GOKUL GLOBAL UNIVERSITY
Approved By Govt. of Gujarat
(Recognized by UGC under Section 22 & 2(f) of 1956)
(Gujarat Private State University Act 4 of 2018)

COURSE STRUCTURE

Master of Engineering

Mechanical Engineering

(Thermal Engineering)

Under

Choice Based Credit System (CBCS)

Faculty of Engineeering
Hansaba College of Engineering & Technology
University Campus, State Highway-41, Siddhpur - 384151, Dist. Patan, Gujarat, INDIA
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Semester -I

Sr. No.	Subject Name	Subject Code	Credit	Teaching Scheme Per Week				Examination Marks				Total Marks
								Theory		Practical		
				Th	Tu	P	Total	SEE (E)	PA (M)	VIVA (V)	PA (I)	
1	Research Skill & Methodology	FEM110001	2	1	0	2	3	0	0	50	50	100
2	Disaster Management (Mandatory Course)	FEM110002	0	2	0	0	2	70	30	0	0	100
3	Applied Computational Method	FEM115101	4	3	0	2	5	70	30	30	20	150
4	Advanced Thermodynamics and Heat Transfer	FEM115102	4	3	0	2	5	70	30	30	20	150
5	Elective-I		4	3	0	2	5	70	30	30	20	150
6	Elective-II		4	3	0	2	5	70	30	30	20	150
Total			**18**	**15**	**0**	**10**	**25**	**350**	**150**	**150**	**150**	**800**

- **Elective-I**
  1. Advanced Internal Combustion Engine- FEM115105
  2. Cryogenic Engineering- FEM115106
  3. Solar Energy Engineering- FEM115107

- **Elective- II**
  1. Thermal and Nuclear Power Plants- FEM115108
  2. Hydrogen and Fuel Cell Technology- FEM115109
  3. Design of Heat Exchanger- FEM115110

Semester -II

Sr. No.	Subject Name	Sub. Code	Credit	Teaching Scheme Per Week				Examination				Total Marks
								Theory		Practical		
				Thy	Tut	Pra	Total	SEE (E)	PA (M)	VIVA (V)	PA (I)	
1	RESEARCH PAPER WRITING (MANDOTARY COURSE)	FEM120001	0	2	0	0	2	70	30	0	0	100
2	EXPERIMENTAL TECHNIQUES AND INSTRUMENTATIONS IN THERMAL SYSTEMS	FEM125101	4	3	0	2	5	70	30	30	20	150
3	ADVANCED FLUID MECHANICS	FEM125102	4	3	0	2	5	70	30	30	20	150
4	ELECTIVE-III		4	3	0	2	5	70	30	30	20	150
5	ELECTIVE-IV		4	3	0	2	5	70	30	30	20	150
6	MINI PROJECT WITH SEMINAR	FEM125109	2	0	0	4	4	0	0	0	100	100
TOTAL			**18**									**800**

- **Elective-III**
  1. Advanced Refrigeration Engineering (FEM125103)
  2. Design and Optimization of Thermal System (FEM125104)
  3. Combustion Engineering (FEM125105)

- **Elective- IV**
  1. Energy Conservation & Management (FEM125106)
  2. Advanced Air conditioning Engineering (FEM125107)
  3. Computational Fluid Dynamics (FEM125108)

Semester -III

Sr. No.	Subject Name	Sub. Code	Credit	Teaching Scheme Per Week				Examination				Total Marks
								Theory		Practical		
				Thy	Tut	Pra	Total	SEE (E)	PA (M)	VIVA (V)	PA (I)	
1	INTERNAL REVIEW-I	FEM135101	2	0	0	4	4	0	0	0	100	100
2	DISSERTATION PHASE-I	FEM135102	8	0	0	16	16	0	0	100	0	100
3	OPEN ELECTIVE		3	3	0	0	3	70	30	0	0	100
4	ELECTIVE-V		3	3	0	0	3	70	30	0	0	100
TOTAL			**16**									**400**

- **Open Elective**
  1. Industrial Safety (FEM135103)
  2. Cost management of Engineering Projects (FEM135104)
  3. Composite Materials (FEM135105)

- **Elective- V**
  1. Advanced Thermal Turbo Machines (FEM135106)
  2. Jet Propulsion & Air-Craft Engineering (FEM135107)
  3. Exergy Analysis of Thermal Systems (FEM135108)

Semester -IV

Sr. No.	Subject Name	Sub. Code	Credit	Teaching Scheme Per Week				Examination				Total Marks
								Theory		Practical		
				Thy	Tut	Pra	Total	SEE (E)	PA (M)	VIVA (V)	PA (I)	
1	INTERNAL REVIEW-II	FEM145101	2	0	0	4	4	0	0	0	100	100
2	DISSERTATION PHASE-II	FEM145102	14	0	0	28	28	0	0	100	0	100
TOTAL			**16**									**200**

FEM110001: RESEARCH SKILL AND METHODOLOGY

Credit-2 **L:T:P -:1:0:2**

Unit No	Subject Content	Teaching Hours	(%) Weightage
1	**Introduction to Research:** Nature and Scopeof Research, Information Based Decision Making and Source of Knowledge. The ResearchProcess, Basic approaches and Terminologies used inResearch, Defining Research Problem and FramingHypothesis, Preparing a Research Plan **Defining the Research Problem and Research Design** What is a Research Problem?, Selecting the Problem, Necessity of Defining the Problem, Meaning of Research Design, Need for Research Design, Future of a Good Design, Important Concepts Relating to Research Design, Different Research Design, Basic Principals of Experimental Designs	13	31
2	**Sampling Design** Census and sample survey, Implications of a Sample Design,Steps in sampling Design, Criteria of Selecting a SamplingProcedure, Characteristics of a Good Sample Design, DifferentTypes of sample Designs, How to Select a Random Sample?,Random Sample from an Infinite Universe, Complex RandomSampling Designs **Methods of Data Collection** Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Data through Schedules, Difference between Questionnaires and Schedules, Some Other Methods of Data Collection, Collection of Secondary Data, Selection of Appropriate Method for Data Collection	14	34
3	**Data Analysis** Data Analysis and Presentation Editing and coding of data, tabulation, graphic presentation of data, cross tabulation, Testing of hypotheses; Parametric and nonparametric tests for Univariate and Bivariate data. Tests of association; simple linear regression and other non-parametric tests, Sampling techniques, Probability, Probability Distributions, Hypothesis Testing, Level	7	12

	ofSignificanceand Confidence Interval, t-test, ANOVA, Correlation, Regression Analysis		
4	**Interpretation of Data and Paper Writing** Layout of a Research Paper, Journals in ComputerScience, Impact factor of Journals, When and where to publish? Ethical issues related to publishing,Plagiarism and Self-Plagiarism, Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer ScienceDiscipline.	**4**	**10**
5	**Report Writing** Significance of Report Writing, Deferent Steps in Writing Report. Layout of the Research Report, Types of Report, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing a Research Report **Patent Rights** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications	**4**	**13**

- **Reference Books:**

1. Research Methodology Methods and Techniques by C. R. Kothari, New Age International Publishers.
2. Research Methodology by D. K. Bhattacharyya, Excel Books Publications.
3. Research Methodology: A Guide for Researchers in Management and Social Sciences by Taylor, Sinha & Ghoshal, PHI Publications

- **Course outcome**

After completion of the course, the students will be able to:

CO-1: Conduct a quality literature review and find the research gap.

CO-2: Identify an original and relevant problem and identify methods to find its solution.

CO-3: Validate the model

CO-4: Present and defend the solution obtained in an effective manner in written or spoken form

CO-5 : take up and implement a research project/ study.

Course Outcomes	Expected Mapping with Programme Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	3	3	2	3	3	1	2	3	3	-	-
CO-2	2	3	3	2	3	3	1	2	3	3	-	-
CO-3	2	3	3	2	3	3	1	2	3	3	-	-
CO-4	2	3	3	2	3	3	1	2	3	3	-	-
CO-5	2	3	3	2	3	3	1	2	3	3	-	-

FEM110002: DISASTER MANAGEMENT

Credit-0 **L:T:P -:2:0:0**

Unit	Description in detail	Teaching Hours	Weightage
I	**Introduction:** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	**04**	**17%**
II	**Repercussions Of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War And Conflicts	**04**	**17%**
III	**Disaster Prone Areas In India:** Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	**04**	**17%**
IV	**Disaster Preparedness And Management:** Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness	**04**	**17%**
V	**Risk Assessment:** Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival. **Disaster Mitigation:** Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	**08**	**32%**

Reference Books :

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Course Outcomes :

After completion of the course, the students will be able to:

CO-1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO-2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO-3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations..

CO-4: Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

CO-5: Understand impact of Disasters and realization of societal responsibilities.

CO-6: Apply Disaster management principles.

Course Outcomes	Expected Mapping with Programme Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2	2	2	3	-	-	1	2	2	1	1
CO-2	3	2	2	1	2	-	-	1	3	2	2	1
CO-3	3	3	1	2	1	-	-	1	2	2	2	2
CO-4	3	3	3	2	2	-	-	-	2	3	2	-
CO-5	3	2	3	2	3	-	-	2	3	2	2	2
CO-6	1	3	2	2	2	-	-	1	3	3	1	2

FEB115101: APPLIED COMPUTATIONAL METHOD

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**ODE** Basic Concepts: Modelling, Differential Equations, Ordinary and Partial differentiation, Order of the equation, Solution, Existence and Uniqueness of Solution, , Initial Value problem, Boundary Value Problem, Linear and Non-Linear Equation. 1st Order ODE: Geometric Meaning of y'= f(x, y), Direction Fields, Euler's Method; Separable ODEs; Exact ODEs (Integrating Factors Method, Existence and Uniqueness of Solution, Linear ODEs (Homogeneous and Non-Homogeneous, Reduction to Linear problems); Orthogonal Trajectories, Linear Dependence and Linear Independence; Homogeneous Linear ODEs of Second Order (Initial Value Problem, Boundary Value Problem), Homogeneous Linear ODEs with Constant Coefficients (Euler's formula and review of the circular and hyperbolic function, Exponential Solutions, Repeated Roots and Stability);Solution by[1/f(D)] r(x) method for finding particular integral. Differential Operator; Modelling of Free Oscillations of Spring-Mass System, Homogeneous Linear ODEs with Non Constant Coefficient (Cauchy-Euler Equation, Non-homogeneous ODE, , Modelling of Forced Oscillations, Solution by Variation of Parameters	9	21%
2	**Laplace Transforms & Fourier Analysis** Laplace Transform, Linearity, First Shifting Theorem (s-Shifting);Transforms of Derivatives and Integrals, ODE; Unit Step Function(Heaviside Function),, Second Shifting Theorem (t-Shifting); Short Impulses, Dirac's Delta Function, Partial Fractions; Convolution, Integral Equations; Differentiation and Integration of Transforms, , ODEs with Variable Coefficients; Systems of ODEs., Fourier Series; Arbitrary Period, Even and Odd Functions, Half-Range Expansions; Forced oscillations, Approximation by Trigonometric Polynomials; Sturm–Liouville Problems, Orthogonal Functions; Orthogonal Series, Generalized Fourier Series, Fourier Cosine and Sine Transforms, Fourier Transform.	10	12%
3	**PDE** Basic Concepts of PDEs; Modeling: Vibrating String, Wave	8	18%

	Equation;Solution by Separating Variables, Use of Fourier Series; D'Alembert's Solution of the Wave Equation, Characteristics; Modelling: Heat Flow from a Body in Space,, Heat Equation: Solution by Fourier Series. Steady Two-Dimensional Heat Problems, Dirichlet Problem; Modelling Very Long Bars: Solution by Fourier Integrals and Transforms, , Membrane, Two-Dimensional Wave Equation; Rectangular Membrane, Double Fourier Series, Laplacian in Polar Coordinates, Circular Membrane, Fourier–Bessel Series; Laplace's Equation in Cylindrical and Spherical Coordinates, Potential; Solution of PDEs by Laplace Transforms.		
4	**LinearAlgebra** Matrices and Vectors: Addition and Scalar Multiplication, Matrix Multiplication; Linear Systems of Equations and Gauss Elimination, Linear Independence, Rank of a Matrix, Vector Space; Solutions of Linear Systems: Existence and Uniqueness, Determinants and Cramer's Rule; Inverse of a Matrix, Gauss–Jordan Elimination; Vector Spaces, Inner Product Spaces, Linear Transformations; Matrix Eigenvalues, Determining Eigenvalues-Eigenvectors and their applications, Symmetric, Skew-Symmetric, and Orthogonal Matrices; Eigenbases, Diagonalization, Quadratic Forms; Complex Matrices and Forms. **NumericAnalysis** Introduction, Solution of Equations by Iteration, Interpolation, Newton's Divided-Difference Interpolating Polynomials, Lagrange Interpolating Polynomials, Coefficients of an Interpolating Polynomial, Inverse Interpolation, Spline Interpolation, Numeric Integration and Differentiation. , Numeric Methods for: First-Order ODEs, Multistep Methods, Systems and Higher (upto second) Order ODEs, Elliptic PDEs, Neumann and Mixed Problems, Irregular Boundary, Parabolic PDEs, Hyperbolic PDEs.	12	23%
5	**Probability & Statistics** Data Representation, Average, Spread; Experiments, Outcomes, Events, Probability, Permutations and Combinations; Random Variables, Probability Distributions; Mean and Variance of a Distribution; Binomial, Poisson, and Hypergeometric Distributions; Normal Distribution, Introduction, Random Sampling; Point Estimation of Parameter, Confidence Intervals, Testing Hypotheses, Decisions; Goodness of Fit, X2 - Test,	9	16%

	Nonparametric Tests, Regression, Linear Regression, Polynomial Regression, General Linear Regression, Nonlinear Regression, Correlation		

References Books: -

1. Advanced Engineering Mathematics, 9/e By Erwin Kreyszig JOHN WILEY & SONS, INC.
2. Advanced Engineering Mathematics, 2/e By M D Greenberg Pearson Education
3. Higher Engineering Mathematics, By Dr. B.S. Grewal, Khanna Publishers.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO-1: Students will be able to develop mathematical models of physical phenomena.

CO-2: Students will be able to solve ordinary and partial differential equations analytically.

CO-3: Students will learn fundamentals and applications of algebra for engineering problems.

CO-4: Solve algebraic equations

CO-5: Carry out interpolations and curve fitting

CO-6: Apply iterative and transformation methods in THERMAL engineering

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	3	2	2	1	3	-	2	-	-	2	2	2
CO-2	3	2	-	-	3	1	-	-	-	-	1	1
CO-3	3	2	2	2	3	1	2	-	3	2	-	2
CO-4	3	-	2	2	2	3	1	-	-	2	-	2
CO-5	3	1	-	1	1	3	3	-	-	-	2	2
CO-6	3	1	1	-	-	1	1	-	2	3	2	2

FEM115102: ADVANCED THERMODYNAMICS & HEAT TRANSFER

Course Objective:-The course is prepared to provide the detailed understanding of laws and principles of Thermodynamics and Heat Transfer

Teaching & Evaluation Scheme:-

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Th:-Theory, Tu: - Tutorial, P:- Practical, SEE:- Semester End Examinations, PA :- Progressive Assessment

Content:-

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Entropy:** Increases of entropy principle and its application, Tds relation, entropy change of solid, liquid and ideal gas, entropy transfer with heat transfer, entropy generation in open and closed system , entropy balance.	5	12%
2.	**Exergy Analysis:** Concepts, exergy balance, Exergy transfer by heat, work & mass, decrease of exergy principle and exergy destruction, applications of Gouy–Stodola theorem, exergetic efficiency, exergy analysis of power and refrigeration cycles, elements of irreversible thermodynamics, second law efficiency.	6	13%
3.	**Basics of Heat Transfer:** **Conduction:** Conduction Rate Equation, Heat Diffusion Equation, Boundary and Initial Conditions, General conduction Equation, Conduction with Heat Generation, Extended Surfaces with Uniform and Non Uniform Cross Sections, Two Dimensional Steady State Conduction: Mathematical, Graphical and Numerical Analysis of Two Dimensional Heat Conduction Unsteady State Conduction: Lumped Parameter Analysis, Numerical Solutions, Heisler and Semi Analytical Analysis.	12	28%
4.	**Convection:** Different Types of Flow and Boundary Layers, Flow Through Tubes, Flow Over Flat Plates, Cylinders, Spheres and Tube Blanks, Free Convection on Flat Surfaces, Cylinders, Spheres and Enclosed Spaces. Heat Transfer during Phase Transformation: Boiling: Pool Boiling and its	12	28%

	Correlations, Forced Convection Boiling, Condensation: Laminar and Turbulent Film Contestation, Film Condensation in Radial Surfaces and Horizontal Tubes, Heat Pipe.		
5.	**Radiation:** Radiation Intensity, Blackbody Radiation, Emission from Real Surfaces. Radiation: Combine with Conduction and Convection, Radiation Exchange with Participating Media, Radiative exchange and overall heat transfer in furnaces.	7	19%

References Books:-

1. Thermodynamics – An Engineering Approach by Yunus Cengel & Boles, McGraw-Hill Publication, New Delhi
2. Fundamentals of Thermodynamics by Sonntag, Borgnakke & Van Wylen, John Wiley & Sons (Asia) Pvt. Ltd.
3. Engineering Thermodynamics by P.K. Nag, McGraw-Hill , New Delhi
4. Fundamentals of Heat and Mass Transfer, by Incropera, Dewitt, John Wiley & Sons (Asia) Pvt. Ltd.
5. Heat Transfer by J P Holman, McGraw-Hill Publication, New Delhi
6. A Heat Transfer Textbook by J H Lienhard, Phlogiston Press

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO-1: Apply entropy principle to various thermal engineering applications
CO-2: Apply the concept of second law efficiency and exergy principle to various thermal engineering applications
CO-3: Analyze steady state and transient heat conduction problems of real life Thermal systems
CO-4: Analyze extended surface heat transfer problems and problems of phase change heat transfer like boiling and condensation
CO-5: Analyze radiation heat transfer problems of various thermal systems
CO-6: Apply the concepts of radiation heat transfer for enclosure analysis.

Course Outcomes	Expected Mapping with Programme Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2	2	2	1	2	-	-	-	-	-	-
CO-2	2	2	2	3	2	2	-	-	-	-	-	-
CO-3	2	2	2	2	2	2	-	-	-	-	-	-
CO-4	3	2	2	1	2	2	-	-	-	-	-	-
CO-5	2	3	2	2	1	2	-	-	-	-	-	-
CO-6	2	2	3	3	2	1	-	-	-	-	-	-

FEM115105: ADVANCED INTERNAL COMBUSTION ENGINE

Course Objective :-The course is prepared to provide the detailed understanding of laws and principles of Thermodynamics and Heat Transfer

Teaching & Evaluation Scheme:-

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Th:-Theory, Tu: - Tutorial, P:- Practical, SEE:- Semester End Examinations, PA :- Progressive Assessment

Content:-

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1	**Engine Design and Operating Parameters:** Engine operating cycles, spark ignition engine operation, compression ignition engine operation, geometrical properties of reciprocating engine, brake torque and power, friction power, indicated power, fuel consumption, air consumption, mechanical efficiency, mean effective pressure, specific fuel consumption, air/fuel and fuel/air ratio, specific emission and emission index, engine design and performance data, Supercharged & turbocharged engine.	6	12%
2	**Gas exchange processes:** Flow through valves, phase of the flow, turbulence, analysis of suction and exhaust processes, manifold tuning, fuel injection systems.	4	10%
3	**Ideal Models of Engine Cycles:** Ideal models of engine processes, thermodynamic relations for engine processes, constant volume cycle, constant pressure cycle, basics of simulation in SI and CI Engine cycles, real engine cycles	4	10%
4	**Alternate fuels for IC engines:** Fuels & their properties, future fuels like Hydrogen, Bio gas, Alcohols, producer gas, LPG, CNG- fuels rating Coal- gasification & liquefaction, Non edible vegetable oils, non edible wild oil, NH3 as substitute fuel for SI and CI engine, fuel additives. Pros and cons of alternate fuel.	6	12%

5	**Combustion in SI and CI engine:** Combustion of SI and CI engine, Normal and abnormal combustion parameters effecting various phases of combustion, Combustion chambers, construction and design, Battery, magneto electronic- ignition system in SI engine, Volumetric efficiency.	8	16%
6	**Heat Transfer, Friction and Lubrication in IC Engines:** Convective and radiative heat transfer, thermal loading on components, friction fundamentals, engine friction components, lubricant requirement, lubrication system.	4	10%
7	**Air–pollution from I.C. Engines:** S.I. & C.I. Engine Emission effects of pollutants on Human health & Biological sphere. Measurement techniques used to measure pollutants. Control of emission from S.I. & C.I. engines, Noise pollution & its control. Catalytic converters, Pollution law.	8	18%
8	**Recent Developments in IC Engines:** MPFI, their advantages & limitations, PIV in turbulence measurement, optical methods for flame velocity measurement, new materials for engine components, improved two stroke engines, hybrid engines and vehicles, lean burn engines, stratified charge engines, HCCI engines	4	12%

List of Suggested Practical:-

1 To study the constructional details and working principal of IC engines

2 To prepare variable speed performance test of a multi / single cylinder petrol / diesel engine and prepare the curve:

(i) BP, IP, FP Vs Speed (ii) Indicated specific fuel consumption Vs Speed

3. To find the indicated horse power on multi cylinder diesel engine / petrol engine by Morse test.

4. To find friction horse power of multi cylinder diesel engine / petrol engine by Willian's line method and motoring method.

5. To study about first law analysis for steady state reacting system and combustion stoichiometric.

6. To prepare heat balance sheet on multi cylinder diesel engine / petrol engine.

7. To study the effect of A/F ratio on the performance of the two stroke single cylinder petrol engine.

8. To analyze the exhaust gases emission from single / multi cylinder petrol engine.

9. To study and draw the valve timing diagram four stroke petrol and diesel engine.

10. To prepare a report on Indian emission norms.

References Books:-

1. Internal Combustion Engine Fundamentals by John B. Heywood, McGraw Hill Education Pvt Ltd.
2. Fundamentals of Internal Combustion Engines by H N Gupta, PHI Learning
3. Internal Combustion Engine by V Ganeshan, McGraw Hill Education Pvt Ltd.
4. Internal Combustion Engine by M L Mathur and R P Sharma, DhanpatRai Publications (P) Ltd.
5. Internal Combustion Engines: Applied Thermo-sciences, Colin R Ferguson, John Wiley and Sons.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO-1: The student can identify different areas of Advanced Internal Combustion Engine.
CO-2: Can find the applications of all the areas in day to day life.
CO-3: Understand the operating characteristics of IC engines.
CO-4: Perform a thermodynamic analysis of IC engine cycles.
CO-5: Perform a combustion analysis of IC engines.
CO-6: Classify and analyze alternate power sources for automobiles.

Course Outcomes	Expected Mapping with Programme Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	1	2	2	1	2	-	-	-	-	-	-
CO-2	2	1	1	1	1	2	-	-	-	-	-	-
CO-3	3	2	3	2	-	2	-	-	-	-	-	-
CO-4	2	2	1	1	1	2	-	-	-	-	-	-
CO-5	2	2	1	1	1	2	-	-	-	-	-	-
CO-6	2	2	3	2	2	2	-	-	-	-	-	-

FEM115108: THERMAL AND NUCLEAR POWER PLANTS

Course Objective:- The course is prepared to provide the detailed insight of Thermal & Nuclear power plants

Teaching & Evaluation Scheme:-

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Th:-Theory, Tu: - Tutorial, P:- Practical, SEE:- Semester End Examinations, PA :- Progressive Assessment

Content:-

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Introduction:** Types of Power plant, thermal & nuclear power plants in India, comparison of thermal & nuclear power plants, Layout of thermal & nuclear power plants, recent developments in power generation.	3	5%
2.	**Steam turbine power plant:** Main elements and working of steam power plant, thermodynamic analysis of simple Rankine cycle, performance enhancement methods; regeneration (up to 3-stages), reheat, thermal analysis of steam condenser & cooling tower, recent development and advancement in steam power plant engineering, maintenance as well as safety measure of components of steam power plant.	12	30%
3.	**Gas turbine power plant:** Elements of gas turbine power plant, thermal analysis of simple gas turbine power plant, performance enhancement methods; intercooling, reheat & regeneration, cogeneration, combined cycle power plant, waste heat recovery systems, maintenance as well as safety measure of components of gas turbine power plant.	10	25%
4.	**Nuclear power plant:** Nuclear reaction, Nuclear Reactor, Classifications, Types of reactors, Site Selection, Method of enriching uranium, Nuclear Power Plant Safety, Bi-Product of	9	25%

	nuclear power generation, Nuclear power plant in India, three stage program, Future of nuclear power.		
5.	**Power plant instrumentations:** Pressure measuring instruments, Temperature measurement and Flow Measurement, pollution types, methods of control, factors affecting the economics, loading factors, utilization factor, performance and operating characteristics of power plant.	5	10%
6.	**Economics of Power Generation:** Load curves, Base load and peak load power plants, Load factor, Plant capacity factor, Plant use factor, Demand factor, Diversity factor, Cost of power plant, Performance and operating characteristics of power plant, Tariff for electric energy.	3	5%

Reference Books:

1. Power Plant Engineering, P.K. Nag, McGraw-Hill Education
2. Power Plant Technology, M.M. El-Wakil, McGraw-Hill Education
3. Thermal Engineering, R.K.Rajput, Laxmi Publication
4. Gas Turbines by V Ganeshan, McGraw Hill Education
5. Steam Turbine Theory and Practice, William J. Kearton, CBS Publication

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO-1: Carry out energy analysis of thermal & nuclear power plants
CO-2: Discuss the layout of thermal power plant and working principle of various types of boilers.
CO-3: Discuss the various types of nuclear reactors used in nuclear power plant
CO-4: Summarize the principles and working of various renewable energy power plants.
CO-5: Explain the energy, economic and environmental issues of power plants
CO-6: Paraphrase the different types of power plant, its function and issues related to them

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	2	2	1	1	1	2	-	-	-	-	-	-
CO-2	2	-	-	-	-	-	-	-	-	-	-	-
CO-3	2	-	-	-	-	-	-	-	-	-	-	-
CO-4	2	-	-	-	-	-	-	-	-	-	-	-
CO-5	2	1	-	-	-	-	3	-	-	-	-	-
CO-6	2	1	-	-	-	-	-	-	-	-	-	-

FEM120001:RESEARCH PAPER WRITING

Credit-0 **L:T:P -:2:0:0**

Sr No	Subject Content	Teaching Hours	(%) Weightage
1.	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	**4**	**17**
2.	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	**4**	**17**
3.	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check	**4**	**17**
4.	key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	**4**	**17**
5.	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions , useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	**08**	**32**

Reference Books:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbo
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidell London, 2011

Course Outcome:

At the end of the course, the student will be able to:

CO 1 Understand that how to improve your writing skills and level of readability.
CO 2 Learn about what to write in each section.
CO 3 Understand the skills needed when writing a Title.
CO 4 Ensure the good quality of paper at very first-time submission
CO 5 Relate the quantum concepts in electron microscopes
CO 6 Describe the unit cell characteristics and the growth of crystals

Course Outcomes	Expected Mapping with Programme Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	-	2	1	3	-	2	3	2	2	2	-
CO-2	3	2	-	-	-	-	-	3	2	-	1	-
CO-3	2	2	2	3	-	-	-	1	2	2	-	-
CO-4	2	-	1	2	-	-	-	3	-	2	-	-
CO-5	3	2	-	1	-	-	-	-	2	-	2	-
CO-6	2	2	3	-	-	-	-	3	2	3	2	-

FEM125101: EXPERIMENTAL TECHNIQUES AND INSTRUMENTATIONS IN THERMAL SYSTEMS

Course Objective:- The course is designed to provide the fundamental knowledge of experimentation techniques, related instruments used for thermal engineering applications

Teaching & Evaluation Scheme:-

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Th:-Theory, Tu: - Tutorial, P:- Practical, SEE:- Semester End Examinations, PA :- Progressive Assessment

Content:-

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Experimentation Planning:** Planning of experiments, various stages in experimental investigations; preliminary, intermediate and final, steady state and transient techniques, selection of measuring devices based on static, dynamic characteristics and allowable uncertainties, basics of Taguchi method for design of experiments	8	17%
2.	**Instrumentation & Measurements:** Fundamental elements of a measuring instrument, static and dynamic characteristics, principles of temperature measurement, calibration of thermocouple, RTD, Orifice plate and Pressure gauge, design of temperature measuring instruments, thermo positive elements, thermocouples in series & parallel, pyrometry, steady state and transient methods of measuring heat flux, measurement of thermal radiation and associated parameters, measurement of turbulence, measurement of thermal conductivity of solids, liquids and gases, measurement of thermo-physical properties, measurement of solar radiation	15	35%
3.	**Advancement in measurements:** Data logging and acquisition, use of sensors for error reduction, elements of microcomputer interfacing, intelligent instruments and their use, Basics of P, PI,	8	17%

	PID controllers, pneumatic and hydraulic controllers, electronic controllers		
4.	**Advanced measurement techniques and analysis:** Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, Telemetry in measurement, Gas Analyzers, Smoke meters, gas chromatography, spectrometry	8	17%
5.	**Uncertainty in measurements:** Errors in instruments, Analysis of experimental data and determination of overall uncertainties in experimental investigation, uncertainties in measurement of measurable parameters like pressure, temperature, flow etc. under various conditions	6	14%

.

References Books:-

1.Mechanical Measurements - Buck & Beckwith - Pearson

2. Measurement systems, Application and Design - E O Doebelin - McGraw-Hill

3. Measurements and Instrumentation in Heat Engineering - Prebrashensky V, Volume I &II, MIR Publishers

4. Experimental Methods for Engineers - J P Holman - McGraw-Hill

5. Instrumentation Devices and Systems - Raman C S, Sharma G R, Mani V S N - McGraw-Hill

6. Principles of Measurements and Instrumentation- Morris AS - Prentice Hall of India

7. Measurement Techniques in Heat Transfer - E R G Eckert and Goldsteen - Technovision

8. Mechanical and Industrial Measurements - R K Jain - Khanna Publishers

9. Experimentation and Uncertainty Analysis for Engineers - Huge W Coleman, W Glenn Steele - John Wiley & Sons

List of Suggested Experiments:

1. To calibrate and measure temperature using thermocouple, RTD.

2. To carry out calibration of pressure measuring devices: U-tube manometer, pressure gauge.

3. To measure the thermal conductivity of any fluid.

4. To carry out calibration of flow measuring devices: orifice meter and rotameter.

5. To measure the direct and diffuse solar radiation using pyranometer and pyrheliometer.

6. To carry out exhaust gas analysis with gas chromatographer.

7. To study and familiar with data logging and acquisition system.

8. To study various electronics controllers used in thermal measurements.

9. To study and compare various advanced measurement techniques.

10. To perform experiment with any thermal system and to carry out uncertainty analysis for the same.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO-1: Discuss experimentation techniques for various thermal systems
CO-2: Discuss the various instruments used for measuring different properties significant for evaluation of performance of thermal systems and to carry out uncertainty analysis.
CO-3: Appraise the computing facilities for measurement and acquisition of different properties.
CO-4: Appraise advanced measurement techniques and systems
CO-5: Understand the concepts of errors in measurements, statistical analysis of data, regression analysis, correlation and estimation of uncertainty.
CO-6: Analyse sensing requirements for measurement of thermo-physical properties, radiation properties of surfaces, and vibration.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	2	2	1	1	-	2	-	-	-	-	-	-
CO-2	2	2	-	2	-	-	-	-	-	-	-	-
CO-3	2	1	1	1	-	2	-	-	-	-	-	-
CO-4	2	1	-	-	2	-	-	-	-	-	-	-
CO-5	3	-	2	2	-	-	-	-	-	-	-	-
CO-6	3	-	2	2	-	-	-	-	-	-	-	-

FEM125102: ADVANCED FLUID MECHANICS

Course Objective:- The course is prepared to provide the detailed understanding of fluid mechanics and gas dynamics principles.

Teaching & Evaluation Scheme:-

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Th:-Theory, Tu: - Tutorial, P:- Practical, SEE:- Semester End Examinations, PA :- Progressive Assessment

Content:-

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Review of Basic Concepts and Fluid Properties:** Basic law of Fluid Motion, Internal stresses and external forces on fluid elements, Review of Concepts of Kinematics of fluid motion, vorticity, circulation, velocity potential and stream function, irrotational flow.	4	10%
2.	**Governing Equations of Fluid Flow in Differential Form:** Navier – Stokes Equation and exact solutions, Energy equation and solution of fluid flow with thermal effects.	3	08%
3.	**Dynamics of Ideal Fluid Motion:** Applications, Integrations of Euler's Equation of Motion, Generalized form of Bernoulli Equation, Potential flows, Principle of Superposition. operations, various types of cascade systems and their analysis	4	10%
4.	**Low Reynolds number Approximation of Navier – Stokes Equation:** Creeping flow over sphere, Stokes and Oseen approximation, Hydrodynamic Theory of Lubrication.	3	08%
5.	**High Reynolds number Approximation:** Prandtl's Boundary Layer Equations, Laminar Boundary Layer over a flat plat, Blausius solution, Falkner – Skan solution, Approximation method for solution of Boundary Layer Equation, Momentum Integral	5	10%

	methods, Holstein and Bohlen method, Thermal Boundary Layer, Reynolds Analogy.		
6.	**Transition to Turbulence:** Introduction to Theory of hydrodynamic stability, Orr-Sommerfeld equation, Results from transition studies, factor affecting transition and its control.	4	10%
7	**Fundamental of Turbulent flows:** Reynolds stress tensor, Phenomenological theories of turbulence, Prandtl's Mixing Length and Eddy Viscosity concepts, Universal Velocity distribution, Laws of the Wall and the Wake.	5	12%
8	**One Dimensional Isentropic Flow:** General features, Working equations, Choking in Isentropic flow, Operation of nozzle, diffuser under varying pressure ratio, performance of real nozzles, applications of isentropic flow.	5	12%
9	**Normal Shocks:** Introductory remarks, Governing equations, Rankine Hugoniot, Prandtl and other relations, weak shocks, thickness of shocks, normal shocks in ducts, performance of convergent divergent nozzle with shocks, moving shock waves, shocks problems in one dimensional supersonic diffuser, supersonic pilot tube.	5	12%
10	**Flow in constant area duct with friction**: Governing equations, Working Formulas and tables, Choking due to friction, Performance of long duct, Isothermal flow in long duct and flow in constant area duct with heating and cooling.	4	08%

References Books:-

1. F M White, Fluid Mechanics, McGraw Hill Publishing Co. Ltd.
2. F M White, Viscous Fluid Flow, McGraw Hill Publishing Co. Ltd.
3. Yunus Cengel and John Cimbala, Fluid Mechanics, McGraw Hill Publishing Co. Ltd.
4. H Schlichting, Boundary Layer Theory, McGraw Hill Publishing Co. Ltd.
5. Fox, Pritchard and McDonald, Introduction to Fluid Mechanics, John Wiley & Sons
6. Zucker & Biblarz, Fundamentals of Gas Dynamics, John Wiley & Sons, Inc.
7. James John and Theo Keith, Gas Dynamics, Pearson Prentice Hall
8. S M Yahya, Fundamentals of Compressible Flow, New Age International Publishers
9. K Murlidhar and G Biswas, Advanced Fluid Mechanics, Narosa Publication

List of Experiments: (any ten)

1. To study the effect of angle of attack on Lift and Drag force

2. To study the loss of energy in wake region behind various models (car, jeep, bus etc.) in the wind tunnel

3. To draw profile of NACA Aero foils

4. To Investigate on Recent development and advances in rarefied gas dynamics

5. To visualize and plot the pattern of flow around an object in a fluid stream using Hale-Shaw apparatus

6. To develop temperature distribution in thermal boundary layer for the flow over a flat plate.

7. To develop a Gas Table (Isentropic flow, Normal shocks, Fanno flow, Rayleigh flow) for different γ values.

8. A case study: Performance of real nozzle.

COURSE OUTCOMES :

After completion of the course, the students will be able to:

CO-1: Apply the fundamentals of kinematics and conservation laws of fluid flow systems.
CO-2: Apply the principles of high and low Reynolds number flows to fluid flow systems.
CO-3: Review the concepts of boundary layer and flow in transition and apply the fundamentals of turbulent flow to various fluid flow systems.
CO-4: Apply the principles of one dimensional isentropic flow to variable area duct and analyze the principles of normal shock formation and its effects.
CO-5: Apply the principles of compressible flow to constant area duct subjected to friction or heat transfer.
CO-6: Apply the concepts in the analysis of fluid flow problems

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	3	2	1	1	1	2	-	-	-	-	-	-
CO-2	3	2	2	2	1	1	-	-	-	-	-	-
CO-3	2	2	2	2	1	1	-	-	-	-	-	-
CO-4	2	2	2	2	1	2	-	-	-	-	-	-
CO-5	3	2	2	1	1	1	-	-	-	-	-	-
CO-6	2	2	3	3	2	1	-	-	-	-	-	-

FEM125103: ADVANCED REFRIGERATION ENGINEERING

Course Objective:- The course is designed to give knowledge of various refrigeration systems, properties of refrigerants and its behavior under various conditions

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Refrigerants:** Alternate eco-friendly refrigerants and their properties, secondary refrigerants, mixture of refrigerants, azeotropics, and salient characteristics of various refrigerants, CFC/HCFC phase-out regulations, Montreal and Kyoto Protocols, synthetic lubricating oil and their properties	4	12%
2.	**Air Refrigeration:** Aircraft refrigeration systems – simple, Boot strap, regenerative and reduced ambient, analysis of an aircraft refrigeration cycles and their applications, calculations of COP of the systems	6	16%
3.	**Vapour Compression Refrigeration:** Balancing of vapour compression refrigeration system, dual pressure vapour compression system and its analysis, compound compression with flash cooler and flash intercooler, multiple expansions, parallel operation, sectionalizing, booster operations, various types of cascade systems and their analysis	12	24%
4.	**Vapour Absorption refrigeration**: properties of LiBr-H_2O and NH_3-H_2O solutions, analysis of vapour absorption refrigeration systems, heat balance, COP comparison with vapour compression refrigeration systems, two stage vapour absorption refrigeration system, solar driven sorption systems, heat sources for absorption systems	12	24%
5.	**Load estimation:** Sources of heat generation, insulating materials, design principles of cold storage, milk tankers and blood plasma storage. **Refrigeration Applications:** Refrigeration for preservation of food, refrigerating systems for transport by trucks and containers, Refrigerated railway cars, Marine refrigeration.	4	12%
6.	**Load estimation:** Sources of heat generation, insulating materials, design principles of cold storage, milk tankers and blood plasma storage. **Refrigeration Applications:** Refrigeration for preservation of food,	4	12%

	refrigerating systems for transport by trucks and containers, Refrigerated railway cars, Marine refrigeration.		

References Books:-

1. Refrigeration and air conditioning, C. P. Arora, McGraw Hill
2. ASHRAE Hand Book, (1) Fundamentals (2) Refrigeration
3. 40 Lessons on Refrigeration and Air Conditioning IIT KGP
4. Principles of Refrigeration, R J Dossat, Pearson Education Asia
5. Refrigeration and air conditioning, Stocker, McGraw Hill
6. Refrigeration and air conditioning, Jordan and Priester, McGraw Hill
7. Industrial Refrigeration Handbook, Stoecker, McGraw Hill

List of Suggested Experiments: (any ten)

1. To compare and analyze advance refrigeration cycle for different refrigerants.
2. Performance analysis of VCR system using capillary tube as a throttling device.
3. Performance analysis of VCR system using thermostatic expansion valve as a throttling device.
4. Design of a steam jet refrigeration system for particular application.
5. Design of cascade refrigeration system for particular application.
6. Performance analysis of "Electrolux" refrigerator.
7. Performance and analysis on heat pump system with different working conditions.
8. To estimate cooling load and star rating (energy efficiency rating) for any refrigeration application like, domestic refrigerator, deep freezer, water cooler etc.
9. To understand percentage running time of domestic refrigerator on a particular thermostat setting.
10. To understand construction and working of Ice Plant and determine COP of it.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO-1: Appraise refrigerants, their properties and applications.
CO-2: Discuss different air and vapour compression refrigeration systems and analyze them.
CO-3: Analyze vapour absorption cycles.
CO-4: Estimate the refrigeration load and appraise applications of refrigeration.
CO-5: Discuss various control devices and tubing operation used in refrigeration
CO-6: Evaluate conventional and alternate refrigerants and their impact on environment

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	3	2	1	2	1	2	-	-	-	-	-	-
CO-2	3	3	2	2	1	1	-	-	-	-	-	-
CO-3	3	-	3	2	-	-	-	-	-	-	-	-
CO-4	3	2	3	2	1	1	-	-	-	-	-	-
CO-5	2	2	2	2	1	1	-	-	-	-	-	-
CO-6	3	-	3	2	-	-	-	-	-	-	-	-

FEM125106: ENERGY CONSERVATION & MANAGEMENT

Course Objective:- The course is prepared to provide detailed understanding of energy conservation and management, 3Es (Energy, Economics and Environment) and their interaction, energy audit and financial management

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	2	5	4	70	30	30	20	150

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Energy conservation:** Principles of energy conservation, Energy Conservation Act 2001 and its features, Electricity Act-2003 & its features, Energy consumption pattern, Resource availability, Energy pricing, Energy Security, Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope, Evaluation of the overall thermal transfer, ECBC code for Building Construction	10	24%
2.	**Energy efficiency in thermal utilities:** Energy efficiency in boilers, furnaces, steam systems, cogeneration utilities, waste heat recovery, compressed air systems, HVAC&R systems, fans and blowers, pumps, cooling tower **Energy efficiency in electrical utilities:** Energy efficiency for electric motors, lighting systems, Characteristics of Light, Types of Lighting, Incandescent Lighting, Fluorescent Lighting, Vapor Lighting, Street Lighting, LED Lighting, Lighting Design, Light Dimming, Tips for Energy Conservation, Products for Energy Conservation in lighting system	10	24%
3.	**Energy Audit:** Definition, objective and principles of Energy Management, Need of Energy Audit and Management, types of energy audit, audit process, Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations and energy audit report, energy audit of building system, lighting system, HVAC system, Water heating system, heat recovery opportunities during energy audit, Industrial audit opportunities, Instruments for Audit and Monitoring Energy and Energy Savings	9	22%

4.	**Energy Economics:** Simple Payback Period, Time Value of Money, Internal Rate of Return, Net Present Value, Life Cycle Costing, Equivalent uniform annual cost (EUAC), Life cycle cost, Discounting factor, Capital recovery, Depreciation, taxes and tax credit, Impact of fuel inflation on life cycle cost, Cost of saved energy, cost of energy generated, Energy performance contracts and role of Energy Service Companies (ESCOs).	9	22%
5.	**Climate Policy:** Kyoto protocol, Clean development mechanism (CDM), Geopolitics of GHG control; Carbon Market	4	8%

References Books:-

1. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press
2. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press
3. Bureau of Energy Efficiency Reference book: No.1, 2, 3 4
4. Energy Management Handbook, W.C. Turner, John Wiley and Sons
5. Carbon Capture and Sequestration: Integrating Technology, Monitoring, and Regulation edited by E J Wilson and D Gerard, Blackwell Publishing
6. Heating and Cooling of Buildings - Design for Efficiency, J. Krieder and A. Rabl, McGraw Hill Publication, 1994

List of Suggested Experiments: (any ten)

1. To understand features and policy framework of Energy Conservation Act-2001 and Electricity Act-2003.
2. To understand detailed energy audit methodology.
3. To perform energy audit of building / institute and suggest energy saving steps.
4. To evaluate the thermal performance of a building.
5. Performance evaluation of air compressors.
6. Determination of efficiency of lighting system/loads.
7. Determination of efficiency of pumping system.
8. To verify "Star Rating" of a Refrigerator/Air conditioner.
9. To understand various aspects of financial management from energy conservation point of view with the help of a case study.
10. To understand different environmental protocols used for clean environment.
11. To carry out load calculation of a residential / commercial building and to suggest modification for energy saving.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO-1: To discuss various principles of energy conservation and to make calculation of cooling load of different types of building
CO-2: To discuss and make calculations pertaining to energy efficiency in thermal and electrical utilities
CO-3: To appraise the energy audit reports of mechanical utilities and lighting system
CO-4:. To discuss various methods of energy economics
CO-5: To discuss various climate policies
CO-6: Students can evaluate and recommend Energy saving and sustainable techniques

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	3	2	2	2	1	1	-	-	-	-	-	-
CO-2	2	3	2	2	1	1	-	-	-	-	-	-
CO-3	2	3	2	2	-	-	1	1	1	-	1	3
CO-4	3	2	2	1	1	2	2	-	-	-	-	-
CO-5	2	-	2	-	-	2	3	-	-	1	1	3
CO-6	2	-	3	-	2	-	2	1	-	1	2	3

FEM125109: MINI PROJECT WITH SEMINAR

Teaching & Evaluation Scheme:-

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	4	4	2	00	00	00	100	100

Th:-Theory, Tu: - Tutorial, P:- Practical, SEE:- Semester End Examinations, PA :- Progressive Assessment

Content:-

Subject Content
A mini project requires comparatively less time than major projects. They are comparatively simpler and have shorter duration. Mini Project helps students to explore and strengthen the understanding of fundamentals through practical application of theoretical concepts. Mini Project can help them to boost their skills and widen their horizon of thinking. It will act like a beginners guide to undertake the major project/dissertation during the final year and will ensure preparedness of students to undertake major projects/dissertation. Students will be required to select the topic relevant to their specialization and that has value addition. Students will get an opportunity to work in actual industrial environment if they opt for internship. Based on the selected topic student will also prepare seminar report based on the literature survey Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. Continuous assessment of Mini Project at Mid Sem and End Sem will be monitored by the departmental committee.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO-1: Identify engineering problems reviewing available literature.
CO-2: Study different techniques used to analyze complex systems.
CO-3: Solve a live problem using software/analytical/computational tools and present solution by using his/her technique applying engineering principles.
CO-4:.Learn to write technical reports and develop skills to present and defend their work in front of technically qualified audience.
CO-5: Outline annotated bibliography of research demonstrating scholarly skills.
CO-6: Prepare a well-organized report employing elements of critical thinking and technical writing.

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	3	2	2	-	-	3	-	-	-	-	-	-
CO-2	3	2	2	-	-	3	-	-	-	-	-	-
CO-3	3	3	2	2	2	1	-	-	-	-	-	-
CO-4	3	2	2	2	1	2	-	-	-	-	-	-
CO-5	3	2	2	-	-	3	-	-	-	-	-	-
CO-6	3	2	2	-	-	3	-	-	-	-	-	-

FEM135101: INTERNAL REVIEW-I

Course Objective :- A project rationale is an argument in favour of implementing the proposed project by your organization. It gives a detailed explanation of why the project is required in the area.

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	4	4	2	00	00	0	100	100

Sr No.	Subject Content
1.	**Course Objective**: To present a problem oriented in depth knowledge of Mid semester Thesis Progress Review. To address the underlying concepts and methods behind Mid semester Thesis Progress Review
2.	**Instructional Method & Pedagogy** At the start of course, the course delivery pattern, prerequisite of the subject will be discussed. Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal weightage should be given to all topics while teaching and conduction of all examinations. Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation. Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation. Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overall internal evaluation.

Course outcome:

After completion of the course, the students will be able to:

CO-1: The student can identify different areas of mid semester Thesis Progress Review.

CO-2: Can find the applications of all the areas in day to day life.

Course Outcomes	Expected Mapping with Programme Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	2	1	3	3	-	-	-	-	-	--	-	-
CO-2	2	1	3	3	-	-	-	-	-	--	-	-

FEM135102: DISSERTATION PHASE-I

Course Objective :- A Dissertation rationale is an argument in favor of implementing the proposed project by your organization. It gives a detailed explanation of why the project is required in the area.

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	16	16	8	00	00	100	0	100

COURSE OUTCOMES :

After completion of the course, the students will be able to:

CO-1: Identify problems and to plan methodologies to solve problems.
CO-2: Carry out exhaustive literature review, study &evaluate collected literature critically and identify the gaps based on the review.
CO-3: Select the specific problem for the study as a project
CO-4: Demonstrate technical writing while preparing project report and present it to evaluation committee to demonstrate presentation skills acquired.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	-	-	-	-	-	-	-	1	-	-	1
CO-2	-	3	-	-	-	-	-	-	-	2	-	1
CO-3	-	2	-	-	-	-	1	1	-	2	2	2
CO-4	2	-	-	-	-	-	-	-	1	-	-	-

FEM135104: COST MANAGEMENT OF ENGINEERING PROJECTS

Course Objective :- The course is designed to discuss the advanced and relevant technologies of cost management of engineering projects and related system components.

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	0	3	3	70	30	0	0	100

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	Introduction and Overview of the Strategic Cost Management Process	5	14%
2.	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making	4	12%
3.	Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	15	32%
4.	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing	14	30%

5.	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	4	12%

References Books:-

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd

COURSE OUTCOMES

After completion of the course, the students will be able to:

CO-1: Understand the concept of strategic cost management
CO-2: Analyze the decision Making and Pricing Strategies
CO-3: Understand the concept of cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost.
CO-4: Determination of Costing System and Inventory valuation
CO-5: Analyse the provision of data for decision making.
CO-6: Able to analyze the Linear Programming, PERT/CPM, Transportation Problems

Course Outcomes	**Expected Mapping with Programme Outcomes** *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	-	-	3	-	-	-	3	-	-	-	-	-
CO-2	-	-	3	-	3	3	3	-	-	-	-	-
CO-3	-	-	3	-	3	3	3	-	-	-	-	-
CO-4	-	-	-	-	2	-	-	-	-	-	-	-
CO-5	-	-	-	-	-	3	3	-	-	-	-	-
CO-6	-	-	3	-	3	3	3	-	-	-	-	-

FEM135108: EXERGY ANALYSIS OF THERMAL SYSTEMS

Course Objective :- The course is design to impart detailed study of exergy analysis of various thermal systems and exergy-economics.

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
3	0	0	3	3	70	30	0	0	100

Sr No.	Subject Content	Teaching Hours	Weightage (%)
1.	**Exergy Destruction:** Lost available work referred to heat engine cycle, refrigeration cycle, heat pump cycle, non-flow and steady flow processes, Mechanism of exergy destruction, modified Gouy-Stodola theorem, concept of effective temperature	5	12%
2.	**Exergy Analysis of Simple Processes:**Mixing and separation process of fluids of different temperature, heat transfer across a temperature difference, expansion and compression process, combustion process	9	22%
3.	**Exergy Analysis of Power Plant:** Maximum power subject to size constraint with fixed heat input and its application to Brayton cycle, Steam turbine power plants: External and internal irreversibility, superheater, reheater, vacuum condenser, regenerative feed water heating, combined feed water heating and reheating Gas turbine power plant: External and internal irreversibility, regeration, reheater, and intercooler, combined steam and gas turbine power plant	14	34%
4.	**Exergy analysis of Refrigeration cycle:** Joule-Thomson Expansion, Work-Producing Expansion, Brayton Cycle, Optimal Intermediate Cooling, Exergy analysis of Air-conditioning applications: Mixtures of air and water vapour, total flow exergy of humid air and liquid water, Evaporative cooling process and other aspects	8	18%
5.	**Exergy-economic Analysis:** Fundamental of exergy-economics, exergy costing of different thermal components: steam or gas turbine, boiler, cogeneration system	6	14%

References Books:-

1. Advanced Engineering Thermodynamics by Adrian Bejan, John Wiley & Sons, Inc.
2. The Exergy Method of Thermal Plant Analysis by T J Kotas, Krieger Publishing Company
3. Thermal Design and Optimization by Adrian Bejan, George Tsatsaronis, Michael Moran, John Wiley & Sons, Inc.
4. Advance Thermodynamics for Engineers by Winterbore D E, Arnold Publication
5. Advanced Thermodynamics for Engineers by Kenneth Wark, McGraw Hill Publishing Co. Ltd.
6. Fundamentals of Engineering Thermodynamics by Michel J Moran, Howard N Shapiro, Daisie D Boettner, Margaret B Bailey, John Wiley & Sons, Inc.

COURSE OUTCOMES

After completion of the course, the students will be able to:

CO-1: To make calculations of exergy and lost work for heat engine, refrigeration and heat pump cycle.
CO-2: To analyze different thermal process with exergy view point.
CO-3: To appraise exergy analysis of different power plant cycles
CO-4: To appraise exergy analysis of different refrigeration cycles and evaporating cooling
CO-5: To compute exergy-economics costing of thermal components
CO-6: Interpret and estimate exergy losses by , exergy calculations, exergetic efficiency, exergy charts.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**
CO-1	3	2	2	3	1	-	-	-	-	-	-	-
CO-2	2	3	2	2	1	-	-	-	-	-	-	-
CO-3	3	3	2	1	1	-	-	-	-	-	-	-
CO-4	2	3	2	2	1	1	-	-	-	-	-	-
CO-5	2	2	3	3	2	1	-	-	-	-	-	-
CO-6	1	-	-	-	-	-	-	-	-	-	-	1

FEM145101: INTERNAL REVIEW-II

Course Objective:- A project rationale is an argument in favor of implementing the proposed project by your organization. It gives a detailed explanation of why the project is required in the area.

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	4	4	2	00	00	0	100	100

Sr No.	Subject Content
1.	**Course Objective**: To present a problem oriented in depth knowledge of Mid semester Thesis Progress Review. To address the underlying concepts and methods behind Mid semester Thesis Progress Review
2.	**Instructional Method & Pedagogy** At the start of course, the course delivery pattern, prerequisite of the subject will be discussed. Lecture may be conducted with the aid of multi-media projector, black board, OHP etc. & equal weightage should be given to all topics while teaching and conduction of all examinations. Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation. Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation. Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of five marks in the overall internal evaluation.

Course outcome :

After completion of the course, the students will be able to:

CO-1: The student can identify different areas of mid semester Thesis Progress Review.
CO-2: Can find the applications of all the areas in day to day life.

Course Outcomes	Expected Mapping with Programme Outcomes *(1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)*											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	3	2	1	3	3	3	1	-	-	-	--	-
CO-2	3	2	1	3	3	3	1	-	-	-	--	-

FEM145102: DISSERTATION PHASE-II

Course Objective :- A dissertation rationale is an argument in favor of implementing the proposed project by your organization. It gives a detailed explanation of why the project is required in the area

Teaching Scheme				Credits	Examination Marks				Total Marks
					Theory		Practical		
Th	Tu	P	Total		SEE (E)	PA (M)	Viva (V)	PA (I)	
0	0	28	28	14	00	00	100	0	100

COURSE OUTCOMES :

After completion of the course, the students will be able to:

CO-1: Solve identified technical problem using acquired knowledge and skill.
CO-2: Use latest equipment, instruments, software tools, infrastructure and learning resources available to solve the identified project problem. Procure resources, if required.
CO-3: Interpret theoretical/experimental findings using available tools
CO-4: Compare the results obtained with results of similar studies
CO-5: Draw conclusions based on the results.

Course Outcomes	Expected Mapping with Programme Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)											
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO-1	1	-	-	-	-	-	-	-	1	-	-	1
CO-2	-	3	-	-	-	-	-	-	-	-	-	-
CO-3	-	2	-	-	-	-	1	1	-	2	2	2
CO-4	2	-	-	-	-	-	-	-	2	-	-	-
CO-5	-	1	-	-	-	-	-	1	-	-	-	2