SAMARTH EDUCATIONAL TRUST
SAWKAR INSTITUTES
SATARA

AGCE

SYLLABUS FIRST YEAR

Master of Technology

Syllabus and Course Structure of First Year M.Tech(Heat Power) Programme at Arvind Gavali College of Engineering, Satara - Designed to nurture foundational knowledge, practical skills, and holistic development for future engineers

ARVIND GAVALI COLLEGE OF ENGINEERING, SATARA.

+91-9957100100
http.//www..agce.edu.in
Panmalewadi, Varye, Satara

DEPARTMENT OF MECHANICAL ENGINEERING (HEAT POWER)

ABOUT THE DEPARTMENT

Mechanical engineering is the Core Department of the Arvind Gavali College of Engineering. The department has all UGC approved faculty members. The department has well-equipped laboratories.

With the growing demand for Mechanical Engineers in the Government and private sectors, the Department is making the best efforts to produce highly trained and capable engineers who can take up the challenges of the real world. Heat Power Engineering plays a crucial role in various industries, including power generation, automotive, aerospace, and renewable energy, making it a vital field for technological advancement and sustainable development. The quality of academic instructions, guidelines, and college activities are designed to produce competent and successful engineers. In the Department, the focus is on preparing professional engineers.

As far as the Department is concerned, academic standards and practical work are the two key parameters. To execute this parameter the department has taken the Initiatives to provide industrial work exposure by sending the students for training to make them fit for future professional challenges. For the extra curriculum activities, the Departmental Association (MESA) has been established by the students. This association conducts various technical and cultural events regularly.

“Nothing is impossible for Mechanical Engineers with Skill Oriented Knowledge.”

DEPARTMENT VISION

To develop professional technocrats and socially responsible engineers in the field of Mechanical engineering.

DEPARTMENT MISSION

M1	To provide quality education to enhance academic competency keeping pace with the industrial needs.
M2	To develop attitude and the professional skills for employability and research.
M3	To imbibe ethical values in graduates for the progressive social development.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)	
PEO 1	The graduates will be able to apply concepts from the fundamental engineering for solving problems in industry.
PEO 2	The graduates will be able to demonstrate the understanding of Mechanical engineering and allied areas to address complex real-life problems.
PEO 3	The graduates will be able to take responsibility to serve the society and to preserve the environment through ethical values.

PROGRAM OUTCOMES (PO)	
PO 1	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization to develop to the solution of complex engineering problems.
PO 2	**Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development.
PO 3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO 4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)
PO 5	**Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO 6	**The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO 7	**Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO 8	**Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO 9	**Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO 10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO 11	**Life-Long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAM SPECIFIC OUTCOMES (PSO)	
PSO 1	Students will be able to acquire competencies in the usage of design, thermal, and manufacturing principals to develop product and process.
PSO 2	Students will be able to impart technological inputs and acquire managerial skills to become technocrats and entrepreneurs.

MAPPING OF PEO'S TO PO'S

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
PEO 1	3	3	3	2	3	2	2	2	2	2	2
PEO 2	2	2	2	3	2	1	1	2	1	1	1
PEO 3	1	1	1	2	1	3	3	2	1	2	1

MAPPING OF PEO's TO PSO's

	PSO 1	PSO2
PEO 1	3	2
PEO 2	2	2
PEO 3	2	3

As per NEP Guidelines Proposed Scheme of Credit Distribution

	Year	FY		SY		Actual Credit
Sr. No.		I	II	III	IV	
1	Basic Science Course	--	--	--	--	--
2	Engineering Science Course	--	--	--	--	--
3	Program/Professional Core Courses	12	12	3	--	27
4	Program/Professional Elective Course	6	6	6	--	18
5	Multi Minor	--	--	--	--	--
6	Open Elective	--	3	--	--	3
7	Vocational and Skill Enhancement Course	--	--	--	--	--
8	Ability Enhancement Course	--	--	--	--	--
9	Entrepreneurship /Economics/ Management Courses (Mgt./Economics/Mkt./Finance)	--	--	--	--	--
10	Indian Knowledge System	--	--	2	--	2
11	Value Education Course	--	--	--	--	--
12	Research Methodology (Project)	--	--	--	--	--
13	Common Egg. Project/Field Project (PBL/Seminar/Mini Project)	--	--	--	--	--
14	Project	--	--	10	20	30
15	Internship/OJT (PBL/Seminar/Mini Project/Virtual Internship/Physical)	--	--	--	--	--
16	Co-curricular Courses	--	--	--	--	--
	Total Credits	**18**	**21**	**21**	**20**	**80**

SEMESTER – I

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs./ Week	Cr	Components	Max	Min for Passing	
1	PCC	25MHP1101	Thermodynamics and Combustion	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
2	PCC	25MHP1102	Advanced Fluid Dynamics	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
3	PCC	25MHP1103	Advanced Heat Transfer	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
4	PCC	25MHP1101L	Thermodynamics and Combustion Laboratory	0	0	2	2	1	CA1	25		40
									CA2	25		
									POE	50	20	
5	PCC	25MHP1102L	Advanced Fluid Dynamics Laboratory	0	0	2	2	1	CA1	25		20
									CA2	25		
									--	--	--	
6	PCC	25MHP1103L	Advanced Heat Transfer Laboratory	0	0	2	2	1	CA1	25		40
									CA2	25		
									POE	50	20	
7	PEC	25MHP1104	Professional Elective Course- I	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
8	PEC	25MHP1105	Professional Elective Course- II	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
			Total	**15**	**0**	**6**	**21**	**18**		**750**		
Total Contact Hours – 21 Total Credits - 18												

Professional Elective Course List for F. Y. M. Tech (Heat Power) SEM – I:

Sr. No.	Track	Course Code	Course Name
PROFESSIONAL ELECTIVE COURSE- I			
1	Study and Design of Thermal Systems	25MHP1104A	Nuclear Engineering
2	Pumps and Turbines	25MHP1104B	Design of Thermal – Turbo Systems
3	Pumps and Turbines	25MHP1104C	Gas Turbines
PROFESSIONAL ELECTIVE COURSE- II			
1	Study and Design of Thermal Systems	25MHP1105A	Design of Hydro - Turbo Systems
2	Heating Ventilation and Air Conditioning	25MHP1105B	Air Conditioning System Design
3	Energy Engineering	25MHP1105C	Design of Solar and Wind System

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ARVIND GAVALI COLLEGE OF ENGINEERING
ENGINEERING (B.Tech & M.Tech) BCA MCA B.VOC
NAAC & NBA Accredited AN AUTONOMOUS INSTITUTE ISO 9001:2015
Approved by AICTE, New Delhi, Recognised by Govt. Of Maha.,DTE Mumbai & Affiliated to Dr.Babasaheb Ambedkar Technological University (BATU), Lonere.
Address : At.Panmalewadi, Post.-Varye, Tal.& Dist.-Satara.-415 015 (Maharashtra)
Phone : 02162 - 261122 , 200100
e-mail : agcenggsatara@gmail.com
Website :-www.agce.edu.in
Institute Code : Engg. DTE EN-6545
BCA 6545, MCA 6545, B.Voc 6545

SEMESTER – II

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs./ Week	Cr	Components	Max	Min for Passing	
1	PCC	25MHP1201	Steam Engineering	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
2	PCC	25MHP1202	Computational Techniques in Fluid Flow and Heat Transfer	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
3	PCC	25MHP1203	Internal Combustion Engine Design	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
4	PCC	25MHP1201 L	Steam Engineering and I.C. Engine Laboratory	0	0	2	2	1	CA1	25		40
									CA2	25		
									POE	50	20	
5	PCC	25MHP1202 L	CFD Laboratory	0	0	2	2	1	CA1	25		20
									CA2	25		
									--	--	--	
6	PCC	25MHP1204	Seminar	0	0	2	2	1	CA1	25		40
									CA2	25		
									OE	50	20	
7	PEC	25MHP1205	Professional Elective Course- III	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
8	PEC	25MHP1206	Professional Elective Course- IV	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
9	OEC	25MHP1207	Research Methodology	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
			Total	**18**	**0**	**6**	**24**	**21**		**850**		
Total Contact Hours – 24 Total Credits - 21												

Professional Elective Course List for F. Y. M. Tech (Heat Power) SEM – II:

Sr. No.	Track	Course Code	Course Name
PROFESSIONAL ELECTIVE COURSE– III			
1	Study and Design of Thermal Systems	25MHP1205A	Design of Heat Exchanger
2	Refrigeration	25MHP1205B	Industrial Refrigeration
3	Food Preservation	25MHP1205C	Food Preservation and Cold Chain Management
4	Automotive and Power Systems	25MHP1205D	Alternative fuels for I.C. Engines
PROFESSIONAL ELECTIVE COURSE - IV			
1	Refrigeration	25MHP1206A	Cryogenics
2	Heating Ventilation and Air Conditioning	25MHP1206B	Industrial Air Conditioning
3	Energy Engineering	25MHP1206C	Energy Conservation and Management
4	Automotive and Power Systems	25MHP1206D	Battery thermal management system

SEMESTER – III

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs./ Week	Cr	Components	Max	Min for Passing	
1	PR	25MHP2301	Dissertation Phase - I	0	0	20	20	10	CA1	25		40
									CA2	25		
									OE	50	20	
2	PCC	25MHP2302	Intellectual Property Rights	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
3	IKS	25MHP2303	Indian Knowledge System: Concepts and Applications in Engineering	2	0	0	2	2	CA1	25		20
									MSE	--		
									CA2	25		
									ESE	--	--	
4	AC	25MHP2304	Universal Human Values (UHV) & Professional Ethics	2	0	0	2	Audit	CA1	25		20
									MSE	--		
									CA2	25		
									ESE	--	--	
5	PEC	25MHP2305	Online/NPTEL /Coursera/Swayam Course 1	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
6	PEC	25MHP2306	Online/NPTEL /Coursera/Swayam Course 2	3	0	0	3	3	CA1	10		40
									MSE	30		
									CA2	10		
									ESE	50	20	
			Total							**500**		
Total Contact Hours –33 Total Credits - 21												

Online/NPTEL/Coursera/Swayam Course List:

ONLINE/NPTEL/COURSERA/SWAYAM COURSES		
Sr. No.	**Course Code**	**Course Name**
1	25MHP2305A	Energy Conservation and Waste Heat Recovery
2	25MHP2305B	Experimental Methods in Fluid Mechanics
3	25MHP2305C	Fundamentals of Convective Heat Transfer
4	25MHP2306A	Heat Exchangers: Fundamentals and Design Analysis
5	25MHP2306B	Solar Energy Engineering and Technology
6	25MHP2306C	Sustainable Energy Technology

SEMESTER – IV

Sr. No.	Category	Course Code	Course Name	Teaching Scheme					Evaluation Scheme			
				L	T	P	Hrs. /Week	Cr	Components	Max	Min for Passing	
1	PR	25MHP2401	Dissertation Phase - II	0	0	40	40	20	CA-1	25		40
									CA-2	25		
									OE	50	20	
			Total	**0**	**0**	**40**	**40**	**20**		**100**		
Total Contact Hours – 40 Total Credits - 20												

Title of the Course: Steam Engineering Course Code: 25MHP1201	L	T	P	Credit
	3	--	--	3

Course Pre-Requisite:

Basic knowledge of Thermodynamics, Fluid Mechanics, and Heat Transfer is required. Familiarity with engineering physics and mechanical systems is recommended for effective understanding.

Course Description:

This course introduces the fundamentals of steam generation, properties of steam, and its applications in power and process industries. Topics include boiler types and operations, steam turbines, heat transfer, condensate systems, and safety practices. Emphasis is placed on energy efficiency, maintenance, and system design. Suitable for mechanical and thermal engineering students.

Course Objectives:

By the end of this course, the students will be able to:

1. To analyze different types of steam cycles and estimate efficiencies in a steam power plant.
2. To design pipe insulation through proper selection of materials with the help of basic heat transfer theory.
3. To access boiler performance for different loading conditions.
4. To develop a professional approach for lifelong learning in steam engineering to include the awareness of social and environmental issues associated with engineering practices

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain working of different boilers and significance of mountings and accessories, and use modern tools for boiler performance assessment.
CO2	Calculate the efficiency of steam cycles using thermodynamic equations.
CO3	Analyze a thermal system for different sources of waste heat
CO4	Suggest suitable controls and instrumentation for effective process monitoring and energy efficiency improvement.
CO5	Design and assess insulation, refractory systems, and steam piping layout for energy savings and safety compliance.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011
CO1	3	2	-	2	3	-	-	-	-	-	2
CO2	3	3	2	2	2	-	-	-	-	-	2
CO3	3	3	2	3	2	2	-	-	-	-	2
CO4	3	3	3	2	3	2	2	-	-	-	2
CO5	3	3	3	2	3	2	2	-	-	-	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents:

Unit No.	Unit Title and Contents	Hours
1	**Introduction** Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers, Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down; IBR, Boiler standards.	**08**
2	**Piping & Insulation** Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.	**08**
3	**Steam Systems** Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipment's Systems.	**08**
4	**Boiler Performance Assessment** Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.	**08**
5	**Energy Conservation and Waste Minimization** Energy conservation options in Boiler; waste minimization, methodology; economic viability of waste minimization.	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Applied Thermodynamics	T. D. Estop, A. Mc Conkey	Parson Publication.
2	A Course in Power Plant Engineering	Domkundwar	S. Chand Publications
3	Engineering Thermodynamics	Yunus A. Cengel and Boles	Tata McGraw-Hill Publishing Co. Ltd.

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Boiler Operation Engineering	P. Chattopadhyay	Tata McGraw Hill Education Pvt. Ltd, N Delhi.
2	Steam: Its Generation and Use	Edited by J. B. Kitto & S C Stultz	The Babcock and Wilcox Company.

Title of the Course: Computational Techniques in Fluid Flow and Heat Transfer Course Code: 25MHP1202	L	T	P	Credit
	3	--	--	3

Course Pre-Requisites:

Basic knowledge of fluid mechanics, heat transfer, and engineering mathematics (especially differential equations and linear algebra). Familiarity with numerical methods and basic programming skills is also recommended

Course Description:

This course introduces numerical methods for solving fluid flow and heat transfer problems. It covers discretization techniques such as finite difference, finite volume, and finite element methods. Students learn to solve governing equations (Navier–Stokes, energy equation) using algorithms like SIMPLE and MAC. Emphasis is placed on stability, convergence, and implementation using computational tools to simulate real-world thermal-fluid systems.

Course Objectives:

By the end of this course, the students will be able to:

1. Enable the students to analyze and solve fluid related problems by applying principles of mathematics, science and engineering.
2. Prepare students to use modern tools, techniques and skills to fulfill industrial needs related to computational techniques in fluid flow and heat transfer.
3. Train students with effective communication skill to demonstrate computational theories.
4. Develop skills in the analysis of fluid systems with mathematical modeling for applications of computers in research or design
5. Develop a professional approach to lifelong learning in the numerical analysis to include the awareness of social and environment issues associated with engineering practices

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain prediction methods, partial differential equations (PDEs), and numerical methods used in fluid and heat transfer simulations.
CO2	Apply Finite Difference Method (FDM) and Finite Volume Method (FVM) to solve fluid and thermal engineering problems.
CO3	Analyze boundary conditions, solution schemes, and numerical stability considerations for fluid flow and heat transfer simulations.
CO4	Compare FVM with alternative numerical methods (e.g., LBM) in terms of accuracy, stability, and computational cost.
CO5	Design a basic CFD simulation using SIMPLE, QUICK or ADI schemes and validate with grid refinement and stability analysis.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011
CO1	3	2	-	2	2	-	-	-	-	-	2
CO2	3	3	3	2	3	-	-	-	-	-	3
CO3	3	3	2	3	3	-	-	-	-	-	3
CO4	3	3	3	3	3	2	-	-	-	-	3
CO5	3	3	3	3	3	-	-	-	-	-	3

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/Group discussions presentation, etc.
MSE is based on 50% of course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Comparison of experimental, theoretical and numerical approaches** Partial differential equations - Physical and mathematical classification -Parabolic, Elliptical and Hyperbolic equations. Computational economy, Numerical stability, Selection of numerical methods, validation of numerical results: Numerical error and accuracy – Round off error, accuracy of numerical results – Iterative convergence – Condition for convergence, Rate of convergence, under-relaxation and over relaxation, Termination of iteration: Tridiagonal Matrix algorithm	**08**
2	**Finite Difference method** Discretization – Converting Derivatives to discrete Algebraic Expressions, Taylor's series approach, polynomial fitting approach, Discretization error.	**08**
3	**Heat conduction** Steady one-dimensional conduction in Cartesian and cylindrical co-ordinates, handling of boundary conditions: Two dimensional steady state conduction problems in Cartesian and cylindrical co-ordinates – point by point and line by line method of Solution: Dealing of Dirichlet, Neumann and Robbins type boundary conditions- Formation of discretized equations for regular boundaries, irregular boundaries and interfaces.	**08**
4	**One dimensional, two dimensional and three dimensional transient heat conduction problems in Cartesian and cylindrical co-ordinates:** Explicit, Implicit, Crank Nicholson and ADI methods- stability of each system Conservation form and conservative property of partial differential equations and finite difference equations- Consistency, stability and convergence for marching problems Discrete perturbation stability analysis - Fourier or Von Neumann stability analysis.	**08**

5	**Finite volume method 1** Discretization of governing equations - Diffusion and convection-diffusion problems steady one-dimensional convection and diffusion, upwind, hybrid and power-law schemes **Finite volume method 2** Discretization equation for two-dimensions: False diffusion, calculation for the Flow Field- Stream function- vortices approach, SIMPLE, SIMPLER, SIMPLEC and QUICK Algorithms. Numerical Marching Techniques. Two-dimensional parabolic flows with heat; Grid generation methods, Adaptive grids	**08**

Textbooks:

Sr. No.	Title	Author	Publisher
1	Numerical Fluid Flow & Heat transfer	S.V. Patankar	Hemisphere Publishing Corp., 1980.
2	Computational Fluid Flow and Heat Transfer	T. Sundernajan, K. Muralidhar	Narosa, 2nd edition, Reprint 2011.

Reference Books:

Sr. No.	Title	Author	Publisher
1	An Introduction to Computational Fluid Dynamics	H. K. Versteeg and W. Malalasekera	Longman Scientific and Technical, 1st edition, 1995
2	Computational Fluid Dynamics	Hoffman Klaus	Vol-1 & 2, A Publication of Engineering Education System, Wichita Kansas, USA, 2000

Title of the Course: Internal Combustion Engine Design Course Code: 25MHP1203	L	T	P	Credit
	3	--	--	3

Course Pre-Requisites:
Thermodynamics, Heat Transfer

Course Description:
This course focuses on the design principles of internal combustion engines, covering thermodynamic cycles, performance parameters, combustion analysis, and mechanical design of key components such as the piston, crankshaft, and valve mechanism. Emphasis is placed on efficiency, emissions, and recent advancements in engine technology

Course Objectives:

By the end of this course, the students will be able to:

1. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to I.C. Engine systems.
2. To train students with effective communication skill to demonstrate I.C. Engine theories.
3. To develop skills in the analysis of I.C. Engine systems in research or design.
4. To develop a professional approach to lifelong learning in the I.C. Engine to include the awareness of social and environment issues associated with engineering practices

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the thermodynamic cycles used in internal combustion engines.
CO2	Apply the knowledge of mathematics, science, and engineering for solving internal combustion engine design problems.
CO3	Analyze the IC engine systems and interpret their design calculations and simulation results.
CO4	Evaluate the performance of I.C. engines under various operating conditions and interpret technical reports.
CO5	Design components of I.C. engines like piston, cylinder, crankshaft, injection and cooling systems considering mechanical and thermal loads.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011
CO1	3	2	-	-	1	-	-	-	-	-	1
CO2	3	3	3	2	3	-	2	-	-	-	2
CO3	3	3	2	3	3	-	3	-	-	-	2
CO4	3	3	2	2	2	2	-	-	-	-	2
CO5	3	3	3	2	3	2	-	-	-	-	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents:

Unit No.	Unit Title and Contents	Hours
1	**Introduction to Engine Design** Engine selection, basic data for design like power torque, speed, mean effective pressure, air consumption, fuel consumption, stroke to bore ratio, heat distribution, exhaust temperature, power to weight ratio	**08**
2	**Design Considerations** Combustion chamber design considerations for S.I. and C.I. engines. Thermal and Mechanical design of cylinder, piston, piston rings, cylinder head, valves, Mechanical design of connecting rod, crankshaft and crank case.	**08**
3	**Simulation of I.C. Engine Processes** Simulation, S.I. Engine simulation with air as working medium, simulation with adiabatic combustion. Definitions of progressive combustion model, gas exchange process model and heat transfer process model.	**08**
4	**Carburetion and Injection** Carburetion Mixture characteristics, distribution, Carburettor systems, Carburettor and stratified charge engines, S.I. Engine fuel injection system and type, Modern Carburettor designs and air Pollution control, altitude compensation. **Injection Systems** Design, Bosch distribution pump, Cummins- P-T injection system, Spray characteristics, quantity of fuel per cycle, types of nozzles, injection timing, fuel line hydraulics.	**08**

5	**Cooling System** Design, Heat transfer in I.C. engines, piston and cylinder temperatures, heat rejected to coolant, comparison of air and water cooling, temperature distribution for air- and water-cooled engine across the cylinder wall, **Ignition System** Requirements, battery ignition, magneto ignition and electronic ignition systems, centrifugal and vacuum advance; spark plug types and selection, firing order and its importance.	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	I. C Engine Fundamentals	J. B. Heywood	Tata McGraw Hill Pub.1st edition 1998.
2	Internal Combustion Engines	V. Ganesan	Tata McGraw Hill Book Co, Eighth Reprint, 2005.

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Internal Combustion Engines and Air Pollution	F. Obert	In-text Educational Publishers, 1st edition 1973.
2	Internal Combustion Engines	Colin Fergusson, Allan	Kirkpatrick
3	High Speed Combustion Engines	P. M. Heldt	Chilton company 4th edition 1956.

Title of the Course: Steam Engineering and I.C. Engine Laboratory Course Code: 25MHP1201L	L	T	P	Credit
	--	--	2	1

Course Prerequisite:

Engineering Thermodynamics, Heat Transfer, Fluid Mechanics, Basic knowledge of Power Cycles.

Course Description:

This lab offers hands-on experience in steam engineering and I.C. engine systems. Students perform experiments on steam generators, condensers, cooling towers, diesel engines, and variable compression engines to study energy conversion, performance, and efficiency.

Course Objectives:

By the end of this course, the students will be able to:

1. To study the working and performance of steam generators and their mountings and accessories.
2. To evaluate the quality of steam and conduct energy analysis of steam power plants.
3. To understand condenser performance and cooling tower characteristics.
4. To perform performance tests on diesel engines and analyse their efficiency.
5. To gain practical exposure to computer-controlled and variable compression ratio I.C. engines.

Note:

1. The practical lab is designed to provide students with hands-on experience in applying the theoretical concepts they have learned in the course. The session aims to enhance their understanding, critical thinking, and problem-solving skills. (1 hour for explaining the concept and 1 hour for activity/ assignment / group discussion / brainstorming session).
2. Incorporating hands-on labs with access to various lab and workshop facilities in the Institute, can enhance the practical aspect of the course and provide students with opportunities to prototype and test their designs.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Demonstrate working principles of steam generators, condensers, and cooling towers.
CO2	Analyze the quality of steam and evaluate energy performance of steam power plant components.
CO3	Conduct performance tests on diesel engines, computer-controlled I.C. engines, and VCR engines.
CO4	Interpret experimental data to assess efficiency and operational characteristics of steam and I.C. engine systems.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	P012
CO1	3	2										1
CO2	3	3		2	2							2
CO3	2	3	3	2	2							2
CO4	2	3	2	3	2							3

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2), have 25% weightage for each component respectively and 50% weightage is for POE.

Assessment Component	Marks
CA1	25
CA2	25
MSE	50
ESE	-

CA1 POE based on 50% course content, attendance, lab overall performance.
CA2 POE based on 100% course content, attendance, lab overall performance.

Course Contents:

Practical No.	List of Experiments	Hours
1	Steam Generators	**02**
2	Mounting and accessories	**02**
3	Quality of Steam	**02**
4	Energy Analysis of Steam Power Plant	**02**
5	Condenser Analysis	**02**
6	Cooling Tower	**02**
7	Performance test on diesel engine	**02**
8	Test on Computer controlled I.C. engine	**02**
9	Test on variable compression ratio I.C. engine	**02**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Applied Thermodynamics	T. D. Eastop, A. McConkey	Parson Publication
2	A Course in Power Plant Engineering	Domkundwar	Dhanpat Rai and Sons

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Applied Thermodynamics	T. D. Eastop, A. McConkey	Parson Publication
2	A Course in Power Plant Engineering	Domkundwar	Dhanpat Rai and Sons
3	Energy Performance Assessment for Equipment & Utility Systems	Bureau of Energy Efficiency	Bureau of Energy Efficiency
4	Boiler Operation Engineering: Questions and Answers	P. Chattopadhyay	Tata McGraw Hill Education Pvt. Ltd., N. Delhi

Useful Links:	
1	https://nptel.ac.in/courses/112/107/112107216/

Title of the Course: CFD Laboratory Course Code: 25MHP1202L	L	T	P	Credit
	--	--	2	1

Course Prerequisite:

Knowledge of Engineering Thermodynamics, Heat and Mass Transfer, Fluid Mechanics, and Basic Numerical Methods.

Course Description:

This course offers a comprehensive understanding of steam power plant operations. It covers the design and functioning of steam generators, boiler mountings and accessories, and assessment of steam quality. It also includes energy analysis of steam power systems, condenser and cooling tower performance and an introduction to numerical and computational methods for analysing fluid flow and heat transfer in thermal systems. The course integrates both theoretical and applied perspectives essential for modern power engineering.

Course Objectives:

By the end of this course, the students will be able to:

1. To Provide an overview of Computational Fluid Dynamics (CFD) principles, applications, and software.
2. To Learn to navigate user interfaces, set boundary conditions, and define simulation parameters.
3. To Understand the governing equations (Navier-Stokes, continuity, and energy equations) used in CFD simulations.

Note:

1. The practical lab is designed to provide students with hands-on experience in applying the theoretical concepts they have learned in the course. The session aims to enhance their understanding, critical thinking, and problem-solving skills. (1 hour for explaining the concept and 1 hour for activity/ assignment / group discussion / brainstorming session).
2. Incorporating hands-on labs with access to various lab and workshop facilities in the Institute, can enhance the practical aspect of the course and provide students with opportunities to prototype and test their designs.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Describe the role and importance of turbulence modeling in simulating turbulent flows using various turbulence models.
CO2	Apply CFD software tools proficiently to set up and solve basic fluid flow problems
CO3	Analyze CFD simulation results to interpret flow characteristics, such as velocity profiles, pressure distribution and turbulence intensity.
CO4	Assess the limitations and assumptions associated with CFD simulations in modeling complex flow phenomena.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	P012
CO1	2	1	1		1				2			3
CO2	2			2	2				2			3
CO3	3	2	3		2				2			3
CO4	3	2	1		2				1			3

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2), have 25% weightage for each component respectively and 50% weightage is for POE.

Assessment Component	Marks
CA1	25
CA2	25
MSE	-
ESE	-

CA1 POE based on 50% course content, attendance, lab overall performance.
CA2 POE based on 100% course content, attendance, lab overall performance.

Course Contents:

Practical No.	List of Experiments	Hours
1	Flow Through a Pipe	**02**
2	Heat Transfer in a Heat Exchanger	**02**
3	Flow Over an Airfoil	**02**
4	Mixing and Stirring in a Stirred Tank Reactor	**02**

Textbooks:

Sr. No.	Title	Author	Publisher
1	Energy Performance Assessment for Equipment & Utility Systems	Bureau of Energy Efficiency	Bureau of Energy Efficiency
2	Boiler Operation Engineering: Questions and Answers	P. Chattopadhyay	Tata McGraw Hill Education Pvt. Ltd., New Delhi
3	Numerical Fluid Flow & Heat Transfer	S. V. Patankar	Hemisphere Publishing Corp., 1980
4	Computational Fluid Flow and Heat Transfer	T. Sundararajan, K. Muralidhar	Narosa Publishing House, 2nd Ed., Reprint 2011

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Applied Thermodynamics	T. D. Eastop, A. McConkey	Parson Publication
2	A Course in Power Plant Engineering	Domkundwar	Dhanpat Rai and Sons
3	Energy Performance Assessment for Equipment & Utility Systems	Bureau of Energy Efficiency	Bureau of Energy Efficiency
4	Boiler Operation Engineering: Questions and Answers	P. Chattopadhyay	Tata McGraw Hill Education Pvt. Ltd., N. Delhi

Useful Links:	
1	https://nptel.ac.in/courses/112/104/112104302/

Title of the Course: Seminar Course Code: 25MHP1204	L	T	P	Credit
	--	--	2	1

Course Prerequisite:
Nil

Course Description:

This seminar explores advanced thermal systems with a focus on steam power plants, energy performance assessment, and computational techniques like CFD. It includes the study of key components, efficiency analysis, and application of numerical methods. Emphasis is placed on current research from reputed journals and conferences to support innovation and practical understanding.

Course Objectives:

By the end of this course, the students will be able to:

1. To review and increase student's understanding of the specific topics.
2. To induce Learning management of values.
3. To teach how research papers are written and read such papers critically and efficiently and to summarize and review them to gain an understanding of a new field, in the absence of a textbook.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Identify and utilize credible sources of information, including academic journals, books and databases.
CO2	Apply the existing knowledge on real life problems.
CO3	Investigate the selected topic/ system.
CO4	Verify the outcomes of the work have solved the specified problems.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	P012
CO1	3	2	1		2				2			3
CO2	2		2		2				3			3
CO3	3	1	3		2				2			3
CO4	3	2	1		2				1			3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	25
CA2	25
OE	50
ESE	-

CA1 POE based on 50% course content, attendance, lab overall performance.
CA2 POE based on 100% course content, attendance, lab overall performance.

Course Contents

Unit No.	Course Contents	Hours
1	The seminar work should preferably be a problem with research potential, involve scientific research review, design, generation, collection, and analysis of data, determine a solution, and preferably bring out the individual contribution. The seminar should be based, preferably, on the area in which the candidate is interested to undertaking the dissertation work. The candidate has to be in regular contact with their guide, and the topic of the seminar must be mutually decided. The examination shall consist of the preparation of a report consisting of a literature review, a detailed problem statement, case studies, etc., according to the type of work carried out. The work must be presented in front of the examiner panel formed by department for evaluation.	**20**

Textbooks:
Suitable books based on the contents of the seminar topic selected.

Reference Books:
Suitable books based on the contents of the seminar topic selected and research papers from reputed national and international journals and conferences.

Useful Links:	
1	As per the need of the seminar topic.

Title of the Course: Design of Heat Exchangers Course Code: 25MHP1205A	L	T	P	Credit
	3	--	--	3

Course Prerequisite:
Fundamentals of heat transfer and fluid mechanics

Course Description:
This course provides an in-depth study of the principles and methods used in the design, analysis, and optimization of heat exchangers. Emphasis is placed on thermal and hydraulic design, performance evaluation, and practical applications across various industries including power generation, HVAC, chemical processing, and automotive systems.

Course Objectives:

By the end of this course, the students will be able to:

1. Enable the students to analyze and solve heat exchanger problems by applying principles of mathematics, science and engineering.
2. Prepare students to use modern tools, techniques and skills to fulfill industrial needs related to design of heat exchanger.
3. Develop skills in the analysis of heat exchanger with mathematical modeling for applications in research or design.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the fundamental principles and types of heat exchangers.
CO2	Apply fundamental knowledge of mathematics, science, and engineering for the needs in heat exchanger designing.
CO3	Analyze the thermal and hydraulic design of different types of heat exchangers.
CO4	Evaluate the design and performance of various types of heat exchangers, including cooling towers and compact exchangers.
CO5	Design a shell-and-tube or compact heat exchanger system considering pressure drop, fouling, and flow arrangement.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011
CO1	3	2	-	-	1	-	-	-	-	-	1
CO2	3	3	3	2	3	-	-	-	-	-	2
CO3	3	3	2	3	3	-	-	-	-	-	2
CO4	3	3	2	2	3	2	-	-	-	-	2
CO5	3	3	3	2	3	2	-	-	-	-	2

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/ Group discussions /presentation, etc.

MSE is based on 50% of course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Types of heat exchanger** Heat Exchangers – Classification according to transfer process, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger.	**08**
2	**Heat exchanger design methodology** Assumption for heat transfer analysis, problem formulation, e-NTU method, P-NTU method, Mean temperature difference method, fouling of heat exchanger, effects of fouling, categories of fouling, fundamental processes of fouling.	**08**
3	**Compact and Double Pipe Heat Exchangers** Thermal and Hydraulic design of compact heat exchanger. Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop.	**08**
4	**Direct-contact heat exchanger, cooling towers** Relation between the wet-bulb and dew point temperatures. The Lewis number, Classification of cooling towers cooling, tower internals and the role of fill, Heat exchange heat transfer by simultaneous diffusion and convection. Analysis of cooling towers measurements. Design of cooling towers, determination of the number of diffusion units.	**08**
5	**Shell and Tube heat exchangers** Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchangers	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Fundamentals of Heat Exchanger Design	Ramesh K. Shah and Dusan P. Sekulic	John Wiley and sons Inc.

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Heat Exchangers: Selection, Rating and ThermalDesign	D.C. Kern ,	McGraw Hill
2	Heat Exchangers: Selection, Rating and ThermalDesign	SadikKakac and Hongton Liu	CRC Press
3	Heat Exchanger Design	A .P. Frass and M.N. Ozisik	McGraw Hill
4	Heat Exchanger Design and Theory Source Book	Afgan N. and Schlinder E.V	McGraw Hill

Useful Links
https://nptel.ac.in/courses/112/105/112105248/

Title of the Course: Industrial Refrigeration Course Code: 25MHP1205B	L	T	P	Credit
	3	--	--	3

Course Prerequisite:

Preliminary knowledge of Thermodynamics**,** Heat Transfer**,** and Basic Refrigeration & Air Conditioning Systems.

Course Description:

This course introduces the concepts and applications of industrial refrigeration distinct from comfort air-conditioning. It covers cold storage techniques for frozen and unfrozen food, food processing refrigeration, and advanced topics such as freeze drying. The thermodynamic principles behind Carnot and vapor compression cycles are analyzed using refrigerant properties. The course explores compressor types used in industrial systems, design and operation of evaporators**,** condensers, and circulation systems**.** Additionally, it includes the study of various refrigeration vessels such as flash tanks, separators and surge drums, emphasizing their role in system efficiency and safety.

Course Objectives:

By the end of this course, the students will be able to:

1. To enable the students to analyse and solve refrigeration related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfil industrial needs related to refrigeration systems.
3. To train students with effective communication skill to demonstrate refrigeration/theories.
4. To develop skills in the analysis of refrigeration systems in research or design.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Describe the basic types and components of industrial refrigeration systems.
CO2	Apply knowledge of mathematics, science, and engineering for the needs in refrigeration.
CO3	Analyze different industrial refrigeration systems and their characteristics.
CO4	Evaluate the performance of various industrial refrigeration systems and their components.
CO5	Design suitable refrigeration system components such as evaporators, compressors, condensers, and piping arrangements for specific industrial applications.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011
CO1	3	2	-	-	1	-	-	-	-	-	1
CO2	3	3	3	2	3	-	-	-	-	-	2
CO3	3	3	2	3	3	-	-	-	-	-	2
CO4	3	3	2	2	2	2	-	-	-	-	2
CO5	3	3	3	2	3	2	-	-	-	-	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents:

Unit No.	Unit Title and Contents	Hours
1	Industrial refrigeration as distinguished from comfort air-conditioning, what is industrial refrigeration, Refrigerated storage of unfrozen food, Frozen food, Refrigeration in food processing, freeze drying	**08**
2	Carnot cycle , conditions for high cop of Carnot cycle ,Steady flow energy equation, Analysis of Carnot cycle using refrigerant enthalpies, Dry vs wet compression, The standard vapor compression cycle	**08**
3	Reciprocating, scroll and screw compressor: Multistage industrial applications, cylinder arrangement, cooling methods - oil injection	**08**
4	Types of Evaporators, Liquid circulation: Mechanical pumping and gas pumping - advantage and disadvantage of liquid re-circulation - circulation ratio - top feed and bottom feed refrigerant - Net Positive Suction Head (NPSH) - two pumping vessel system – suction risers, design, piping loses. Different Industrial Condensers arrangement	**08**
5	Vessels in industrial refrigeration: High pressure receiver - flash tank -liquid and vapor separator, separation enhancers, low pressure receivers, surge drum	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	C. P. Arora	Refrigeration and Air Conditioning	Tata McGraw Hill Education Pvt. Ltd.
2	Wilbert F. Stocker	Industrial Refrigeration Handbook	McGraw-Hill Professional Publishing

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Roy J. Dossat	Principles of Refrigeration	Pearson
2	ASHRAE	Handbook: Refrigeration	ASHRAE
3	ASHRAE	Handbook: HVAC Systems and Equipment	ASHRAE
4	ISHRAE, ASHRAE	Journal of Air Conditioning and Refrigeration	ISHRAE / ASHRAE
5	Roy J. Dossat	Principles of Refrigeration	Pearson

Useful Links:	
1	https://nptel.ac.in/courses/112/105/112105129/

Title of the Course: Food Preservation and Cold Chain Management Course Code: 25MHP1205C	L	T	P	Credit
	3	--	--	3

Course Prerequisite:
Preliminary knowledge of Biology **(**especially Microbiology), Chemistry, and Food Science.

Course Description:
In this course the students will learn topics from differential equations, special functions, and integral calculus.

Course Objectives:

By the end of this course, the students will be able to:

This course provides a comprehensive overview of traditional and modern methods of food preservation aimed at extending shelf life and ensuring food safety. It covers the role of microorganisms in food spoilage and preservation, and introduces low-temperature techniques such as refrigeration and freezing, as well as high-temperature methods like pasteurization and sterilization. Students will learn about moisture control techniques including drying, dehydration, and evaporation, along with modern technologies such as irradiation, pulsed electric fields, high-pressure processing, and microwave heating**.** The course emphasizes scientific principles behind each method, equipment used, and their applications in the food industry.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Describe the importance of microorganisms in food preservation and introduce the basics of various food processing and preservation technologies.
CO2	Identify suitable food preservation techniques for various food products and apply cold chain management practices.
CO3	Analyze the compositional and technological aspects of milk, fish, and other food products during preservation.
CO4	Evaluate the effectiveness and efficiency of food preservation and cold chain management strategies.
CO5	Design a basic food preservation system using a combination of traditional and emerging preservation techniques.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011
CO1	3	2	-	-	1	1	-	-	-	-	1
CO2	3	3	3	2	3	2	2	-	-	-	2
CO3	3	3	2	3	3	2	-	-	-	-	2
CO4	3	3	2	2	2	3	2	-	-	-	2
CO5	3	3	3	2	3	2	2	-	-	-	2

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Food Microbiology:** Principles of Food Preservation, microorganisms associated with foods bacteria, yeast and mold, Importance of bacteria, yeast and molds in foods. Classification of microorganisms based on temperature, pH, water activity, nutrient and oxygen requirements, typical growth curve of microorganisms. Classification of food based on pH, Food infection, food intoxication, definition of shelf life, perishable foods, semi perishable foods, shelve stable foods.	**08**
2	**Food Preservation by Low Temperature Freezing and Refrigeration:** Introduction to refrigeration, cool storage and freezing, definition, principle of freezing, freezing curve, changes occurring during freezing, types of freezing i.e. slow freezing, quick freezing, introduction to thawing, changes during thawing and its effect on food. Freezing methods -direct and indirect, still air sharp freezer, blast freezer, fluidized freezer, plate freezer, spiral freezer and cryogenic freezing.	**08**
3	**Food Preservation by high temperature**: Commercial heat preservation methods: Sterilization, commercial sterilization, Pasteurization, and blanching.	**08**
4	**Food Preservation by Moisture control:** Drying and Dehydration - Definition, drying as a means of preservation, differences between sun drying and dehydration (i.e. mechanical drying), heat and mass transfer, factors affecting rate of drying, normal drying curve, names of types of driers used in the food industry. Drying methods and equipment, air convection dryer, tray dryer, tunnel dryer, continuous belt dryer, fluidized bed dryer, spray dryer, drum dryer, vacuum dryer, freeze drying foam mat drying. Evaporation - Definition, factors affecting evaporation, names of evaporators used in food industry.	**08**
5	**Food Preservation by Irradiation and chemicals** Introduction, units of radiation, kinds of ionizing radiations used in food irradiation, mechanism of action, uses of radiation processing in food industry, concept of cold sterilization. Recent Trends Pulsed electric fields, High pressure technology, Ohmic heating, Microwave heating, Hurdle technology.	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Potter N. H.	Food Science	CBS Publication, New Delhi
2	Ramaswamy H., Marcott M.	Food Processing Principles and Applications	CRC Press

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	B. Srilakshmi	Food Science	New Age Publishers
2	Meyer	Food Chemistry	New Age
3	Bawa A. S., O. P. Chauhan et al.	Food Science	New India Publishing Agency
4	Frazier W. C., Westhoff D. C.	Food Microbiology	TMH Publication, New Delhi
5	Desrosier N. W., Desrosier J. N.	The Technology of Food Preservation	CBS Publication, New Delhi

Useful Links:	
1	https://nptel.ac.in/courses/126/105/126105011/
2	https://nptel.ac.in/courses/126/103/126103017/

Title of the Course: Alternative Fuels for I.C. Engine Course Code: 25MHP1205D	L	T	P	Credit
	3	--	--	3

Course Prerequisite:

Basic knowledge of Thermodynamics and Combustion. Fundamentals of Internal Combustion Engines

Course Description:

This course introduces conventional petroleum fuels, their refining processes, and properties relevant to I.C. engines. It emphasizes the need for alternative fuels such as alcohols, LPG, CNG, hydrogen, biogas, and producer gas, along with their production methods, properties, and application in engines. The course covers single-fuel and dual-fuel engine operation, required engine modifications, and the performance and emission characteristics of alternative fuels in comparison with conventional gasoline and diesel engines.

Course Objectives:

By the end of this course, the students will be able to:

1. To provide knowledge of petroleum-based fuels, their refining process, and properties relevant to IC engines.
2. To introduce the need, availability, and methods of production of alternative fuels.
3. To study the performance and emission characteristics of SI and CI engines using alternative fuels.
4. To understand required modifications in engines for single-fuel and dual-fuel operations.
5. To evaluate the potential of alternative fuels in reducing dependency on fossil fuels and minimizing environmental impact.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the structure, refining process, and properties of petroleum fuels used in IC engines.
CO2	Identify the need for alternative fuels and describe their methods of production.
CO3	Analyze the combustion, performance, and emission characteristics of SI engines operating on alternative fuels.
CO4	Evaluate the use of alternative fuels in CI engines under dual-fuel operation and required modifications.
CO5	Assess the techno-economic and environmental benefits of alternative fuels compared to conventional fuels.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011
CO1	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	2	-	-	-	-	-	2
CO3	3	3	-	2	2	-	-	-	-	-	2
CO4	3	2	3	2	3	-	-	-	-	-	2
CO5	2	2	-	2	2	2	3	-	-	-	3

Assessment Scheme:
Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/Group discussions presentation, etc.
MSE is based on 50% of course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents

Unit No.	Unit Title and Contents	Hours
1	**Special Functions** Gamma function and its properties, Beta function and its properties, Differentiation under integral sign (Leibniz rule): Basic techniques with examples.	**08**
2	**First Order Differential Equations and Its Applications** Concept of order, degree and formation of ODEs, Linear differential equations, and equations reducible to linear form. Exact differential equations and integrating factor method. Applications to orthogonal trajectories (cartesian and polar equations), Kirchhoff's law.	**08**
3	**Laplace Transforms and Applications** Definition of Laplace transforms and its inverse, transforms of elementary function, properties of Laplace transform, transforms of derivatives and integral, Convolution theorem (statement only), Evaluation of integral using Laplace transforms.	**08**
4	**Fourier and Z – transforms** Fourier Transform (FT): Complex exponential form of Fourier series, Fourier integrals (sine and cosine forms), Fourier transform, and its inverses, Fourier Sine, and Cosine Transforms. Z - Transform (ZT): Introduction, Definition, ZT of standard sequences, properties (Linearity, shifting), inverse Z- transforms, (basic method), Solution of simple linear difference equations.	**08**
5	**Vector Calculus** Scalar and vector fields: Gradient, divergence, and curl, Solenoidal and Irrotational vector fields, Vector identities (statement only), Line and surface integrals, Green's theorem (in the plane), Gauss divergence theorem, and Stokes theorem (without proofs).	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Higher Engineering Mathematics	Dr. B. S. Grewal	Khanna Publishers Delhi
2	A Textbook of Applied Mathematics Vol. I & II	P. N. Wartikar & J. N. Wartika	Pune Vidyarthi Griha Prakashan, Pune
3	A textbook of Engineering Mathematics	N.P. Bali and Manish Goyal	Laxmi Publications private limited

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Engineering Mathematics II	G.V. Kumbojkar	C.Jamnadas and Co.
2	Advanced Engineering Mathematics	H. K. Dass	S. Chand & Company Pvt. Ltd, New Delhi
3	A Textbook of Engineering Mathematics	N. P. Bali, Iyengar	Laxmi Publications (P) Ltd., New Delhi
4	Engineering Mathematics	Ravish R Singh and Mukul Bhatt	McGraw Hill Education (India) Private Limited, Chennai.
5	Advanced Engineering	Erwin Kreyszi	John Wiley & Sons

Title of the Course: Cryogenics Course Code: 25MHP1206A	L	T	P	Credit
	3	--	--	3

Course Pre-Requisite: Refrigeration and air conditioning

Course Description:

This course provides a comprehensive introduction to cryogenics, the study of the production and effects of very low temperatures (typically below –150°C or 123 K). Students will explore the fundamental principles of thermodynamics, heat transfer, and fluid mechanics as they relate to cryogenic systems. The course covers cryogenic materials, liquefaction of gases (e.g., helium, nitrogen, hydrogen), insulation techniques, storage and transportation of cryogens, and applications in science, medicine, aerospace, and industry.

Course Objectives:

By the end of this course, the students will be able to:

1. To Understand the basic principles of cryogenics and low-temperature physics.
2. To Analyze the properties and behaviors of materials at cryogenic temperatures.
3. To Design and evaluate cryogenic systems and equipment.
4. To Apply cryogenic techniques in practical scenarios across different industries

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the basic principles of low-temperature physics and their significance.
CO2	Apply knowledge of cryogenic materials to select appropriate materials for specific applications.
CO3	Examine the safety protocols and risk assessments necessary for handling cryogenic systems.
CO4	Assess the design and functionality of cryogenic storage and transfer systems.
CO5	Design a cryogenic liquefaction or refrigeration system with suitable thermodynamic and material considerations.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	1	-	-	-	-	-	1
CO2	3	3	3	2	3	2	-	-	-	-	2
CO3	3	3	2	3	3	3	3	-	-	-	2
CO4	3	3	2	3	3	3	-	-	-	-	2
CO5	3	3	3	3	3	2	-	-	-	-	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions /presentation, etc.
MSE is based on 50% of course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents:

Unit No.	Unit Title and Contents	Hours
1.	**Introduction to Cryogenics** VCRS Cycle, Limitation of VCRS System, Cascade system, History and development of cryogenics. Basic principles of thermodynamics relevant to cryogenics.	**08**
2.	**Gas Liquefaction, Separation and Purification System** Thermodynamically ideal system, Joule-Thomson effect, Adiabatic expansion, Actual liquefaction systems, Performance parameters, Critical components of liquefaction systems. Ideal gas separation system, separation of binary mixtures at cryogenic temperatures, Requirement of Purification, Purification systems at low temperatures.	**08**
3.	**Cryogenic Refrigeration Systems** Joule-Thompson Refrigeration systems, Expansion engine refrigeration systems, Philips refrigerators, G-M Refrigerators, Stirling Refrigerator, Solvay Refrigerator, Magnetic Refrigeration.	**08**
4.	**Properties of Engineering Materials** Material properties at low temperatures, Thermal, Mechanical and Magnetic properties of cryogens.	**08**
5.	**Cryogenic Fluid Storage, Handling and Transfer** Handling, Insulation, Instrumentation & Vacuum Technology Temperature, Pressure, Flow rate and Liquid level measurement. Cryogenic storage vessels, Dewar and large tanks, Storage and transport of LNG and other liquefied industrial gases. Liquid hydrogen storage and transport for hydrogen-fueled vehicles. Special insulation requirements at low temperatures, insulating materials. Need of vacuum, various vacuum pumps.	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1.	Cryogenics	Dr. B. S. Gawali	Mahalaxmi Publication
2.	Cryogenic Engineering	R. B. Scott	CRC Press

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1.	Helium Cryogenics	Steven W. Van Sciver	McGraw Hill
2.	Handbook of Cryogenic Engineering	J.G. Weisend II	CRC Press
3.	Fundamentals of Cryogenic Engineering	Mamoru Ishigaki and Nobuyuki Yoshida	McGraw Hill

Title of the Course: Industrial Air-Conditioning Course Code: 25MHP1206B	L	T	P	Credit
	3	--	--	3

Course Pre-Requisite:

Basic Thermodynamics, Fundamentals of Heat and Mass Transfer, Fluid Mechanics, Engineering Mathematics

Course Description:

This course covers the principles and applications of psychometrics, heat and mass transfer in HVAC systems, air cleaning methods, ventilation strategies, and air handling equipment. Topics include moist air properties, psychrometric charts, air washers, ventilation standards, air filtration systems, noise control, fan and duct design, and the complete design of a year-round air conditioning system. Analytical and graphical approaches are used for system performance analysis.

Course Objectives:

By the end of this course, the students will be able to:

1. To enable the students to analyse and solve air conditioning related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfil industrial needs related to air conditioning.
3. To train students with effective communication skills to demonstrate air conditioning theories.
4. To develop skills in the analysis of air conditioning systems in research or design.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the principles, processes, and equipment of psychrometry and air conditioning.
CO2	Apply knowledge of mathematics, science, and engineering for the needs in air-conditioning system design.
CO3	Analyze different air-conditioning systems and their characteristics.
CO4	Evaluate the performance and interpret the reports in the field of air-conditioning.
CO5	Design an effective air-handling system using psychrometric principles and air-conditioning components.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	1	1	-	-	-	-	1
CO2	3	3	3	2	3	2	-	-	-	-	2
CO3	3	3	2	3	3	2	-	-	-	-	2
CO4	3	3	2	2	3	2	-	-	-	-	2
CO5	3	3	3	2	3	2	-	-	-	-	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Assignment/ Surprise test/ Quiz/Seminar/Group discussions /presentation, etc.
MSE is based on 50% course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents:

Unit No.	Unit Title and Contents	Hours
1.	**Psychometric:** moist air properties; mass transfer and evaporation of water into moist air; theory of psychrometer; correlation of w.b.t. with temperature of adiabatic saturation; Lewis number; construction of psychometric chart.	**08**
2.	**Heat and Mass Transfer**: Direct contact transfer equipment; simple air washer and indirect evaporative cooling contact mixture principle; enthalpy potential; basic equation for direct contact transfer equipment; graphical and analytical methods for heat and mass transfer analysis of air washers with heated and chilled water sprays	**08**
3.	**Ventilation:** Necessity; ventilation standards; natural and mechanical ventilation; forces for natural ventilation; general ventilation rules; determining ventilation requirement; use of decay equation.	**08**
4.	**Air Cleaning:** Physical and chemical vitiation of air; permissible concentration of air contaminants; mechanical and electronic air cleaners; dry and wet filters; radiators and convectors. Design of a year-round air conditioning system.	**08**
5.	**Air handling Equipment:** Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units. air conditioning apparatus, unitary equipment, accessory equipment, Noise control. Piping and Ducts: Pressure drops in piping and fittings; design of water and refrigerant piping; Air conditioning duct design methods.	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Refrigeration & Air Conditioning	Manohar Prasad	New Age Publishers
2	Refrigeration & Air Conditioning	Stoecker	McGraw Hill, 1992
3	A textbook of Engineering Mathematics	N.P. Bali and Manish Goyal	Laxmi Publications private limited

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Refrigeration & Air Conditioning	Manohar Prasad	New Age Publishers
2	Refrigeration & Air Conditioning	Stoecker	McGraw Hill, 1992
3	ASHRAE Handbook: HVAC Systems and Equipment	ASHRAE	ASHRAE, 1996
4	Control Systems for Heating, Ventilation and Air-Conditioning	Hainer R.W.	Van Nostrand
5	Modern Air Conditioning	Norman C. Harris	McGraw-Hill, New York, 1974

Title of the Course: Energy Conservation and Management Course Code: 25MHP1206C	L	T	P	Credit
	3	--	--	3

Course Pre-Requisite:

Environmental Studies, Elements of Mechanical Engineering, Thermodynamics

Course Description:

Covers energy resources, auditing, management, and conservation techniques, with focus on industrial efficiency, financial analysis, environmental impact, and sustainable development.

Course Objectives:

By the end of this course, the students will be able to:

1. To emphasis the student to study and understand the energy data of industries.
2. To explain the problems energy accounting and balancing
3. To workout energy audit and motivate the students to suggest methodologies for energy savings.
4. To prepare the students utilize the available resources in optimal ways.
5. To emphasis the student to study and understand the energy data of industries.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Describe various energy conservation techniques and their applications in different sectors.
CO2	Use energy audit tools and techniques to assess the energy performance of buildings and industrial processes.
CO3	Exercise energy audit and suggest methodologies for energy savings.
CO4	Review and interpret energy policies and their implications for energy management practices.
CO5	Design a basic energy audit and conservation plan considering financial, technical and environmental aspects.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	3	2	-	-	-	1
CO2	3	3	2	3	3	3	2	-	-	2	2
CO3	3	3	3	3	3	3	3	1	1	2	3
CO4	2	2	1	2	2	3	3	2	1	2	2
CO5	3	3	3	3	3	3	3	2	1	2	3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Assignment/ Surprise test/ Quiz/ Seminar/ Group discussions /presentation, etc.

MSE is based on 50% course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents

Unit No.	Unit Title and Contents	Hours
1.	**Introduction of Commercial and non-commercial energy** Commercial and non-commercial energy, Primary energy resources, Commercial energy production, Final energy consumption, Indian energy scenario, Sectorial energy consumption, Energy needs of growing economy, Energy intensity on purchasing power parity (PPP) basis, long term energy scenario, Energy pricing, Energy security, Energy strategy for the future, Energy conservation and its importance	**08**
2.	**Energy auditing** methodology & analysis, Definition of energy management & its objectives, energy audit, need, types of energy audit, energy performance, matching energy use to requirements, maximizing systems efficiencies, energy audit instruments and metering.	**08**
3.	**Financial Management** Investment need, Appraisal and criteria Financial Analysis techniques, Simple Payback Period, Return On Investment, Net Present Value, Interest rate of return, Risk and sensitivity analysis, Financing Options, ESCOS.	**08**
4.	**Energy Conservation in Energy Intensive Industries**. Cogeneration – Need, Principle, Technical Options for Cogeneration. Classification, Factors Influencing choice, Heat to Power ratios, Load Patterns, Prime movers used in Conservation. Advantages and Disadvantages of various systems. Case Studies	**08**
5.	**Energy and Environment** Air pollution, Climate change, United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM methodology and procedure, Sustainable Development.	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Energy Manager Training Manual (4 Volumes)	Bureau of Energy Efficiency (BEE)	www.energymanagertraining.com, Bureau of Energy Efficiency, Govt. of India, 2004

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Energy Manager Training Manual (4 Volumes)	Bureau of Energy Efficiency (BEE)	www.energymanagertraining.com, BEE, Govt. of India, 2004
2	Energy Management	W.R. Murphy, G. McKay	Butterworth's
3	Industrial Energy Management and Utilization	L.C. Witte, P.S. Schmidt, D.R. Brown	Hemisphere Publishing, Washington, 1988
4	Design and Management for Energy Conservation	P.W. Callaghan	Pergamon Press, Oxford
5	Energy Manager Training Manual (4 Volumes)	Bureau of Energy Efficiency (BEE)	www.energymanagertraining.com, BEE, Govt. of India, 2004

Title of the Course: Battery Thermal Management System Course Code: 25MHP1206D	L	T	P	Credit
	3	--	--	3

Course Prerequisite:
Basic knowledge of Thermodynamics and Heat Transfer.

Course Description:
This course covers fundamentals of electrochemistry, lithium-ion battery technologies, and battery pack construction. It introduces Battery Management Systems (BMS), their design, protection, and control, along with recent trends in energy storage, renewable integration, recycling, and economic aspects.

Course Objectives:

By the end of this course, the students will be able to:

1. To understand the fundamentals of electrochemistry and lithium-ion battery technologies.
2. To study battery pack construction, protection, and safety mechanisms.
3. To explain the functions, topology, and requirements of Battery Management Systems (BMS).
4. To develop knowledge of BMS design, installation, testing, and troubleshooting.
5. To explore recent trends, renewable integration, recycling, and economic aspects of battery systems.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the fundamentals of electrochemistry, lithium-ion chemistry and performance characteristics of EV batteries.
CO2	Identify and describe battery pack construction, safety, and protection features.
CO3	Analyze the functionality, topology, and requirements of Battery Management Systems (BMS).
CO4	Design and evaluate BMS circuits, including installation, testing, and troubleshooting.
CO5	Interpret recent trends in energy storage, renewable integration, recycling, and economic aspects of battery systems.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	2	-	-	-	2
CO2	2	3	2	-	2	-	2	-	-	-	2
CO3	3	3	-	2	2	-	3	-	-	-	2
CO4	3	2	3	3	3	-	3	-	-	-	2
CO5	2	2	-	2	2	2	3	-	-	-	3

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/Group discussions presentation, etc.

MSE is based on 50% of course content.

ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents:

Unit No.	Unit Title and Contents	Hours
1.	**Energy and Electrochemistry:** Sources of energy for propulsion & their comparison: Net Calo1ific Value, Conversion efficiency, History and background of battery technology, Electrochemistry fundamentals & te1minologies, Lithium ion battery and different chemistries, Portable power applications and electrical load requirements, Factors affecting the choice of EV battery systems, Commercially available lithium ion cells, Electrical characteristics of battery: Capacity, C-rate, impedance, DOD, SOC, SOH, Life cycles, Mechanical characteristics, Fonn factor, Safety.	**08**
2.	**Battery Pack Construction:** Battery modules and complete battery pack system, Assembly methods, Electrical connections, Cell level protection system, batte1y pack level protection system, Understanding laptop battery pack system.	**08**
3.	**Battery Management System:** Introduction, Battery pack requirements: Measurement, Protection and management, Cell balancing, Battery pack electronics, Battery Management System (BMS): Functionality, technology and topology (centralized) modular, master-slave, distributed).	**08**
4.	**Design of Battery Management System:** BMS Application Specific Integrated Circuit (ASIC) selection, Analog BMS design, Digital BMS design, BMS deploying: Installing, testing and Troubleshooting	**08**
5.	**Recent Trends and Economy:** Communication systems for battery pack, Review of electric car battery pack, Important considerations, Recent trends: Grid level energy storage, Solar & wind integration, Recycling and pricing.	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Electric Vehicle Technology Explained	James Larrninie	John Wiley & Sons
2.	Themal Management of Electric VehicleBattery Systems	Ibrahim Dincer, Halil S. Hamut, Nader Javani,	ISBN: 978-1-118-90024-6

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1	Modem Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals	Mehrdad Ehsani, Yimin Gao, Ali Emadi	CRC Press

Title of the Course: Research Methodology Course Code: 25MHP1207	L	T	P	Credit
	3	--	--	3

Course Prerequisite: Nil

Course Description:

This course provides students with a systematic understanding of research processes, methodologies, and techniques used across academic and professional disciplines. It covers the formulation of research problems, development of research objectives and hypotheses, selection of appropriate research designs, data collection methods, statistical analysis, interpretation of results, and academic writing.

Course Objectives:

By the end of this course, the students will be able to:

1. To prepare students for undergoing research, identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology.
2. To enable students to interpret the results, propose theories, suggest possible/alternative solutions, solve, and prove the solution adapted–logically and analytically, conclude the research findings.
3. To impart knowledge to analyse critically the literature and publish research in reputed conferences/ journals.
4. To expose students to research ethics, IPR and Patents.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the fundamental research process, including identification of research problems, formulation of objectives, and approaches to data collection and analysis.
CO2	Apply statistical and experimental methods such as T-test, ANOVA, and regression analysis in research methodology.
CO3	Analyze research problems using hypothesis testing and validate findings with appropriate tools and techniques.
CO4	Compose research articles, project reports, and dissertations using effective technical writing and reference management tools.
CO5	Draft patent and IPR documentation include filing procedures and explain national/international frameworks for protection of intellectual property.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	2
CO2	3	3	2	2	2	-	-	-	-	-	2
CO3	3	3	2	2	3	-	-	-	-	-	2
CO4	3	3	3	2	3	-	-	-	-	-	2
CO5	3	3	2	2	3	2	3	-	-	-	2

Assessment Scheme:

Two components of Continuous Assessment (CA-1, CA-2), Mid Semester Examination (MSE) and End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment Component	Marks
CA1	10
CA2	10
MSE	30
ESE	50

CA1 and **CA2** are based on Surprise test/ Assignment/ Quiz/Seminar/ Group discussions presentation, etc.
MSE is based on 50% of course content.
ESE is based on 100% course content with 60-70% weightage for course content covered after MSE.

Course Contents:

Unit No.	Unit Title and Contents	Hours
1.	**Engineering Research Process:** Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Definition, scope and objectives of research problem. Approaches of investigation of solutions for research problems, data collection, analysis, interpretation.	**08**
2.	**Research Methodology:** Problem statement formulation, resources identification for solutions, Experimental and Analytical modeling, Simulations, Numerical and Statistical methods in engineering research. Hypothesis and its testing by different techniques: T-Test, Z-test etc.	**08**
3.	**Research Methods:** Uni and Multivariate Analysis: ANOVA, Design of Experiments/Taguchi Method, Regression Analysis. Software tools like spreadsheets. Processing and Analysis of Data: Processing Operations, Types of Analysis-Presentation and Interpretation of Data Editing, Classification and Tabulation-Interpretation. Analyze your results and draw conclusions.	**08**
4.	**Research Practices:** Effective literature studies approaches, critical analysis, Plagiarism, Research ethics, Mendeley - Reference Management Software. Research communication- Effective Technical Writing, Writing a research article for Journal/conference paper, Technical report, Dissertation/ Thesis report writing, Software used for report writing such as word, Latex etc. Presentation techniques for paper/report/seminar. Publishing article in Scopus/SCI/Web of science indexed journal or conference.	**08**
5.	**Patents:** Patent Rights: Scope of Patent Rights, Various Patent databases, Geographical Indications. Procedure for grants of patents, Patenting under Patent Cooperation Treaty (PCT). Licensing and transfer of technology. Administration of Patent System. Introduction to International Scenario: World Intellectual Property Organization (WIPO), Trade-Related Aspects of Intellectual Property Rights (TRIPs), Patenting under PCT	**08**

Textbooks:			
Sr. No.	**Title**	**Author**	**Publisher**
1.	Research Methodology	Kothari C. R	New Age International
2.	Research Methodology: An Introduction for Science & Engineering Students	Melville Stuart and Goddard Wayne,	Juta and Company

Reference Books:			
Sr. No.	**Title**	**Author**	**Publisher**
1.	Intellectual Property in New Technological Age	Merges Robert, Menell Peter, Lemley Mark,	ASPEN Publishers
2.	Intellectual Property Rights Under WTO	Ramappa T	S. Chand