DEPARTMENT OF MECHANICAL ENGINEERING

ANNA UNIVERSITY, CHENNAI

VISION OF THE DEPARTMENT

We, at the Department of Mechanical Engineering, Anna University shall strive hard to impart knowledge and state-of-the-art training to our students and expose them to broad areas of Mechanical Engineering, namely Design, Manufacturing, Energy, Thermal Sciences and currently related interdisciplinary areas, so that they can later practice their profession at home or abroad keeping in mind the needs and concern of the society they represent, safeguarding values, ethics and be instrumental in bringing about an overall technological development.

MISSION OF THE DEPARTMENT

1. To deliver knowledge in Mechanical Engineering with high educational standards so that the outgoing students are employable and globally competitive.
2. To produce graduate and post graduate engineers with core competency as well as relevant software skills and social responsibility.
3. To be dynamic in imparting knowledge to students depending upon the changing national and International needs.
ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
M.E. INTERNAL COMBUSTION ENGINEERING (R 2021)
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):
   The Internal Combustion Engineering program seeks to prepare PG students for productive and rewarding careers in the transport and mobility arena. The PEOs are listed below

   | I.  | To develop skill and acquire knowledge in modern engine technologies and develop smart future mobility solutions |
   | II. | To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve real time problems in engines and mobility science |
   | III. | Become a successful entrepreneur and be a part of a supply chain or manufacture engine/mobility solutions for sustainable development |

2. PROGRAMME OUTCOMES (POs):
   On successful completion of the Programme, graduates will possess:

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<td>1</td>
<td>An ability to independently carry out research/investigation and development work to solve practical problems</td>
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<td>An ability to write and present a substantial technical report/document</td>
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<td>Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program</td>
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<td>Demonstrate skills to use modern engineering tools, software and equipment’s to analyze multidisciplinary problems.</td>
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<td>An ability to develop a mobility solution, component, product and process for sustainable development.</td>
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<td>Understand the impact of engineering solutions on societal transformation.</td>
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4. PEO/PO Mapping:

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## ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M.E. INTERNAL COMBUSTION ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND SYLLABUS
SEMESTER I

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TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 73
## Foundation Courses (FC)

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## Program Core Courses (PCC)

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## Research Methodology and IPR Courses (RMC)

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## PROFESSIONAL ELECTIVES
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### SEMESTER II, ELECTIVE II

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<td>Engine Pollution and Control</td>
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### SEMESTER III, ELECTIVE IV

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### SEMESTER III, ELECTIVE V

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### AUDIT COURSES (AC)

Registration for any of these courses is optional to students

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### EMPLOYABILITY ENHANCEMENT COURSES (EEC)

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COURSE OBJECTIVES:

- To study various numerical techniques to solve linear and non-linear algebraic and transcendental equations.
- To compare ordinary differential equations by finite difference and collocation methods.
- To establish finite difference methods to solve Parabolic and hyperbolic equations.
- To establish finite difference method to solve elliptic partial differential equations.
- To provide basic knowledge in finite elements method in solving partial differential equations.

UNIT I  ALGEBRAIC EQUATIONS  12

UNIT II  ORDINARY DIFFERENTIAL EQUATIONS  12

UNIT III  FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS  12

UNIT IV  FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS  12
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  12

TOTAL: 60 PERIODS

COURSE 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.
- Solving parabolic and hyperbolic partial differential equations by finite difference methods.
- Compute solution of elliptic partial differential equations by finite difference 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.

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IC4151 ALTERNATE FUELS FOR IC ENGINES L T P C 3 0 0 3

COURSE OBJECTIVES:
1. To expose potential alternate fuels and their characteristics
2. To use appropriate synthetic fuels and fuel additives for better combustion characteristics
3. To utilise alcohol fuels effectively for lower emissions
4. To elaborate on the utilisation of Bio-Diesel and its types as a suitable fuel in CI engines
5. To utilise different gaseous fuels and predict their performance and combustion characteristics

UNIT I INTRODUCTION 9

UNIT II SPECIAL AND SYNTHETIC FUELS 9
Different synthetic fuels, Merits, and demerits, Dual, Bi-fuel and Pilot injected fuel systems, Fuel additives – types and their effect on performance and emission characteristics of engines, Flexi-fuel systems, Ethers - as fuel and fuel additives, properties and characteristics.
UNIT III  ALCOHOL FUELS  9

UNIT IV  BIO-DIESEL FUELS  9
Vegetable oils and their important properties. Fuel properties characterization. Methods of using vegetable oils – Blending, preheating, Transesterification and emulsification – Performance, combustion and emission characteristics in diesel engines. Third generation biofuels, Ternary and Quaternary fuels, Issues & limitation of using vegetable oils in IC engines

UNIT V  GASEOUS FUELS  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
1  Expose potential alternate fuels and their characteristics
2  Use appropriate synthetic fuels and fuel additives for better combustion characteristics
3  Utilise alcohol fuels effectively for lower emissions
4  Elaborate on the utilisation of Bio-Diesel and its types as a suitable fuel in CI engines
5  Utilise different gaseous fuels and predict their performance and combustion characteristics

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COURSE OBJECTIVES
1. To make familiar with the design and operating characteristics of engines
2. To understand the basic principles of combustion
3. To gain knowledge in the principles of SI engine combustion
4. To understand the concepts of CI engine system
5. To understand the basic concepts of gas turbine combustion and the latest technological advances in low temperature combustion

UNIT I ENGINE BASICS

UNIT II COMBUSTION PRINCIPLES
Combustion – Combustion equations, chemical equilibrium and Dissociation -Theories of Combustion - Flammability Limits - Reaction rates - Laminar and Turbulent Flame Propagation in Engines, Flame structure and speed - Chemical kinetics.

UNIT III COMBUSTION IN S.I. ENGINES
Stages of combustion, Cylinder pressure measurement and heat release analysis normal and abnormal combustion, knocking, Variables affecting Knock, Features and design consideration of combustion chambers, Types of combustion chambers, Cyclic variations, Lean burn combustion, Stratified charge combustion systems. Heat release correlations.

UNIT IV COMBUSTION IN C.I. ENGINES
Stages of combustion, and spray formation and characterization, air motion, swirl measurement, knock and engine variables, Features and design considerations of combustion chambers, delay period correlations, heat release correlations, Influence of the injection system on combustion, Direct and indirect injection systems.

UNIT V COMBUSTION IN GAS TURBINES & LOW TEMPERATURE COMBUSTION CONCEPTS IN I.C. ENGINE

COURSE OUTCOMES
1. Given an engine design specification, predict performance and fuel economy trends
2. Apply basic concepts in the design of combustion systems
3. Able to design SI engine system
4. Develop an understanding of real world diesel engine design issues
5. Develop an ability to optimize future engine design for better fuel economy, performance, and emissions
REFERENCES

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TE4151 ADVANCED HEAT TRANSFER

COURSE OBJECTIVES
1. To impart knowledge on conduction heat transfer associated with radiation.
2. To impart knowledge on the turbulent forced convective heat transfer.
3. To impart knowledge on the significance of Phase Change Heat Transfer and Mass Transfer.
4. To teach the heat exchanger design aspects including compact heat exchangers.
5. To impart knowledge on Mass transfer as an engineering phenomenon.

UNIT I CONDUCTION AND RADIATION HEAT TRANSFER
One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer - various pin profiles - pin optimization - transient conduction - conduction with moving boundaries - radiation in gases and vapour. Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection

UNIT II TURBULENT FORCED CONVECTIVE HEAT TRANSFER
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
Condensation on bank of tubes - boiling – pool and flow boiling - heat Transfer Enhancement Techniques.
UNIT – IV HEAT EXCHANGERS

UNIT – V MASS TRANSFER
Mass transfer - vaporization of droplets - combined heat and mass transfers applications – Cooling Towers, Evaporative condensers, solar pond, Cooling and dehumidification systems – porous media heat transfer

TOTAL : 60 PERIODS

COURSE OUTCOMES:
1. Upon completion of this course, the students will be able to:
2. Analyse problems on heat transfer associated with conduction and convection and radiation through vapours and gases.
3. Analyse problems on turbulent heat transfer and also solve high speed flow problems.
4. Analyse problems on phase change heat transfer.
5. Estimate the performance of compact heat exchangers and also understand the use of correlations to predict heat transfer from specific devices
6. Understand and analyse the mass transfer associated with heat transfer in engineering systems

REFERENCES

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COURSE OBJECTIVES:
- To achieve an understanding of basic principle and scope of thermodynamics.
- To predict the availability and irreversibility associated with the thermodynamic processes.
- To analyse the properties of ideal and real gas mixtures and to understand the basic concepts of thermal systems

UNIT I THERMODYNAMIC PROPERTY RELATIONS 12
Thermodynamic Potentials, Maxwell relations, Generalised relations for changes in Entropy, Internal Energy and Enthalpy, Generalised Relations for \( C_p \) and \( C_v \), Clausius Clapeyron Equation, Joule Thomson Coefficient, Bridgeman Tables for Thermodynamic Relations.

UNIT II REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS 12

UNIT III AVAILABILITY ANALYSIS 12

UNIT IV FUEL – AIR CYCLES AND THEIR ANALYSIS 12

UNIT V THERMO CHEMISTRY 12

COURSE OUTCOMES:
On successful completion of this course the student will be able to
1. Apply the law of thermodynamics to thermal systems.
2. Analyse the actual thermodynamic cycles
3. Design and analyse a multi component thermodynamic system
4. Apply the thermodynamics concepts in automotive systems
5. Understand and analyse the combustion of different fuels
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RM4151      RESEARCH METHODOLOGY AND IPR       L T P C
UNIT I       RESEARCH DESIGN                        6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II      DATA COLLECTION AND SOURCES           6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.
Data - Preparing, Exploring, examining and displaying.

UNIT III     DATA ANALYSIS AND REPORTING           6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association.
Presenting Insights and findings using written reports and oral presentation.

UNIT IV      INTELLECTUAL PROPERTY RIGHTS          6

UNIT V       PATENTS                                6

TOTAL : 30 PERIODS
REFERENCES

IC4111  INTERNAL COMBUSTION ENGINES LABORATORY  L T P C 0 0 4 2

COURSE OBJECTIVES:
- To impart the knowledge on the practical aspects of Internal Combustion Engine Systems
- To impart the knowledge on the advanced engine technologies
- To understand the combustion, performance and emission behavior of SI and CI engine system at different load and speed conditions
- To understand the behavior of engine system at different operating conditions
- To understand the influence of after treatment system on emission reduction from engine systems
- To know the measurement of important fuel properties and its role

LIST OF EXPERIMENTS
1. Disassembly and Assembly of engines
2. Study of advanced diesel and gasoline engine technology engines
3. Study and drawing of engine components with dimensions.
4. Experimental investigation of combustion, performance and emission characteristics of spark ignition engine.
5. Experimental investigation of combustion, performance and emission characteristics of compression ignition engine
7. Experimental study on the effect of fuel injection pressure on CI engine performance, combustion, and emission characteristics.
8. Experimental study on the effect of fuel injection timing on CI engine performance, combustion and emission characteristics.
9. Experimental study on the effect of preheating air and fuel on engine performance, combustion and emission characteristics.
10. Performance evaluation of After Treatment Systems
11. Determination of Flash and Fire point of various fuel blends.
12. Determination of Viscosity of various fuel blends.

LABORATORY REQUIREMENTS
1. Single or Multi Cylinder SI and CI Engine for disassembly and assembly
2. Engine Components for drawing and dimensioning
3. Single/ Multi-Cylinder S.I. Engine Test Rig with combustion and emission measurement facility
4. Single/ Multi-Cylinder C.I. Engines Test Rig with combustion and emission measurement facility
5. Exhaust Gas Analyser (To measure HC, CO, NOx, O₂, CO₂)
6. Smoke Meter
7. In cylinder Pressure Transducers, Charge Amplifiers, and crank angle encoders/crank sensor module with high speed data acquisition system
8. Open cup or Closed cup Flash and Fire Point Apparatus
9. Viscometer

COURSE OUTCOMES:
- Understand the various components of engine, its function, assembling of engine parts and working of advanced engine technologies
- Understand the procedures of conducting performance, combustion and emission test on engines and its significance
- Understand the method of calculating the volumetric efficiency and fuel-air ratio of an engine
- Understand the effect of various operating parameters of the engine on combustion, performance and emissions
- Understand the methods of calculating fuel properties

TOTAL: 60 PERIODS

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IC4252 ELECTRONIC ENGINE MANAGEMENT SYSTEMS

COURSE OBJECTIVES
1. To provide basic grounding on electronics
2. To learn the various sensors used in engine management systems
3. Give an overview of different types of ignition systems
4. To understand the significance of gasoline injection systems
5. To know the latest advancements in Diesel injection systems

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS
UNIT II                  SENSORS AND ACTUATORS

UNIT III                SI ENGINE MANAGEMENT

UNIT IV                 CI ENGINE MANAGEMENT

UNIT V                  DIGITAL ENGINE CONTROL SYSTEM

TOTAL: 45 PERIODS

COURSE OUTCOMES:
- Understand the basic electronic components and controls used in Sensors
- Explain the different types of sensors used in an automobile engine
- Describe the ignition and injection methods used in an SI engine
- Describe the fuel injection systems in a diesel engine and the emission control systems
- Explain the electronic systems used in the fuel control system and the dash board unit.

REFERENCES:
2. Automobile Electronics by Eric Chowanietz SAE

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COURSE OBJECTIVES:
- To impart the basic engine design skills to the learners such that there is seamless transition to advanced design concepts
- To provide the basic grounding on the piston engine design philosophy
- To provide knowledge for the design of engine components
- To provide knowledge about design philosophy of engine subsystems
- To enable the student to use CAD for preparing production drawings

UNIT I GENERALIA
Principle of similitude, Choice of material, Stress, Fatigue and Noise, Vibration and Harshness considerations (NVH)

UNIT II DESIGN OF MAJOR COMPONENTS
Piston system, Power Cylinder System, Connecting rod assembly, Crankshaft system, Valve Gearing, Stress analyses.

UNIT III DESIGN OF OTHER COMPONENTS / SUBSYSTEMS
Inlet and exhaust manifolds, cylinder block, cylinder-head, crankcase, engine mountings, gaskets, bearings, flywheel, turbocharger, supercharger, computer controlled fuel injection system, Basics of ignition, lubrication and cooling system design. Introduction to design of catalytic converters, particulate traps and EGR systems.

UNIT IV DESIGN SPECIFICS OF TWO-STROKE ENGINE SYSTEMS
Arrangement and sizing of ports, piston assembly, intake and exhaust system, scavenging, application to automotive gasoline and marine diesel engines.

UNIT V CONCEPTS OF COMPUTER AIDED DESIGN
Preparation of working drawings of designed components using CAD system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The student will be able to
1. Select appropriate material for the engine components based on the functional requirements
2. Design engine components such as piston, connecting rod, crank shaft, and valves.
3. Design cylinder block, cylinder head, flywheels and subsystems
4. Design the ports and components for two stroke engines
5. Translate the design into drawings/models.

REFERENCES:
IC4291  COMPUTATIONAL FLUID DYNAMICS  L  T  P  C  3 0 0 3

COURSE 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 governing equations for diffusion processes.
- To develop finite volume discretised forms of the convection-diffusion processes.
- To develop pressure-based algorithms for flow processes.
- To introduce various turbulence models, Large Eddy Simulation and Direct Numerical Simulation.

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 MODELS

Turbulence – RANS equation - Algebraic Models, One equation model, Two equation models – \( k \) & standard \( k - \epsilon \) model, Low Reynold number models of \( k - \epsilon \), Large Eddy Simulation (LES), Direct Numerical Simulation (DNS) - Introduction. Solving simple cases using standard CFD codes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course the students will be able to:

- Analyse the governing equations and boundary conditions.
- Analyse various discretization techniques for both steady and unsteady diffusion problems.
- Analyse the various convection-diffusion problems by Finite-Volume method.
- Analyse the flow processes by using different pressure bound algorithms.
- Select and use the different turbulence models according to the type of flows.

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IC4202 INSTRUMENTATION FOR THERMAL SYSTEMS

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COURSE OBJECTIVES:
1. To expose students to basic characteristics of measurement parameters
2. To enable the students use appropriate measurement system for various applications
3. To enable the students to measure thermo physical properties of solids and fuels
4. To elaborate the students on the need, types of control systems and components of a control system
5. To design a suitable control system for various thermal systems
UNIT I MEASUREMENT CHARACTERISTICS
Introduction to measurements, Errors in measurements, Statistical analysis of data, Regression analysis, correlation, estimation of uncertainty and presentation of data, design of experiments – Experimental design factors and protocols

UNIT II MEASUREMENTS IN THERMAL SYSTEMS
Basic Electrical measurements, Transducers and its types, Signal conditioning and processing - Measurement of temperature, pressure, velocity, flow – basic and advanced techniques, and radiation properties of surfaces

UNIT III MEASUREMENT OF FUEL PROPERTIES AND POLLUTANTS
Thermo / Physical / Chemical and transport properties of solids, liquids and gaseous fuels, Analysers – Flame Ionisation Detector, Non-Dispersive Infrared Analyser, Chemiluminescent detector, Smoke meters, and Gas chromatography

UNIT IV CONTROL SYSTEMS, COMPONENTS AND CONTROLLERS
Introduction, Open and closed loop control systems, Transfer function. Types of feedback and feedback control system characteristics – Control system parameters – DC and AC servomotors, servo amplifier, potentiometer, synchro transmitters, synchro receivers, synchro control transformer, stepper motors - Continuous, Discontinuous and Composite control modes – Analog and Digital controllers

UNIT V DESIGN OF MEASUREMENT AND CONTROL SYSTEMS
Data logging and acquisition - Sensors for error reduction, elements of computer interfacing, Timers, and Counters, design of measurement and control systems for specific applications - Fault finding – Computer based controls

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
1 Understand the fundamental concepts of measurement parameters
2 Select the suitable type of sensor for a measuring a fundamental parameter
3 Use appropriate devices to measure different properties of solids and fuels
4 Distinguish between measurement and control systems, and use appropriate control system for an application
5 Construct a complete control system for a thermal application

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REFERENCES:

IC4211  ANALYSIS AND SIMULATION LABORATORY FOR INTERNAL COMBUSTION ENGINEERING  L T P C
0 0 4 2

COURSE OBJECTIVE:
Use of standard application software for solving engine flow and combustion problems
1. Engine intake flow analysis using different Port shapes
2. Engine exhaust flow analysis
3. Engine in-cylinder cold flow analysis for the given engine sector model
4. Fuel spray studies
5. Combustion and emission analysis
6. Engine hood cooling analysis

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 Gambit, Star-CD es-ice, Star-CD enabled CFM, CCM+, DARS BASIC, DARS CFD, STAR-CD, Equation solving software like MATLAB, Engg equation solver
2. Every student in a batch must be provided with a terminal
3. Hardware is compatible with the requirement of the above software.

TOTAL: 60 PERIODS

COURSE OUTCOMES:
The students will be able to
1. Design and analyse the flow pattern in an engine inlet and exhaust system
2. Perform modeling of a cooling system of an engine
3. Use the appropriate tools/ software packages for design, meshing and analysis
4. Simulate the emission from the engine exhaust
5. Analysis of the fuel and combustion system

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IC4212 MINI PROJECT WITH SEMINAR

COURSE OBJECTIVES:
- During the seminar session each student is expected to prepare and present a topic on Energy related issues / technology, for a duration of about 30 minutes.
- In a session of three periods per week, 4 students are expected to present the seminar.
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- Students are encouraged to use various teaching aids such as overhead projectors, power point presentation and demonstrative models.

TOTAL: 30 PERIODS

IC4311 PROJECT WORK - I

COURSE OBJECTIVES:
- A research project topic may be selected either from published lists or from the creative ideas of the students themselves in consultation with their project supervisor.
- To improve the student research and development activities.

EVALUATION
Project work evaluation is based on Regulations of Credit system University Departments - Post graduate programmes of Anna University

TOTAL: 90 PERIODS

COURSE OUTCOME:
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.

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IC4411 PROJECT WORK - II

COURSE OBJECTIVES:
- The objective of the research project work is to produce factual results of their applied research idea in the thermal Engineering, from phase – I.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Division.
- A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Division based on oral presentation and the project report.
- To improve the student research and development activities.
EVALUATION
• Project work evaluation is based on Regulations of Credit system Affiliated Colleges- Post graduate programmes of Anna University

TOTAL = 180 PERIODS

COURSE OUTCOME:
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.

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IC4001 AUTOMOTIVE TECHNOLOGY

COURSE OBJECTIVES:
• To distinguish different types of chassis, frames and body and its component design.
• To introduce the concept of aerodynamics in automobiles.
• To estimate the forces acting on vehicle during turning and acceleration.
• To identify various safety technologies incorporated in automobiles.
• To introduce the need for alternative power plants and its types.

UNIT I VEHICLE STRUCTURE
Basic construction of Chassis, types of Chassis layout, types of Body, types of frames, Loads acting on vehicle frame, materials for frames, testing of frames, Bharat New Vehicle Safety Assessment Program (BNVSAP) - Protocols.

UNIT II AUTOMOTIVE AERODYNAMICS

UNIT III VEHICLE DYNAMICS
Vehicle Dynamics – Steady state handling characteristics, Types of forces acting on a vehicle body, Roll centre, Roll axis, Vehicle under side forces, Calculation of Maximum acceleration, Reaction forces for different drives, Stability Control.

UNIT IV SAFETY TECHNOLOGIES
Antilock Braking System, Electronic Brake Force Distribution, Dual stage Airbag, Seatbelt Pre-tensioner, Dynamic Radar Cruise Control, Traction control system, Pre-Collision System, Automatic High Beam, Adaptive Headlights, Daytime Running Lamp, Active headrests, Crumple Zone
UNIT V ALTERNATIVE POWER PLANT


TOTAL : 45 PERIODS

COURSE OUTCOMES:
On successful completion of the course, the students will be able to:
1. Categorise various vehicles based on its chassis, body and know how vehicle testing is carried out.
2. Compute drag coefficients and recognise the need for drag reduction in automobiles.
3. Determine the various forces acting on the automobile and its effect while in motion.
4. Recognise the various safety technologies incorporated in automobiles and their pros and cons.
5. Distinguish the working of various alternate power plants for automobiles.

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COURSE OBJECTIVES:
1) To introduce the concept of different types of fluid flow and its characteristics.
2) To model flows using analytical techniques.
3) To introduce the effect of boundary layers on a flow and its effect on the flow properties.
4) To distinguish the effects of pressure waves, flame propagation and special types of flow in engine.
5) To introduce different methods of flow visualisation techniques with its instrumentation.

UNIT I INTRODUCTION TO FLUID FLOW

UNIT II POTENTIAL FLOW
Streamlines, Path lines, streak lines and time lines, Stream function and Velocity Potential function – Source, Sink and Doublet. Combination of flows - Rankine half body, Rankine full body, Vorticity, Rotational and Irrotational flows, Flow past a cylinder.

UNIT III BOUNDARY LAYERS

UNIT IV COMPRESSIBLE FLOW AND SPECIAL FLOWS

UNIT V FLOW VISUALISATION

COURSE OUTCOMES:
On successful completion of this course, the students will be able to:
1) Use different approximations for the flow problem under consideration.
2) Model basic flows and develop codes for numerical flow visualization
3) Apply the concepts of viscous fluid flow for prediction of thickness of boundary layer and to predict overall flow characteristics.
4) Analyse compressible flow in engine like compression, knocking.
5) Select different flow visualisation techniques required for their experiments.

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IC4003  SIMULATION OF I.C. ENGINE PROCESSES  L T P C  3 0 0 3

COURSE OBJECTIVES:
• To impart knowledge on simulation of various engine processes used in prime movers and power plants.
• To learn the simulation of engine combustion based on first and second law of thermodynamics.

UNIT I  SIMULATION PRINCIPLES  9

UNIT II  SIMULATION OF COMBUSTION IN SI ENGINES  9

UNIT III  SIMULATION OF COMBUSTION IN CI ENGINES  9
UNIT IV SIMULATION OF TWO STROKE ENGINES

UNIT V SIMULATION OF GAS TURBINE COMBUSTORS

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course the student will be able to
1. Simulate the SI engine processes
2. Simulate the CI engine processes
3. Simulate advance combustion concepts
4. Simulate the gas turbine processes
5. Simulate the different engine processes in 2 and 4 stroke engines.

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OBJECTIVES:
1. To identify the processes behind fuel extraction system.
2. To understand the theory behind lubrication.
3. To study the properties of lubricants.
4. To elaborate the properties of fuels used in IC engines.
5. To understand the need of fuel rating.

UNIT I MANUFACTURE OF FUELS AND LUBRICANTS 9
Structure of petroleum, refining process, fuels, thermal cracking, catalytic cracking, polymerization, alkylation, isomerisation, blending, products of refining process. Manufacture of lubricating oil base stocks, manufacture of finished automotive lubricants.

UNIT II THEORY OF LUBRICATION 9
Engine friction: introduction, total engine friction, effect of engine variables on friction, hydrodynamic lubrication, elasto hydrodynamic lubrication, boundary lubrication, bearing lubrication, functions of the lubrication system, introduction to design of a lubricating system.

UNIT III PROPERTIES AND TESTING OF LUBRICANTS 9
Specific requirements for automotive lubricants, oxidation deterioration and degradation of lubricants, synthetic lubricants, classification of lubricating oils, properties of lubricating oils, tests on lubricants. Grease, classification, properties, test used in grease.

UNIT IV PROPERTIES AND TESTING OF FUELS AND COMBUSTION 9
Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, flash point, fire point, distillation, vapour pressure, spontaneous ignition temperature, viscosity, pour point, flammability, ignitability, diesel index, API gravity, aniline point, carbon residue, copper strip corrosion etc. combustion in SI and CI Engine.

UNIT – V ADDITIVES FOR LUBRICANTS AND FUELS 9
Additive - mechanism, requirements of additive, petrol fuel additives, diesel fuel additives and additive mechanism for lubricants. Introduction to Nano fluids.

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Identify the processes behind fuel extraction system.
2. Understand the theory behind lubrication.
3. Study the properties of lubricants.
4. Elaborate the properties of fuels used in IC engines.
5. Understand the need of fuel rating and additives.

REFERENCES:
COURSE OBJECTIVES:
- To familiarize with the concept of compressible flow and effect of shock waves.
- To recognize and distinguish the working of various aircraft engines.
- To design and match aircraft components and calculate its performance.
- To gain insight on the working principle of rocket engines, different feed systems, propellants and their properties and dynamics of rocket.
- To design rockets for various space applications and calculate rocket performance.

UNIT I  WAVE MOTION AND SHOCK WAVES  9

UNIT II  AIR-BREATHING ENGINES  9

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

UNIT IV  ROCKET PROPULSION  9

UNIT V  ROCKET STAGING AND PERFORMANCE  9

TOTAL : 45 PERIODS
COURSE OUTCOMES:
On successful completion of this course, the students will be able to:
1) Use concepts of compressible flow to design variable area ducts for the given conditions.
2) Identify various aircraft engines and know its inner workings with emphasis on its limitations and applications.
3) Mix and match various components of an aircraft engine for its design conditions.
4) Classify various rocket engines based on its type and design it for requirements.
5) Use orbital mechanics principles to design payload for rockets.

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EY4071 BIO ENERGY TECHNOLOGIES

COURSE OBJECTIVES:
1. To learn availability of biomass, methods of biomass analysis and study of characteristics.
2. To create awareness on the technologies available for conversion of biomass to energy in terms of its technical competence and economic implications.
3. To impart knowledge on stoichiometry and combustion of biofuels and costing of biomass technologies.
4. To elucidate the thermochemical conversion methods of biomass and its use in engines.
5. To provide insight to the possibilities of producing liquid fuels form biomass.

UNIT-I INTRODUCTION
UNIT- II  BIOMETHANATION  9
Microbial systems – phases in biogas production – parameters affecting gas production –
effect of additives on biogas yield – possible feed stocks. Biogas plants – types – design –
constructional details and comparison – biogas appliances – burner, luminaries and power
generation – effect on engine performance.

UNIT- III  COMBUSTION  9
Perfect, complete and incomplete combustion-stoichiometric air requirement for biofuels-
equivalence ratio – fixed Bed and fluid Bed combustion – fuel and ash handling systems –
steam cost comparison with conventional fuels.

UNIT- IV  GASIFICATION, PYROLYSIS AND CARBONISATION  9
Chemistry of gasification- types–comparison–application–performance evaluation–
economics – dual fuelling in IC engines – 100 % Gas Engines – engine characteristics on
gas mode – gas cooling and cleaning systems – Pyrolysis – Classification – process
governing parameters – Typical yield rates. Carbonization Techniques–merits of carbonized
fuels

UNIT- V  LIQUIFIED BIOFUELS  9
History of usage of Straight Vegetable Oil (SVO) as fuel – Biodiesel production from oil
seeds, waste oils and algae – Process and chemistry – Biodiesel health effects / emissions
/performance. Production of alcoholic fuels (methanol and ethanol) from biomass –engine
modifications

TOTAL:45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Estimate the availability of surplus biomass and study the characteristics
2. Design a biogas plant for different bioenergy sources
3. Determine and compare the cost of steam generation from biofuels with conventional
fuels.
4. Analyze the influence of process governing parameters in thermo chemical conversion
of biomass and in internal combustion engines
5. Evaluate the production of liquid biofuels for power generation from biomass

REFERENCES
1. David Boyles,Bio Energy Technology Thermodynamics and costs, Ellis Horwood
 Chichester,1984.
2. Iyer PV Retal, Thermo chemical Characterization of Biomass, MNES
 Hill,1986
5. Tom B Reed, Biomass Gasification–Principles and Technology, Noyce Data
 Corporation,1981.
7. David C. Dayton , Thomas D. Foust ,Analytical Methods for Biomass Characterization
 and Conversion (Emerging Issues in Analytical Chemistry), Elsevier,2019

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COURSE OBJECTIVES

1. To provide an insight about effect of engine out emissions on human health and environment
2. To impart the knowledge on various pollutant species formations in SI and CI engine
3. To divulge about various emission measurement techniques in engines and its significance
4. To provide a discernment about various emission control methods
5. To impart the knowledge about international and national driving cycles and emission standards

UNIT I AIR POLLUTION – ENGINES
Atmospheric pollution from automotive, stationary engines and gas turbines, Global warming – Greenhouse effect, Effects of engine pollution on human health and environment.

UNIT II POLLUTANT FORMATION
Formation of Oxides of nitrogen, Carbon monoxide, Hydrocarbon, Aldehydes, Smoke and Particulate matter emissions. Effects of Engine design and operating variables on emission formation, Noise pollution.

UNIT III EMISSION MEASUREMENT TECHNIQUES
CO, CO2 - Non dispersive infrared gas analyzer, NOx - Chemiluminescent analyzer, HC - Flame ionization detector, Smoke – Opacity and filter paper measurements, Particulate Matter – Full flow and Partial flow dilution tunnel, Gas chromatography, Noise measurement.

UNIT IV EMISSION CONTROL TECHNIQUES
Engine design modifications, Fuel modification, Evaporative emission control, EGR, Air injection, Thermal reactors, Water injection, Common rail direct injection and Gasoline direct injection system, After treatment systems - Catalytic converters, Diesel oxidation catalyst, Particulate traps, De-NOx catalysts, SCR systems. Low temperature combustion concepts

UNIT V DRIVING CYCLES AND EMISSION STANDARDS
Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
1. Understand about atmospheric pollution from engines and its impact on human health and environment.
2. Understand the formation of emissions in both SI and CI engines.
3. Understand the various measurement techniques used globally for the measurement of automotive and stationary engine out emissions.
4. Learn the various control methods/techniques used in IC engine to control the engine out emissions
5. Learn the transient and steady state driving cycles performed on automotive and stationary engines and emission standards that are followed in the national and international level.
REFERENCES:
5. George Springer and Donald J Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum press, 2013

Mapping of CO with PO

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IC4092 HYBRID AND ELECTRIC VEHICLES

COURSE OBJECTIVES:
- To introduce the concept of hybrid and electric drive trains.
- To elaborate on the types and utilisation of hybrid and electric drive trains.
- To expose on different types of AC and DC drives for electric vehicles.
- To understand and utilise different types of energy storage systems.
- To introduce concept of energy management strategies and drive sizing.

UNIT I INTRODUCTION
Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II HYBRID ELECTRIC DRIVE TRAINS
Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.
UNIT III  CONTROL OF AC & DC DRIVES  9
Introduction to electric components used in hybrid and electric vehicles, Configuration and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT IV  ENERGY STORAGE  9

UNIT V  DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES  9
Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of energy management strategies, implementation issues.

TOTAL : 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course, the students will be able to:
1. Characterise and configure hybrid drivetrains requirement for a vehicle
2. Design and apply appropriate hybrid and electric drive trains in a vehicle
3. Design and install suitable AC and DC drives for electric vehicles.
4. Arrive at a suitable energy storage system for a hybrid / electric vehicle
5. Apply energy management strategies to ensure better economy and efficiency

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COURSE OBJECTIVES:

- To develop the knowledge about combustion kinetics in SI and CI engines.
- To understand the combustion reaction kinetics in SI and CI engines.

UNIT I  INTRODUCTION  9

UNIT II  CHEMICAL KINETICS OF COMBUSTION  9

UNIT III  MODELLING  9
Calculation of equilibrium composition. Enthalpy and Energy, Coefficients for reactions and adiabatic flame temperature, Modeling of CO, HC NO reactions in SI and CI Engines – Soot Modeling

UNIT IV  GASOLINE ENGINE COMBUSTION  9

UNIT V  DIESEL ENGINE COMBUSTION  9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course the student will be able to
1. understand the concept of combustion kinetics
2. Modeling of the combustion process of different fuels
3. Modeling advanced combustion process
4. Understand and formulate the kinetics for CI engine combustion
5. Understand and formulate the kinetics for SI engine combustion
REFERENCES:

EY4092 ENERGY FORECASTING, MODELING AND PROJECT MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:
1. To impart knowledge about the present status of energy scenario in India.
2. To predict the energy demand using various forecasting models.
3. To develop an optimization model for the effective utilization of energy sources.
4. To understand and learn the procedure to write the project proposal.
5. To learn the present status of energy policies in the country.

UNIT- I ENERGY SCENARIO

UNIT- II FORECASTING MODEL

UNIT- III OPTIMIZATION MODEL

UNIT- IV PROJECT MANAGEMENT

UNIT- V ENERGY POLICY

TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Illustrate the energy scenario and appraise energy availability
2. Predict energy demand using various forecasting models.
3. Develop different optimization model for energy planning.
4. Formulate project proposal and financial evaluation.
5. Interpret the national and state energy policies.

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TE4073 HYDROGEN AND FUEL CELL TECHNOLOGIES  L  T  P  C  3 0 0 3

COURSE 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

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

UNIT V APPLICATION OF FUEL CELL AND ECONOMICS
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

COURSE 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.

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IC4071  BOUNDARY LAYER THEORY AND TURBULENCE  L  T  P  C
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COURSE OBJECTIVES:
1) To introduce the fundamental concepts of boundary layer in real flows.
2) To distinguish between turbulent and laminar boundary layers.
3) To model turbulent flows using various approaches.
4) To analyse various flow parameters using statistical principles.
5) To introduce the types, characteristics of wall shear flows from free shear flows.

UNIT I  FUNDAMENTALS OF BOUNDARY LAYER THEORY  9
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  9

UNIT III  TURBULENCE AND TURBULENCE MODELS  9

UNIT IV  STATISTICAL THEORY OF TURBULENCE  9

UNIT V  TURBULENT FLOWS  9

TOTAL : 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course, the students will be able to:
1) Analyse flow with the principles of boundary layer theory
2) Distinguish turbulent boundary layer for various types of flows
3) Select and use various turbulence models for the appropriate applications.
4) Apply the statistical theory for averaging various flow parameters.
5) Differentiate the characteristics of wall shear and free shear flows.

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REFERENCES:

IC4007 ADVANCED COMBUSTION CONCEPTS IN ENGINES

COURSE OBJECTIVES
- To provide fundamental knowledge about HCCI and its background
- To provide insight about Gasoline and Diesel LTC methods
- To impart knowledge on LTC control methods and its significance
- To provide insight about the fuel requirements for LTC and its effect
- To impart knowledge on LTC combustion operation with alternative fuels

UNIT I LOW TEMPERATURE COMBUSTION ENGINE FUNDAMENTALS
Introduction, low temperature combustion (LTC) Fundamentals – Background of LTC, Principle, Benefits, Challenges, Need for control.

UNIT II GASOLINE AND DIESEL LTC ENGINES
Conventional Gasoline Combustion, Effects of EGR, Techniques to HCCI operation in gasoline engines, Conventional Diesel Combustion, Overview of diesel HCCI engines, Techniques –Early Injection, Multiple injections, Narrow angle direct injection (NADI™) concept, Modulated kinetics (MK)combustion – First and Second generation of MK combustion, emission, performance improvement.

UNIT III LOW TEMPERATURE COMBUSTION CONTROL
Control Methods, Combustion timing sensors, HCCI/SI switching, Transition between operating modes (HCCI-SI-HCCI), Fuel effects in HCCI - gasoline, diesel, auto-ignition requirement, combustion phasing, Influence of equivalence ratio, auto-ignition timing, combustion duration, auto-ignition temperature and auto-ignition pressure, Combustion limits, IMEP and indicated efficiency, other approaches to characterizing fuel performance in HCCI engines.

UNIT IV ADVANCED COMBUSTION FUEL REQUIREMENTS
Introduction, Background, Diesel fuel HCCI, HCCI fuel ignition quality, Gasoline HCCI, HCCI fuel specification, Fundamental fuel factors.
UNIT V  LTC WITH ALTERNATIVE FUELS
Natural gas HCCI engines, CNG HCCI engines, methane/n- butane/air mixtures. DME HCCI
engine - chemical reaction model, Combustion completeness, Combustion control system, Method
of combining DME and other fuels, Unmixed-ness of DME/air mixture

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The students will be able to
• Understand the fundamentals of HCCI combustion, benefits and challenges
• Learn the methods followed to achieve HCCI in Gasoline and Diesel engines
• Learn the HCCI combustion control methods and its significance
• Understand the fuel requirements for HCCI operation and its role on complete load range
  operation
• Learn the HCCI operation with alternative fuels and its comparison over conventional fuels

TEXT BOOKS:
1. Hua Zhao “HCCI and CAI Engines for automotive industry” Wood Head Publishing in

REFERENCES:
4. HCCI Diesel Engines - Nptel - https://nptel.ac.in/courses/112104033/34
5. HCCI and CAI Engines – Nptel - https://nptel.ac.in/courses/112104033/33

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IC4008  MANUFACTURING AND TESTING OF ENGINE COMPONENTS  L T P C
3 0 0 3

COURSE OBJECTIVES:
• To provide a comprehensive module on the aspects of materials, manufacture and testing
  of piston engine assemblies, components, and subsystems.
• To equip the learners with necessary domain inputs such that they can pursue research,
  consultancy, academics, or other vocation.
• To introduce the students to CNC programming
• To emphasis on the importance of quality management system
• To provide knowledge necessary to perform computer aided engine testing
UNIT I MATERIALS AND PRODUCTION METHODS

UNIT II ENGINE COMPONENTS
Cylinder Block, Cylinder Head, Crankcase and Manifolds, Piston Assembly, Connecting Rod, Crankshaft, Camshaft and Valve Train - Testing Methods.

UNIT III ENGINE AUXILIARIES
Fuel injectors, radiators, fans, coolant pumps, ignition system, intake and exhaust systems, and catalytic converters.

UNIT IV COMPUTER INTEGRATED MANUFACTURING
Integration of CAD, CAM and CIM – Networking - CNC programming for machining of Engine Components.

UNIT V QUALITY ASSURANCE AND TESTING
TS 16949, ISO and BIS codes for testing – Instrumentation for engine testing - computer aided engine testing - metrology for manufacture of engine components - engine tribological aspects.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The student will be able to
1. Choose appropriate materials for manufacturing of engine components.
2. Develop the production process for manufacturing engine components and auxiliaries.
3. Choose appropriate test methods and parameters to test the quality of engine components.
4. Develop CNC programs for simple components.
5. Perform computer aided engine testing.

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COURSE OBJECTIVES:
- The main objective of this course is to introduce the concept and principle of operation of special vehicles such as Bulldozers, Ditchers, Bucket excavators, farm equipments, military vehicles etc. At the end of the course, the students can have a better understanding of the application of the special types of vehicles in the excavation of earth.

UNIT – I INTRODUCTION
The design features of Automotive, Locomotive, Marine, Stationery and Generator-set engines.

UNIT – II S.I. ENGINE SYSTEMS

UNIT – III C.I. ENGINE SYSTEMS
Compression ignition engine system variants – Low, Medium and High speed system characteristics, High pressure fuel injection systems, Homogeneous Charge Compression Ignition systems, Dual and dedicated alternate fueled engine systems, coal and producer gas fueled engine systems, cogeneration system, Total engine systems.

UNIT – IV SPECIAL PURPOSE ENGINE SYSTEM
Engines for special applications – Mining, Defense, Off-highway – Tractor, Bulldozer etc. Submarines, Race car engine systems, Flexible fueled systems.

UNIT – V LIFE CYCLE ANALYSES OF ENGINE SYSTEMS
Life cycle cost.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Design features of engines for different applications
2. Understanding different types of SI and CI engine systems
3. Understand the engines for earth moving and constructional equipments
4. Understand the concepts of high performance engines
5. Analysis of life cycle

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REFERENCES:

IC4010 SUPERCHARGING AND TURBOCHARGING

UNIT I SUPERCHARGING

UNIT II TURBOCHARGING

UNIT III SCAVENGING OF TWO STROKE ENGINES

UNIT IV PORTS AND MUFFLER DESIGN
Porting – Port flow characteristics-Design considerations – Design of Intake and Exhaust Systems – Tuning: Kadenacy system.

UNIT V EXPERIMENTAL METHODS AND RECENT TRENDS IN TWO STROKE ENGINES
COURSE OUTCOMES:
1. Recognize and understand reasons for differences among operating characteristics of superchargers
2. Differentiate among different types of turbocharging methods and design turbochargers
3. Exposure to the different terminologies and scavenging systems
4. Design a two stroke cycle engine
5. Develop skills to run engine dynamometer experiments and understand methods of eliminating short circuiting

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EY4091 ADVANCED ENERGY STORAGE TECHNOLOGIES L T P C
9
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COURSE OBJECTIVES:
1. To understand the various types of energy storage technologies and its applications.
2. To study the various modeling techniques of energy storage systems using TRNSYS.
3. To learn working concepts and types of batteries.
4. To make the students to get understand the concepts of Hydrogen and Biogas storage.
5. To provide the insights on super capacitor, Fly wheel and compressed energy storage system.

UNIT– I INTRODUCTION
Necessity of energy storage–types of energy storage–comparison of energy storage technologies– Applications.

UNIT– II THERMAL STORAGE SYSTEM
Thermal storage–Types–Modelling of thermal storage units–Simple water and rock bed storage system–pressurized water storage system–Modelling of phase change storage system–Simple units, packed bed storage units – Modelling using porous medium approach, Use of TRNSYS.

49
UNIT–III ELECTRICAL ENERGY STORAGE 9
Fundamental concept of batteries—measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel–Cadmium, Zinc Manganese di oxide and modern batteries for example(i)zinc-Air(ii)Nickel Hydride,(iii)Lithium Battery.

UNIT– IV HYDROGEN AND BIOGAS STORAGE 9

UNIT– V ALTERNATE ENERGY STORAGE TECHNOLOGIES 9
Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:

1. Identify the energy storage technologies for suitable applications.
2. Analyze the energy storage systems using TRNSYS.
3. Summarise the concepts and types of batteries.
4. Examine the principle of operation of Hydrogen and Biogas storage systems.
5. Explain the working of super capacitor, Flywheel and compressed energy storage systems

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COURSE OBJECTIVES
1. To impart the knowledge on the principle of conventional motor drives, various starting and speed control methods of motors.
2. To understand the concepts of various losses and harmonics effects in motors.
3. To study the Power Electronics components and controllers.
4. To provide insights of Superconductivity theory and super conducting magnetic energy storage.
5. To understand the concept of Solid State motor controllers and their applications.

UNIT I  CONVENTIONAL MOTOR DRIVES  9
Characteristics of DC and AC motor for various applications - starting and speed control - methods of breaking.

UNIT II  PHYSICAL PHENOMENA IN ELECTRICAL MACHINES  9
Various losses in motors-Saturation and Eddy current effects - MMF harmonics and their influence of leakage-stray losses - vibration and noise.

UNIT III  SOLID STATE POWER CONTROLLERS  9

UNIT IV  SUPERCONDUCTIVITY  9
Principle of Super conductivity, super conducting generators-motors and magnets - Super conducting magnetic energy storage (SMES).

UNIT V  SOLID STATE MOTOR CONTROLLERS  9
Single and Three Phase fed DC motor drives - AC motor drives - Voltage Control - Rotor resistance control - Frequency control - Slip Power Recovery scheme

TOTAL: 45 PERIODS

OUTCOMES
1. Diagnose the operations of conventional motor drives, various starting and speed control methods of motors.
2. Analyze the different losses and harmonic effects in motors.
3. Recognize the Power electronics components and design the controllers.
4. Apply the Superconductivity theory and analyze the super conducting magnetic energy storage.
5. Analyse the concept of Solid State motor controllers and their applications
REFERENCES
3. Rene Husson, Modelling and Control of Electrical machines, Elsevier Science Ltd, 2009

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING

COURSE OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS

UNIT III TITLE WRITING SKILLS
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, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS
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

UNIT V VERIFICATION SKILLS
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

COURSE OUTCOMES
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

AX4092 DISASTER MANAGEMENT

COURSE OBJECTIVES
- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS

UNIT III DISASTER PRONE AREAS IN INDIA
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 Periods
COURSE OUTCOMES
CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

AX4093 CONSTITUTION OF INDIA L T P C 2 0 0 0

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

UNIT IV ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION
District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila

UNIT VI ELECTION COMMISSION
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

OUTCOMES
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
- The Constitution of India,1950(Bare Act),Government Publication.

AX4094 தமிழின் துவக்கப்பொட்டி L T P C 2000

UNIT I சங்க இலக்கியம்
1. குறிஞ்சிப் பொட்டின் மலர்க்கொட்சி - புறநொனூறு(95,195)
2. புழையல் (82)
3. புழையல் பரப்பு மன்காளுத்திக் கற்றுத் தந்து பனுறு (65)

UNIT II புறநொனூறு
1. புறநொனூறு பொட்டின் மலர்க்கொட்சி - புறநொனூறு(82)
2. புறநொனூறு பொட்டின் மலர்க்கொட்சி - புறநொனூறு(82)
- அரசியல், தியாப்தியல், இன்றியல், அசார்களச் செயல் (தமிழக மற்றும் சிறுபாட்டு தொழில்)

UNIT III தமிழ் கப்பல்பொறிக்கள்
1. கல்வித்துறைகள் பங்களித்த கல்வி - தியாப்தியல் மற்றும் சிறுபாட்டுத் தொழில்
2. முடித்தலை இன்றியப் படைப்பங்கள் - தமிழக மற்றும் சிறுபாட்டு தொழில்

UNIT IV அசார்களை குறிப்பிட்டு
1. கல்வியாறு தொழில்துறை - பங்களித்த கல்வியாறு தொழில்துறை, பங்களித்த தொழில்துறை, தமிழக மற்றும் சிறுபாட்டு தொழில்துறை, இன்றியப் படைப்பங்கள்
2. குறிப்பிட்டு
   - கல்வியாறு தொழில்துறை
3. தமிழ்கல்வி (617, 618) - தொழிட்டு கல்வி முன்னெடுப்பு
4. தமிழக மற்றும் சிறுபாட்டு தொழில்துறை
5. படைநாடு
   - தமிழ்கல்வி படைநாடு
6. அசார்களை (4) - முழுமை
   குறிப்பிட்டு (11) - தொழில்
   குறிப்பிட்டு (11) - பங்களித்த, பங்களித்த
   குறிப்பிட்டு 50 (27) - பங்களித்த
   விளிம்பைப் படைநாட்டு கல்வியாறு

UNIT V சிறு தமிழ் இலக்கியம்
1. சிறு தமிழ், - கல்வியாறு படைநாடு விளிம்பை
   - கல்வியாறு விளிம்பை கல்வி
   - கல்வியாறு விளிம்பை கல்வி
   - பங்களித்த விளிம்பை
   - பங்களித்த, - தொழில்
2. தமிழ் இலக்கியம் படைநாடு தமிழ் இலக்கியம், - கல்வியாறு
3. தமிழ் இலக்கியம் தமிழ்கல்வி
4. தமிழ் இலக்கியம் விளிம்பை தமிழ் இலக்கியம், - கல்வி விளிம்பை
5. தமிழ் தியாப்தியல்,
6. தொல்லியல் கல்வி, 
7. கருத்துக்கேற்ற நூற்றாண்டுகள் தமிழ் தொகுப்பு.

TOTAL: 30 PERIODS

தமிழ் தொகுப்பு தொல்லியல் / புதுக்காலம்

1. தமிழ் தொல்லியல் கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
2. தமிழ் விக்கிப்பீட்டை (Tamil Wikipedia)
   - https://ta.wikipedia.org
3. தரமூர் அதிசய நூற்றாண்டு
4. பல்கலைக்கழகம் கல்விக்கழகம்
   - தமிழ் பல்கலைக்கழகம், தஞூர் வள்ளை
5. தமிழ்ப் பல்கலைக்கழகம்
   - தமிழ் பல்கலைக்கழகம் (thamilvalarchithurai.com)
6. அரியல் கல்விக்கழகம்
   - தமிழ் பல்கலைக்கழகம், தஞூர் வள்ளை