SRI VENKATESWARA COLLEGE OF ENGINEERING
(An Autonomous Institution, Affiliated to Anna University, Chennai)
SRIPERUMBUDUR TK - 602 117
Regulations – 2018

M.E. Internal Combustion Engineering

Choice Based Credit System (CBCS)

Curriculum and Syllabi

SEMESTER - I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	PRE REQUISITES	FIXED/ MOVABLE
THEORY										
1.	MA18182	Advanced Numerical Methods	BS	4	3	1	0	4	Nil	Fixed
2.	IC18101	Advanced Heat Transfer	PC	4	3	1	0	4	Nil	Fixed
3.	IC18102	Advanced Thermodynamics	PC	4	3	1	0	4	Nil	Fixed
4.	IC18103	Combustion and Emissions in Engines	PC	3	3	0	0	3	Nil	Fixed
5.	IC18104	Alternative Fuels and Energy Systems	PC	3	3	0	0	3	Nil	Fixed
6.		Professional Elective I	PE	3	3	0	0	3	Nil	Fixed
PRACTICAL										
7.	IC18111	I.C. Engines Laboratory	PC	4	0	0	4	2	Nil	Fixed
TOTAL				**25**	**18**	**3**	**4**	**23**	-	-

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	PRE REQUISITES	FIXED/ MOVABLE
THEORY										
1.	IC18201	Electronic Engine Management Systems	PC	3	3	0	0	3	Nil	Fixed
2.	IC18202	Internal Combustion Engine Design	PC	3	3	0	0	3	Nil	Fixed
3.	IC18203	Instrumentation for Thermal Systems	PC	3	3	0	0	3	Nil	Fixed
4.	IC18204	Engine and Component Testing	PC	3	3	0	0	3	IC18103	Fixed
5.		Professional Elective II	PE	3	3	0	0	3	Nil	Floating
6.		Professional Elective III	PE	3	3	0	0	3	Nil	Floating
7.	MC18081	Introduction to Research Methodology and IPR	MC	2	2	0	0	2	Nil	Fixed
PRACTICAL										
7.	IC18211	Engine Simulation Laboratory	PC	4	0	0	4	2	Nil	Fixed
8.	IC18212	Technical Seminar I	EEC	2	0	0	2	1	Nil	Fixed

TOTAL	26	19	1	6	23	-	-

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	PRE REQUISITES	FIXED/ MOVABLE
THEORY										
1.		Professional Elective IV	PE	3	3	0	0	3	Nil	Floating
2.		Professional Elective V	PE	3	3	0	0	3	Nil	Floating
3.		Professional Elective VI	PE	3	3	0	0	3	Nil	Floating
PRACTICAL										
4.	IC18312	Technical Seminar II	EEC	2	0	0	2	1	IC18212	Fixed
5.	IC18311	Project Work Phase I	EEC	12	0	0	12	6	Nil	Fixed
TOTAL				**23**	**9**	**0**	**14**	**16**	-	-

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	PRE REQUISITES	FIXED/ MOVABLE
PRACTICAL										
7.	IC18411	Project Work Phase II	EEC	24	0	0	24	12	IC18311	Fixed
TOTAL				**24**	**0**	**0**	**24**	**12**	**-**	**-**

Total Credits: 74

SEMESTER 1

PROFESSIONAL ELECTIVES -I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	PRE REQUISITES	FIXED/ MOVABLE
1.	IC18001	IC Engine Auxiliary Systems	PE	3	3	0	0	3	Nil	
2.	IC18002	Marine Diesel Engines	PE	3	3	0	0	3	Nil	
3.	IC18003	Engine Pollution and Control	PE	3	3	0	0	3	Nil	

SEMESTER 2

Professional Elective – II & III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	PRE REQUISITES	FIXED /MOVABLE
1.	IC18004	Simulation of I.C. Engine Processes	PE	3	3	0	0	3	IC18103	
2.	IC18005	Supercharging and Scavenging	PE	3	3	0	0	3	Nil	
3.	IC18006	Fluid Flow and Heat Transfer in Engines	PE	3	3	0	0	3	IC18101	
4.	IC18007	Computational Fluid Dynamics for Thermal Systems	PE	3	3	0	0	3	Nil	
5.	IC18008	Flow Visualization Techniques for I.C. Engines	PE	3	3	0	0	3	IC18103	
6.	IC18009	Specialty Engines	PE	3	3	0	0	3	Nil	

SEMESTER 3

PROFESSIONAL ELECTIVE – IV& V

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	PRE REQUISITES	FIXED /MOVABLE
1.	IC18010	Boundary Layer Theory and Turbulence	PE	3	3	0	0	3	IC18101	
2.	IC18011	Combustion and Reaction Kinetics in I.C. Engines	PE	3	3	0	0	3	IC18103	
3.	IC18012	Homogeneous Charge Compression Ignition Combustion in Engines	PE	3	3	0	0	3	IC18101	
4.	IC18013	Design and Analysis of Turbomachines	PE	3	3	0	0	3	Nil	
5.	IC18014	Research Methodology	PE	3	3	0	0	3	MC18081	
6.	IC18015	Safety in Transportation system	PE	3	3	0	0	3	Nil	
7.	IC18016	Advanced Automobile Engineering	PE	3	3	0	0	3	Nil	
8.	IC18017	Aircraft and Space Propulsion	PE	3	3	0	0	3	Nil	

MANDATORY COURSES

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C	PRE REQUISITE	FIXED /MOVABLE
1	MC18081	Introduction to Research Methodology and IPR	MC	2	2	0	0	2	Nil	

Summary

Name of the Programme									
Subject Area	**Credits per Semester**								**Total**
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
Humanities and Social Sciences (HS), including Management									
Basic Sciences (BS) including Mathematics, Physics, Chemistry, Biology	4								
Professional Subjects-Core (PC), relevant to the chosen specialization/branch; (May be split into Hard (no choice) and Soft (with choice), if required)	16	14							
Engineering Sciences (ES), including Materials, Workshop, Drawing, Basics of, Electrical/Electronics/Mechanical/Computer Engineering, Instrumentation									
Professional Subjects – Electives (PE), relevant to the chosen specialization/ branch	3	6	9						
Mandatory Subjects - (MC), relevant to the chosen specialization/ branch		2							
Project Work, Seminar and/or Internship in Industry or Elsewhere (EEC)		1	7	12					
Total Credits	**23**	**23**	**16**	**12**					**74**

MA 18182	ADVANCED NUMERICAL METHODS	L	T	P	C
	(Common to Mechatronics, CAD and Internal Combustion Engineering)	3	1	0	4

OBJECTIVES :

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

UNIT I ALGEBRAIC EQUATIONS 12

Systems of linear equations: Gauss Elimination method, pivoting techniques, Thomas algorithm for tridiagonal system –Gauss Seidel, SOR iteration methods - Systems of nonlinear equations: Fixed point iterations, Newton Raphson Method, Graffe's Root squaring method, Eigen value problems-Faddeev – Leverrier Method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 12

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep method shooting method, BVP: Finite difference method, orthogonal collocation method, orthogona collocation with finite element method, Galerkin finite element method.

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

Parabolic equations: explicit and implicit finite difference methods, weighted average approximation - Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method; First order hyperbolic equations – method of characteristics, different explicit and implicit methods; numerical stability analysis, method of lines – Wave equation: Explicit scheme- Stability of above schemes.

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, and Dirichlet 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

Partial differential equations – Finite element method - orthogonal collocation method, orthogonal collocation with finite element method, Galerkin finite element method-one parameter.

TOTAL : 60 PERIODS

OUTCOMES :

- Developes the skill to solve linear system of equations using direct and iterative methods and also acquire the knowledge of solving Eigen Value problems.
- Acquire the skill to solve ordinary differential equations using single step, multistep methods and finite element method.
- Apply numerical technique to solve parabolic and hyperbolic PDE using finite difference methods
- Apply numerical technique to solve elliptic PDE using finite difference technique.
- Acquire the skill to solve PDE using finite element method.

REFERENCES :

1. Saumyen Guha and Rajesh Srivastava, “Numerical methods for Engineering and Science”, Oxford Higher Education, New Delhi, 2010
2. Gupta S.K., “Numerical Methods for Engineers”, 3rd Edition Reprint, New Age Publishers, 2018
3. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, 9th Edition – Revised, Cengage Learning, India Edition, New Delhi, 2010
4. Jain M. K, Iyengar S. R, Kanchi M. B., Jain R. K, “Computational Methods for Partial Differential Equations”,2nd Edition, New Age Publishers, 2012
   Morton K.W. and Mayers D.F., “Numerical solution of partial differential equations”, Cambridge University press, Cambridge, 2014.

IC18101	ADVANCED HEAT TRANSFER	L	T	P	C
		3	1	0	4

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**	**15**

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer - 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**	**10**

Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model – k Є 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**	**10**

Condensation with shears edge on bank of tubes - boiling – pool and flow boiling - heat exchanger –Є – NTU approach and design procedure - compact heat exchangers.

UNIT IV	**NUMERICAL METHODS IN HEAT TRANSFER**	**15**

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**	**10**

Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer Correlations in various applications like I.C. engines - compressors and turbines.

TOTAL: (L:45 + T:15): 60 PERIODS

OUTCOMES:

- On successful completion of this course the students are capable to

- Differentiate the principles of conduction and radiation heat transfer
- Understand the principles and applications of turbulent forced convective heat transfer, phase change heat transfer and heat exchanger

• Understand the principles of numerical methods in heat transfer and engine heat transfer correlation		
	(Use of Standard HMT Data Book permitted)	
REFERENCES:		
1.	YunusA.Cengal, Heat and Mass Transfer – A practical Approach, 4th edition, Tata McGraw - Hill,2011.	
2.	Holman.J.P, Heat Transfer, Tata McGraw Hill, 10th Edition,2016.	
3.	Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co, 1985.	
4.	Incropera F.P. and DeWitt. D.P, Fundamentals of Heat & Mass Transfer, 7th edition John Wiley & Sons, 2011.	
5.	Nag.P.K, Heat Transfer, Tata McGraw-Hill, 2007.	
6.	Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2012.	
7.	Yadav, R., Heat and Mass Transfer, Central Publishing House, 2004.	

IC18102	ADVANCED THERMODYNAMICS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To achieve an understanding of basic principle and scope of thermodynamics relations.
- To predict the availability and irreversibility associated with the thermodynamic processes.
- To analyze 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 Cp and Cv, ClausiusClayperon Equation, Joule-Thomson Coefficient, Bridgeman Tables for Thermodynamic Relations.

UNIT II	**REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS**	**12**

Equations of State (mention three equations), Fugacity, Compressibility, Principle of Corresponding States, Use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition, partial molar properties, Real gas mixtures, Ideal solution of real gases and liquids, Equilibrium in multi-phase systems, Gibbs phase rule for non-reactive components.

UNIT III	**CHEMICAL AVAILABILITY**	**12**

Introduction, Reversible work, Availability, Irreversibility and Second-Law Efficiency for a closed System and Steady-State Control Volume. Availability Analysis of Simple Cycles. Chemical availability, Environmental state, Air-conditioning processes. Fuel Chemical availability, availability analysis of chemical processes–steam power plant, combustion and heat transfer losses, preheated inlet air, problems.

UNIT IV	**FUEL – AIR CYCLES AND THEIR ANALYSIS**	**12**

Ideal Models of Engine Processes, Fuel–Air Cycle Analysis – SI Engine cycle Simulation, CI Engine Cycle Simulation, Results of Cycle Calculations, over expanded Engine Cycles, Availability Analysis of Engine Processes – Availability Relationships – Entropy changes in Ideal Cycles – Availability Analysis of Ideal Cycles – Effect of Equivalent Ratio, Comparison with Real Engine Cycles.

UNIT V	**THERMO CHEMISTRY**	**12**

Ideal Gas Laws and Properties of Mixtures, Combustion Stoichiometry, Application of First Law of Thermodynamics – Heat of Reaction – Enthalpy of Formation – Adiabatic Flame Temperature. Second Law of Thermodynamics Applied to Combustion – Entropy, Maximum Work and Efficiency Chemical Equilibrium: - Equilibrium Combustion Products. Dynamic Properties of Working Fluids: Unburned Mixture – Low Temperature Combustion Products – High

Temperature Combustion Products, Problems	
	TOTAL: (L: 45+ T: 15): 60 PERIODS
OUTCOMES:	
• The students are capable to analyze the behavior of ideal and real gas. • The student will be able to analyze the fuel air cycle for IC engine. • The student will be able to understand the thermo chemistry of a system.	
(Use of Standard Thermodynamics Data Book permitted)	
REFERENCES:	
1.	Kenneth Wark., J. R, Advanced Thermodynamics For Engineers, McGraw-Hill Inc, 1995.
2.	Yunus A. Cengel and Michael A. Boles, Thermodynamics, McGraw-Hill Inc, 8th edition, 2014.
3.	B.P. Pundir, I.C. engine combustion and emissions, Narosa Publishing House, 2010.
4.	Bejan, A, Advanced Engineering Thermodynamics, John Wiley and Sons, 4th edition 2016.
5.	Holman,J.P, Thermodynamics, Fourth Edition, McGraw-Hill Inc, 1988.

IC18103	COMBUSTION AND EMISSION IN ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand combustion in spark ignition and diesel engines.
- To identify the nature and extent of the problem of pollutant formation and control in internal combustion engines government legislation.

UNIT I	**COMBUSTION PRINCIPLES**	**8**

Combustion – Combustion equations, heat of combustion - Theoretical flame temperature - chemical equilibrium and dissociation - Theories of Combustion - Pre-flame reactions - Reaction rates - Laminar and Turbulent Flame Propagation in Engines

UNIT II	**COMBUSTION IN S.I. ENGINE**	**12**

Initiation of combustion, stages of combustion, normal and abnormal combustion, knocking combustion, pre-ignition, knock and engine variables, features and design consideration of combustion chambers. Flame structure and speed, Cycle by cycle variations, Lean burn combustion, stratified charge combustion systems. Heat release correlations. After treatment devices for SI engines.

UNIT III	**COMBUSTION IN C.I. ENGINE**	**10**

Stages of combustion, vaporization of fuel droplets and spray formation, 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. After treatment devices for diesel engines.

UNIT IV	**COMBUSTION IN GAS TURBINES**	**5**

Flame stability, re-circulation zone and requirements - Combustion chamber configuration, materials.

UNIT V	**EMISSIONS**	**10**

Main pollutants in engines, Kinetics of NO formation, NOx formation in SI and CI engines.Unburned hydrocarbons, sources, formation in SI and CI engines, Soot formation and oxidation, Particulates in diesel engines, Emission control measures for SI and CI engines, Effect of emissions on Environment and human beings.

TOTAL(L:45+T:0): 45 PERIODS

OUTCOMES:

- Students will be able to compare the combustion of SI and CI Engine and analyse the effect of engine operating and design parameters on the engine combustion and its mixture requirements.
- Students will be capable to analyse the causes, measuring & controlling techniques of SI and CI Engine pollutants.

• Students will be able to compare the combustion of IC Engine and Gas turbine and analyse the effect of parameters on the gas turbine combustion.		
	(Use of Standard Data Book permitted)	
REFERENCES:		
1.	Ramalingam, K.K, Internal Combustion Engines, Scitech Publications (India) Pvt. Ltd, 2004.	
2.	Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co, 2012.	
3.	John B.Heywood, Internal Combustion Engine Fundamentals,McGraw Hill Book, 2018	
4.	Mathur, M.L, and Sharma, R.P, A Course in Internal Combustion Engines, DhanpatRai Publications Pvt. New Delhi-2, 1993.	
5.	Obert, E.F, Internal Combustion Engine and Air Pollution, International Text Book Publishers, 1983.	
6.	Cohen,H, Rogers,G,E.C, and Saravanamuttoo, H.I.H, Gas Turbine Theory, Longman Group Ltd, 2017	

IC18104	ALTERNATIVE FUELS AND ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course imparts the basic knowledge of working understanding of the engineering issues and perspectives affecting fuel and engine development and energy systems
- They are also able to examine future trends and development in electric vehicles
- They can explore further fuel specification and performance requirements for advanced combustion systems and energy for future vehicles.

UNIT I	**LIQUID FUELS FOR I.C ENGINES**	**9**

Requirements of fuels -Different Techniques of utilizing alternative liquid fuels– Blends, Neat form, Reformed Fuels - Manufacturing, Storage-Ignition accelerators and other additives - Performance and Emission Characteristics of alternative liquid fuels

UNIT II	**GASEOUS FUELS FOR I.C ENGINES**	**9**

Availability and Suitability and properties of Potential Alternative Fuels - Use of Hydrogen, CNG, LPG, Natural Gas, Producer Gas, Biogas, LPG, Natural gas, CNG in IC engines. Dual fueling – Safety Precautions – Engine performance and emissions.

UNIT III	**FUEL CELL TECHNOLOGY**	**9**

Basic Principles - Classification – Alkaline, Proton Exchange Membrane, Direct Methanol, Phosphoric Acid & Molten Carbonate – Parts - Automotive applications

UNIT IV	**ELECTRIC VEHICLES**	**9**

Introduction, Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics,Dynamics of vehicle motion - Propulsion System.

UNIT V	**BATTERY FOR ELECTRIC VEHICLES**	**9**

Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state ofDischarge, Depth of Discharge, Technical characteristics, Battery pack Design, Propertiesof Batteries.

TOTAL: (L: 45+ T:0):45 PERIODS

OUTCOMES:

Students are capable to

- Understand the various alternative fuel options available for conventional fuels and their performance and emission characteristics.
- Analyze the working principle, types and performance of fuel cell.
- Understand the energy systems for electric vehicles and their application.

REFERENCES:

1. Osamu Hirao and Richard K Pefley, Present and Future Automotive Fuels, John Wiley and Sons, 1988.

2.	Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990.
3.	Fuel Cell Systems Explained, James Larminie and Andrew Dicks, 2nd Edition, John Wiley & Sons Inc, 2018.
4.	IqbalHussain, Electric & Hybrid Vehicles – Design Fundamentals, CRC Press.2011
5.	Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, Research Studies press,Taunton, UK 1998.
6.	Automotive Lubricants Reference Book, Second Edition, Roger F. Haycock andJohn E. Hillier, SAE International Publications, 2004.
7.	PEM Fuel Cells Theory and Practice, FranoBarbir, Elsevier Academic Press, 2005

IC18111	I.C. ENGINES LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To understand the behaviour of IC Engine system at different operating conditions.
- To understand the influence of individual components on the Overall performance of the IC Engine system.

LIST OF EXPERIMENTS

1.	Disassembly and Assembly of Engines.
2.	Study and drawing of engine components with dimensions.
3.	Experimental Study of S.I. Engine fuelled with 20% Ethanol fuel.
4.	Experimental Study on C.I. Engines fuelled with 20% Ethanol fuel.
5.	Experimental Study on the effect of fuel injection pressure on the Engine Performance, Combustion and Emission Characteristics.
6.	Experimental Study on the effect of air preheating on Engine Performance, combustion and Emission Characteristics.
7.	Determination of Flash and Fire point of various fuel blends.
8.	Determination of viscosity of various fuel blends.
9.	Study of Engine cooling system in a RITZ Car equipped with scan tool software.
10.	Experimental Study on the effect of fuel preheating on Engine Performance, combustion and Emission Characteristics

TOTAL: (L:0+ T: 60): PERIODS

OUTCOMES:

- The students are able to understand the operation, testing and maintenance of CI engines.
- The students will be able to understand the Operation, testing and maintenance of SI engines
- The students will be familiar with the properties of tested fuels

REFERENCES:

1.	I.C Engines Laboratory Manual Prepared by Faculty of Mechanical Engineering, Sri Venkateswara College of Engineering.
2.	InternalCombustion Engine by V.Ganesan,Forth Edition,2012.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Qty
1	S.I Engine Components.	1
2	C.I Engine Components.	1
3	Single/ Multi-cylinder S.I. Engines.	1
4	Single/ Multi-cylinder C.I. Engines.	1
5	Exhaust Gas Analyser(To measure HC, CO, NOx, O_2, CO_2).	1
6	Smoke Meter.	1
7	Pressure Transducer.	1
8	Charge Amplifier.	1
9	Data Acquisition System.	1
10	Flash and Fire Point Apparatus.	1
11	Redwood Viscometer.	1
12	Engine cooling system in RITZ car.	1

IC18201	ELECTRONIC ENGINE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To give an in-depth knowledge of various sensors used in IC engine management systems.
- To give an overview of different types of fuel injection and ignition systems.
- To know the latest technological advancements in vehicle power plant.

UNIT I	**BASICS OF ELECTRONICS**	**7**

Semiconductors, Transistors, Amplifiers, Integrated circuits – Analog and Digital, Logic Gates, Microcontrollers, Analog to Digital and Digital to Analog Converters.

UNIT II	**SENSORS**	**8**

Sensors - Air flow, Pressure, Temperature, Speed, Exhaust gas Oxygen, Knock and Position, Principle of operation, construction and its characteristics.

UNIT III	**IGNITION SYSTEMS**	**10**

Ignition fundamentals, Solid state ignition systems, High energy ignition systems, Electronic spark timing and control. Combined ignition and fuel management systems. Dwell angle calculation, Ignition timing calculation.

UNIT IV	**GASOLINE INJECTION SYSTEMS**	**10**

Open loop and closed loop systems, Mono-point, Multi-point, Direct injection systems and Air assisted systems – Principles and Features, Types of injection systems, Idle speed, lambda, knock and spark timing control.

UNIT V	**DIESEL INJECTION SYSTEMS**	**10**

Heat release, control of fuel injection, Inline injection pump, Rotary Pump and Injector– Construction and principle of operation, Electronic control, Common rail and unit injector systems– Construction and principle of operation.

TOTAL: (L:45 + T:0): 45 PERIODS

OUTCOMES:

- The student will be able to understand the basics of electronics and thereby to develop the Electronic engine management systems.
- The student will be familiar with of various sensors and their effects in I.C engines.
- The student will be able to understand the electronically controlled Ignition systems.
- The students will be able to understand the latest Gasoline and Diesel Injection systems

REFERENCES:

1.	Robert N. Brady, Automotive Computers and Digital Instrumentation, Prentice Hall, 1988.
2.	Tom Denton, Automotive Electrical and Electronic Systems, 4th Edition, Taylor and Francis

	Group, 2013.
3.	Bosch Technical Instruction Booklets, Robert Bosch GmbH, Germany, 1985.
4.	Duffy Smith, Auto Fuel Systems, The Good Heart-Wilcox Company Inc., Publishers, 1992
5.	Gasoline Engine Management, Third Edition, Robert Bosch, Bentley Publications, 2004.
6.	Diesel Engine Management, Fourth Edition, Robert Bosch, Newness Publications, 2006.
7.	Eric Chowanietz, Automobile Electronics, SAE Publications 1995.
8.	William B. Ribbens, Understanding Automotive Electronics, Sixth Edition, Elsevier Inc, 2017.

IC18202	INTERNAL COMBUSTION ENGINE DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the basic engine design skills to the learners such that there is seamless transition to advanced design concepts.
- To provide the design knowledge on the engine design philosophy.

UNIT I	**GENERALIA**	**8**

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

UNIT II	**DESIGN OF MAJOR COMPONENTS**	**9**

Piston system, Power Cylinder System, Connecting rod assembly, Crankshaft system, Valve Gearing, Stress analyses.

UNIT III	**DESIGN OF OTHER COMPONENTS / SUBSYSTEMS**	**10**

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**	**9**

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**	**9**

Preparation of working drawings of designed components using CAD system.

TOTAL: (L:45 + T:0): 45 PERIODS

OUTCOMES:

- Student are able to design engine components for varied applications.
- Student will able to design two stroke engine piston and port system.
- Student will be analyze the IC engine components in CAD system.

(Use of Standard Engine Design Data Book permitted)

REFERENCES:

1.	Vehicular Engine Design, Kevin L. Hoag, SAE International USA / Springer – Verlag, Wien, Austria, 2006.
2.	Engineering Design, A Systematic Approach, G. Pahl, W. Beltz J. Fieldhusen and K.H. Grote, Springer.
3.	Modern Engine Technology from A to Z, Richard Van Basshuysen and Fred Schafer, SAE International, USA and Siemens VDO, Germany, 2007.
4.	Introduction to Engine Valvetrains, Yushu Wang, SAE International, USA, 2007.

5.	Introduction to Internal Combustion Engines, Richard Stone, Fourth Edition SAE International, USA and Macmillan Press, 2012.
6.	Engineering Fundamentals of the Internal Combustion Engine, Willard W. Pulkrabek, Second Edition, Prentice – Hall of India Pvt. Ltd, New Delhi, 2006.
7.	Diesel Engine Reference Book, Second Edition, RodicaBaranescu and Bernard Challen (Editors), Society of Automotive Engineers, Inc., USA, 1999.
8.	Internal Combustion Engine Design, A. Kolchin and V. Demidov, MIR Publishers, Moscow, 1984.

IC18203	INSTRUMENTATION FOR THERMAL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course imparts the knowledge to carry out error analysis and uncertainty of measurements
- Students will gain the knowledge of the applicability measuring instruments and errors associated with them and to measure pressure.
- Students will gain the knowledge about the heat release from an IC engine, and understand use of flow visualization techniques.

UNIT I	MEASUREMENT CHARACTERISTICS	9

Instruments - Classification and Characteristics – Static and dynamic, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuringinstruments.

UNIT II	MEASUREMENT OF PHYSICAL QUANTITIES	11

Measurement of Temperature- Thermistor, Resistance Temperature Detector, Thermocouples, Pressure – Manometer, Bourdon gauge, Diaphragm gauge, electrical methods, In cylinder pressure transducer, Flow – Venturimeter, Rotameter, Ultrasonic flow meter, Vortex flow meter, Thermal mass flow meter, Turbine flow meter.

UNIT III	ADVANCED MEASUREMENTS	9

Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, Particle Image Velocimetry. Thermo physical properties of micro and Nano fluids. Gas Analysers – Flame Ionisation Detector, Non-Dispersive Infrared Analyser, Smoke meters, and Gas chromatography

UNIT IV	AIR QUALITY MEASUREMENTS	8

Air-Pollution standards, general air-sampling techniques, opacity measurement,Sulphur dioxide measurement, particulate sampling technique, combustion products measurement.

UNIT V	DATA ACQUISITION AND Control SYSTEM	8

Data logging and acquisition - sensors for error reduction, elements of computer interfacing, timers and counters, analog to digital & digital to analog conversion. Open & closed loop control systems, Control system parameters,Servo motors, Stepper motors.

TOTAL: (L:45 + T:0): 45 PERIODS

OUTCOMES:

- Students will able to understand the concepts of errors in measurements, statistical analysis of data, estimation of uncertainty
- Students will able to understand the principles in the measurement of thermo-physical properties
- Students will gain the knowledge of the applicability of data acquisition and control

systems.	
REFERENCES:	
1.	Holman, J.P., Experimental methods for Engineers, Tata McGraw-Hill, 8th Ed.2012..
2.	Barney G.C, Intelligent Instrumentation, Second Edition, Prentice Hall of India, 1988.
3.	Doblin E.O, Measurement System Application and Design, 5 ed, 2004, TataMcGraw-Hill.
4.	Instrumentation, Measurement and Analysis; BC Nakra, and KK Chaudhry; 2 ed, 2004,Tata McGraw-Hill.
5.	Bolton.W, Industrial Control & Instrumentation, Universities Press, Second Edition, 2001.

IC18204	ENGINE AND COMPONENTTESTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The main aim of this courseis to give students in depth knowledge of engine testingand evaluation techniques.
- This course highlight on standards and information fora range of types of engine tests

UNIT I	**ENGINE TEST SERVICES**	**8**

Test cell requirements, control room, aeration, air conditioning and exhaust, cooling system lubrication system, fuel supply systems, noise and vibration control in test cells, electrical test.

UNIT II	**ENGINE DYNAMOMETER AND TESTS EQUIPMENTS**	**9**

Engine dynamometers, types of dynamometers, dynamometer panels, engine controllers, data acquisition, engine dynamometer coupling, fuel consumption meter, air fuel ratio measurement, oil consumption measurement, temperature and pressure measurement, humidity measurement

UNIT III	**ENGINE MEASUREMENTS**	**10**

Engine test standards, full throttle and part throttle performance, road load testing, ISO mapping, heat balance test, Automotive and stationary diesel engine testing and related standards, friction measurement test, durability test, maintenance.

UNIT IV	**ENGINE EMISSION MEASUREMENTS IN DIFFERENT MODES**	**9**

Emission analysers, emission cycles for petrol and diesel commercial vehicles, tractors and gensets, steady state and transient cycles, CVS dilution tunnel, particulate emissions.

UNIT V	**ADVANCED ENGINE TESTING**	**9**

Use of special equipments, fuel injection pressure, combustion pressure, needle lift, heat balance, gas exchange process, Spray and combustion photography, swirl measurement.

TOTAL: (L:45 + T0:): 45 PERIODS

OUTCOMES:

On successful completion of this course the student will be able to

- Understand the process of engine testing and emission measurements.
- Obtain the informations about testing standards, Evaluate performance of different engine& and different fuels.
- Understand the methodology of emission measurements and data analyze.

REFERENCES:

1.	Ganesan.V.Internal Combustion Engines, Tata-McGraw Hill Publishing Co, New Delhi, 2013.
2.	Heldt.P.M.,High Speed Combustion Engines, Oxford IBH Publishing Co,1985.

3.	Obert.E.F.,Internal Combustion Engine analysis and Pratice,International Text Book Co.,Scranton,Pennsylvania,1988.
4.	Maleev.V.M, Diesel Engine Operation and Maintenance, McGraw Hill, 1974.
5.	Dicksee.C.B, Diesel Engines, Blackie & Son Ltd, London, 1964, A.J.Martyr, M.A.Plint, Engine Testing Theory and Practice, SAE International, Third Edition, 2007.
6.	William.H.Crouse, Automotive Engines, McGraw Hill Publishers, 1985. 4. Ellinger, H.E, Automotive Engines, Prentice Hall Publishers, 1992.

IC18211	ENGINE SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To learn the modeling and simulation analysis of various thermal engineering concepts for the application of engine using analysis software's.

FOCUS: USE OF STANDARD APPLICATION SOFTWARE FOR SOLVING HEAT TRANSFER PROBLEMS.

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: (L:0 + T:60:):60 PERIODS

OUTCOMES:

- The student will able to analyze the conduction heat transfer simulation analysis on different thermal engineering applications using simulation software
- The student will able to analyze the convective heat transfer simulation analysis on different thermal engineering applications using simulation software
- The student will able to analyze the radiative heat transfer simulation analysis on different thermal engineering applications using simulation software.

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

REFERENCES:

1.	Finite Element Analysis- Theory and Applications with ANSYS-Third Edition-Pearson Publications-SaeedMoaveni, 2011.
2.	Klee, Harold “Simulation of Dynamic Systems with Matlab and Simulink” CRC Press Inc,

	Taylor &Francis Group: Boca Raton London New York, 2007.
3.	Louis Gary Lamit, Creo™ Parametric 2.0, 1st Edition,2014.
4.	MehrzadTabatabaian, COMSOL 5 for Engineers, Mercury Learning and Information, kindle Edition, 2015.
5.	Li PengFei,Xu Min Yi, Wang FeiFei, Proficient in CFD engineering simulation and real cases - FLUENT GAMBIT ICEM CFD Tecplot, Posts and Telecom Press, 2011.
6.	http://www.bakker.org/cfmbook/cfmbook.htm
7.	http://www.cfd-online.com/Wiki/Fluent_FAQ#Gambit_Turbo
SIMULATION LAB – REQUIREMENT:	
1.	Software - Modeling software like ProE, Gambit, Ansysetc 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.	Hardware are compatible with the requirement of the above software.

IC18212	TECHNICAL SEMINAR-I	L	T	P	C
		0	0	2	1

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: (L:0 + T:30): 30 PERIODS

IC18311	PROJECT WORK PHASE I	L	T	P	C
		0	0	12	6

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 - Postgraduate programmes of Sri Venkateswara college of Engineering (Autonomous).

TOTAL: (L: + T:180): 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.

IC18312	TECHNICAL SEMINAR-II	L	T	P	C
		0	0	2	1

OBJECTIVES:

- During the seminar session each student is expected to prepare and present a topic onEnergy 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: (L:0 + T:30): 30 PERIODS

IC18411	PROJECT WORK PHASE II	L	T	P	C
		0	0	24	12

OBJECTIVES:

- The objective of the research project work is to produce factual results of their appliedresearch idea in the thermal Engineering, from phase – I.
- To improve the student research and development activities.

EVALUATION

- Project work evaluation is based on Regulations of Credit system - Post graduate programmes of Sri Venkateswara college of Engineering (Autonomous).
- 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 jointlyby external and internal examiners constituted by the Head of the Division based on oralpresentation and the project report.

TOTAL: (L:0 + T:360):360 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.

SEMESTER I
PROFESSIONAL ELECTIVE – I

IC18001	I.C. ENGINE AUXILIARY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview of engine auxiliary systems like fuel supply, cooling and lubrication
- To impart knowledge on Gasoline and Diesel fuel injection system, requirement, Componentsand types of ignition.

UNIT I	**CARBURETION**	**7**

Gasoline - air mixtures. Mixture requirements - Mixture formation - Carburettor, Choke, Carburettor systems for emission control- Secondary Air Injection.

UNIT II	**GASOLINE INJECTION AND IGNITION SYSTEMS**	**12**

Petrol Injection - Pneumatic and Electronic Fuel Injection Systems, Ignition systems - Requirements, Timing Systems, Energy requirement, Spark plug operation, Electronic and Distributor less Ignition Systems.

UNIT III	**DIESEL FUEL INJECTION SYSTEMS**	**9**

Atomisation, penetration and dispersion, Rate and duration of injection, Fuel line hydraulics, Fuel pump, Injectors, CRDI Governors

UNIT IV	**INTAKE AND EXHAUST MANIFOLDS**	**7**

Intake system components, Air filter, Intake manifold, VGT, VNT, Exhaust manifold and exhaust pipe, Exhaust mufflers & Resonators

UNIT V	**LUBRICATION AND COOLING SYSTEMS**	**10**

Lubricating systems- Theory, requirements and types, Lubrication - piston rings, crankshaft bearings, camshaft, Cooling systems – Need, Engine heat transfer, liquid and air cooled engines, Oil cooling, Additives and lubricity improvers.

TOTAL: (L:45 + T:0): 45 PERIODS

OUTCOMES:

On successful completion of this course the student will be able

- To understand the need and working of various auxiliaries of engine systems.
- To understand the various lubrication and cooling systems used in engine

REFERENCES :

1.	Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co, 4th Edition, 2012.
2.	Eric Chowanietz, Automobile Electronics, SAE International, 1995.

3.	Heinz Heisler, Advanced Engine Techology, Butterworth Heinmann Publishers, Second Edition, 2002.
4.	Duffy Smith, Auto Fuel Systems, Good Heart Wilcox Company Inc., Publishers, 1987

IC18002	MARINE DIESEL ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the marine engine fundamentals and mechanics in better way

UNIT I	**ENGINE FUNDAMENTALS**	**10**

Engine Operation; Operating Cycles; Performance factors; Supercharging and Scavenging Systems for two stroke and four stroke cycle engines, Submarine Engine Systems, Fuels and Lubricants, Engine Pollution and Control.

UNIT II	**MECHANICS**	**10**

Dynamics of crank gear, Engine Vibration, Design, Engine Systems, Speed governors and Accessory equipments.

UNIT III	**INSTRUMENTATION AND CONTROL**	**10**

Automatic instruments and remote control of marine engines, Testing - Standard codes - Rating.

UNIT IV	**TYPICAL MODERN MARINE PROPULSION ENGINE SYSTEMS**	**8**

M.A.N, B & W, Pielstick etc.

UNIT V	**AUXILIARY SYSTEMS**	**7**

Starting and reversing gears, Fuel systems, cooling system and Lubrication system

TOTAL: (L:45 + T:0): 45 PERIODS

OUTCOMES:

On successful completion of this course the student will be able to

- Familiar with the fundamentals of marine engine operation.
- Understand the marine engine mechanics.
- Understand different auxiliary systems of marine diesel engine.

REFERENCES:

1.	John Lamb, The Running and Maintenance of the Marine Diesel Engine, Charles Griffin and Company Ltd., U.K., (Sixth Edition), 1976.
2.	C.C. Pounder, Marine Diesel Engines, Newnes – Butterworths, UK, (Fifth Edition), 1998.
3.	N. Petrovsky, Marine Internal Combustion Engines, Translation from Russian by Horace E Isakson, MIR Publishers, Mascow,1974.
4.	Doug Woodyard (Editor), Pounder's Marine Diesel Engines, ButterworthHeinemann,UK (Seventh Edition), 1998.
5.	C.T.Wilbur and D.A.Wight, Pounder's Marine Diesel Engines, ButterworthHeinemann,UK (Sixth Edition), 1991.
6.	George H.Clark, Industrial and Marine Fuels Reference Book, Butterworth-and

	Company,(Publishers) Ltd. U.K., 1998.

IC18003	ENGINE POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on pollutant formation and control.
- To impart knowledge on various emission instruments and techniques.

UNIT I	**AIR POLLUTION - ENGINES AND TURBINES**	**7**

Atmospheric pollution from Automotive and Stationary engines and gas turbines, Global warming, Photochemical smog, acid rain, Green-house effect and effects of engine pollution on Health and environment.

UNIT II	**POLLUTANT FORMATION**	**10**

Formation of oxides of nitrogen, carbon monoxide, hydrocarbon, aldehydes and Smoke, Particulate emission. volatile organic compounds(VOCs), poly aromatic hydrocarbons (PAH), soluble organic fraction (SOF); Effects of Engine Design and operating variables on Emission formation in SI and CI engines .

UNIT III	**EMISSION MEASUREMENT TECHNIQUES**	**9**

Non dispersive infrared gas analyzer, gas chromatography, Chemiluminescent analyzer and flame ionization detector, smoke meters – Noise measurement and control.

UNIT IV	**EMISSION CONTROL TECHNIQUES**	**11**

Design modifications, fuel modification, evaporative emission control, EGR, catalytic converters, Particulate traps, NOx converters, SCR systems. Diesel exhaust after treatment: diesel oxidation catalyst (DOC), diesel particulate filter (DPF), application of microprocessor in emission control, Common rail injection system, GDI and HCCI concepts

UNIT V	**DRIVING CYCLES AND EMISSION STANDARDS**	**8**

Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards.

TOTAL: (L:45 + T:0):45 PERIODS

OUTCOMES:

On successful completion of this course the student will be able to

- Understand about the pollutant formation in IC engines
- Understand about various techniques of emission measurement
- Understand about various techniques of emission control of IC engines and also driving cycles and emission standards

REFERENCES:

1. John. B. Heywood, “Internal Combustion engine fundamentals” McGraw – Hill, 2018.
2. B. P. Pundir, “IC Engines Combustion and Emission” Narosa publishing house, 2010.

3.	Crouse William, Automotive Emission Control, Gregg Division /McGraw-Hill,1980.
4.	Ernest, S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 1980.
5.	George Springer and Donald J.Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum press, 1973.
6.	Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, Third Edition, 1973.

SEMESTER III
PROFESSIONAL ELECTIVE – II & III

IC18004	SIMULATION OF I.C. ENGINE PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the simulation of engine combustion based on first and second law of thermodynamics

UNIT I	**SIMULATION PRINCIPLES**	**9**

First and second laws of thermodynamics – Estimation of properties of gas mixtures - Structure of engine models – Open and closed cycle models - Cycle studies. Chemical Reactions, First law application to combustion, Heat of combustion – Adiabatic flame temperature. Hess Law-Lechatlier principle. Heat transfer in engines – Heat transfer models for engines. Simulation models for I.C. Engines. (Ideal and actual cycle simulation) Chemical Equilibrium and calculation of equilibrium composition.

UNIT II	**SIMULATION OF COMBUSTION IN SI ENGINES**	**9**

Combustion in SI engines, Flame propagation and velocity, Single zone models – Multi zone models – Mass burning rate, Turbulence models – One dimensional models – Chemical kinetics modeling – Multidimensional models, Flow chart preparation.

UNIT III	**SIMULATION OF COMBUSTION IN CI ENGINES**	**9**

Combustion in CI engies Single zone models – Premixed-Diffusive models – Wiebe' model – Whitehouse way model, Two zone models - Multizone models- Meguerdichian and Watson's model, Hiroyasu's model, Lyn's model – Introduction to Multidimensional and spray modeling, Flow chart preparation.

UNIT IV	**SIMULATION OF TWO STROKE ENGINES**	**9**

Thermodynamics of the gas exchange process - Flows in engine manifolds – one dimensional and multidimensional models, Flow around valves and through ports Models for scavenging in two stroke engines – Isothermal and non-isothermal models, Heat Transfer and Friction.

UNIT V	**SIMULATION OF GAS TURBINE COMBUSTORS**	**9**

Gas Turbine Power plants – Flame stability, Combustion models for Steady Flow Simulation – Emission models. Flow chart preparation.

TOTAL: (L:45 + T:0):45 PERIODS

OUTCOMES:

On successful completion of this course the student will be able to

- Understand the principles of simulation of combustion in SI and CI engines.
- Understand the principles of simulation of two stroke engines.

• Understand the principles of simulation of gas turbine combustors.		
	(Use of Standard Simulation Data Book permitted)	

REFERENCES:

1.	Ashley S. Campbell, Thermodynamic Analysis of Combustion Engines, Kriegerpublication co, 1985.
2.	V.Ganesan, Computer Simulation of Spark Ignition Engine Processes, Universities Press, 2000.
3.	V. Ganesan, Computer Simulation of C.I. Engine Processes, Universities Press, 2000.
4.	Cohen H. Rogers GEC. – Gas Turbine Theory – Pearson Education India Fifth edition, 2017.
5.	Bordon P. Blair, The Basic Design of two-Stroke engines, SAE Publications, 1990.
6.	Horlock and Winterbone, The Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol. I & II, Clarendon Press, 1986.
7.	J.I.Ramos, Internal Combustion Engine Modeling, Butterworth – Heinemann ltd, 1999.
8.	J.N.Mattavi and C.A.Amann, Combustion Modeling in Reciprocating Engines, Plenum Press, 1980.

IC18005	SUPERCHARGING AND SCAVENGING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the supercharging and turbo charging effect on I.C engine performance and emissions.
- To understand the scavenging of two stroke engines and design aspects of muffler and port design.

UNIT I	**SUPERCHARGING**	**8**

Engine modifications required. Effects on Engine performance - Thermodynamics Mechanical Supercharging. Types of compressors – Positive displacement blowers – Centrifugal compressors – Performance characteristic curves – Suitability for engine application – Matching of supercharger compressor and Engine.

UNIT II	**TURBOCHARGING**	**8**

Turbocharging methods - Thermodynamics – Engine exhaust manifolds arrangements. – Waste gate, Variable nozzle turbochargers, Variable Geometry Turbocharging – Surging - Matching of compressor, Turbine and Engine.

UNIT III	**SCAVENGING OF TWO STROKE ENGINES**	**12**

Features of two stroke cycle engines – Classification of scavenging systems – Charging Processes in two stroke cycle engine – Terminologies – Sankey diagram – Relation between scavenging terms – scavenging modeling – Perfect displacement, Perfect mixing. Mixture control through Reed valve induction.

UNIT IV	**PORTS AND MUFFLER DESIGN**	**8**

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**	**9**

Experimental techniques for evaluating scavenging – Firing engine tests – Non firing engine tests – Development in two stroke engines for improving scavenging. Direct injection two stroke concepts.

TOTAL: (L:45 + T:0):45 PERIODS

OUTCOMES:

Students are able to

- Understand and explain turbo charging and supercharging and exhaust emissions
- Understand design principle of two stroke engine parts like inlet port, exhaust port and muffler etc.
- Match turbochargers with engines and design two stroke cycle engines

.		
	(Use of Standard Data Book permitted)	

REFERENCES:

1.	Schweitzer, P.H., Scavenging of Two Stroke Cycle Diesel Engine, MacMillan Co., 1949.
2.	John B. Heywood, Two-Stroke Cycle Engine: It's Development, Operation and Design, SAE Publications, 2018.
3.	G P Blair, Four Cycle Engines Design and Simulation, SAE Publications, 1999.
4.	Heinz Heisler, Advanced Engine Techology, Butterworth Heinmann Publishers, 2002.
5.	Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, 1980.
6.	Richard Stone, Internal Combustion Engines, SAE, 2012.
7.	Watson, N. and Janota, M.S., Turbocharging the I.C. Engine, MacMillan Co., 1982.
8.	John. B. Heywood, “Internal Combustion engine fundamentals” McGraw – Hill, 2018.
9.	B. P. Pundir, “IC Engines Combustion and Emission” Narosa publishing house, 2010.

IC18006	FLUID FLOW AND HEAT TRANSFER IN ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fluid flow in an IC engine, aspects of heat transfer and cooling of components.

UNIT I	**INTRODUCTION**	**9**

Basics Laws, Newtonian Fluids, Navier – Stokes Equations, Compressible and Incompressible Flows, Stream Functions and velocity Potential, Vorticity Dynamics.

UNIT II	**LAMINAR AND TURBULENT FLOWS**	**9**

Ideal - flows and Boundary layers, Flows at Moderate Reynolds Numbers, Characteristics of High -Reynolds Number Flow, Ideal Flows in a plane, Axi-symmetric and Three dimensional Ideal Flows and Boundary Layers, Low Reynolds Numbers Flows. Swirl, Squish and Tumble.

UNIT III	**LUBRICATION, SURFACETENSION EFFECTS, MICROSCALE EFFECTS**	**5**

Lubrication, Surface Tension effects, Micro scale effects.

UNIT IV	**COMPRESSIBLE FLOW**	**10**

One dimensional compressible Gas flow, Isentropic Gas Relations, Compressible flow in Nozzles, Area – velocity Relations, Converging – Diverging Nozzle effects of viscous friction and Heat Transfer Introduction to Multi-Dimensional flow.

UNIT V	**CONVECTIVE HEAT TRANSFER – MASS TRANSFER AND HEAT TRANSFER IN POROUS MEDIA**	**12**

Convective Heat Transfer – Parallel Flow (Hagen – Poiseuille Flow), Couette Flow, Sudden acceleration of a Flat Plate, Creeping flow, Mass transfer Diffusion and Convection, combined Heat and Mass Transfer, Heat transfer in Porous Media.

TOTAL: (L:45 + T: 0):45 PERIODS

OUTCOMES:

On successful completion of this course the student will be able to

- Understand laminar and turbulent flow concepts in engine system.
- Understand lubrication, surface tension effects, microscale effects in heat transfer
- Understand the principles of convective heat transfer – mass transfer and heat transfer in porous media.

REFERENCES:

1.	Ronald L. Panton, Incompressible flow, 4th Edition, Wiley, 2013.
2.	K. Muralidhar and G. Biswas, Advanced Engg. Fluid Mechanics, Narosa Publishing House, 2015.

3.	Frank M. White, Viscous Fluid Flow, 3rd Edition, McGraw Hill, 2011.
4.	I.G. Currie, Fundamental Mechanics of fluids, 4th Edition, McGraw Hill 2011.
5.	F.P. Incropera and B. Lavine, Fundamentals of Heat and Mass Transfer, 7th Edition, Willey, 2011.
6.	Welty, C. Wicks, Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition, Wiley 2009.
7.	Warren M Rehsenow and Harry Y Choi, Heat and Mass Momentum Transfer, Prentice Hall, 1980.

IC18007	COMPUTATIONAL FLUID DYNAMICS FOR THERMAL SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims to introduce numerical modelling 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	**COMPUTATIONAL FLUID DYNAMICS FOR THERMAL SYSTEMS**	**8**

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II	**DIFFUSION PROCESSES: FINITE VOLUME METHOD**	**10**

Steady one-dimensional diffusion, Two and three dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes.

UNIT III	**CONVECTION – DIFFUSION PROCESSES: FINITE VOLUME METHOD**	**9**

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**	**9**

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.

UNIT V	**TURBULENCE AND ITS MODELLING**	**9**

Description of turbulent flow, free turbulent flows, flat plate boundary layer and pipe flow.
Algebraic Models, One equation model, k – ε & k – ω models Standard and High and Low Reynolds number models.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

Students are able to

- apply concept of CFD to analyse flow in thermal systems.
- solve complex problems in the field of heat transfer and fluid dynamics.
- understand finite volume discretised forms of the CFD equations.
- understand explicit & implicit algorithms for solving the Euler Equations &Navier Stokes Equations.

REFERENCES:

1.	Muralidhar, K., and Sundararajan, T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2003.
2.	Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., Computational fluid Mechanics and Heat Transfer, Hemisphere Publishing Corporation, New York, USA, 2012.
3.	Bose, T.K. Numerical Fluid Dynamics, Narosa Publishing House, 1997.
4.	Fletcher, C.A.J. Computational Techniques for Fluid Dynamics 1, Fundamental and General Techniques, Springer – Verlag, 1991.
5.	Fletcher, C.A.J. Computational Techniques for fluid Dynamics 2, Specific Techniques for Different Flow Categories, Springer – Verlag, 1988.
6.	Muralidhar, K. and Sundararajan, T, Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2003.
7.	Subas and V.Patankar, Numerical heat transfer fluid flow, Hemisphere Publishing Corporation, 1980.
8.	Taylor, C and Hughes, J.B., Finite Element Programming of the Navier-Stokes Equation, Pineridge Press Limited, U.K., 1981.
9.	Versteeg and Malalasekera, N., An Introduction to computational Fluid Dynamics The Finite volume Method, Pearson Education, Ltd., 2007.

IC18008	FLOW VISUALISATION TECHNIQUES FOR I.C. ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the significance of flow visualisation techniques in IC engine flow processes.

UNIT I	**INSTRUMENTATION FOR FLOW VISUALISATION**	**9**

Schilieren photography – Laser Velocimeter –Laser Doppler velocimetery Illuminated Particle Visualisation Holography - Photography and Holography techniques. Particle Image velocitymetry.

UNIT II	**FLOW VISUALISATION OF INTAKE PROCESS**	**9**

Engine optical access, Design of optical engine, Thermal properties of materials used for optical engine, Optical material Properties, Optical processing of materials – Optical techniques.

UNIT III	**IN-CYLINDER FLOW**	**9**

Visual Experiment of In-cylinder flow by Laser sheet method, In-cylinder using Tomographic PIV ,intake flow visualization by light colour layer examination method, photographic measurement techniques-Doppler global Velocimetry.

UNIT IV	**COMBUSTION VISUALISATION**	**9**

Endoscopes, Advanced cameras used for Spray and combustion visualization, Fiber Optic Tools used in SI and CI engines, Laser diagnostics of Flames in IC engines.

UNIT V	**NUMERICAL FLOW VISUALISATION**	**9**

Direct, Geometric and texture based flow visualization, Dense Geometric Flow visualization – ,Surface flow visualisation techniques IC engines.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

- On successful completion of this course the student will be able to apply concept of flow visualisation techniques to IC engines.
- Student will also be able to understand the various optical material and techniques used in IC engines

REFERENCES:

1.	V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Book Co, 2013.
2.	J.P. Holman, Experimental Methods for Engineers, McGraw – Hill Inc., 2001.
3.	Wolfgang Merzkirch, Flow Visualisation, 2nd Edition, Academic Press, 1987.
4.	Marshall B. Long, Optical Methods in flow and Particle Diagnosis, Society of Photo Optics,1989.
5.	B.H. LakshmanaGowda, A Kaleidoscopic view of Fluid Flow Phenomena, Wiley

	Eastern,1992.
6.	Will Schroeder, Ken Martin and Bill Lorensen, An Object – Oriented Approach to 3DGraphics, 2nd Edition, Prentice Hall, 1998.

IC18009	SPECIALITY ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To give an in-depth knowledge of S.I & C.I Engine system.
- To give an overview of different types of special purpose engine systems
- To know the latest technological advancements in Automotive vehicle system
- T analyse life cycle of an I.C Engine systems.

UNIT I	**INTRODUCTION**	**10**

The design features of Automotive, Locomotive, Marine, ,Stationary and Generator-set engines.

UNIT II	**S.I. ENGINE SYSTEMS**	**10**

Spark ignition engine system variants – Stoichiometric, Lean-burn, port injected/direct injected, carburetted, Air assisted fuel injection engines, HEV Engines. Illustrations – Honda CVCC, Toyota Prius,Orbital Engine etc. Rotary piston engines, Dedicated alternative fuelled engine systems – CNG, LPG, H2, Alcohols, Stirling cycle.

UNIT III	**C.I. ENGINE SYSTEMS**	**10**

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 fuelled engine systems, coal and producer gas fuelled engine systems, cogeneration system, Total engine systems.

UNIT IV	**SPECIAL PURPOSE ENGINE SYSTEMS**	**10**

Engines for special applications – Mining, Defence, Off-highway – Tractor, Bulldozer etc. Submarines, Race car engine systems, Flexible fuelled systems.

UNIT V	**LIFE CYCLE ANALYSIS OF ENGINE SYSTEMS**	**5**

Life cycle cost analysis of I.C Engine systems.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

- The student will be able to understand the concepts of SI & CI Engine systems.
- The student will be able to understand the concepts of Special purpose engine systems.
- The student will be able to understand Race car engine systems
- The student will be able to understand the Life cycle cost analysis of I.C Engine systems.

REFERENCES:

1. Diesel Engine Reference Book, Bernard Challen and RodicaBaranescu (Editors) 2nd Edition, R – 183, SAE International , 1999.

SEMESTER III
PROFESSIONAL ELECTIVE – IV,V& IV

IC18010	BOUNDARY LAYER THEORY TURBULENCE	L	T	P	C
		3	0	0	3

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**	**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**

Internal Flows – Couette flow – Two-Layer Structure of the velocity Field – Universal Laws of the wall – Friction law – Fully developed Internal flows – Channel Flow, Couettee – Poiseuille flows, Pipe Flow

UNIT III	**TURBULENCE AND TURBULENCE MODELS**	**9**

Nature of turbulence – Averaging Procedures – Characteristics of Turbulent Flows – Types of Turbulent Flows – Scales of Turbulence, Prandtl's Mixing length, Two-Equation Models, Low – Reynolds Number Models, Large Eddy Simulation.

UNIT IV	**STATISTICAL THEORY OF TURBULENCE**	**9**

Ensemble Average – Isotropic Turbulence and Homogeneous Turbulence – Kinematics of Isotropic Turbulence – Taylor's Hypothesis – Dynamics of Isotropic Turbulence - Grid Turbulence and decay – Turbulence in Stirred Tanks.

UNIT V	**TURBULENT FLOWS**	**9**

Wall Turbulent shear flows – Structure of wall flow – Turbulence characteristics. of Boundary layer – Free Turbulence shear flows – Jets and wakes – Plane and axi-symmetric flows.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

Students are capable to

- apply the concepts of boundary layer theory and turbulence to Practical applications..
- analyze the turbulent models.
- Apply the statistical theory of turbulence to practical applications.

REFERENCES:

1. G. Biswas and E. Eswaran, Turbulent Flows, Fundamentals, Experiments and Modelling,

	Narosa Publishing House, 2002.
2.	H. Schlichting and Klaus Gersten, Boundary Layer Theory, Springer 2004.
3.	R.J. Garde, Turbulent Flow, New Age International (p) Limited, Publishers, 2010.
4.	Holman,J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc, 1988..

IC18011	COMBUSTION AND REACTION KINETICS IN I.C ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The objective is toprovide students with a basic understandingof combustion phenomena and basic theory, and enable them to acquire the basic knowledge and theories of thermo chemistry.
- To understandthe traditional and alternative fuel combustion characteristics, aswell asthe formation mechanism ofpollutant productions during combustion.

UNIT I	**INTRODUCTION**	**8**

Gaseous, liquid and solid fuels, Application of the firstand second laws of thermodynamics to combustion,-Low temperature reactions-CoolFlames-as applied to detonation.High temperature reactions-speciesconcentrationand products formation.

UNIT II	**CHEMICAL KINETICS OF COMBUSTION**	**9**

Elementaryreactions, Pre-ignition kinetics,Ignition delay Nitric OxideKinetics,Soot Kinetics, Calculations,- Reaction control effectonEngine performance and emissions.

UNIT III	**MODELLING**	**10**

Calculation of equilibrium composition.Enthalpy andEnergy, Coefficients for reactionsand adiabatic flame temperature,Modeling ofCO,HCNO reactions inSIandCIEngines - Soot Modelling.

UNIT IV	**GASOLINE ENGINE COMBUSTION**	**8**

Combustion inS.1.Engines,Laminarflametheory, Flame structure,Turbulent premixed flames, Homogeneous Combustion reactions betweenGasolineand air- Reaction rate Constants -species determination. Burning rate estimation.

UNIT V		**10**

Combustionin CI Engine, Spray formation, Spray dynamics, Spray models, Introduction to diesel enginecombustion,Premixed and diffusion combustion reactions - Lean-flameReactions - Lean flame *out*reactions-Species determination.Emissions and Combustion, Burning rate estimation.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

Students will be

- Familiar with operating characteristics and thermodynamic analysis of common internal combustion engine cycles
- Familiar with environmental, social and technological issues related to the future wide spread use of internal combustion engines
- Able to follow recent developments in internal combustion engine technology.

REFERENCES:		
1.	J.F.Ferguson,InternalCombustion -Applied ThermosciencesEngines,JohnWiley and Sons, 2015.	
2.	R.S. Benson &N.D. Whitehouse, Internal Combustion Engines, First edition, PergamonPress, England 1979.	
3.	Gary LBormann,CombustionEngineering, WCB McGrawHill, 1998.	
4.	John. B. Heywood, Internal Combustion engine fundamentals, McGraw – Hill, 2018.	
5.	A.F. Williams, combustion inflames, Oxford Press, Second Edition, 2018.	
6.	S.P. Sharma, Fuels andCombustion, S.P. Chand and Co., Sixth Edition, 1984.	
7.	YunusCengel, Thermodynamicsan Engineeringapproach, McGraw-Hill Education, 2014.	
8.	S.W. Benson, The FoundationsofChemical Kinetics, McGraw-Hill, 1982.	

IC18012	HOMOGENEOUS CHARGE COMPRESSION IGNITION COMBUSTION IN ENGINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To develop the knowledge on HCCI combustion and its benefits and applications.

UNIT I	HCCI ENGINE FUNDAMENTALS	9

Introduction, HCCI Fundamentals – Background of HCCI, Principle, Benefits, Challenges, Need for control, Commercial HCCI engines.

UNIT II	GASOLINE AND DIESEL HCCI COMBUSTION ENGINES	9

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.

UNIT III	HCCI CONTROL	9

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 characterising fuel performance in HCCI engines.

UNIT IV	HCCI FUEL REQUIREMENTS & COMBUSTION WITH ALTERNATIVE FUELS	9

Fundamental fuel factors for HCCI engines, Diesel fuelled HCCI, Gasoline HCCI, 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, 'unmixedness'of DME/air mixture.

UNIT V	LOW-TEMPERATURE AND PREMIXED COMBUSTION	9

Basic concept, Characteristics of combustion and exhaust emissions, modulated kinetics (MK)combustion – First and Second generation of MK combustion, Emission, performance improvement.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

- The student will be able to understand the fundamentals of HCCI combustion systems.
- The student will be able to understand the Gasoline and Diesel HCCI Engine systems.
- The student will be able to understand the various controlling methods and effects of fuels on HCCI Engine systems.
- The student will be able to understand the modulated kinetics combustion systems.

REFERENCES:

1.	Hua Zhao, HCCI and CAI Engines for automotive industry, Wood Head Publishing in Mechanical Engineering, 2007.
2.	Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co, 2012.
3.	B.P. Pundir I.C. Engines Combustion and Emission, 2010, Narosa Publishing House. B.P. Pundir, Engine Combustion and Emission, 2011, Narosa Publishing House
4.	John B Heywood, "Internal Combustion Engines Fundamentals", McGraw Hill International Edition, 2018.

IC18013	DESIGN AND ANALYSIS OF TURBO MACHINES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the working and design principles of thermal turbomachines.
- To study the fundamental concepts of energy balance in a turbine system
- To understand the potential ways of designing and developing energy efficient turbines.

UNIT I	**INTRODUCTION:**	**9**

Classification of impellers: axial flow, radial flow and mixed flow machines, the equations of motion in rotating frame of reference, effect of Coriolis and Centrifugal forces, momentum and energy equation, Euler equation, similarity rules and Cordier diagram.

UNIT II	**AEROFOIL THEORY & CASCADE ANALYSIS:**	**9**

Aerofoil Theory**:** Fundamentals, isolated aerofoil, generation of lift, cascade of aerofoil, Kutta-Joukowsky relation, conformal transformation.

Cascade Analysis**:** Two-dimensional cascade theory, lift and drag, blade efficiency, estimation of loss, cascade nomenclature, compressor and turbine cascade

UNIT III	**AXIAL FLOW MACHINE**	**9**

Axial Flow Machine: Two-dimensional pitch line design and analysis, h-s diagram, degree of reaction, effect of Mach number, performance and efficiency, three-dimensional flow in axial turbomachines, radial equilibrium, secondary flow, tip clearance and loss.

UNIT IV	**RADIAL AND MIXED FLOW MACHINE & MULTISTAGE MACHINE:**	**9**

Radial and Mixed Flow Machine: Analysis and design, effect of circulation and Coriolis forces, reversal eddies and slip factor.

Multistage Machine: Analysis of multistage axial compressors and turbines, prediction of stage performance and effect of stacking; rotating stall and surge, turbine blade heat load and blade cooling.

UNIT V	**EXPERIMENTS AND CFD:**	**9**

Experiments and CFD: Discussion on experimental methods to measure flow and thermal fields in turbomachines, applications of CFD in analysis and design of turbomachinery.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

- The students will be capable of analyzing a turbine as a system and design energy efficient turbines. auxiliaries of engine systems.
- The students will be able to know the working principles, analyzing and design energy efficient of Axial, Radial and Multistage turbines.
- The students will be to potential ways of designing and developing energy efficient turbines.

REFERENCES:		
1.	GanesanV., Gas Turbines, Tata McGraw-Hill Education**,**Edition-New Delhi,2010.	
2.	Heinz P. Bloch and Murari P. Singh, ―Steam turbines-Design, Applications and Re-Rating‖, 2 edition, McGraw Hill, New Delhi,2008.	
3.	Dixon, S.L., ―Fluid Mechanics and Thermodynamics of Turbo machines, Elsevier India Pvt. Ltd.-New Delhi -2014.	
4.	Logan Earl, Jr, ―Hand book of Turbo machinery, 2nd edition, Marcel Dekker,2003.	
5.	Shepherd, D.G., ― Principles of Turbo machinery, MacMillan,1998.	

IC18014	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable students to get basic understanding of scientific research methods.
- To develop capacity to independently analyse and define a research problem and report preparation

UNIT I	**OBJECTIVES AND TYPES OF RESEARCH**	**9**

Objectives and types of research – Identification of research problem– Researchmethods vs Methodology. Types of research – Descriptive vs. Analytical, Applied vs.Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

UNIT II	**RESEARCH FORMULATION**	**11**

Definition and formulation of research problem -Selecting the problem - Importance of literature reviewin defining a problem – Literature review – Primary and secondary sources – web as a source – searching the web - Critical literaturereview – Identifying gap areas from literature review

UNIT III	**RESEARCH DESIGN AND METHODS**	**9**

Research design - Features of good design – Important concepts relating to researchdesign – Observation and Facts-Prediction and explanation,Induction, Deduction, Development of Models. Developing a research plan - Exploration,Description, Diagnosis, Experimentation. Determining experimental and sample designs.

UNIT IV	**DATA COLLECTION AND ANALYSIS**	**8**

Observation andCollection of data - Methods of data collection – Sampling Methods- Data Processing andAnalysis strategies - Measurement levels and scaling – Types of errors – Sampl ing adequacy - Interpretation of data

UNIT V	**REPORTING AND TECHNICAL WRITING**	**8**

Report preparation – Structure of report – graphs and illustration tools -Technical reports and thesis – Significance – Different steps in thepreparation – Layout, structure and Language of typical reports – Illustrations and tables- Bibliography, referencing and footnotes - Finalising research report.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

- Understanding the Scope and objectives of research problem.
- Sources of research problem, Criteria Characteristics of a good research problem,
- Approaches of investigation of solutions for research problem, data collection, analysis, technical writing

REFERENCES:

1. Pannerselvam. R Research Methodology, Prentice-Hall of India Private Ltd, New Delhi 2007

2.	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K, 2002. An introduction toResearch Methodology, RBSA Publishers.
3.	Kothari, C.R,2004. Research Methodology: Methods and Techniques. New Age International (P) Ltd., New Delhi.
4.	Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssPublications. 2 volumes.
5.	Coley, S.M. and Scheinberg, C. A., 1990, Proposal Writing, SagePublications.
6.	Day, R.A., 1992.How to Write and Publish a Scientific Paper, CambridgeUniversity Press.
7.	Fink, A, 2009. Conducting Research Literature Reviews: From the Internet toPaper. Sage Publications& Instrumentation, Universities Press, Second Edition, 2001.

IC18015	SAFETY IN TRANSPORTATION SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To achieve an understanding of principles of safety management.
- To provide the students about the various activities/steps to be followed in safe handling the hazardous goods transportation from one location to another location.
- To educate the reasons for the road accident and the roles and responsibilities of a safe Driver and the training needs of the driver.
- To inculcate the culture of safe driving and fuel conservation along with knowing of basic traffic symbols followed throughout the highways

UNIT I	**PRINCIPLES OF SAFETY MANAGEMENT**	**9**

History of Safety movement – Evolution of modern safety concept -general concepts of management - Importance of training creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

UNIT II	**FIRE PREVENTION AND PROTECTION**	**9**

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems –various classes of fires - A, B, C, D, E –types of fire extinguishers.

UNIT III	**TRANSPORTATION OF HAZARDOUS GOODS**	**9**

Transport emergency card (TREM) –driver training-parking of tankers on the highways-speed of the vehicle –warning symbols –design of the tanker lorries -static electricity-responsibilities of driver -inspection and maintenance of vehicles-check list-loading and decanting procedures communication.

UNIT IV	**ROAD TRANSPORT**	**9**

Introduction –factors for improving safety on roads –causes of accidents due to drivers and pedestrians-design, selection, operation and maintenance of motor trucks-preventive maintenance-check lists-motor vehicles act –motor vehicle insurance and surveys.

UNIT V	**DRIVER AND SAFETY**	**9**

Driver safety programme –selection of drivers –driver training-tacho-graph driving test-driver's responsibility-accident reporting and investigation procedures-fleet accident frequency-safe driving incentives-slogans in driver cabin-motor vehicle transport workers act-driver relaxation and rest pauses –speed and fuel conservation –emergency planning and Haz mat codes.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

The students will be able to

- Recognize various safety activities undertaken in transporting of hazardous goods
- Understand the various symbols which are specific to the road safety and able to reduce the

accidents occurred in the roads.	
REFERENCES:	
1.	Blake R.B, Industrial Safety, Prentice Hall, Inc, New Jersey, 1973.
2.	Fire Prevention and fire fighting, Loss prevention Association, India.
3.	Babkov, V.F, Road Conditions and Traffic Safety, MIR Publications,Moscow,1986.
4.	Kadiyali, Traffic Engineering and Transport Planning,KhannaPublishers, New Delhi, 1983.
5.	Motor Vehicles Act, 1988, Government of India.
6.	Pasricha, Road Safety guide for drivers of heavy vehicle,Nasha Publications, Mumbai, 1999.
7.	Popkes, C.A, Traffic Control and Road Accident Prevention, Chapman and Hall Limited, 1986.
8.	K.W .Ogden, Safer Roads –A guide to Road Safety Engineering.

IC18016	ADVACED AUTOMOBILE ENGINERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To make the students familiar in automobile various parts, their functions and pollution.
- To understand the construction and working principle of various parts of an automobile.
- To have the practice for assembling and dismantling of engine parts and transmission system.

UNIT I	**VEHICLE STRUCTURE AND ENGINES**	**10**

Layout, Vehicle construction, Chassis, Frame and Body, Engine - types – components – functions, materials, construction, operation, and its applications in land (Off road and On road), water and air vehicles, Performance, Air pollution and Pollution standards- variable valve timing (VVT) and its necessity-Engine emission control by four way catalytic converter system, SCR system and EGR systemEmission norms (Euro and BS) and Driving cycle(Euro and BS)..

UNIT II	**ENGINE AUXILIARY SYSTEMS**	**10**

Carburettors, Electronic Fuel Injection Systems – Monopoint, Multipoint, GDI and Direct Injection Systems, Supercharger and Turbocharger - Electrical Systems – Battery, Generator, Starting Motor, and Ignition (Battery and Electronic Types).

UNIT III	**TRANSMISSION SYSTEMS**	**10**

Clutch - Types and Construction, Fluid Flywheel and Torque Converter, Gear Boxes, Manual and Automatic - Overdrives – Propeller Shaft - Differential and Rear Axle.

UNIT IV	**RUNNING SYSTEMS**	**8**

Steering Geometry and Types, Types of front axle, Suspension systems, Braking systems, Wheel and Tyres.

UNIT V	**ALTERNATIVE POWER PLANT**	**7**

Electric vehicles and Fuel cell vehicle – Types, construction, principle of operation and characteristics- Feasibility study of Electric, Hybrid and Fuel cell vehicle.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

- The students will be able to identify the different components in automobile engineering.
- The students will be able to different auxiliary and transmission systems used in Automobiles.
- Students will familiar with various alternative power plant for IC engines..

REFERENCES:

1.	William Crouse, Automobile Engineering, McGraw Hill, 2012
2.	R.B. Gupta, Automobile Engineering, SatyaPrakashan, 1993.
3.	Newton and Steeds, Motor Vehicles, ELBS, 1985

4.	Duffy Smith, Auto Fuel Systems, The Good Heat Willcox Company Inc, 1987.
5.	Kirpal Singh, Automobile Engineering, Standard Publishers Distributors Delhi, 2007.

IC18017	AIRCRAFT AND SPACE 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.

(Use of Standard Gas Tables permitted)

UNIT I	**GAS DYNAMICS**	**8**

Wave motion - Compressible fluid flow through variable area devices – Stagnation state Mach Number and its influence and properties, Isentropic Flow, Rayleigh and Fanno Flow-isothermal flow Normal shock and oblique shock waves.

UNIT II	**THERMODYNAMICS OF AIRCRAFT ENGINES**	**9**

Theory of Aircraft propulsion – Thrust – Various efficiencies – Different propulsion systems – Turboprop – Ram Jet – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft. Variable thrust- nozzles – vector control.

UNIT III	**PERFORMANCE CHARACTERISTICS OF AIRCRAFT ENGINES**	**9**

Engine - Aircraft matching – Design of inlets nozzles and Diffusers- Performance characteristics of Ramjet,Turbojet, Turboprop, Scramjet and Turbofan engines.

UNIT IV	**ROCKET PROPULSION**	**9**

Theory of rocket propulsion – Types of combustion chamber-Rocket equations – Escape and Orbital velocity – Multi-staging of Rockets – Space missions – Performance characteristics – Losses and efficiencies.

UNIT V	**ROCKET THRUST CHAMBER**	**10**

Combustion in solid and liquid propellant classification – rockets of propellants and Propellant Injection systems – Non-equilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

On successful completion of this course the student will be able

- To understand the fundamentals of gas dynamics.
- To understand the working of different types of aircraft and rocket propulsion systems.
- To understand the performance Characteristics aircraft and rocket propulsion systems.

REFERENCES:

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 2009.

2.	Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons New York, 1970.
3.	Zucrow N.J. Aircraft and Missile Propulsion, Vol. I and Vol. II, John Wiley and Sons Inc,
4.	S. M.Yahya, Fundamentals of Compressible Flow. Third edition, New Age International Pvt Ltd, 2003.
5.	Bonney E.A. Zucrow N.J. Principles of Guided Missile Design, Van Nostranc Co., 1956.
6.	E.Rathakrishnan, Gas Dynamics, Fifth edition, 2013, PHI learning private limited.
7.	Ganesan. V, Gas Turbines, Tata McGraw Hill Publishing Co., New Delhi,1999.
8.	Somasundaram. PR.S.L, Gas Dynamics and Jet Propulsions, New Age International Publishers, 1996.

MANDATORY COURSES

MC18018	INTRIDUCTION TO RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	0	0	2

OBJECTIVES:

- The objective is to provide students with a basic understanding of research methodologies and awareness about IPR.

UNIT I — **8**

Meaning of research problem, Sources of research problem, Criteria Characteristicsof a good research problem, Errors in selecting a research problem, Scope and objectives ofresearch problem.
Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT II — **9**

Effective literature studies approaches, Selection of research title, importance of keywords, critical analysis of inferences from literature study. Problem identification from inferences. Plagiarism, Research ethics.

UNIT III — **10**

Effective technical writing, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report Developing a Research Proposal, Format of research proposal, methods of evaluating research proposal, presentation and assessment by a review committee

UNIT IV — **8**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process ofPatenting and Development: technological research, innovation, patenting, development.International Scenario: International cooperation on Intellectual Property. Procedure forgrants of patents, Patenting under PCT

UNIT V — **10**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patentinformation and databases. Geographical Indications.New Developments in IPR: Administration of Patent System. New developments inIPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge CaseStudies, IPR and IITs.

TOTAL: (L:45 + T: 0): 45 PERIODS

OUTCOMES:

At the end of this course, students will be able to

- Understand research problem formulation & Analyze research related information and

Follow research ethics

- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understand that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new

REFERENCES:

1.	Stuart Melville and Wayne Goddard, Research methodology: an introduction for science& engineering students.
2.	Wayne Goddard and Stuart Melville, Research Methodology: An Introduction.
3.	Ranjit Kumar, 2nd Edition, Research Methodology: A Step by Step Guide for beginners.
4.	Halbert, Resisting Intellectual Property, Taylor & Francis Ltd ,2007.
5.	Mayall ,Industrial Design, McGraw Hill, 1992.
6.	Niebel , Product Design, McGraw Hill, 1974.
7.	Asimov , Introduction to Design, Prentice Hall, 1962.
8.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, Intellectual Property in New Technological Age, 2016.
9.	Ramappa, Intellectual Property Rights Under WTO, S. Chand, 2008