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
E: dean.fac.engg@gokuluniversity.ac.in W: www.gokuluniversity.ac.in M: +91 95109 73860

## 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** |

# OUTCOME BASED EDUCATION

For the implementation of an outcome-based education the first requirement is to develop an outcome based curriculum and incorporate an outcome-based assessment in the education system. By going through outcome-based assessments, evaluators will be able to evaluate whether the students have achieved the outlined standard, specific and measurable outcomes. With the proper incorporation of outcome-based education there will be a definite commitment to achieve a minimum standard for all learners without giving up at any level. At the end of the programme running with the aid of outcome-based education, a student will be able to arrive at the following outcomes:

| | |
|---|---|
| **PO1** | An ability to acquire, apply and share in-depth knowledge in the area of thermal engineering. |
| **PO2** | An ability to conduct independent research and generate new knowledge for the benefit of mankind |
| **PO3** | Graduates will demonstrate an ability to identify, formulate and solve thermal engineering problems |
| **PO4** | Graduates will demonstrate research skills to critically analyze complex thermal engineering problems for synthesizing new and existing information for their solutions. |
| **PO5** | An ability to maintain a high level of professional and intellectual integrity, ethics of research and scholarly standards. |
| **PO6** | Graduates will demonstrate skills to use modern engineering tools, software and equipment to analyze and solve complex engineering problems. |
| **PO7** | Graduates will demonstrate and ability to work on laboratory and multidisciplinary tasks. |
| **PO8** | Students will be able to convey thoughts effectively on the basis of acquired soft skills and self confidence with peers, subordinates and higher authority for the consistent and effective knowledge sharing process |
| **PO9** | Graduates will be able to understand the need for, and an ability to engage in life-long learning and continual updating of professional skills |
| **PO10** | Graduate will acquire knowledge about current issues/advances in engineering practices. |

## PROGRAMME SPECIFIC OUTCOMES

Mechanical Engineering Programme Students will be able to:

| | |
|---|---|
| **PSO-1** | To analyse the problems and create solution by applying engineering knowledge with a multidisciplinary approach in the area of thermal engineering, manufacturing systems and product design |
| **PSO-2** | To analyze, interpret and provide solutions to the real life mechanical engineering problems using engineering software/tools. |
| **PSO-3** | To work effectively in a team to address complex issues by engaging in lifelong learning and following ethical and environmental practices |

**FEM110001: RESEARCH SKILL AND METHODOLOGY**

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

**Objective:** The students should get familiar with the Research Skill and its Methodology.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | Credits | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | | Practical | | |
| Th | Tu | P | Total | | SEE (E) | PA (M) | Viva (V) | PA (I) | |
| 0 | 1 | 2 | 3 | 2 | 00 | 00 | 50 | 50 | 100 |

| Sr. | Content | Total Hrs | % Weightage |
|---|---|---|---|
| 1 | **Introduction to Research:** Nature and Scope of Research, Information Based Decision Making and Source of Knowledge. The Research Process, Basic approaches and Terminologies used in Research, Defining Research Problem and Framing Hypothesis, Preparing a Research Plan | 6 | 12% |
| 2 | **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 | 7 | 19% |
| 3 | **Sampling Design** Census and sample survey, Implications of a Sample Design, Steps in sampling Design, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, Different Types of sample Designs, How to Select a Random Sample?, Random Sample from an Infinite Universe, Complex Random Sampling 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 | 14 | 34% |

| | | | |
|---|---|---|---|
| | Secondary Data, Selection of Appropriate Method for Data Collection | | |
| **4** | **Data Analysis**<br>Data Analysis and Presentation Editing and coding of data, tabulation, graphic presentation of data, cross tabulation, Testing of hypotheses; Parametric and nonparametric tests for Uni variant and Bi variant data. Tests of association; simple linear regression and other non-parametric tests, Sampling techniques, Probability, Probability Distributions, Hypothesis Testing, Level of Significance and Confidence Interval, t-test, ANOVA, Correlation, Regression Analysis<br>**Interpretation of Data and Paper Writing**<br>Layout of a Research Paper, Journals in Computer Science, 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 Science Discipline. | **11** | **22%** |
| **5** | **Report Writing**<br>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<br>**Patent Rights**<br>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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | 2 | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-2** | - | 2 | 2 | - | - | - | - | - | - | - | 1 | - | - |
| **CO-3** | - | - | - | - | - | 2 | - | - | - | - | - | 2 | - |
| **CO-4** | 1 | - | - | 2 | 2 | - | - | - | - | - | - | 2 | - |
| **CO-5** | 1 | 2 | - | 2 | 2 | - | - | - | - | - | - | 2 | - |

**FEM110002: DISASTER MANAGEMENT**

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

**Objective:** The students should get familiar with the Disaster and its challenges.

**Teaching & Evaluation Scheme:-**

| Teaching Scheme | | | | Credits | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | | Practical | | |
| Th | Tu | P | Total | | SEE (E) | PA (M) | Viva (V) | PA (I) | |
| 2 | 0 | 0 | 2 | 0 | 70 | 30 | 00 | 00 | 100 |

| Sr | Content | Total Hrs | % Weightage |
|---|---|---|---|
| 1. | **Introduction:** Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude. | 4 | 17 |
| 2. | **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 | 4 | 17 |
| 3. | **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 | 4 | 17 |
| 4. | **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 | 4 | 17 |
| 5. | **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. | 8 | 32 |

List of Suggested Tutorials:

1. Difference between an experiment and survey.
2. Problems faced by researchers.
3. A research scholar has to work as a judge and derive the truth and not as a pleader who is only eager to prove his case in favour of his plaintiff. Justify the statement.
4. Examine the significance of research.
5. Research is much concerned with proper fact finding, analysis and evaluation. Do you agree? Support your answer.
6. Issues to be attended by researchers in formulating research problem.
7. Develop a research plan.
8. Different ways of sampling.
9. Merits and demerits of different data collection methods.
10. Interpretation is a fundamental component of research process. Justify the statement.
11. Layout of research report.

**References 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-2** | 1 | 2 | | - | - | - | - | - | - | - | 1 | - | - |
| **CO-3** | 1 | 1 | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO-4** | 1 | 2 | - | - | - | - | - | 2 | - | - | 1 | - | - |
| **CO-5** | 1 | 2 | - | - | - | - | - | - | - | - | - | - | 2 |
| **CO-6** | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 |

**FEB115101: APPLIED COMPUTATIONAL METHOD**

**Program:** Master of Engineering **Subject / Branch:** Thermal (Mechanical)

**Year** : 1st **Semester:** I

**Course title :** Applied Computation Method **Course code :** FEM115101
**Course type :** Core Course **Course credit :** 04
**Pre-requisite :** Zeal to learn the subject

**Rationale :** The course intends to provide mathematical foundations to graduate students. The course should enhance their ability to develop mathematical models and solve problems using analytical and numerical methods.

**Teaching Examination 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 |

**Course Objective:**

To impart knowledge on numerical methods that will come in handy to solve numerically the problems that arise in engineering and technology. This will also serve as a precursor for future research.

**Content**

| Sr No. | Subject Content | Teaching Hours | Weightage (%) |
|---|---|---|---|
| 1 | **ODE**<br>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, | 12 | 20% |

| | | | |
|---|---|---|---|
| | 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 | | |
| 2 | **Laplace Transforms & Fourier Analysis**<br>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 | 15% |
| 3 | **PDE**<br>Basic Concepts of PDEs; Modeling: Vibrating String, Wave 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. | 8 | 20% |

| | | | |
|---|---|---|---|
| 4 | **LinearAlgebra**<br>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.<br>**NumericAnalysis**<br>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 | 25% |
| 5 | **Probability & Statistics**<br>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, Nonparametric Tests, Regression, Linear Regression, Polynomial Regression, General Linear Regression, Nonlinear Regression, Correlation | 9 | 20% |

**Tutorials:**

1. Directional fields, Euler's Method; Separable ODEs; Exact ODEs (Integrating Factors Method, Existence and Uniqueness of Solution)
2. Linear ODEs (Homogeneous and Non-Homogeneous, Reduction to Linear problems); Orthogonal Trajectories.
3. 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)

4. Solution by [1/f(D)] r(x) method for finding particular integral. Differential Operator; Modeling of Free Oscillations of Spring-Mass System
5. Homogeneous Linear ODEs with Non Constant Coefficient (Cauchy-Euler Equation, Non-homogeneous ODE, Modeling of Forced Oscillations, Solution by Variation of Parameters.
6. Laplace Transform, Linearity, First Shifting Theorem (s-Shifting);Transforms of Derivatives and Integrals, ODE; Unit Step Function(Heaviside Function)
7. Second Shifting Theorem (t-Shifting); Short Impulses, Dirac's Delta Function, Partial Fractions; Convolution, Integral Equations
8. Differentiation and Integration of Transforms, ODEs with Variable Coefficients; Systems of ODEs.
9. Fourier Series; Arbitrary Period, Even and Odd Functions, Half-Range Expansions; Forced oscillations
10. Approximation by Trigonometric Polynomials; Sturm–Liouville Problems, Orthogonal Functions; Orthogonal Series, Generalized Fourier Series

**Reference 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.

**Suggested Readings:**

1. Swaym video lecture.
2. Mathematics magazine

**Online Resources:**

1. http://nptel.ac.in
2. https://ocw.mit.edu/courses
3. https://www.edx.org

**Practical / Activities:**

1. Problems solving.
2. Tutorial solving.
3. Seminar by students.

**Course Outcome:**

After learning the course the students should 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:** Apply iterative and transformation methods in THERMAL engineering

**CO-5:** Carry out interpolations and curve fitting

**CO-6:** Students will learn fundamentals and applications of algebra for engineering 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | 2 | - | 2 | - | - | - | - | - | - | 2 | 1 | 1 |
| **CO-2** | - | 2 | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-3** | 2 | 2 | - | - | - | - | - | - | 1 | - | - | 2 | - |
| **CO-4** | 1 | - | 2 | 2 | - | - | - | - | - | - | - | - | 2 |
| **CO-5** | 2 | 1 | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-6** | 2 | 1 | 1 | - | - | - | - | - | 1 | - | 2 | - | 1 |

## 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:**<br>**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 | 12 | 28% |

| | | | |
|---|---|---|---|
| | Enclosed Spaces.<br>Heat Transfer during Phase Transformation: Boiling: Pool Boiling and its 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.<br>Radiation: Combine with Conduction and Convection, Radiation Exchange with Participating Media, Radiative exchange and overall heat transfer in furnaces. | 7 | 19% |

- **List of suggested Practical**:-

1. Heat conduction apparatus
2. Stefan Boltzmann Apparatus
3. Forced convection Apparatus
4. Natural Convection Apparatus
5. Double Pipe Heat Exchanger
6. Emissivity Measurements Apparatus
7. Condensation in Drop & Film Forms
8. To measure convective heat transfer co-efficient and effectiveness of the fin under natural convection.
9. To measure convective heat transfer co-efficient and effectiveness of the fin under forced convection.

- **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 | PSO-1 | PSO-2 | PSO-3 |
| CO-1 | 2 | - | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO-2 | 2 | - | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO-3 | 1 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO-4 | 1 | 1 | - | - | - | - | - | - | - | - | - | 2 | - |
| CO-5 | - | 1 | - | 2 | - | - | 2 | - | - | - | - | 2 | - |
| CO-6 | - | 1 | - | 2 | - | - | 2 | - | - | - | - | - | - |

## FEM115105: ADVANCED INTERNAL COMBUSTION ENGINE

**Course Objectives:-**

Engine operating parameters like fuel-air mixtures, temperature and cycles.supercharging, turbo charging and flow through ports and valves

| 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 | **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** | **PSO 1** | **PSO 2** | **PSO 3** |
| **CO-1** | 1 | - | - | - | 1 | - | 1 | - | - | 1 | 1 | - | 1 |
| **CO-2** | 1 | - | - | - | 1 | - | 1 | - | - | 1 | - | 1 | - |
| **CO-3** | - | 1 | - | 1 | - | 1 | - | - | - | 1 | - | - | 1 |
| **CO-4** | 1 | - | - | 1 | - | - | - | 1 | - | - | 1 | - | 1 |
| **CO-5** | 1 | 1 | - | - | 1 | - | 1 | - | - | - | 1 | - | 1 |
| **CO-6** | 1 | - | 1 | - | 1 | - | - | 1 | - | 1 | - | - | 1 |

## FEM115106: CRYOGENIC ENGINEERING

**Course Objective:**-The course is designed to give knowledge of cryogenics engineering, cryo fluids, properties of material and its behavior under various conditions.

**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**:Properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric& magnetic properties, super conducting materials, thermo electric materials, composite materials, properties of cryogenic fluids, super fluidity of He3 & He 4. | 7 | 16% |
| 2. | **Applications of Cryogenic Systems:** Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsion | 6 | 15% |
| 3. | **Cryogenic Insulation:** expanded foams, gas filled & fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, opacified powder insulation, multilayer insulation, comparison of performance of various insulations | 5 | 13% |
| 4. | **Gas Liquefaction Systems:** Introduction, thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde Hampton, Pre-cooled LindeHampson, Linde dual pressure, cascade, claude, kapitza, heyland systems using expanders, comparison of | 7 | 18% |

| | | | |
|---|---|---|---|
| | liquefaction systems, introduction to cryogenics vessels | | |
| **5.** | **Advanced Cryo coolers:** Philips refrigerators, Importance of regenerator effectiveness for the Philips refrigerators, Gifford single volume refrigerator, Gifford double volume refrigerators analysis, COP, FOM, regenerators, pulse tube refrigerators, various types of pulse tube refrigerator | 10 | 21% |
| **6.** | **Cryogenic Refrigeration System:** Ideal isothermal and reversible isobaric source refrigeration cycles, Joule Thomson system, cascade or pre-cooled Joule–Thomson refrigeration systems, expansion engine and cold gas refrigeration systems | 7 | 17% |

- **List of Suggested Practical**:-

1. Study and analysis of isothermal source cryo-refrigeration system
2. Study of cryogenic properties of hydrogen and helium.
3. Study of low temperature measurement instrument.
4. Study of flow measurement and quality measurement instrument.
5. Study of cryogenic application (superconductivity)
6. Study of cryogenic application in space technology.
7. Study of cryogenic application in bio medical and food preservation
8. Study and testing of cascade refrigeration system.
9. Study of ideal liquefaction system.
10. Study of hydrogen liquefaction system
11. Study of helium liquefaction system

- **References Books:-**

1. Cryogenic process engineering, Thomas M Flynn, Informa Health Care
2. Miniature refrigerators for cryogenic sensors and cold electronics, Graham Walker, ClarendonPress
3. Cryogenic technology & applications, A R Jha, Butterworth-Heinemann
4. Cryocooler, Fundamentals Part I &II, Graham Walker, Plenum Press, New York
5. Cryogenic Regenerative Heat Exchangers, R.A. Ackermann, Springer
6. Cryogenic systems, R F Barron, Oxford University Press
7. Cryogenic heat transfer, R F Barron, Taylor & Francis Group.

- **Course Outcomes:**

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

**CO-1:**Understand the concept of cryogenic fundamental.
**CO-2:**Learn the requirement and use of proper insulation.
**CO-3:**Understand about the concept of cry cooler and application in various fields.
**CO-4:**Select the proper cryogenic fluid for particular applications like, cryo metallurgy, medical applications etc.
**CO-5:**Learn about the cryogenic refrigerators for different applications.

| 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | 2 | - | - | - | - | - | - | - | 2 | - | - | 2 |
| **CO-2** | 1 | 2 | - | 2 | 3 | - | - | - | - | - | 2 | - | - |
| **CO-3** | 2 | 2 | - | - | - | - | - | - | 2 | 2 | - | - | 3 |
| **CO-4** | 1 | 1 | - | - | - | - | 2 | - | 2 | - | - | - | 3 |
| **CO-5** | 1 | 2 | - | - | - | - | - | - | 2 | 1 | - | - | 2 |

**FEM115107: SOLAR ENERGY ENGINEERING**

**Course Objective:**-The course is designed to give knowledge and relevant technologies in the area of solar energy.

**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:- SemesterEnd Examinations, PA :-Progressive Assessment

**Content:-**

| Sr No. | Subject Content | Teaching Hours | Weightage (%) |
|---|---|---|---|
| 1 | **INTRODUCTION TO SOLAR RADIATION**: Earth and solar constant, spectral distribution of extraterrestrial radiation; earth sun angle; solar time; instruments for solar radiation; solar radiation geometry; sun shine hours; solar radiation of tilted surface. | 5 | 10% |
| 2 | **SOLAR HEATING OF BUILDINGS**: Building forms and functions; aspects of solar heating of buildings; components of solar heating systems; solar space heating system; prediction of heating loads; sizing of active solar space heating system; | 10 | 25% |
| 3 | **SOLAR REFRIGERATION AND AIR CONDITIONING**: Carnot refrigeration cycle; absorption cooling; principle of absorption cooling; basics of absorption cooling; lithium bromide water absorption system; aqua ammonia absorption system; intermittent absorption system; vapor compression system; Desiccant cooling. | 10 | 25% |

| | | | |
|---|---|---|---|
| 4 | **SOLAR THERMAL ENERGY STORAGE**: Need of thermal energy storage; size and duration of storage; sensible and latent heat storage; storage in phase change materials (PCM); storage in reversible chemical reaction. | 7 | 15% |
| 5 | **SOLAR ENERGY FOR INDUSTRIAL PROCESS HEAT**: Industrial solar energy usage; industrial process heat systems; hot water industrial process heat system; hot air industrial process heat system; steam industrial process heat system; problems with SIPH Systems. | 10 | 25% |

**Major Equipments**: - Solar flat plate collector, Concentrating solar collector, Solar cooker, Solar air heater as drier of any product, Solar still

**List of Suggested Experiments:-**

1. Measurement of solar radiation using pyranometer and other solar radiation measuring instruments.
2. Performance evaluation of solar flat plate collector.
3. To study the effect of solar flat plate collector in parallel combination.
4. Performance evaluation of concentrating solar collector.
5. To study the effect of concentrating solar collector in series arrangements.
6. Performance evaluation of solar cooker.
7. Performance evaluation of solar air dryer.
8. Performance evaluation of solar still.
9. To compare of solar thermal power systems.
10. Performance evaluation of solar funnel.

**References Books**:-

1SOLAR ENERGY H P Garg& J prakash; Tata Mcgraw Hill; 1997
2. Solar Energy – Principles of Thermal Collection and Storage, S P Sukhatme, McGraw Hill
3. Solar Energy and Utilization G.D. Rai; khanna publishers, New Delhi.1982
4. Solar Energy Engineering, Processes and SystemsKalogirou S; Elsevier, 2009
5. Principles of Solar Engineering D. Y. Goswami, F Kreith and J. F. Kreider; Taylor and Francis, Philadepha

List of open source software/ learning Website:-

1. http://nptel.ac.in/

**Active learning Assessment**:-

1. To design / make model concentrated solar power tower technology for illumine LED bulb. Students may use the data of its own location.
2. To develop a model of planetary system to understand the solar geometry.
3. To develop an experimental setup of solar water heater with pumping system.
4. To design / make model of solar A/C system.
5. Power consumption calculation of college building for solar system and find alternative way of

conventional power generation system.

**Course Outcomes**:- After Learning the course the students shall be able to:

1. Apply fundamental solar energy concepts to individual components.
2. Predict performance of solar energy systems.
3. Select systems using solar engineering principles.
4. Design systems to utilize solar energy.
5. To understand the thermal analysis, thermal efficiency, energy losses of concentrating and non-concentrating collectors of solar radiation system.
6. To know the various applications of solar thermal energy

| **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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | 2 | - | - | - | - | 2 | - | - | - | 3 | - | - |
| **CO-2** | - | 2 | 2 | - | 3 | 2 | - | - | - | - | - | 2 | - |
| **CO-3** | 2 | - | - | - | - | 2 | 2 | - | 2 | - | - | - | 2 |
| **CO-4** | - | - | - | 2 | - | 2 | - | - | - | 2 | - | 2 | - |
| **CO-5** | 1 | 1 | - | - | - | - | 2 | - | 3 | - | - | - | 2 |
| **CO-6** | - | - | 2 | - | 2 | 2 | - | 1 | - | - | 1 | - | - |

**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

- **List of Suggested Practical**:-

1. Study of Modern Steam Power Plant.
2. Study of Steam Turbines. (Impulse, Reaction and governing).
3. Study of Gas and Steam Turbine Combined Cycles.
4. Study of Nuclear Power Plant.
5. Study of different types of steam nozzle and design a nozzle.
6. Study of different feed water treatment plants.
7. Comparative study of different types of high pressure boilers.

**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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | 1 | - | 2 | - | 2 | - | - | - | - | - | 2 | - |
| **CO-2** | - | 2 | - | - | 2 | - | - | - | 2 | 2 | - | - | 3 |
| **CO-3** | 2 | 1 | 2 | - | - | - | - | 2 | 2 | - | - | - | 3 |
| **CO-4** | 1 | 2 | - | - | 2 | - | 2 | - | - | - | 2 | - | - |
| **CO-5** | 1 | 1 | - | - | - | - | - | 3 | - | - | 2 | - | - |
| **CO-6** | 2 | 2 | - | - | - | - | - | 2 | - | - | 3 | - | - |

## FEM115109: HYDROGEN AND FUEL CELL TECHNOLOGY

**Course Objective:-** To impart knowledge on use of hydrogen for achieving sustainable growth and facilitate analysis of the challenges in transition to hydrogen economy.

**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. | **Hydrogen – Fundamentals:** Hydrogen as a source of energy, physical and chemical properties, salient characteristics, relevant issues and concerns | 4 | 5% |
| 2. | **Hydrogen Storage and Applications:** Production of hydrogen, steam reforming, water electrolysis, gasification and woody biomass conversion, biological hydrogen production, photo dissociation, direct thermal or catalytic splitting of water, hydrogen storage options, compressed gas, liquid hydrogen, hydride, chemical storage, safety and management of hydrogen, applications of hydrogen | 15 | 40% |
| 3. | **Fuel Cells- Types:** Brief history, principle, working, thermodynamics and kinetics of fuel cell process, types of fuel cells; AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits, performance evaluation of fuel cell, comparison of battery Vs fuel cell | 13 | 30% |
| 4. | **Fuel Cells -Application And Economics:** Fuel cell usage for domestic power systems, large scale power generation, automobile, space applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells | 10 | 25% |

- **References Books:-**

1. Viswanathan, B and M AuliceScibioh, Fuel Cells – Principles and Applications, Universities Press
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma
3. Bent Sorensen (Sorensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier Academic Press, UK
4. Kordesch, K and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany
5. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, NewYork Ltd., London
6. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA

- **List of Suggested Practical:-**

1 To study fundamentals of Hydrogen energy and its application
2 To study various methods for production of hydrogen
3 To study different methods for storage of hydrogen
4 To study about safety, environmental impacts and economics of transition to hydrogen system
5 To study principle, working, thermodynamics and kinetics of fuel cell process
6 To study different types of Fuel Cells along with its merits and demerits
7 To study and demonstration of Proton Exchange Membrane Fuel Cell
8 To study about different parameters affecting the performance of fuel cell
9 To study usage of fuel cell for domestic power system and large-scale power generation
10 To study various applications and economics of fuel cell.

**COURSE OUTCOMES:**

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

**CO-1** Students able to understand and demonstrate the hydrogen production technologies, storage methods and strategies for transition to hydrogen economy
**CO-2** Students able to know the concepts and characteristics of various types of fuel cell
**CO-3** Students able to consist and demonstrate the working of fuel cells
**CO-4** Students able to know the application of fuel cells with economic and environment 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 | PSO-1 | PSO-2 | PSO-3 |
| CO-1 | 1 | 1 | 2 | 2 | - | - | 2 | - | - | - | 2 | - | - |
| CO-2 | 2 | 2 | - | - | - | - | - | - | - | 2 | 3 | - | - |
| CO-3 | 1 | 1 | 2 | 2 | - | - | 2 | - | - | - | 2 | - | - |
| CO-4 | 1 | 1 | 2 | 2 | - | - | 2 | 2 | 3 | - | 2 | - | 2 |

## FEM115110: DESIGN OF HEAT EXCHANGER

**Course Objective:**-The course is prepared to provide the detailed insight of Design Of Heat Exchanger.

**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:- SemesterEnd Examinations, PA :- Progressive Assessment

**Content:-**

| Sr No. | Subject Content | Teaching Hours | Weightage (%) |
|---|---|---|---|
| 1. | **Basic design of Heat Exchanger and Classification :** Classification of heat exchanger, selection of heat exchanger, Thermal-Hydraulic fundamentals, Overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multipass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, Fouling, Rating and sizing problems, heat exchanger design methodology | 6 | 15% |
| 2. | **Fouling of heat exchangers:** Basic consideration, effect of fouling on heat transfer and pressure drop, cost of fouling, design of heat exchangers subject to fouling, fouling resistance, cleanliness factor, techniques to control fouling | 4 | 10% |
| 3. | **Design of double pipe heat exchangers:** Thermal and Hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop | 6 | 13% |
| 4. | **Design of Shell & tube heat exchangers:** Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method. | 6 | 12% |
| 5. | **Condensers and evaporators** **Condenser:** Shell and tube condenser, plate condenser, air cooled condenser, direct contact condenser, condenser for refrigeration and air-conditioning, thermal design of shell and tube condenser **Evaporator:** Evaporator for refrigeration and air-conditioning, thermal analysis of evaporator, standards for evaporators and condensers | 7 | 20% |

| | | | |
|---|---|---|---|
| **6** | **Heat transfer enhancement and performance evaluation:** Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis | 6 | 15% |
| **7** | **COMPACT AND PLATE HEAT EXCHANGERS**: Types - Merits and Demerits -Design of Compact heat exchangers, plate heat exchangers, performance influencing parameters, limitations, Heat Transfer and Pressure Drop Calculations, and its Applications | 7 | 15% |

- **References Books:-**

1. Heat Exchanger Selection, Rating and Thermal Design by Sadik, Kakac, CRC Press
2. Fundamentals of Heat Exchanger Design by Ramesh K Shah, Wiley Publication
3. Compact Heat Exchangers by Kays, V.A. and London, A.L., McGraw Hill
4. Heat Exchanger Design Handbook by Kuppan, T, Macel Dekker, CRC Press
5. Heat Exchanger Design Hand Book by Schunder E.U., Hemisphere Pub.
6. Process Heat transfer by Donald Q Kern, McGraw Hill

- **Major Equipments**:-

1.Shell and tube heat exchanger
2. Plate type heat exchanger
3. Tube and tube heat exchanger
4 Compact heat exchanger
5 Vapor Compression Refrigeration system (evaporator and condenser)

- **List of Suggested Practical:-**

1. Study of Fundamentals of Fluid Flow and Heat Transfer
2. Design of heat exchange equipment by using LMTD method.
3. Design of heat exchange equipment by using effectiveness– NTU method.
4. Design and analysis of double pipe heat exchanger with parallel and counter flow arrangement.
5. Design and analysis of shell and tube type heat exchanger.
6. Design and analysis of plate type heat exchanger.
7. Design of evaporator for refrigeration system.
8. Design of condenser for refrigeration system.
9. Study and Analysis of Plate Type Heat Exchanger

- **Course Outcomes:-**

After learning the course the students should be able to

**CO-1:** Learn how to design common types of heat exchangers; namely shell-and-tube, tube and tube

**CO-2:** Learn to select appropriate Heat Exchanger for the given application

**CO-3:** Become aware of single and multiphase heat transfer and friction coefficient correlations, and they will know how to select the appropriate ones for the case in hand.

| 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | 2 | - | - | - | 2 | - | - | - | - | 1 | - | - |
| **CO-2** | 2 | - | 3 | 2 | - | - | - | - | 2 | - | 2 | 1 | - |
| **CO-3** | 3 | 2 | 1 | 1 | - | - | - | - | - | - | 2 | 1 | - |

**FEM120001: RESEARCH PAPER WRITING**

**Objective:** The students should get familiar with the Research Paper Writing.

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

**Teaching & Evaluation Scheme:-**

| Teaching Scheme | | | | Credits | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory | | Practical | | |
| Th | Tu | P | Total | | SEE (E) | PA (M) | Viva (V) | PA (I) | |
| 2 | 0 | 0 | 2 | 0 | 70 | 30 | 0 | 0 | 100 |

| Sr. | Content | Total Hrs | % 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<br>Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission | 8 | 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'sbook
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg 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 | PSO-1 | PSO-2 | PSO-3 |
| CO-1 | 2 | 2 | - | - | - | - | - | - | - | - | - | 1 | - |
| CO-2 | 2 | 2 | - | - | 1 | - | - | - | - | - | - | - | - |
| CO-3 | 2 | 1 | - | - | 1 | - | - | 2 | - | - | - | 1 | - |
| CO-4 | 1 | 2 | - | - | - | - | - | 2 | - | - | - | - | - |
| CO-5 | 1 | 2 | - | - | - | - | - | - | - | - | - | - | - |
| CO-6 | 1 | 1 | - | - | - | - | - | - | - | - | - | - | - |

**FEM125101: EXPERIMENTAL TECHNIQUES AND INSTRUMENTATIONS IN THERMAL SYSTEMS**

**OBJECTIVE** The objectives of a course focused on experimental techniques and instrumentations in thermal systems are designed to provide students with practical skills and knowledge in conducting experiments related to thermal sciences. Here are some specific objectives for such a course:
Introduction to Experimental Methods Instrumentation Familiarity Measurement Principles Calibration Techniques Uncertainty Analysis

| 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. | **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, PID controllers, pneumatic and hydraulic controllers, electronic | 8 | 17% |

| | | | |
|---|---|---|---|
| | 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

**Suggested Books**: - Mechanical and Industrial Measurements - R K Jain - Khanna Publishers

**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

**CO1** Provide students with a comprehensive overview of various experimental techniques used in the field of thermal systems

**CO2** Familiarize students with a range of instrumentation commonly employed in thermal experiments, such as thermocouples, thermistors, flowmeters, pressure sensors, and heat flux sensors.

**CO3** Teach students the underlying principles behind measurements in thermal systems, including temperature, pressure, flow rates, heat transfer rates, and other relevant parameters

**CO4** Instruct students on calibration methods for thermal measurement instruments to ensure accurate and reliable data

**CO5** Teach students how to assess and quantify uncertainties associated with measurements in thermal systems, promoting a thorough understanding of the limitations of experimental data

| **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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 3 | - | 2 | 2 | - | - | - | - | - | - | 2 | - | - |
| **CO-2** | 3 | - | 2 | - | - | 2 | - | - | - | - | 2 | - | - |
| **CO-3** | 3 | - | 2 | 3 | - | 2 | - | - | - | - | 1 | - | - |
| **CO-4** | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | - |
| **CO-5** | 3 | - | 2 | 2 | - | 1 | - | - | - | - | 1 | - | - |

## 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, RankineHugoniot, 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.**YunusCengel 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:**

**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:**Apply the principles of one dimensional isentropic flow to variable area duct and analyze the principles of normal shock formation and its effects.
**CO-4:**Apply the principles of compressible flow to constant area duct subjected to friction or heat transfer.
**CO-5:**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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | - | 2 | - | - | - | - | - | - | - | - | 2 | - |
| **CO-2** | 2 | 2 | - | - | - | 2 | 2 | - | - | - | 2 | - | - |
| **CO-3** | - | 2 | 2 | - | 2 | 1 | - | - | - | - | - | - | 2 |
| **CO-4** | 2 | 2 | 1 | - | 2 | 2 | - | - | - | - | - | - | 2 |
| **CO-5** | - | - | 2 | 2 | - | - | - | - | 2 | - | 2 | - | - |

## FEM125103: ADVANCED REFRIGERATION ENGINEERING

**Course Objective:**-The course is designed to give knowledge of various refrigeration systems, properties of refrigerants and its behaviour 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.<br>**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.<br>**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:**

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:**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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | 2 | - | - | 2 | 2 | - | - | - | - | 2 | - | 2 |
| **CO-2** | 2 | 2 | - | - | - | - | 2 | - | 2 | - | - | 2 | - |
| **CO-3** | - | 2 | - | 2 | - | - | - | - | - | 2 | - | 2 | - |
| **CO-4** | 2 | - | - | - | 2 | - | - | - | 2 | - | - | - | - |
| **CO-5** | - | 2 | - | - | - | - | - | - | - | - | 2 | - | 3 |

**FEM125104: DESIGN AND OPTIMIZATION OF THERMAL SYSTEMS**

**Course Objective:-**The course is designed to give fundamental knowledge, relevant technologies and design aspects of various thermal systems used in engineering.

**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:** Engineering Design, Design as Part of Engineering Enterprise, Design versus analysis, need for optimization, basic characteristics of thermal system, Formulation of the Design Problem, Steps in the Design Process, Computer-Aided Design | 8 | 18% |
| 2. | **Modeling& Simulation of thermal systems:** Basic considerations in design, importance of modeling in design, types of models, mathematical modeling, physical modeling and dimensional analysis, solution procedure, merging of different models, accuracy and validation, system simulation, curve fitting, methods of numerical simulation, numerical simulation versus real systems | 12 | 30% |
| 3. | **Optimization:** Introduction, Formulation of optimization problems, Calculus techniques: Lagrange multiplier method, Search methods, Concept of interval of uncertainty, reduction ratio, reduction ratios of simple search techniques like exhaustive search, dichotomous search, Fibonacci search and Golden section search, numerical examples Method of steepest ascent/steepest descent, conjugate gradient method: examples, New generation optimization techniques: Genetic algorithm and simulated annealing, Introduction to Bayesian framework for optimization | 16 | 38% |

| | | | |
|---|---|---|---|
| **4.** | **Economic Considerations:** Calculation of Interest, Worth of Money as a Function of Time, Series of Payments, Raising Capital, Taxes, Economic Factor in Design, Application to Thermal Systems, Carbon Credit Calculation | 6 | 14% |

- **References Books:-**

1. Design and optimization of thermal systems, Y Jaluria, McGraw Hill.
2. Elements of thermal fluid system design, L C Burmeister, Prentice Hall
3. Essentials of Thermal System Design and Optimization, C Balaji, Ane Books/CRC Press
4. Design of thermal systems, W F Stoecker, McGraw Hill
5. Introduction to optimum design, J S Arora, McGraw Hill

- **List of Suggested Experiments:**

1. To evaluate need for optimization in engineering enterprise.
2. Exercise on mathematical modelling and problem formulation for optimization of various thermal system.
3. Write a program to implement single variable optimization technique.
4. Write a program to implement multivariable optimization techniques.
5. Write program to implement genetic algorithm.
6. To discuss different economics considerations used for design and optimization of thermal systems.
7. To apply various methods of numerical simulation for thermal systems optimization.
8. To apply reduction ratios of simple search techniques used for optimization.
9. To calculate carbon credit for specific case study.
10. To appraise different types of modeling techniques.

- **Course Outcomes:-**

**CO-1.** Explain engineering design of thermal systems.
**CO-2.**Discuss different models used in modelling of thermal systems.
**CO-3.**Appraise various optimization techniques and apply the same to thermal system design.
**CO-4.**Determine costing of thermal systems.

| **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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | - | 2 | - | - | 2 | - | - | - | 2 | - | 2 | - |
| **CO-2** | - | 1 | - | 2 | - | - | - | 2 | 2 | - | 2 | - | - |
| **CO-3** | 1 | - | - | - | - | 2 | - | - | 2 | - | 2 | - | - |
| **CO-4** | - | 1 | 2 | - | - | - | 2 | - | - | 2 | - | - | 2 |

**FEM125105: COMBUSTION ENGINEERING**

**Course Objective:-**The course is designed to give fundamental knowledge, relevant technologies and design aspects of various thermal systems used in engineering.

**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 to Combustion and Thermochemistry:** Review of Property Relations, Reactant and Product Mixtures, Adiabatic Flame Temperatures, Chemical Equilibrium, Equilibrium Products of Combustion, Rudiments of Mass Transfer, Liquid – Vapor Interface Boundary Conditions, Droplet Evaporation. | 6 | 16% |
| 2 | **Chemical Kinetics and Mechanisms:** Global versus Elementary Reactions, Elementary Reaction Rates, Rates of Reaction for Multi – step Mechanisms, The H2 – O2 System, Carbon Monoxide Oxidation, Oxidation of Higher Paraffins, Methane Combustion, Oxides of Nitrogen Formation. | 6 | 16% |
| 3 | **Coupling Chemical and Thermal Analysis of Reacting Systems:** Constant Pressure and Constant Volume Fixed Mass Reactor, Well Stirred Reactor, Plug Flow Reactor, Applications to Combustion System Modeling. | 4 | 10% |

| | | | |
|---|---|---|---|
| **4** | **Simplified Conservation Equations for Reacting Flows:** Mass Conservation (Continuity), Momentum Conservation, Energy Conservation, The Concept of a Conserved Scalar. | 3 | 6% |
| **5** | **Laminar Premixed Flames:** Physical Description, Simplified Analysis, Factors Influencing Flame Velocity and Thickness, Flame Speed Correlations for Selected Fuels, Quenching, Flammability and Ignition, Flame Stabilization.<br>**Laminar Diffusion Flames – Burning Jets:** Non reacting Constant Density Laminar Jet, Jet Flame Physical Description, Simplified Theoretical Descriptions, Flame Lengths for Circular – Port and Slot Burners, Soot Formation and Destruction. | 8 | 18% |
| **6** | **Droplet Evaporation and Burning:** Simple Model of Droplet Evaporation and Droplet Burning, One Dimensional Vaporization Controlled Combustion, Some Applications of Droplet Evaporation and Droplet Burning. | 4 | 10% |
| **7** | **Turbulent Premixed and Non premixed Flames:** Definition of Turbulence, Length Scales in Turbulent flows, Analyzing Turbulent Flows, Axisymmetric Turbulent Jet, Definition of Turbulent Flame Speed, Structure of Turbulent Premixed Flames, Wrinkled Laminar Flame Regime, Distributed Reaction Regime, Flamelets in Eddies Regime, Flame Stabilization, Jet Flames, Applications of Turbulent Premixed Flames. | 8 | 18% |
| **8** | **Burning of Solids:** Coal Fired Boilers, Heterogeneous Reactions, Burning of Carbon, Coal Combustion. | 3 | 6% |

- **Reference Books:**

1. An Introduction to Combustion – Concept and Applications, Stephen R Turns, McGraw-Hill
2. Principles of Combustion, Kenneth K. Kuo, John Wiley & Sons
3. Fundamentals Of Combustion, D P Mishra, PHI Learning
4. Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, Warnatz, J., Maas, Ulrich, Dibble, Robert W., Springer
5. Understanding Combustion (English) 2nd Edition, H S Mukunda, Universities Press
6. Flame and Combustion by J A Barnard and J N Bradley, Chapman and Hall.

- **List of Suggested Experiments:**

1. To estimate the fuel composition from the analysis of exhaust gases.
2. To find the calorific value of the given fuel.
3. To find the effect of temperature on various flow properties of liquid fuel.
4. To calculate the amount of heat release by combustion of solid fuel at different surrounding conditions.

5. To observe the effect of various parameters on the flame structure.
6. To measure the change of operating parameters on the spray of liquid fuel.
7. To understand the process of droplet evaporation and burning under various condition.
8. To study about chemical and thermal analysis of reacting systems.
9. To observe the effect of turbulence on the flames.
10. To analyses the effect of various operating parameters on the flame stabilization.

- **Course Outcomes:-**

**CO-1**.Discuss concepts of the thermo-chemistry of combustion to evaluate the quality of combustion in energy systems, including thermal engines.
**CO-2.**Appraise laminar and turbulent premixed and non-premixed flames.
**CO-3.**Model droplet evaporation and burning and explain their applications.
**CO-4.**Analyze combustion of solid fuels.

| **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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | 2 | 2 | - | - | - | 2 | - | - | - | 2 | - | - |
| **CO-2** | 2 | - | - | 2 | - | 2 | - | - | - | - | - | 2 | - |
| **CO-3** | - | 1 | - | - | 2 | - | - | - | 2 | - | - | - | 3 |
| **CO-4** | 2 | 2 | - | - | - | - | 2 | - | - | 2 | - | 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<br>**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:**

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.

## ➢ 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

| 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-2** | 1 | 2 | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-3** | 1 | 2 | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO-4** | 1 | - | - | - | - | - | - | - | 2 | 1 | - | - | 1 |
| **CO-5** | - | - | - | - | - | - | - | - | 1 | 1 | - | - | 2 |

**FEM125107: ADVANCED AIR CONDITIONING ENGINEERING**

**Course Objective:-**The course is designed to give advanced knowledge and relevant technologies in the area of Air conditioning engineering which includes load calculations, component design, air distribution and handling.

**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. | **Applied psychometric**: Different psychometric charts, combinations of different processes and their representation on psychometric charts, psychometric calculations for cooling and dehumidification, high latent heat load, dehumidified air quantities based on total and effective room loads, GSHF and RSHF, effective surface temperature, effect of bypass factor on GSHF, analysis for using all outside air, psychometric of partial load control | 5 | 12% |
| 2. | **Design conditions and Heat load calculation:** Selection of inside design conditions for different applications, Thermal comfort, Different equations governing thermal exchanges, environmental indices, AQ and its importance, Basic terminology for heat load calculation, heat transfer through walls and roofs, heat gain through glass, solar heat gain factor, shading of glass, shading devices and its selection, load due to other sources, stack effect, brief idea about other ASHRAE methods of calculating cooling load | 5 | 12% |
| 3. | **Distribution of Air:** Terminology, outlet performance, types of | 10 | 24% |

| | | | |
|---|---|---|---|
| | outlets, location of outlets, factors affecting grill performance, selection of outlets using nomographs and tables, room air diffusions performance index (ADPI) and its use in outlet selection, types of ducts, duct materials and their accessories, duct construction, factors affecting duct construction, friction charts and other correction factors, losses, design velocity and its selection, duct heat gain or loss, duct insulation, duct layouts, duct sizing methods, noise and their isolation. | | |
| **4.** | **Air conditioning systems:** Factors affecting the selection of the systems, classification, design procedure, system features, controls of all air, air water, all water, DX, VAV and dual duct systems, basic idea of cold air distributions systems | 10 | 24% |
| **5.** | **Evaporative cooling equipment:** Cooling tower: Types, construction, working and performance; Evaporative air cooler: Types, construction, working and performance, testing of evaporative air coolers as per IS standards, indirect evaporative cooling; Air washer: Types, construction, working, performance | 5 | 12% |
| **6.** | **Air handling systems:** Types, construction and performance characteristics of fans, fan laws, testing as per IS and AMCA standards, fan selection with the help of tables, charts and curves, fan drive arrangements and discharge from fans | 4 | 8% |
| **7** | **Advances in Air Conditioning:** Chilled beam, clean room concept, filtration of suspended particles, PPM control and methods, types of filters | 3 | 8% |

- **References Books:-**

After learning the course the students should be able to

1. Air Conditioning Engineering by W P Jones, Butterworth-Heinemann, Boston, Oxford
2. Refrigeration and Air conditioning by C P Arora, McGraw-Hill Publication
3. Hand book of Air conditioning Systems Design by Carrier Corporation
4. Air conditioning Principles and Systems by Edward G. Pita, John Wiley& Sons Australia Limited
5. HVAC Testing Adjusting and Balancing Manual by John Gladstone 3rd, McGraw-Hill Publication
6. ASHRAE Handbook of HVAC Systems and Equipment
7. ASHRAE Handbook of HVAC Applications
8. Fan Handbook by Frank P Bleier, McGraw-Hill Professional

- List of Suggested Experiments:

1. To study various instruments used in air conditioning.
2. Study of advanced air conditioning systems.
3. Study of air conditioning test rig.
4. Study of clean room.

5. Performance evaluation of air conditioning system with different psychometric conditions.
6. To carry out cooling load calculation of a residential/commercial building.
7. Design of duct system for above selected building.
8. To determine the capacity of window or split air conditioner.
9. To determine humidifying efficiency of air cooler.

- **Course Outcomes:-**

**CO-1**. To make calculation of various Psychrometric processes
**CO-2.** To estimate the cooling load requirements of residential and commercial building and design the system components accordingly
**CO-3.** To make use of tables and nomographs to design air distribution systems
**CO-4.** To develop the skills to analyze the domestic and industrial requirement of air conditioning systems and evaporative cooling equipment
**CO-5.** To select fan for particular air conditioning system and discuss recent developments in air conditioning

| 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 | PSO-1 | PSO-2 | PSO-3 |
| CO-1 | 2 | - | - | - | - | - | 2 | - | - | - | 1 | - | - |
| CO-2 | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - | - |
| CO-3 | - | 1 | - | - | - | - | 1 | - | - | - | - | - | - |
| CO-4 | 1 | 1 | 1 | - | - | - | - | - | 2 | - | - | 2 | - |
| CO-5 | 1 | 1 | - | - | - | - | 2 | - | - | - | - | 2 | - |

**FEM125108: COMPUTATIONAL FLUID DYNAMICS**

**Course Objective:-** The course is formulated to impart detailed study of computational techniques in field of fluid flow 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. | **Introduction:** What is Computational fluid dynamics (CFD) and how it works? CFD as design and research tool, impact of CFD in Engineering, governing equations of fluid dynamics: Models flow, time rate of change (of moving fluid element), divergence of velocity and its physical meaning, continuity, momentum and energy equations, mathematical behaviour of partial differential equations | 4 | 10% |
| 2. | **Basic Concept of Discretization:** Introduction to discretization technique, introduction to finite differences: Taylor's series expansion, difference equations: explicit and implicit approach, errors and stability analysis, CFL condition Grid Transformation: Introduction, general transformation equations, matrices and Jacobean, transformed version of governing equation particularly suited for CFD, compressed grids, elliptic grid generation, adaptive grids | 10 | 24% |
| 3. | **Simple CFD Technique:** Lax Wandroff technique, Mac-Cormack's technique, relaxation technique and its use with low speed, alternating direction implicit technique (ADI), pressure correction | 8 | 18% |

| | | | |
|---|---|---|---|
| | technique: need for staggered grid and its formula, boundary condition for pressure correction method | | |
| **4.** | **Heat Conduction and Convection:** Conduction: 1D conduction equation, grid layout discretization, stability and convergence, dealing with non-linearity, methods of solution, 2D conduction. Convection: 1D convection, exact solution and its discretization, upwind difference scheme, comparison of central difference scheme, upwind difference scheme and exact solution, numerical false diffusion, hybrid and power-law schemes, total variation diminishing scheme, 2D Convection: Cartesian and complex domain, Unsteady conduction and convection, Stability of the unsteady flow. | 10 | 24% |
| **5.** | **Finite Volume Method:** Introduction to finite volume method (FVM), FVM for diffusion and convection–diffusion problems, discretization of equation for two-dimension, false diffusion, computation of the flow field using stream function and vorticity formulation, solution procedure for unsteady flow calculations: SIMPLE, SIMPLEC, PISO, and MAC algorithms, Solution algorithms for pressure–velocity coupling in steady flows | 10 | 24% |

- **References Books:-**

1. An Introduction to Computational Fluid Dynamics: The Finite Volume Method, H. K. Versteeg, W. Malalasekera, Pearson Education Ltd.
2. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Hemisphere Publishing Co.
3. Fundamentals of Computational Fluid Dynamics Vol. I, II, III, Hoffman and Chiang, Engineering Education System
4.Computational Heat Transfer, K. Murlidhar, G. Biswas, T. Sundarajan, V. Eshwaran, Narosa Publication
5.Computational Fluid Dynamics: A Practical Approach, Jiyuan Tu, Guan HengYeoh, Chaoqun Liu, Elsevier
6.Principles of Computational Fluid dynamics, Pieter Wesseling, Springer International Edition
7. Introduction to Fluid Mechanics, Edward J Shaughnessy, Jr., Ira M Katz, Oxford University press

- **List of Suggested Experiments:**

1. Perform Analytical and Numerical analysis on Pin-Fin to calculate temperature distribution.
2. Perform Analytical and Numerical analysis on 1-D steady state heat conduction to calculate temperature distribution along wall thickness.
3. Perform Analytical and Numerical analysis on 2-D steady state heat conduction to calculate temperature distribution along wall thickness.
4. Perform Analytical and Numerical analysis on 1-D unsteady state heat conduction along the wall thickness.
5. Perform Analytical and Numerical analysis on 2-D unsteady state heat conduction along the wall

thickness.

6. Perform Analytical and Numerical analysis on steady and unsteady state heat transfer by convection.
7. Perform Numerical analysis on flow through pipe with varying Reynolds number.

**Course Outcomes:-**

After learning the course the students should be able to

**CO-1.** To develop perception of major theories, approaches and methodologies used in CFD

**CO-2.** To analyze and apply CFD analysis to solve major engineering design problems involving fluid flow and heat transfer

**CO-3.** To build up the skills in the implementation of CFD methods (e.g. boundary conditions) in actual engineering using commercial CFD codes

| 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | 1 | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-2** | 1 | 1 | - | - | - | 2 | 2 | - | - | - | - | 2 | - |
| **CO-3** | 1 | 2 | 1 | - | - | - | 2 | - | 1 | - | - | 2 | - |

**FEM125109: MINI PROJECT WITH SEMINAR**

**COURSE OBJECTIVE** : Study different techniques used to analyze complex systems. Solve a live problem using software/analytical/computational tools and present solution by using his/her technique applying engineering principles Learn to write technical reports and develop skills to present and defend their work in front of technically qualified audience. Outline annotated bibliography of research demonstrating scholarly skills Prepare a well-organized report employing elements of critical thinking and technical writing 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<br>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:

**CO1** Identify engineering problems reviewing available literature.

**CO2** Study different techniques used to analyze complex systems.

**CO3** Solve a live problem using software/analytical/computational tools and present solution by using his/her technique applying engineering principles

**CO4** Learn to write technical reports and develop skills to present and defend their work in front of technically qualified audience.

**CO5** Outline annotated bibliography of research demonstrating scholarly skills

**CO6** 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 | PSO-1 | PSO-2 | PSO-3 |
| CO-1 | 3 | - | 2 | 2 | 3 | - | - | - | - | - | 2 | - | - |
| CO-2 | 3 | - | 2 | - | 3 | - | - | - | - | - | 2 | - | - |
| CO-3 | 3 | - | 3 | - | 1 | - | - | - | - | - | 1 | - | - |
| CO-4 | 3 | - | 2 | - | 2 | - | - | - | - | - | 2 | - | - |
| CO-5 | 3 | - | 2 | - | 3 | - | - | - | - | - | 1 | - | - |
| CO-6 | 3 | - | 2 | - | 3 | - | - | - | - | - | 1 | - | - |

**FEM135101: INTERNAL REVIEW-I**

**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:

**CO1** The student can identify different areas of mid semester Thesis Progress Review.

**CO2** 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 3 | - | 2 | 2 | - | - | - | - | - | - | 2 | - | - |
| **CO-2** | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | - |

**FEM135102: DISSERTATION PHASE-I**

**Course objective:** In the context of a dissertation's Phase I, typically, this phase involves the initial planning and proposal stage of the research. The course outcomes for a Dissertation Phase I may include the following: Research Problem, Identification Literature Review, Research Objectives and Questions, Theoretical Framework Research, Design Feasibility, Assessment Research Significance

| 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

**CO1** Students should be able to identify and articulate a clear research problem or question that is relevant to the field of study.

**CO2** Demonstrate the ability to conduct a comprehensive literature review that establishes the existing knowledge and identifies gaps or areas for further investigation

**CO3** Formulate specific research objectives and questions that guide the research process and contribute to addressing the identified research problem

**CO4** Develop a theoretical framework that provides a conceptual foundation for the research, linking the study to relevant theories or conceptual models

**CO5** Design an appropriate research methodology, including the selection of research methods, data collection techniques, and data analysis procedures

| **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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 3 | - | 2 | 2 | - | - | - | - | - | - | 2 | - | - |
| **CO-2** | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | - |
| **CO-3** | 3 | - | 2 | 3 | - | - | - | - | - | - | 1 | - | - |
| **CO-4** | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | - |
| **CO-5** | 3 | - | 2 | 2 | - | - | - | - | - | - | 1 | - | - |

**FEM135103: INDUSTRIAL SAFETY**

**Course Objective :-** Workplace safety is very important for each and every employee in the industry because all the workers desire to work in a safe and protected atmosphere.

**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 | 0 | 3 | 3 | 70 | 30 | 0 | 0 | 100 |

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

**Content:-**

| Sr No. | Subject Content | Teaching Hours | Weightage (%) |
|---|---|---|---|
| 1. | **Industrial safety:** Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods | 5 | 14% |
| 2. | **Fundamentals of maintenance engineering**: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment | 4 | 12% |
| 3. | **Wear and Corrosion and their prevention:** Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods | 15 | 32% |

| | | | |
|---|---|---|---|
| **4.** | **Fault tracing:** Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes | 14 | 30% |
| **5.** | **Periodic and preventive maintenance:** Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance | 4 | 12% |

- **References Books:-**

**1.**Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services
**2.** Maintenance Engineering, H. P. Garg, S. Chand and Company
**3.** Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication
**4.** Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London

**List of Suggested Book:**

**1.** Maintenance Engineering, H. P. Garg, S. Chand and Company

## COURSE OUTCOMES

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

**CO-1**: Analyze the effect of release of toxic substances

**CO-2**: Understand the industrial laws, regulations and source models.

**CO-3**: Apply the methods of prevention of fire and explosions.

**CO-4:** Understand the relief and its sizing methods.

**CO-5**: Understand the methods of hazard identification and preventive measures.

| 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 1 | - | - |
| **CO-2** | 3 | 2 | - | 1 | 1 | - | - | - | - | - | 2 | - | - |
| **CO-3** | 2 | 2 | - | 1 | - | - | - | - | - | - | 1 | - | - |
| **CO-4** | 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO-5** | 3 | 1 | 1 | 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.<br>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

**List of Suggested Book:**

Charles T. Horngren and George Foster, Advanced Management Accounting

## 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.

| **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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | - | - | - | - | - | - | - | 1 | 2 | 1 | - | - |
| **CO-2** | 3 | - | - | 1 | - | - | - | - | - | - | 2 | - | - |
| **CO-3** | 2 | 2 | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-4** | 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO-5** | 3 | 1 | 1 | 2 | - | - | - | - | - | - | 1 | - | - |

**SUBJECT NAME: COMPOSITE MATERIALS**

**SUBJECT CODE: FEM135105**

**Course Objective:-** Equip students with knowledge on composite strengthening addition of components and their production routes. Familiarize students about the properties and response of composite structures subjected to mechanical loading.

**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 | 0 | 3 | 3 | 70 | 30 | 0 | 0 | 100 |

| Sr No. | Subject Content | Teaching Hours | Weightage (%) |
|---|---|---|---|
| 1. | **Introduction**: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance | 5 | 14% |
| 2. | **Reinforcements:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions | 4 | 12% |
| 3. | **Manufacturing of Metal Matrix Composites:** Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications | 15 | 32% |
| 4. | **Manufacturing of Polymer Matrix Composites**: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications | 14 | 30% |

| | | | |
|---|---|---|---|
| **5.** | **Strength:** Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations | 4 | 12% |

**References Books:-**

**1.** Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany
**2.** Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition,
**3.** Hand Book of Composite Materials-ed-Lubin
**4.** Composite Materials – K.K.Chawla
**5.** Composite Materials Science and Applications – Deborah D.L. Chung
**6.** Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi

**List of Suggested Book:**

1.Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition

**COURSE OUTCOMES**

**CO-1:** Explain the advantages and applications of composite materials
**CO-2:** Describe the properties of various reinforcements of composite materials
**CO-3:** Summarize the manufacture of metal matrix, ceramic matrix and C-C composite
**CO-4:** Describe the manufacture of polymer matrix composites.
**CO-5:** Formulate the failure theories of composite materials.

| **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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | - | - | - | - | 1 | 1 | - | 1 | 2 | 1 | - | - |
| **CO-2** | 3 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| **CO-3** | 2 | 2 | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-4** | 3 | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO-5** | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |

**FEM135106: ADVANCED THERMAL TURBO MACHINES**

**Course Objective :-** The course is designed to discuss the advanced and relevant technologies of turbo machineries and related system components.

**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 | 0 | 3 | 3 | 70 | 30 | 0 | 0 | 100 |

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

**Content:-**

| Sr No. | Subject Content | Teaching Hours | Weightage (%) |
|---|---|---|---|
| 1. | **Fundamentals of Turbo Machines:** Introduction to turbo machines, classifications, applications, fundamental laws and equations, specific speed, thermodynamic and dimensional analysis applied to turbo machines. | 5 | 14% |
| 2. | **Principles of Turbo Machines:** Transfer of energy to fluids, performance characteristics with standard curves, comparison and selection criteria of various turbo machines | 4 | 12% |
| 3. | **Centrifugal & Axial Flow Compressors:**Centrifugal blowers and compressors, Euler's characteristics and velocity triangles of centrifugal compressor, hydraulic efficiency, analysis of flow through impeller, diffusers and casing, pressure recovery, slip factor, disc friction, Stanitz and Stodola formulas, axial flow fans and compressors, geometry of axial flow compressor, velocity diagrams, vortex and airfoil theory, stage pressure ratio, degree of reaction, stage design, surge, chocking and stall, blade twist and design considerations for supersonic flow. | 15 | 32% |
| 4. | **Analysis of Axial & Radial Flow Gas Turbines:** Work done, velocity triangles and efficiencies, thermodynamic flow analysis, Zweifels relation, cascade analysis, Soderberg– Hawthrone – ainley-correlations, secondary flow, blade angles for variable degree of reaction, stresses in blades, blade assembling, materials and cooling of blades, matching of compressor and turbine; off-design performance. | 14 | 30% |

| | | | |
|---|---|---|---|
| **5.** | **Testing and control of Turbo Machines:** Performance testing, noise control, speed control, throttling control at discharge and inlet and maintenance of fans, blowers, compressors and turbines. | 4 | 12% |

- **References Books:-**

1. Axial Flow Compressors: Fluid Mechanics and Thermodynamics by J. H. Horlock, Krieger Publishing
2. Centrifugal Pumps and Blowers, Austin H. Chruch, John Wiley and Sons, Chennai, Dekker, Inc.
3. Element of Gas Dynamics by Liepeman and Roshkow, Dover Publications
4. Element of Gas Dynamics by S. M. Yahya, McGraw Hill Publishers
5. Fluid Dynamics and heat Transfer of Turbo machinery, Budugur Lakshminarayana, John Wiley and Sons
6. Fundamentals of Turbo machinery/William W Perg/John Wiley & Sons
7. Gas Turbines Theory and Practice/Zucrow/John Wiley & Sons/New York
8. Handbook of Turbo machinery, Edited by Earl Logan Jr, Ramendra Roy; Second Edition , Marcel
9. Practice on Turbo Machines/ G.Gopal Krishnan & D.Prithviraj/ Sci Tech Publishers
10. Principles of Jet Propulsion and Gas Turbine/NJ Zucrow/John Wiley & Sons/New York
11. Principles of Turbo Machines/DG Shepherd / Macmillan
12. Theory and practice of Steam Turbines/ WJ Kearton/ELBS Pitman/London
13. Turbines, Pumps, Compressors by S. M. Yahya, McGraw Hill Publishers

- **Course Outcomes:-**

After learning the course the students should be able to

**CO-1.** To discuss the principles and energy transfer process in turbo machines.

**CO-2.** To understand the structural and functional aspects of major components of turbo machines.

**CO-3.** Analyse the turbo machines to improve and optimize its performance

**CO-4.** To understand control and maintenance aspects of turbo machines.

| 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 1 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-2** | 1 | - | - | - | - | - | - | - | 1 | - | 1 | - | - |
| **CO-3** | 1 | 1 | 2 | 2 | - | - | - | - | - | - | - | 2 | - |
| **CO-4** | 1 | 1 | - | - | - | - | - | - | - | - | - | - | 2 |

**FEM135107: JET PROPULSION & AIR-CRAFT ENGINEERING**

**Course Objective :-** The course is prepared to provide the insight of jet propulsion engines their performance characteristics and relevant technology.

**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 | 0 | 3 | 3 | 70 | 30 | 0 | 0 | 100 |

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

**Content:-**

| Sr No. | Subject Content | Teaching Hours | Weightage (%) |
|---|---|---|---|
| 1. | **Fundamental of Gas Dynamics:** Study of Wave motion, stagnation condition and parameters, Mach Number and its influence, Isentropic Flow, Rayleigh and Fanno Flow | 5 | 14% |
| 2. | **Principles of Jet Propulsion:** Fundamentals of aircraft propulsion, aircraft matching, thrust, various efficiencies, rockets and air breathing jet engines, classifications, turbo-jet, turbo-fan, turbo-prop, pulse jet & ramjet engine and their performance characteristics | 12 | 28% |
| 3. | **Solid & Liquid Propulsion System:** The concept of Solid & Liquid propellants, classification, homogeneous and heterogeneous propellants, composite propellant oxidizers and binders, effect of binder on propellant properties, burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates, liquid propellants; classification, cryogenic and storage propellants, physical and chemical characteristics of liquid propellant | 12 | 28% |
| 4. | **Solid & Liquid Propulsion Engines:**Solid propellant rocket engine, internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters, rocket motor hardware design, heat transfer considerations in solid rocket motor design, Liquid propellant rocket engine, system layout, pump and pressure feed systems, feed system | 13 | 30% |

| | | | |
|---|---|---|---|
| | components, design of combustion chamber, characteristic length, constructional features, and chamber wall stresses, heat transfer and cooling aspects | | |

- **References Books:-**

**1.** Mechanics and Dynamics of Propulsion – Hill and Peterson
**2.** Principles of Jet Propulsion and Gas Turbines- Zucrow N.J., John Wiley and Sons New York
**3.** Gas Turbines & Propulsive Systems – Khajuria & Dubey (Dhanpatrai)
**4.** Rocket propulsion elements – Sutton
**5.** Rocket propulsion – Bevere
**6.** Jet propulsion – Nicholas Cumpst
**7.** Aircraft and Missile Propulsion - Zucrow N.J.Vol. I and Vol. II, John Wiley and Sons Inc, New York
**8.** Fundamentals of Compressible Flow - S. M.Yahya, Third edition, New Age International Pvt Ltd

- **Course Outcomes:-**

After learning the course the students should be able to
**CO-1.** Explain fundamental of gas dynamics
**CO-2.** Appraise the working of different types of aircraft and rocket propulsion systems and their performance characteristics.
**CO-3.** Discuss different propulsion engine with respect to various operating and effecting parameters.

| **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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | - | - | - | - | - | - | - | - | - | 2 | - | - |
| **CO-2** | 1 | 2 | 2 | - | - | - | - | - | 1 | - | - | 2 | - |
| **CO-3** | 1 | 1 | 2 | - | - | - | - | - | 1 | 2 | - | 2 | - |

**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

| 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 2 | - | - | - | - | - | - | - | - | - | 1 | - | - |
| **CO-2** | 1 | - | 1 | 2 | - | - | - | - | - | - | - | 2 | - |
| **CO-3** | 1 | - | - | 2 | - | 2 | - | - | - | - | - | 2 | - |
| **CO-4** | 1 | - | - | 2 | - | 2 | - | - | - | - | - | 2 | - |
| **CO-5** | 1 | 2 | - | - | - | - | - | - | - | - | 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 carry 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:

**CO1** The student can identify different areas of mid semester Thesis Progress Review.

**CO2** Can find the applications of all the areas in day-to-day life

**CO3** Review students' written and oral communication skills, particularly in the context of presenting experimental findings, writing reports, and discussing thermal concepts

| 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 | PSO-1 | PSO-2 | PSO-3 |
| CO-1 | 3 | - | 2 | 2 | - | - | - | - | - | - | 2 | - | - |
| CO-2 | 3 | - | 2 | - | - | - | - | - | - | - | 2 | - | - |
| CO-3 | 3 | - | 2 | 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:

**CO1** Solve identified technical problem using acquired knowledge and skill

**CO2** Develop a realistic and detailed timeline for the completion of each phase of the research, including data collection, analysis, and the writing of the dissertation

**CO3** Demonstrate effective oral and written communication skills by presenting the research proposal to an academic audience, including faculty members or a dissertation committee

**CO4** Ability to incorporate feedback from faculty or the dissertation committee into the research proposal, showing a capacity for constructive revision and improvement

**CO5** 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** | **PSO-1** | **PSO-2** | **PSO-3** |
| **CO-1** | 3 | - | 3 | 2 | - | - | - | 1 | - | - | 2 | - | - |
| **CO-2** | 3 | - | 3 | - | - | 2 | - | 1 | - | - | 2 | - | - |
| **CO-3** | 3 | - | - | - | - | 2 | - | 2 | - | - | 1 | - | - |
| **CO-4** | 3 | - | - | - | - | - | - | 2 | - | - | 2 | - | - |
| **CO-5** | 3 | - | 3 | 2 | - | 1 | - | 1 | - | - | 1 | - | - |