PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare students to excel in research or to succeed in Thermal engineering profession through global, rigorous post graduate education.

II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve thermal engineering problems.

III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design and create novel products and solutions for the real life problems.

IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach and an ability to relate thermal engineering issues to broader social context.

V. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES:

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
3. Graduates will demonstrate an ability to design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate an ability a system, component or process as per needs and specifications.
5. Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
6. Graduates will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduates will be able to communicate effectively in both verbal and written form.
9. Graduates will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduates will develop confidence for self education and ability for life-long learning.
## PEO / PO Mapping

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**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE =72**

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## LIST OF ELECTIVES FOR M.E THERMAL ENGINEERING

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<td>TE5010</td>
<td>Cogeneration and Waste Heat Recovery Systems</td>
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### EMPLOYABILITY ENHANCEMENT COURSES (EEC)

<table>
<thead>
<tr>
<th>SL. NO.</th>
<th>COURSE CODE</th>
<th>COURSE TITLE</th>
<th>CATEGORY</th>
<th>CONTACT PERIODS</th>
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<td>1.</td>
<td>TE5211</td>
<td>Technical Seminar – I</td>
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OBJECTIVES:
The course will develop numerical methods aided by technology to solve algebraic, transcendental and differential equations and to apply finite element methods for solving the boundary value problems in differential equations. The course will further develop problem solving skills and understanding of the application of various methods in solving engineering problems. This will also serve as a precursor for future research.

UNIT I ALGEBRAIC EQUATIONS

UNIT II ORDINARY DIFFERENTIAL EQUATIONS

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS
Laplace and Poisson’s equations in a rectangular region: Five point finite difference schemes, Leibmann's iterative methods, Dirichlet's and Neumann conditions – Laplace equation in polar coordinates: Finite difference schemes – Approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD

TOTAL: 60 +15 = 75 PERIODS

OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:

- Solve an algebraic or transcendental equation, linear system of equations and differential equations using an appropriate numerical method.
- Solving the initial boundary value problems and boundary value problems using finite difference and finite element methods.
- Selection of appropriate numerical methods to solve various types of problems in engineering and science in consideration with the minimum number of mathematical operations involved, accuracy requirements and available computational resources.
REFERENCES:

TE5151 ADVANCED HEAT TRANSFER

OBJECTIVES
- To develop the ability to use the heat transfer concepts for various applications like finned systems, turbulence flows, high speed flows.
- To analyse the thermal analysis and sizing of heat exchangers and to learn the heat transfer coefficient for compact heat exchanges.
- To achieve an understanding of the basic concepts of phase change processes and mass transfer.

UNIT I CONDUCTION AND RADIATION HEAT TRANSFER 12

UNIT II TURBULENT FORCED CONVECTIVE HEAT TRANSFER 12
Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model – k ε model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

UNIT III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 12
Condensation with shears edge on bank of tubes - boiling – pool and flow boiling - heat exchanger - Ε – NTU approach and design procedure - compact heat exchangers.

UNIT IV NUMERICAL METHODS IN HEAT TRANSFER 12
Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation - steady one-dimensional convection and diffusion problems - calculation of the flow field – SIMPLER Algorithm

UNIT V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION 12
Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer correlations in various applications like I.C. engines, compressors and turbines.

TOTAL : 60 PERIODS
OUTCOMES

- On successful completion of this course the student will be able to understand the fundamental concept of heat transfer mechanisms.
- Understand the application of numerical methods in heat transfer applications.
- Knowledge in combined heat and mass transfer mechanisms in engine applications.

REFERENCES


TE5101 ADVANCED THERMODYNAMICS

OBJECTIVES

- To develop the ability to use the thermodynamics concepts for various applications like availability analysis and thermodynamic relations.
- To analyse the real gas behaviour and chemical thermodynamics.
- To achieve an understanding of the basic concepts of Statistical and Irreversible thermodynamics.

UNIT I

AVAILABILITY ANALYSIS AND THERMODYNAMIC PROPERTY RELATIONS


UNIT II

REAL GAS BEHAVIOUR AND MULTI – COMPONENT SYSTEMS


UNIT III

CHEMICAL THERMODYNAMICS AND EQUILIBRIUM

UNIT IV  STATISTICAL THERMODYNAMICS  12

UNIT V  IRREVERSIBLE THERMODYNAMICS  12
Conjugate fluxes and forces - entropy production Onsager’s reciprocity relations - thermo – electric phenomena, formulations.

TOTAL : 60 PERIODS

OUTCOME
• After the completion of the syllabus students able to understanding the application of thermodynamics in real gas behaviour, availability analysis, statistical and irreversible thermodynamics.

REFERENCES

TE5102  ADVANCED FLUID MECHANICS  L T P C
3 0 0 3

OBJECTIVES
• To understand the laws of fluid flow for ideal and viscous fluids.
• To represent the real solid shapes by suitable flow patterns and to analyze the same for aerodynamics performances.
• To understand the changes in properties in compressible flow and shock expansion.

UNIT I  BASIC EQUATIONS OF FLOW  6
Three dimensional continuity equation - differential and integral forms – equations of motion momentum and energy and their engineering applications.

UNIT II  POTENTIAL FLOW THEORY  12
UNIT III VISCOS FLOW THEORY

UNIT IV BOUNDARY LAYER CONCEPT
Boundary Layer - displacement and momentum thickness - laminar and turbulent boundary layers in flat plates - velocity distribution in turbulent flows in smooth and rough boundaries - laminar sub layer.

UNIT V COMPRESSIBLE FLUID FLOW
One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers – fundamentals of supersonics – normal and oblique shock waves and calculation of flow and fluid properties over solid bodies (like flat plate, wedge, diamond) using gas tables.

TOTAL: 45 PERIODS

OUTCOME
- After the completion of the syllabus students able to familiarized about the ideal and viscous fluid flow, boundary layer concepts and changes in properties in compressible flow and shock expansion.

REFERENCES

TE5111 THERMAL ENGINEERING LABORATORY

OBJECTIVES:
- To conduct experiments on various Thermal Engineering devices to study the performance and its applications.

LIST OF EXPERIMENTS
1. Performance test on Spark Ignition engine and Compression Ignition using the alternate fuels.
2. Emission measurement in Spark Ignition and Compression Ignition Engines
3. Performance test on variable compression ratio petrol and diesel engines.
4. Performance study in a cooling tower.
5. Performance study in a refrigeration and heat pump systems.
6. Performance Study in a solar water heater.
8. Direct and diffused solar radiation measurements.
11. Performance and characteristics studies on fan.
13. Study on Thermal Storage Systems

TOTAL: 60 PERIODS

OUTCOMES: Upon completion of the course, the students will be able to:
- Know the various alternate fuels are available for IC engines
- Understand the thermodynamic relations for thermal engineering devices.
- Understand the working principle of different renewable energy sources.
- Measure the properties of different fuels

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Single cylinder / multi cylinder Automotive Engine with data acquisition system - 1 No
2. Flue gas analyzer - 1 No
3. Smoke meter - 1 No
4. Single cylinder variable Compression ratio petrol engine - 1 No
5. Single cylinder variable Compression ratio Diesel engine - 1 No
6. Cooling tower test rig - 1 No
7. Refrigeration cum Heat Pump test rig - 1 No
8. 100 LPD Solar flat plate water heater test rig - 1 No
9. Pyranometer - 1 No
10. Redwood / Saybolt viscometer - 1 No
11. Bomb calorimeter apparatus - 1 No
12. Gas colorimeter - 1 No
13. Cloud & Pour point apparatus - 1 No
14. Non-IBR Boiler test rig - 1 No
15. Parallel flow / Counter flow Heat exchanger test rig - 1 No
16. Fan test rig - 1 No

TE5201 INSTRUMENTATION FOR THERMAL ENGINEERING

OBJECTIVES
- To provide knowledge on various measuring instruments for thermal engineering.
- To understand the various steps involved in error analysis and uncertainty analysis.
- To provide knowledge on advance measurement techniques.

UNIT I MEASUREMENT CHARACTERISTICS
Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments

UNIT II MICROPROCESSORS AND COMPUTERS IN MEASUREMENT
Data logging and acquisition – use of sensors for error reduction, elements of micro computer interfacing, intelligent instruments in use.
UNIT III MEASUREMENT OF PHYSICAL QUANTITIES 10
Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.

UNIT IV ADVANCE MEASUREMENT TECHNIQUES 8
Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement.

UNIT V MEASUREMENT ANALYSIS 10
Chemical thermal, magnetic and optical gas analyzers, measurement of smoke, Dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

TOTAL: 45 PERIODS

OUTCOME
- On the completion of the syllabus students get knowledge about the thermal engineering measuring devices, utilization of computers in measurement applications and advanced measuring systems.

REFERENCES

TE5291 ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

OBJECTIVES
- To impart knowledge on the atmosphere and its present condition, global warming and eco-legislations.
- To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
- To elaborate on the technologies available for generating energy from waste.

UNIT I INTRODUCTION 9
UNIT II AIR POLLUTION
Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.

UNIT III WATER POLLUTION
Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

UNIT IV WASTE MANAGEMENT

UNIT V OTHER TYPES OF POLLUTION FROM INDUSTRIES

TOTAL: 45 PERIODS

OUTCOME
- On successful Completion of this course the student will be understand Emission standards, waste management power generation and pollution from various industries.

REFERENCES

TE5202 FUELS AND COMBUSTION

OBJECTIVES
- To understand the types of fuels.
- To understand the principles of combustion and combustion equipments.
- To understand the thermodynamic process behind the combustion.
UNIT I \hspace{2cm} CHARACTERIZATION \hspace{2cm} 8


UNIT II \hspace{2cm} SOLID OF LIQUID FUELS \hspace{2cm} 10


Liquid Fuels Types - Sources - Petroleum Fractions - Classification - Refining - Properties of Liquid Fuels - Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number etc, - Alcohols - Tar Sand Oil - Liquefaction of Solid Fuels.

UNIT III \hspace{2cm} GASEOUS FUEL \hspace{2cm} 7


UNIT IV \hspace{2cm} COMBUSTION : STOICHIOMETRY & KINETICS \hspace{2cm} 12


UNIT V \hspace{2cm} COMBUSTION EQUIPMENTS \hspace{2cm} 8


OUTCOME

• On successful Completion of this course the student will be understand combustion, Types of Fuels, Combustion Equipments

REFERENCES

OBJECTIVES:
- To learn the modeling and simulation analysis of various thermal engineering application using analysis softwares.

LIST OF EXPERIMENTS
1. Heat exchanger analysis – NTU method
2. Heat exchanger analysis – LMTD method
3. Convection heat transfer analysis – Velocity boundary layer.
4. Convection heat transfer analysis – Internal flow
5. Radiation heat transfer analysis – Emissivity
6. Critical radius of insulation
7. Lumped heat transfer analysis
8. Conduction heat transfer analysis
9. Condensation heat transfer analysis

TOTAL: 60 PERIODS

OUTCOMES:
- On successful completion of this course the student will have knowledge in various heat transfer simulation study on different thermal engineering applications by using analysis softwares.

DYNAMIC LINKING OF MAT LAB AND REF PROP SOFTWARE
SIMPLE CFD PROBLEMS FOR PRACTICE

NOTE: The above exercises are only guidelines to maintain the standard for teaching and conduct of examination.

SIMULATION LAB – REQUIREMENT:
1. Software - Modeling software like ProE, Gambit, Ansys, etc
   Analysis software like Ansys, fluent, CFX, etc
   Equation solving software like Matlab, Engg equation solver
2. Every students in a batch must be provided with a terminal
3. Hardwares are compatible with the requirement of the above software.
TE5211
TECHNICAL SEMINAR - I
L T P C
0 0 2 1

OBJECTIVES:
- To Enhance the ability of self-study
- To Improve presentation and communication skills
- To Increase the breadth of knowledge.

GUIDELINES
- The student is expected to present a seminar in one of the current topics in the field of Thermal Engineering related issues / technology.
- The seminar shall be of 30 minutes duration and give presentation to the Seminar Assessment Committee (SAC).
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- In a session of three periods per week, 4 students are expected to present the seminar.
- Students are encouraged to use various teaching aids such as power point presentation and demonstrative models.
- Students are required to prepare a seminar report in the prescribed format given by the Department.

EVALUATION
Technical Seminar I evaluation is based on Regulations of Post graduate programmes of Anna University.

TOTAL: 30 PERIODS

OUTCOMES:
At the end of the course, the student will be able to
- Identify and choose appropriate topic of relevance.
- Assimilate literature on technical articles of specified topic and develop comprehension.
- Prepare technical report.
- Design, develop and deliver presentation on specified technical topic

TE5301
DESIGN AND OPTIMIZATION OF THERMAL ENERGY SYSTEMS
L T P C
3 0 0 3

OBJECTIVES
- To learn basic principles underlying piping, pumping, heat exchangers; modeling and optimization in design of thermal systems.
- To develop representational modes of real processes and systems.
- To optimization concerning design of thermal systems.

UNIT I DESIGN CONCEPTS
Design Principles, Workable Systems, Optimal Systems, Matching of System Components, Economic Analysis, Depreciation, Gradient Present Worth factor, modelling overview – levels and steps in model development - Examples of models – curve fitting and regression analysis

UNIT II MODELLING AND SYSTEMS SIMULATION
Modelling of thermal energy systems – heat exchanger - solar collectors – distillation - rectification turbo machinery components - refrigeration systems - information flow diagram - solution of set of nonlinear algebraic equations - successive substitution - Newton Raphson method- examples of thermal systems simulation
UNIT III  OPTIMIZATION  10
Objectives - constraints, problem formulation - unconstrained problems - necessary and sufficiency conditions. Constrained optimization - Lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis - New generation optimization techniques – examples

UNIT IV  DYNAMIC BEHAVIOUR  8
Steady state Simulation, Laplace Transformation, Feedback Control Loops, Stability Analysis, Non-Linearities

UNIT V  APPLICATIONS AND CASE STUDIES  8
Case studies of optimization in thermal systems problems- Dealing with uncertainty- probabilistic techniques – Trade-offs between capital and energy using Pinch analysis

TOTAL: 45 PERIODS

OUTCOME
• On successful Completion of this course the student will be understand modeling and optimization of Thermal systems.

REFERENCES

TE5311  TECHNICAL SEMINAR - II  L T P C
0 0 2 1

OBJECTIVES:
• To enhance the reading ability required for identification of his/her field of interest.
• To develop skills regarding professional communication and technical report writing.
• To establish the fact that student is not a mere recipient of ideas, but a participant in discovery and inquiry.
• To learn how to prepare and publish technical papers.

GUIDELINES
• The student is expected to present a seminar in one of the current topics in the field of Thermal Engineering related issues / technology.
• The seminar shall be of 30 minutes duration and give presentation to the Seminar Assessment Committee (SAC).
• The committee shall evaluate the seminar based on the style of presentation, technical context, and coverage of the topic, adequacy of references, depth of knowledge and the overall quality.
A faculty guide is to be allotted and he/she will guide and monitor the progress of the student and maintain attendance also.
Each student has to submit a seminar report in the prescribed format given by the Institution.
In a session of three periods per week, 4 students are expected to present the seminar.
Students are encouraged to use various teaching aids such as power point presentation and demonstrative models.
It is recommended that the report for Technical Seminar II may be in the form of a technical paper which is suitable for publishing in Conferences/Journals as a review paper.

EVALUATION
Technical Seminar II evaluation is based on Regulations of Post graduate programmes of Anna University.

TOTAL: 30 PERIODS

OUTCOMES:
At the end of the course, the student will be able to
- Develop the capacity to observe intelligently and propose and defend opinions and ideas with tact and conviction.
- Develop skills regarding professional communication and technical report writing.
- Learn the methodology of publishing technical papers.

TE5312 PROJECT WORK PHASE – I

OBJECTIVES:
- To improve the skills in reading technical magazines, conference proceedings and journals.
- To develop the skill of identifying research problems/projects in the field of Thermal Engineering.
- To familiarize with the design and analysis tools required for the project work and plan the experimental platform, if any, required for project work.

GUIDELINES
- Each student has to identify the topic of project related to the field of Thermal Engineering.
- The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.
- The topic has to be approved by a review committee constituted by the department.
- The work has to be presented periodically in front of the review committee.
- The preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The project report should be presented in standard format as provided by the Anna University.

EVALUATION
Project Work Phase - I evaluation is based on Regulations of Post graduate programmes of Anna University.

TOTAL: 90 PERIODS
OUTCOMES:
The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated in their project work phase – II.

TE5411

PROJECT WORK PHASE – II

L T P C
0 0 24 12

OBJECTIVES:

- To improve the skills in publishing technical papers in conference proceedings and journals.
- To produce factual results of their applied research idea in the Thermal engineering, from phase – I.

GUIDELINES

- Each student has to complete project (phase II) under the guidance of a faculty member, as specified in Phase I.
- The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.
- The topic has to be approved by a review committee constituted by the department.
- The work has to be presented periodically in front of the review committee.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study.
- The project report should be presented in standard format as provided by the Anna University.

EVALUATION

Project Work Phase - II evaluation is based on Regulations of Post graduate programmes of Anna University.

TOTAL: 180 PERIODS

OUTCOMES:
The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

TE5001

AIRCRAFT AND JET PROPULSION

L T P C
3 0 0 3

OBJECTIVES

To gain insight on the working principle of rocket engines, different feed systems, propellants and their properties and dynamics of rockets.
UNIT I  GAS DYNAMICS  8

UNIT II  THERMODYNAMICS OF AIRCRAFT ENGINES  9

UNIT III  PERFORMANCE CHARACTERISTICS OF AIRCRAFT ENGINES  9
Engine - Aircraft matching – Design of inlets and nozzles – Performance characteristics of Ramjet, Turbojet, Scramjet and Turbofan engines.

UNIT IV  ROCKET PROPULSION  9

UNIT V  ROCKET THRUST CHAMBER  10

TOTAL = 45 PERIODS

OUTCOME
- On successful completion of this course the student will be able to understand the working of different types of Aircraft and Jet propulsion systems and their performance characteristics.

REFERENCES
OBJECTIVES

- To study in detail on the hydrogen production methodologies, possible applications and various storage options.
- To understand the working principle of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics.
- To study the cost effectiveness and eco-friendliness of Fuel Cells.

UNIT I  HYDROGEN – BASICS AND PRODUCTION TECHNIQUES  9

UNIT II  HYDROGEN STORAGE AND APPLICATIONS  9

UNIT III  FUEL CELLS  9

UNIT IV  FUEL CELL – TYPES  9
Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits.

UNIT V  APPLICATION OF FUEL CELL AND ECONOMICS  9
Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

TOTAL: 45 PERIODS

OUTCOME
After completion of the syllabus student able to:
Know the working of various fuel cells, their relative advantages / disadvantages and hydrogen generation/storage technologies.

REFERENCES
OBJECTIVES

- To explain concept of various forms of Non-renewable and renewable energy.
- To outline division aspects and utilization of renewable energy sources for both domestic and industrial applications.
- To study the environmental and cost economics of using renewable energy sources compared to fossil fuels.

UNIT I COMMERCIAL ENERGY

Coal, Oil, Natural gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India.

UNIT II SOLAR ENERGY


UNIT III WIND ENERGY


UNIT IV BIO-ENERGY


UNIT V OTHER TYPES OF ENERGY

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plant - ocean wave energy conversion - tidal energy conversion – small hydro - geothermal energy - geothermal power plant – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.

OUTCOMES

After completion of the syllabus student able to :
- Understand the commercial energy and renewable energy sources.
- Know the working principle of various energy systems.

REFERENCES


TE5002 ADVANCED INTERNAL COMBUSTION ENGINES L T P C
3 0 0 3

OBJECTIVES
- To gain insight on the working principle of spark ignition engines and compression ignition engines.
- To study the pollutant formation and its control in IC engines.
- To study the recent technologies adopted in IC engine applications.

UNIT I SPARK IGNITION ENGINES

UNIT II COMPRESSION IGNITION ENGINES

UNIT III POLLUTANT FORMATION AND CONTROL
Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.

UNIT IV ALTERNATIVE FUELS
Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

UNIT V RECENT TRENDS

TOTAL = 45 PERIODS

OUTCOME
On successful completion of this course the student will be able to understand the working principle of IC engines, source of pollution formation and its control and recent trends in IC engines.
REFERENCES

TE5003 CRYOGENIC ENGINEERING

OBJECTIVES
- To give introductory knowledge of cryogenic Engineering.
- To impart knowledge in liquefaction, separation of cryogenics gases and working of cryocoolers.
- To embark on a research career in Cryogenic Engineering.

UNIT I INTRODUCTION
Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.

UNIT II LIQUEFACTION CYCLES

UNIT III SEPARATION OF CRYOGENIC GASES

UNIT IV CRYOGENIC REFRIGERATORS
J. T. Cryocoolers, Stirling Cycle Refrigerators, G.M. Cryocoolers, Pulse Tube Refrigerators Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Magnetic Refrigerators.

UNIT V HANDLING OF CRYOGENS
Cryogenic Dewar, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Instrumentation to measure Flow, Level and Temperature.

OUTCOME
On successful completion of this course the student will be able to understand Concepts of cryogenic, cryogenic refrigeration and handling of the cryogens.

REFERENCES

TE5004  REFRIGERATION SYSTEMS  

OBJECTIVES

- To study the cycle analysis pertaining to Refrigeration systems.
- To study the performance of system components and their balancing in cycles.
- To study the significance of Refrigerants and their impact on the environment.

UNIT I  INTRODUCTION AND REFRIGERANTS  6

UNIT II  REFRIGERATION CYCLES – ANALYSIS  12

UNIT III  REFRIGERATION SYSTEM COMPONENTS  9
Compressor- Types, performance, Characteristics, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their Behaviour with fluctuating load, cycling controls, other components such as Accumulators, Receivers, Oil Separators, Strainers, Driers, Check Valves, Solenoid Valves Defrost Controllers, etc.

UNIT IV  SYSTEM BALANCING  9
Balance points and system simulation - compressor, condenser, evaporator and expansion devices performance – Complete system performance; graphical and mathematical analysis – sensitivity analysis.

UNIT V  ELECTRICAL DRIVES & CONTROLS  9
Electric circuits in Refrigeration systems, Refrigerant control devices, Types of Motors, Starters, Relays, Thermostats, Microprocessor based control systems, Pressure controls and other controls, Acoustics and noise controls.

TOTAL = 45 PERIODS

OUTCOME

- The student will be able to understand different refrigeration systems and do the design of the same for a particular applications.
REFERENCES

TE5071  COMPUTATIONAL FLUID DYNAMICS FOR THERMAL SYSTEMS            L  T  P  C
            3  0  0 3

OBJECTIVES:
• This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
• To develop finite volume discretised forms of the CFD equations.
• To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations.

UNIT I  GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES

UNIT II  DIFFUSION PROCESSES: FINITE VOLUME METHOD

UNIT III  CONVECTION – DIFFUSION PROCESSES: FINITE VOLUME METHOD
One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.

UNIT IV  FLOW PROCESSES: FINITE VOLUME METHOD
Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

UNIT V  TURBULENCE AND ITS MODELING
Description of turbulent flow, free turbulent flows, flat plate boundary layer and pipe flow. Algebraic Models, One equation model, $k - \varepsilon$ & $k - \omega$ models Standard and High and Low Reynolds number models.

TOTAL: 45 PERIODS
OUTCOME:
• On successful completion of this course the student will be able to apply concept of CFD to analyse flow in thermal systems.

REFERENCES

TE5005 FANS, BLOWERS AND COMPRESSORS L T P C
3 0 0 3

OBJECTIVES
• To develop knowledge about turbo machinery and its working principles.
• To formulate analysis of compressors, centrifugal blowers and testing of fans.

UNIT I PRINCIPLES OF TURBO MACHINERY 10
Introduction to turbo machines - Transfer of energy to fluids - Performance characteristics - fan laws - Dimensionless parameters - Specific speed - selection of centrifugal, axial, and mixed flow machines.

UNIT II ANALYSIS OF CENTRIFUGAL BLOWERS AND FANS 10
Centrifugal Blowers: Theoretical characteristic curves, Eulers characteristics and Eulers velocity triangles, losses and hydraulic efficiency, flow through impeller inlet volute, diffusers, leakage disc friction mechanical losses multivane impellers of impulse type, cross flow fans.

UNIT III ANALYSIS OF COMPRESSOR 14
Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers.

UNIT IV TESTING AND CONTROL OF FANS 5
Fan testing, noise control, materials and components blower regulation, speed control, throttling, control at discharge and inlet.

UNIT V APPLICATIONS OF BLOWERS 6
Applications of blowers, induced and forced draft fans for air conditioning plants, cooling towers, ventilation systems, booster systems.

TOTAL = 45 PERIODS


OUTCOME
• After completion of this course students get knowledge about Turbo machinery and its working principles, analysis of compressors and centrifugal blowers.

REFERENCES

TE5006 FOOD PROCESSING, PRESERVATION AND TRANSPORT  
OBJECTIVES
To develop knowledge about processing, preserving and storing of food products.

UNIT I INTRODUCTION 
Microbiology of Food Products, Mechanism of food spoilage critical microbial growth requirements, Design for control of micro organisms, The role of HACCP, Sanitation, Regulation and standards.

UNIT II PROCESSING & PRESERVATION 

UNIT III FREEZING & DRYING 
Precooling, Freeze drying principles, Cold storage & freezers, Freezing drying limitations, Irradiation techniques, Cryofreezing, Numerical and analytical methods in estimating Freezing, Thawing times, Energy conservation in food industry.

UNIT IV COLD STORAGE DESIGN & INSTRUMENTATION 
Initial building consideration, Building design, Specialized storage facility, Construction methods, Refrigeration systems, Insulation techniques, Control & instrumentation, Fire protection, Inspection & maintenance

UNIT V PACKAGING AND TRANSPORT 

TOTAL = 45 PERIODS

OUTCOMES
• The student will be able to understand methods of food processing and preservation of foods.
• The student will be able to understand packing and transporting food products.
REFERENCES

EY5091                  NUCLEAR ENGINEERING                   L T P C
                                       3 0 0 3

OBJECTIVES
- To describe fundamental study of nuclear reactions
- To learn nuclear fuels cycles, characteristics. Fundamental principles governing nuclear fission chain reaction and fusion
- To discuss future nuclear reactor systems with respect to generation of energy, fuel breeding, incineration of nuclear material and safety.

UNIT I     NUCLEAR REACTIONS
Mechanism of nuclear fission - nuclides - radioactivity – decay chains - neutron reactions - the fission process - reactors - types of fast breeding reactor - design and construction of nuclear reactors - heat transfer techniques in nuclear reactors - reactor shielding.

UNIT II    REACTOR MATERIALS
Nuclear Fuel Cycles - characteristics of nuclear fuels - Uranium - production and purification of Uranium - conversion to UF4 and UF6 - other fuels like Zirconium, Thorium – Beryllium.

UNIT III   REPROCESSING
Nuclear fuel cycles - spent fuel characteristics - role of solvent extraction in reprocessing - solvent extraction equipment.

UNIT IV    SEPARATION OF REACTOR PRODUCTS
Processes to be considered - 'Fuel Element' dissolution - precipitation process – ion exchange - redox - purex - TTA - chelation -U235 - Hexone - TBP and thorax Processes - oxidative slaging and electro - refining - Isotopes - principles of Isotope separation.

UNIT V     WASTE DISPOSAL AND RADIATION PROTECTION
Types of nuclear wastes - safety control and pollution control and abatement - international convention on safety aspects - radiation hazards prevention.

TOTAL = 45 PERIODS

OUTCOME
- Understanding fundamentals of nuclear reactors and reactions.
- Knowledge in nuclear fission chain reaction and fusion.
- Awareness about reprocessing of spent fuel and waste disposal.
OBJECTIVES

- To understand the vehicle structure, engine and its auxiliary systems.
- To develop the knowledge about vehicle transmission system.
- To get knowledge about alternative sources for Vehicles.

UNIT I  VEHICLE STRUCTURE AND ENGINES  10
Layout, Vehicle construction, Chassis, Frame and Body, Engine - types, construction, operation, performance, Air pollution and Pollution standards.

UNIT II  ENGINE AUXILIARY SYSTEMS  10
Carburetors, Electronic Fuel Injection Systems – Monopoint, Multipoint and Direct Injection Systems, Electrical Systems – Battery, Generator, Starting Motor, and Ignition (Battery and Electronic Types).

UNIT III  TRANSMISSION SYSTEMS  10

UNIT IV  RUNNING SYSTEMS  8
Steering Geometry and Types, Types of front axle, Suspension systems, Braking systems, Wheel and Tyres.

UNIT V  ALTERNATIVE SOURCES FOR AUTOMOBILES  7
Electric vehicles and Fuel cells – Types, construction, principle of operation and characteristics.

TOTAL = 45 PERIODS

OUTCOME

- Students able to get knowledge about vehicle structure, auxiliary systems, transmission and recent alternative sources for vehicles.
REFERENCES

TE5007  AIR CONDITIONING SYSTEMS  L  T  P  C
3   0  0   3

OBJECTIVES
- To learn the psychometric concepts underlying Air conditioning process.
- To learn the design features and load estimation principles of specific Air conditioning system.
- To learn about the critical auxiliary systems such as air distribution circuits, water distribution circuits etc.

UNIT I  PSYCHROMETRY AND AIR CONDITIONING PROCESSES  9
Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation. Summer and winter Air conditioning, Enthalpy potential and its insights.

UNIT II  LOAD ESTIMATION  10

UNIT III  AIR CONDITIONING SYSTEMS  8
Thermal distribution systems – Single, multi zone systems, terminal reheat systems, Dual duct systems, variable air volume systems, water systems and Unitary type systems.

UNIT IV  AIR DISTRIBUTION AND CONTROL  10
Flow through Ducts, Static & Dynamic Losses, Diffusers, Duct Design–Equal Friction Method, System Balancing, Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units – Control of temperature, humidity, air flow and quality.

UNIT V  HVAC SYSTEM IN AUTOMOBILES  8
Automotive System layout and Components- Commonly used Refrigerants- Safety devices – Climate control – Fuel efficiency aspects.

TOTAL = 45 PERIODS

OUTCOME
On successful completion of this course the student will be able to understand conceptually the design of a HVAC system.
REFERENCES

TE5008 ENERGY MANAGEMENT IN THERMAL SYSTEMS

OBJECTIVES
- To learn the present energy scenario and the need for energy conservation.
- To learn the instruments suitable for energy auditing.
- To study the various measures for energy conservation and financial implications for various thermal utilities.

UNIT I INTRODUCTION

UNIT II INSTRUMENTS FOR ENERGY AUDITING

UNIT III THERMAL UTILITIES: OPERATION AND ENERGY CONSERVATION

UNIT IV THERMAL ENERGY TRANSMISSION / PROTECTION SYSTEMS
Steam traps – refractories – optimum insulation thickness – insulation – piping design.

UNIT V FINANCIAL MANAGEMENT
Investment – need, appraisal and criteria, financial analysis techniques – break even analysis – simple payback period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept.

TOTAL = 45 PERIODS

OUTCOME
- After completion of the syllabus students able to audit the power plants, the various measures for energy conservation and financial implications for various thermal utilities.
AIM:
To impart knowledge on various alternative fuels for I.C. Engines

OBJECTIVES:
- Gain a working understanding of the engineering issues and perspectives affecting fuel and engine development
- Examine future trends and development, including hydrogen as an internal combustion engine fuel.
- Explore further fuel specification and performance requirements for advanced combustion systems.

UNIT I  INTRODUCTION

UNIT II  LIQUID FUELS FOR S.I. ENGINES
Requirements, Utilisation techniques – Blends, Neat form, Reformed Fuels, Storage and Safety, Performance and Emission Characteristics

UNIT III  LIQUID FUELS FOR C.I. ENGINES
Requirements, Utilisation techniques - Blends, Neat fuels, Reformed fuels, Emulsions, Dual fuelling, Ignition accelerators and Additives, Performance and emission characteristics.

UNIT IV  GASEOUS FUELS FOR S.I. ENGINES

UNIT V  GASEOUS FUELS FOR C.I. ENGINES
Hydrogen, Biogas, Liquefied Petroleum gas, Compressed Natural gas in CI engines. Dual fuelling, Performance and emission characteristics.

TOTAL: 45 PERIODS

OUTCOME:
- On successful completion of this course the student will be able to understand the various alternative fuel options available for conventional fuels and their performance and emission characteristics.

REFERENCES
OBJECTIVES

- To learn the thermal and stress analysis on various parts of the heat exchangers.
- To analyze the sizing and rating of the heat exchangers for various applications.

UNIT I  FUNDAMENTALS OF HEAT EXCHANGER


UNIT II  FLOW AND STRESS ANALYSIS


UNIT III  DESIGN ASPECTS


UNIT IV  COMPACT AND PLATE HEAT EXCHANGERS


UNIT V  CONDENSERS AND COOLING TOWERS

Design of surface and evaporative condensers – cooling tower – performance characteristics.

TOTAL = 45 PERIODS

OUTCOME

After completion of the syllabus student able to:

- Design the heat exchanger based on the information provided for a particular application and do the cost economic analysis

REFERENCES

OBJECTIVES:
- To design and analyse the performance of Turbo machines for engineering applications
- To understand the energy transfer process in Turbomachines and governing equations of various forms.
- To understand the structural and functional aspects of major components of Turbomachines.
- To design various Turbomachines for power plant and aircraft applications

UNIT I 
INTRODUCTION
Basics of isentropic flow – static and stagnation properties – diffuser and nozzle configurations - area ratio – mass flow rate – critical properties. Energy transfer between fluid and rotor velocity triangles for a generalized turbomachines - velocity diagrams. Euler’s equation for turbomachines and its different forms. Degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, overall and polytropic

UNIT II 
CENTRIFUGAL AND AXIAL FLOW COMPRESSORS
Centrifugal compressor - configuration and working – slip factor - work input factor – ideal and actual work - pressure coefficient - pressure ratio. Axial flow compressor – geometry and working – velocity diagrams – ideal and actual work – stage pressure ratio - free vortex theory – performance curves and losses

UNIT III 
COMBUSTION CHAMBER

UNIT IV 
AXIAL AND RADIAL FLOW TURBINES

UNIT V 
GAS TURBINE AND JET ENGINE CYCLES
Gas turbine cycle analysis – simple and actual. Reheated, Regenerative and Intercooled cycles for power plants. Working of Turbojet, Turbofan, Turboprop, Ramjet, Scarmjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, specific fuel consumption, thermal and propulsive efficiencies.

TOTAL: 45 PERIODS

OUTCOMES:
When a student completes this subject, he / she can
- Understand the design principles of the turbomachines
- Analyse the turbomachines to improve and optimize its performance

REFERENCES:
OBJECTIVES
To understand the theory of turbulent flow and its modeling, structure types and a detailed insight about turbulence.

UNIT I FUNDAMENTALS OF BOUNDARY LAYER THEORY
Boundary Layer Concept, Laminar Boundary Layer on a Flat Plate at zero incidence, Turbulent Boundary Layer on a Flat plate at zero incidence, Fully Developed Turbulent Flow in a pipe, Boundary Layer on an airfoil, Boundary Layer separation.

UNIT II TURBULENT BOUNDARY LAYERS

UNIT III TURBULENCE AND TURBULENCE MODELS

UNIT IV STATISTICAL THEORY OF TURBULENCE

UNIT V TURBULENT FLOWS

TOTAL = 45 PERIODS

OUTCOME
- On successful completion of this course the student will be able to apply the concepts of boundary layer theory and turbulence.

REFERENCES
OBJECTIVES

- To make the students to understand the energy scenario and the environmental issues related to the power plants.
- To create awareness to the students on the various utilities in the power plants and the avenues for optimizing them.

UNIT I  INTRODUCTION
Overview of Indian power sector – load curves for various applications – types of power plants – merits and demerits – criteria for comparison and selection - Economics of power plants.

UNIT II  STEAM POWER PLANTS

UNIT III  DIESEL AND GAS TURBINE POWER PLANTS

UNIT IV  ADVANCED POWER CYCLES

UNIT V  HYDROELECTRIC & NUCLEAR POWER PLANTS

TOTAL = 45 PERIODS

OUTCOMES

- Understanding the concept of various power plant cycles.
- Possible mitigation of anthropogenic emissions by optimizing the power plant cycles/utilities.

REFERENCES
OBJECTIVES

- To educate the students on the types of boilers with their constructional and functional significance.
- To understand the working and design of fuel preparation units and boilers.
- To introduce the concept of boiler design, emission aspects.

UNIT I  BASICS  8

UNIT II  FUELS AND BOILER TYPES  8

UNIT III  COMPONENTS DESIGN  12

UNIT IV  AUXILIARY EQUIPMENTS – DESIGN & SIZING  10

UNIT V  EMISSION ASPECTS  7

TOTAL = 45 PERIODS

OUTCOMES

- Familiarization with Boiler cycles, components and will have specialized knowledge in steam boiler performance evaluation.
- Emission related aspects in terms of CO₂ NOx emission, mitigation etc will make them to realize the impact of Coal / fuel burning in the society.

REFERENCES
FLUIDIZED BED SYSTEMS

OBJECTIVES

- To introduce the concepts of fluidization and heat transfer in fluidized beds.
- To understand the design principles and apply the same for industrial applications.

UNIT I  FLUIDIZED BED BEHAVIOUR  12

UNIT II  HEAT TRANSFER  6

UNIT III  COMBUSTION AND GASIFICATION  6

UNIT IV  DESIGN CONSIDERATIONS  9

UNIT V  INDUSTRIAL APPLICATIONS  12
Physical operations like transportation, mixing of fine powders, heat exchange, coating, drying and sizing. Cracking and reforming of hydrocarbons, carbonization, combustion and gasification. Sulphur retention and oxides of nitrogen emission Control.

TOTAL: 45 PERIODS

OUTCOME

- Understand the working principles, merits and limitations of fluidized bed systems.
- Apply fluidized bed systems for a specific engineering applications.
- Analyse the fluidized bed systems to improve and optimize its performance.

REFERENCES

OBJECTIVES

- To learn the various types of thermal storage systems and the storage materials.
- To develop the ability to model and analyze the sensible and latent heat storage units.
- To study the various applications of thermal storage systems.

UNIT I INTRODUCTION

Necessity of thermal storage — types-energy storage devices — comparison of energy storage technologies - seasonal thermal energy storage - storage materials.

UNIT II SENSIBLE HEAT STORAGE SYSTEM

Basic concepts and modeling of heat storage units - modeling of simple water and rock bed storage system – use of TRNSYS – pressurized water storage system for power plant applications – packed beds.

UNIT III REGENERATORS


UNIT IV LATENT HEAT STORAGE SYSTEMS

Modeling of phase change problems – temperature based model - enthalpy model - porous medium approach - conduction dominated phase change – convection dominated phase change.

UNIT V APPLICATIONS

Specific areas of application of energy storage – food preservation – waste heat recovery – solar energy storage – green house heating – power plant applications – drying and heating for process industries.

TOTAL: 45 PERIODS

OUTCOME

- On completing of the syllabus students can able understand the principles of heat storage systems, regenerators and its applications.

REFERENCES

OBJECTIVES
- To analyze the basic energy generation cycles.
- To detail about the concept of cogeneration, its types and probable areas of applications.
- To study the significance of waste heat recovery systems and carry out its economic analysis.

UNIT I  INTRODUCTION

UNIT II  COGENERATION TECHNOLOGIES

UNIT III  ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES

UNIT IV  WASTE HEAT RECOVERY SYSTEMS

UNIT V  ECONOMIC ANALYSIS

OUTCOME
- On completing of the syllabus students can able understand the principles of cogeneration systems, waste heat recovery systems, applications of cogeneration and economis analysis of waste heat recovery systems.

REFERENCES
OBJECTIVES
To impart scientific, statistical and analytical knowledge for carrying out research work effectively.

UNIT I  INTRODUCTION TO RESEARCH
The hallmarks of scientific research – Building blocks of science in research – Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.

UNIT II  EXPERIMENTAL DESIGN

UNIT III  DATA COLLECTION METHODS

UNIT IV  MULTIVARIATE STATISTICAL TECHNIQUES
Data Analysis – Factor Analysis – Culster Analysis -Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical(SPSS) Software Package in Research.

UNIT V  RESEARCH REPORT
Purpose of the written report – Concept of audience – Basics of written reports. Integral parts of a report – Title of a report, Table of contents, Abstract, Synopsis, Introduction, Body of a report – Experimental, Results and Discussion – Recommendations and Implementation section – Conclusions and Scope for future work.

TOTAL = 45 PERIODS

OUTCOME
• After completion of the syllabus students will able to get knowledge about the different research techniques and research report.

REFERENCES