can also select a practical problem from the field of Mechanical Engineering to work on. By the end of the semester, each student must submit a final report to the Head of the Department. The report must be authenticated by their guide.

Assessment

The mini project is worth a total of 50 marks, with 30 marks for the internal assessment and 20 marks for the semester-end examination. The semester-end examination will be conducted by a committee of three faculty members. Students must bring their completed reports, which should be duly authenticated by their guide and the Head of the Department. Each student will individually present their work to the committee, who will then evaluate them and award marks accordingly.

CA-I (a)	Review-I: 15 Marks (Concept/knowledge in the topic = 10 marks, Literature-05 marks)
CA-II (b)	Review-II: 15 Marks (Report writing & Presentation =15 Marks)
Practical/ viva voce (c)	20 Marks (Individual evaluation through viva voce / test (20 marks)
Total (d)	50 Marks

