ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

REGULATIONS 2017

M.E. INTERNAL COMBUSTION ENGINEERING

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To prepare students to excel in I.C. Engineering profession.
II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve real time problems.
III. To train students with good scientific and engineering knowledge to develop innovative products.
IV. To inculcate students with professional and ethical attitude, and effective communication skills with an ability to relate engineering issues for societal transformation.
V. To train the students with academic excellence and good leadership qualities.

PROGRAMME OUTCOMES (POs) :

On successful completion of the programme,

1. Post Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Post Graduates will demonstrate ability to identify, formulate and solve engineering problems.
3. Post Graduates will demonstrate ability to experiment, analyze and interpret data.
4. Post Graduates will demonstrate ability to design a system, component, product and process as per needs and specifications.
5. Post Graduates will demonstrate skills to use modern engineering tools, software and equipments to analyze multidisciplinary problems.
6. Post Graduates will demonstrate knowledge of professional and ethical responsibilities.
7. Post Graduates will communicate effectively their technical knowledge.
8. Post Graduates will understand the impact of engineering solutions on societal transformation.
9. Post Graduates will develop ability for life-long learning.

Mapping of PEOs with POs

Programme Educational Objectives	Programme Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
I	✓	✓		✓					
II	✓		✓		✓	✓			
III				✓	✓	✓			
IV						✓	✓	✓	
V		✓	✓						✓

		Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
YEAR 1	**SEM 1**	Advanced Numerical Methods	√				√				√
		Advanced Heat Transfer	√	√			√				√
		Thermodynamics for IC Engineering	√	√			√				√
		Combustion and Emissions in Engines	√		√		√				√
		Professional Elective I									√
		Professional Elective II									√
		I.C. Engines Laboratory	√	√	√	√	√	√	√		√
	SEM 2	Engine Pollution and Control			√			√	√		√
		Internal Combustion Engine Design	√	√	√	√	√			√	√
		Instrumentation for Thermal Systems	√	√	√	√	√			√	√
		Alternative Fuels for IC Engines			√		√	√		√	√
		Professional Elective III									√
		Professional Elective IV									√
		Thermal Systems Simulation Laboratory	√	√	√	√	√	√	√		√
		Technical Seminar - I	√	√	√		√		√	√	√
YEAR 2	**SEM 1**	Electronic Engine Management Systems		√	√		√			√	√
		Professional Elective V									√
		Professional Elective VI									√
		Technical Seminar - II	√	√	√		√		√	√	√
		Project Work Phase I	√	√	√	√	√	√	√	√	√
	SEM 2	Project Work Phase II	√	√	√	√	√	√	√	√	√

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M.E. INTERNAL COMBUSTION ENGINEERING

CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA5153	Advanced Numerical Methods	FC	5	3	2	0	4
2	TE5151	Advanced Heat Transfer	FC	4	4	0	0	4
3	IC5101	Thermodynamics for IC Engineering	PC	5	3	2	0	4
4	IC5102	Combustion and Emissions in Engines	PC	3	3	0	0	3
5		Professional Elective I	PE	3	3	0	0	3
6		Professional Elective II	PE	3	3	0	0	3
PRACTICALS								
7	IC5111	I.C. Engines Laboratory	PC	4	0	0	4	2
			TOTAL	**27**	**19**	**4**	**4**	**23**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	IC5201	Engine Pollution and Control	PC	3	3	0	0	3
2	IC5202	Internal Combustion Engine Design	PC	5	3	0	0	3
3	IC5203	Instrumentation for Thermal Systems	PC	3	3	0	0	3
4	IC5251	Alternative Fuels for IC Engines	PC	3	3	0	0	3
5		Professional Elective III	PE	3	3	0	0	3
6		Professional Elective IV	PE	3	3	0	0	3
PRACTICALS								
7	TE5261	Thermal Systems Simulation Laboratory	PC	4	0	0	4	2
8	IC5211	Technical Seminar - I	EEC	2	0	0	2	1
			TOTAL	**26**	**18**	**0**	**6**	**21**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	IC5301	Electronic Engine Management Systems	PC	3	3	0	0	3
2.		Professional Elective V	PE	3	3	0	0	3
3.		Professional Elective VI	PE	3	3	0	0	3
PRACTICALS								
4	IC5311	Technical Seminar - II	EEC	2	0	0	2	1
5	IC5312	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**23**	**9**	**0**	**14**	**16**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	IC5411	Project Work Phase II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

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

FOUNDATION COURSES (FC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA5153	Advanced Numerical Methods	FC	4	3	2	0	4
2.	TE5151	Advanced Heat Transfer	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	IC5101	Thermodynamics for IC Engineering	PC	5	3	2	0	4
2.	IC5102	Combustion and Emissions in Engines	PC	3	3	0	0	3
3.	IC5111	I.C. Engines Laboratory	PC	4	0	0	4	2
4.	IC5201	Engine Pollution and Control	PC	3	3	0	0	3
5.	IC5202	Internal Combustion Engine Design	PC	5	3	0	0	3
6.	IC5203	Instrumentation for Thermal Systems	PC	3	3	0	0	3
7.	IC5251	Alternative Fuels for IC Engines	PC	3	3	0	0	3
8.	TE5261	Thermal Systems Simulation Laboratory	PC	4	0	0	4	2
9.	IC5301	Electronic Engine Management Systems	PC	3	3	0	0	3

ELECTIVES FOR M.E. INTERNAL COMBUSTION ENGINEERING
SEMESTER I (Elective I & II)

SL.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	IC5001	Speciality Engines	PE	3	3	0	0	3
2	IC5002	Engine Auxiliary Systems	PE	3	3	0	0	3
3	IC5003	Aircraft and Space Propulsion	PE	3	3	0	0	3
4	IC5004	Manufacturing and Testing of Engine Components	PE	3	3	0	0	3
5	IC5005	Marine Diesel Engines	PE	3	3	0	0	3
6	IC5091	Automobile Engineering	PE	3	3	.0	0	3

SEMESTER II (Elective III & IV)

SL.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	IC5006	Simulation of I.C. Engine Processes	PE	3	3	0	0	3
2	IC5007	Supercharging and Scavenging	PE	3	3	0	0	3
3	IC5008	Fluid Flow and Heat Transfer in Engines	PE	3	3	0	0	3
4	TE5071	Computational Fluid Dynamics for Thermal Systems	PE	3	3	0	0	3
5	IC5009	Flow Visualisation Techniques for I.C. Engines	PE	3	3	0	0	3

SEMESTER III (Elective V & VI)

SL.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	TE5073	Boundary Layer Theory and Turbulence	PE	3	3	0	0	3
2	IC5010	Combustion and Reaction Kinetics in I.C. Engines	PE	3	3	0	0	3
3	IC5011	Homogeneous Charge Compression Ignition Combustion in Engines	PE	3	3	0	0	3
4	EY5092	Design and Analysis of Turbomachines	PE	3	3	0	0	3
5	MF5072	Research Methodology	PE	3	3	0	0	3
6	MF5075	Industrial Safety	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	IC5211	Technical Seminar - I	EEC	2	0	0	2	1
2.	IC5311	Technical Seminar - II	EEC	2	0	0	2	1
3.	IC5312	Project Work Phase I	EEC	12	0	0	12	6
4.	IC5411	Project Work Phase II	EEC	24	0	0	24	12

MA5153 ADVANCED NUMERICAL METHODS L T P C
(Common to Environmental Science and Technology, Chemical Engineering and PRPC) 3 2 0 4

OBJECTIVES :

The course will develop numerical methods aided by technology to solve algebraic, transcendental and differential equations and to apply finite element methods for solving the boundary value problems in differential equations. The course will further develop problem solving skills and understanding of the application of various methods in solving engineering problems. This will also serve as a precursor for future research.

UNIT I ALGEBRAIC EQUATIONS 12+3

Systems of linear equations : Gauss elimination method – Pivoting techniques – Thomas algorithm for tri diagonal system – Jacobi, Gauss Seidel, SOR iteration methods – Conditions for convergence - Systems of nonlinear equations : Fixed point iterations, Newton's method, Eigen value problems : Power method and Given's method.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 12+3

Runge - Kutta methods for system of IVPs – Numerical stability of Runge - Kutta method – Adams - Bashforth multistep method, Shooting method, BVP : Finite difference method, Collocation method and orthogonal collocation method.

UNIT III FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 12+3

Parabolic equations : Explicit and implicit finite difference methods – Weighted average approximation - Dirichlet's and Neumann conditions – Two dimensional parabolic equations – ADI method : First order hyperbolic equations – Method of numerical integration along characteristics – Wave equation : Explicit scheme – Stability.

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 12+3

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+3

Basics of finite element method : Weak formulation, Weighted residual method – Shape functions for linear and triangular element – Finite element method for two point boundary value problems, Laplace and Poisson equations.

TOTAL : 60 + 15 = 75 PERIODS

OUTCOMES :

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

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

REFERENCES :
1. Burden, R.L., and Faires, J.D., “Numerical Analysis – Theory and Applications”, 9th Edition, Cengage Learning, New Delhi, 2016.
2. Gupta S.K., “Numerical Methods for Engineers”, New Age Publishers, 1995.
3. Jain M. K., Iyengar S. R., Kanchi M. B., Jain, “Computational Methods for Partial Differential Equations”, New Age Publishers ,1993.
4. Sastry, S.S., “Introductory Methods of Numerical Analysis”, 5th Edition, PHI Learning, 2015.
5. Saumyen Guha and Rajesh Srivastava, “Numerical methods for Engineering and Science”, Oxford Higher Education, New Delhi, 2010.
6. Smith, G. D., "Numerical Solutions of Partial Differential Equations: Finite Difference Methods", Clarendon Press, 1985.

TE5151 ADVANCED HEAT TRANSFER L T P C
4 0 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 12

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 12

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 12

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 12

Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation - steady one-dimensional convection and diffusion problems - calculation of the flow field – SIMPLER Algorithm

UNIT V MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION 12

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

TOTAL : 60 PERIODS

OUTCOMES

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

REFERENCES

1. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004.
2. Holman.J.P., Heat Transfer, Tata McGraw Hill, 2002.
3. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 2002.
4. Nag.P.K., Heat Transfer, Tata McGraw-Hill, 2002.
5. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985.
6. Yadav, R., Heat and Mass Transfer, Central Publishing House, 1995.
7. Yunus A.Cengal., Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.

IC5101 THERMODYNAMICS FOR IC ENGINEERING L T P C
3 2 0 4

AIM:

To enrich the knowledge of students in thermodynamics

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 Cp and Cv, Clausius Clayperon 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 generalised charts for enthalpy and entropy departure, fugacity coefficient, Lee- Kesler generalised 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 AVAILABILITY ANALYSIS 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 of closed and control volume. Fuel Chemical availability, Evaluation of the availability of hydrocarbon fuels.

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, Availability Analysis of Engine Processes – Availability Relationships – Entropy changes in Ideal Cycles – Availability Analysis of Ideal 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 constant evaluation K_p & K_f, Equilibrium composition evaluation of ideal gas and real gas mixtures.

T=15, TOTAL: 60 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to apply the law of thermodynamics to thermal systems.

REFERENCES

1. B.P. Pundir, I.C. engine combustion and emissions. Narosa Publishing House, July 2010.
2. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 1988.
3. DeHotf, R.T., Thermodynamics in Materials Science, McGraw-Hill Inc., 1993.
4. Holman,J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1988
5. Kenneth Wark., J. R, Advanced Thermodynamics For Engineers, McGraw-Hill Inc., 1995.
6. Rao, Y.V.C., Postulational and Statistical Thermodynamics, Allied Publisher Limited, New Delhi, 1994.
7. Sears, F.W. and Salinger G.I., Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Third Edition, Narosa Publishing House, New Delhi, 1993.
8. Smith, J.M. and Van Ness., H.C., Introduction to Chemical Engineering Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1987.
9. Sonntag, R.E., and Van Wylen, G, Introduction to Thermodynamics, Classical and Statistical Third Edition, , John Wiley and Sons, 1991
10. Yunus A. Cengel and Michael A . Boles, Thermodynamics, McGraw-Hill Inc., 2006.

IC5102 COMBUSTION AND EMISSION IN ENGINES L T P C
3 0 0 3

AIM:

To enrich knowledge of combustion and emission in IC engines.

OBJECTIVES:

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

UNIT I COMBUSTION PRINCIPLES 9

Combustion – Combustion equations, heat of combustion – chemical equilibrium and Dissociation - Theories of Combustion - Flammability Limits - Reaction rates - Laminar and Turbulent Flame Propagation in Engines. Introduction to spray formation and characterization.

UNIT II COMBUSTION IN S.I. ENGINES 10

Stages of combustion, normal and abnormal combustion, knocking, variables affecting knock, Features and design consideration of combustion chambers. Flame structure and speed, Cyclic variations, Lean burn combustion, Stratified charge combustion systems. Heat release correlations.

UNIT III COMBUSTION IN C.I. ENGINES 10

Stages of combustion, vapourisation 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.

UNIT IV COMBUSTION IN GAS TURBINES 9

Flame stability, Re-circulation zone and requirements - Combustion chamber configurations, Cooling, Materials.

UNIT V EMISSIONS 7

Carbon Monoxide, Unburnt Hydrocarbons, Oxides of Nitrogen, Particulate Matter and Smoke – sources. Emission control measures for SI and CI engines. Effect of emissions on environment and human beings.

TOTAL: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to understand the concept of the combustion in engines.

REFERENCES:

1. B.P. Pundir Engine Combustion and Emission, Narosa Publishing House, 2011.
2. Cohen, H, Rogers, G, E.C, and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd., 1980.
3. Domkundwar V, A Course in Internal Combustion Engines, Dhanpat Rai & Co. (P) Ltd, 2002.
4. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2003.
5. John B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill Book, 1998.
6. Mathur, M.L., and Sharma, R.P., A Course in Internal Combustion Engines, Dhanpat Rai Publications Pvt.New Delhi-2, 1993.
7. Obert, E.F., Internal Combustion Engine and Air Pollution, International Text Book Publishers, 1983.
8. Rajput R.K. Internal Combustion Engines, Laxmi Publications (P) Ltd, 2006.
9. Ramalingam, K.K., Internal Combustion Engines, SciTech Publications (India) Pvt. Ltd., 2004.
10. Willard W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engines, Second Edition, Pearson Prentice Hall, 2007,.

IC5111 I.C. ENGINES LABORATORY L T P C
0 0 4 2

AIM:

To impart knowledge on the practical aspects of Internal Combustion Engine Systems.

OBJECTIVES:

- To understand the behaviour of system at different operating conditions
- To understand the influence of individual components on the Overall performance of the 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 with alternative fuels.

4. Experimental Study on C.I. Engines with alternative fuels.
5. Experimental Study on the effect of fuel injection pressure on the Engine Performance, Heat Transfer and Emission Characteristics.
6. Experimental Study on the effect of preheating air and fuel on Engine Performance, Heat Transfer and Emission Characteristics.
7. Determination of Volumetric efficiency and Equivalence ratio in a single cylinder D.I. Diesel engine.
8. Determination of Flash and Fire point of various fuel blends.
9. Determination of viscosity of various fuel blends

LABORATORY REQUIREMENTS

1. S.I Engine Components
2. C.I Engine Components
3. Single/ Multi-cylinder S.I. Engines
4. Single/ Multi-cylinder C.I. Engines
5. Exhaust Gas Analyser (To measure HC,CO,NO_x,O_2,CO_2)
6. Smoke Meter
7. Pressure Transducer
8. Charge Amplifier
9. Data Acquisition System
10. Flash and Fire Point Apparatus
11. Redwood Viscometer

TOTAL: 60 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to have hands on experience in Operation, testing and maintenance of engines.

IC5201 ENGINE POLLUTION AND CONTROL L T P C
3 0 0 3

AIM:

- To educate the students about pollution formation in engines, and importance of its control.
- To educate the ways and means to protect the environment from various types of engine Pollution.

OBJECTIVES:

- To create an awareness on the various environmental pollution aspects and issues.
- To give a comprehensive insight into the pollution in engine and gas turbines.
- To impart knowledge on pollutant formation and control.
- To impart knowledge on various emission instruments and techniques.

UNIT I AIR POLLUTION - ENGINES AND TURBINES 6

Atmospheric pollution from Automotive and Stationary engines and gas turbines, Global warming – Green-house effect and effects of engine pollution on environment.

UNIT II POLLUTANT FORMATION 10

Formation of oxides of nitrogen, carbon monoxide, hydrocarbon, aldehydes and smoke, particulate emission. Effects of engine design - operating variables on emission formation – Noise pollution.

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 12

Engine design modifications, Fuel modification, evaporative emission control, EGR, air injection, thermal reactors, water injection, catalytic converters, common rail injection system, particulate traps, NOx converters, SCR systems. 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: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to understand about the emission formation and its control in engines.

REFERENCES

1. B. P. Pundir, "IC Engines Combustion and Emission" Narosa publishing house, 2010.
2. Crouse William, Automotive Emission Control, Gregg Division /McGraw-Hill,1980
3. Ernest, S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 1980.
4. George Springer and Donald J.Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum press, 1973.
5. John. B. Heywood, "Internal Combustion engine fundamentals" McGraw – Hill, 1988.
6. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, Third Edition, 1973.

IC5202 INTERNAL COMBUSTION ENGINE DESIGN L T P C
3 0 0 3

AIM:

To impart the basic engine design skills to the learners such that there is seamless transition to advanced design concepts.

OBJECTIVES:

- To provide the basic grounding on the piston engine design philosophy.

UNIT I GENERALIA 5

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

UNIT II DESIGN OF MAJOR COMPONENTS 12

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

UNIT III DESIGN OF OTHER COMPONENTS / SUBSYSTEMS 12

Inlet and exhaust manifolds, cylinder block, cylinder-head, crankcase. Design aspects of engine mountings, gaskets, bearings. 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 10

Scavenging, Arrangement and sizing of ports, piston assembly, intake and exhaust system, application to automotive gasoline engines.

UNIT V CONCEPTS OF COMPUTER AIDED DESIGN 6

Preparation of working drawings of designed components using CAD system.

TOTAL:45 PERIODS

OUTCOME:

The student would have gained an insight /understanding on the rudiments of piston engine design philosophy as a prelude to higher level design activities for varied applications.

REFERENCES

1. An Introduction to Engine Testing and Development, Richard D. Atkids, SAE International, USA, 2009.
2. Design and Simulation of Four-Stroke Engines, Gordon P. Blair, Society of Automotive Engineers, Inc., USA, 1999.
3. Diesel Engine Reference Book, Second Edition, Rodica Baranescu and Bernard Challen (Editors), Society of Automotive Engineers, Inc., USA, 1999.
4. Engineering Design, A Systematic Approach, G. Pahl, W. Beltz J. Fieldhusen and K.H. Grote, Springer
5. Engineering Fundamentals of the Internal Combustion Engine, Willard W. Pulkrabek, Second Edition, Prentice – Hall of India Pvt. Ltd., New Delhi, 2006.
6. Internal Combustion Engine Design, A. Kolchin and V. Demidov, MIR Publishers, Moscow, 1984.
7. Internal Combustion Engine Fundamentals, John B. Heywood, McGraw – Hill Book Company, 1988.
8. Internal Combustion Engine Handbook: Basics, Components, Systems and Perpectives, Richard Van Basshuysen and Fred Schafer (Editors) SAE International USA and Siemes VDO Automotive, Germany, 2002.
9. Introduction to Engine Valve trains, Yushu Wang, SAE International, USA, 2007.
10. Introduction to Internal Combustion Engines, Richard Stone, Fourth Edition SAE International, USA and Macmillan Press, 2012.
11. Modern Engine Technology from A to Z, Richard Van Basshuysen and Fred Schafer, SAE International, USA and Siemens VDO, Germany, 2007.
12. Springer – Verlag, Wien, Austria, 2006.
13. Vehicular Engine Design, Kevin L. Hoag, SAE International USA /

IC5203 INSTRUMENTATION FOR THERMAL SYSTEMS

L	T	P	C
3	0	0	3

AIM:

To enhance the knowledge of the students about various measuring instruments, importance of error and uncertainty analysis, and advanced measurement

OBJECTIVES:

- To understand the working of measuring instruments and errors associated with them
- To carry out error analysis and uncertainty of measurements
- To measure pressure and heat release from an IC engine, understand use of flow visualisation 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 measuring instruments.

UNIT II MEASUREMENT OF PHYSICAL QUANTITIES 12

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. Gas Analysers – Flame Ionisation Detector, Non-Dispersive Infrared Analyser, Chemiluminescent detector, Smoke meters, and Gas chromatography.

UNIT IV CONTROL SYSTEMS 10

Open & closed loop control systems, Response, Transfer function, Types of feedback, feedback Control system characteristics, Control system parameters, Servo motors, Stepper motors, Servo Amplifiers, Continuous control modes.

UNIT V DATA ACQUISITION SYSTEM 5

Data logging and acquisition - Sensors for error reduction, elements of computer interfacing, Timers and Counters, Analog to Digital & Digital to Analog conversion.

TOTAL: 45 PERIODS

OUTCOME:

On successful completion of this course the student will be able to plan their experiments and understand the suitability, accuracy and uncertainty associated with the instrument used for measuring thermal system parameters**.**

REFERENCES:

1. Barney G.C, Intelligent Instrumentation, Second Edition, Prentice Hall of India, 1988.
2. Bolton.W, Industrial Control & Instrumentation, Universities Press, Second Edition, 2001.
3. Doblin E.O, Measurement System Application and Design, Second Edition, McGraw Hill, 1978.
4. Holman, J.P., Experimental methods for Engineers, Tata McGraw-Hill, 7th Ed.2001.
5. Morris.A.S, Principles of Measurements and Instrumentation, Prentice Hall of India, 1998.
6. Nakra, B.C., Choudhry K.K., Instrumentation, Measurements and Analysis Tata McGraw Hill, New Delhi, 2nd Edition 2003.

IC5251 ALTERNATIVE FUELS FOR IC ENGINES L T P C

3 0 0 3

AIM:

To impart knowledge on various alternative fuels for I.C. Engines

OBJECTIVES:

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

UNIT I INTRODUCTION 12

Availability, Suitability, Properties, Merits and Demerits of Potential Alternative Fuels – Ethanol, Methanol, Diethyl ether, Dimethyl ether, Hydrogen, Liquefied Petroleum Gas, Natural Gas, Bio-gas and Bio-diesel.

UNIT II LIQUID FUELS FOR S.I. ENGINES 9

Requirements, Utilisation techniques – Blends, Neat form, Reformed Fuels, Storage and Safety, Performance and Emission Characteristics

UNIT III LIQUID FUELS FOR C.I. ENGINES 8

Requirements, Utilisation techniques - Blends, Neat fuels, Reformed fuels, Emulsions, Dual fuelling, Ignition accelerators and Additives, Performance and emission characteristics.

UNIT IV GASEOUS FUELS FOR S.I. ENGINES 8

Hydrogen, Compressed Natural gas, Liquefied Petroleum gas, and Bio gas in SI engines – Safety Precautions – Engine performance and emissions.

UNIT V GASEOUS FUELS FOR C.I. ENGINES 8

Hydrogen, Biogas, Liquefied Petroleum gas, Compressed Natural gas in CI engines. Dual fuelling, Performance and emission characteristics.

TOTAL: 45 PERIODS

OUTCOME:

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

REFERENCES

1. Alcohols as motor fuels progress in Technology - Series No.19 - SAE Publication USE, 1980.
2. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications,1990.
3. Maheswar Dayal, Energy today a tomorrow - I and B, Horishr India, 1982.
4. Osamu Hirao and Richard K. Pefley, Present and Future Automotive Fuels, John Wiley and Sons,1988.
5. Richard L.Bechfold – Alternative Fuels Guide Book - SAE International Warrendale, 1997.
6. Roger F. Haycock and John E Hillier., Automotive Lubricants Reference Book, Second Edition, SAE International Publications, 2004.
7. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984.

TE5261 THERMAL SYSTEMS SIMULATION LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

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

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

OUTCOMES:

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

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

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

SIMULATION LAB – REQUIREMENT:

1. Software - Modeling software like ProE, Gambit, Ansys, etc
   Analysis software like Ansys, fluent, CFX, etc
   Equation solving software like Matlab, Engg equation solver
2. Every students in a batch must be provided with a terminal
3. Hardwares are compatible with the requirement of the above software.

IC5211 TECHNICAL SEMINAR - I

L	T	P	C
0	0	2	1

OBJECTIVES:

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

GUIDELINES

- The student is expected to present a Seminar in one of the current topics in the field of Energy Engineering related issues / technology.
- The Seminar shall be of 30 minutes duration and give presentation to the Seminar Assessment Committee (SAC).
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the

student and maintain attendance also.

- In a session of two periods per week, 4 students are expected to present the Seminar.
- Students are encouraged to use various teaching aids such as power point presentation and demonstrative models.
- Students are required to prepare a seminar report in the prescribed format given by the Department.

EVALUATION

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

TOTAL: 30 PERIODS

OUTCOMES:

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

- Identify and choose appropriate topic of relevance.
- Assimilate literature on technical articles of specified topic and develop comprehension.
- Prepare technical report.
- Design, develop and deliver presentation on specified technical topic

IC5301 ELECTRONIC ENGINE MANAGEMENT SYSTEMS L T P C
3 0 0 3

AIM:

To learn the various sensors and engine management systems used in petrol and diesel engines

OBJECTIVES:

- To give an in-depth knowledge of various sensors used in engine management
- 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 5

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

UNIT II SENSORS 8

Sensors - Air flow, Pressure, Temperature, Speed, Exhaust gas Oxygen, Knock Camshaft and Position, Principle of operation, construction and 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 12

Open loop and closed loop systems, Mono-point, Multi-point, Direct injection systems and Air assisted systems – Principles and Features, 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, unit injector systems and unit pump systems – Construction and principle of operation.

TOTAL: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to understand about Electronic Engine Management Systems

REFERENCES

1. Bosch Technical Instruction Booklets.
2. Diesel Engine Management, Fourth Edition, Robert Bosch, Newness Publications, 2005.
3. Duffy Smith, Auto Fuel Systems, The GoodHeart-Wilcox Company Inc., Publishers, 1992.
4. Eric Chowanietz, Automobile Electronics, SAE Publications 1995.
5. Gasoline Engine Management, Third Edition, Robert Bosch, Bentley Publications, 2004.
6. Robert N. Brady, Automotive Computers and Digital Instrumentation, Prentice Hall, 1988.
7. Tom Denton, Automotive Electrical and Electronic Systems, 4th Edition, Taylor and Francis Group, 2004.
8. William B. Ribbens, Understanding Automotive Electronics, Sxith Edition, Elsevier Inc, 2002.

IC5311	TECHNICAL SEMINAR - II	L	T	P	C
		0	0	2	1

OBJECTIVES:

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

GUIDELINES

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

EVALUATION

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

TOTAL: 30 PERIODS

OUTCOMES:

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

- Develop the capacity to observe intelligently and propose and defend opinions and ideas with tact and conviction.
- Develop skills regarding professional communication and technical report writing.
- Learn the methodology of publishing technical papers.

IC5001	SPECIALITY ENGINES	L	T	P	C
		3	0	0	3

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 fueled engine systems – CNG, LPG, H_2, 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 fueled engine systems, coal and producer gas fueled 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 fueled systems.

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

Life cycle cost.

TOTAL: 45 PERIODS

REFERENCES

1. Bosch Technical Instruction Booklets, Robert Bosch GmbH, Germany, 1985.
2. Diesel Engine Reference Book, Bernard Challen and Rodica Baranescu (Editors) 2nd Edition, R – 183, SAE International , 1999.
3. Introduction to Internal Combustion Engines, Richard Stone, Third Edition, Society of Automotive Engineers, Inc,USA, 1999.
4. Some Unusual Engines, L.J.K. Setright, Mechanical Engineering Publication Ltd., UK, 1975.
5. The Wankel R C Engine, R.F.Ansdale, A.S.Barnes & Co.,USA, 1969.
6. The Warnkel Engine, Design, Development, Application, Jan P.Norbye, Chilton Book Company, USA,1971.

IC5002 **ENGINE AUXILIARY SYSTEMS** **L T P C**
3 0 0 3

AIM:

This course aims to impart the knowledge about engine auxiliaries like fuel supply and distribution, ignition, lubrication and cooling systems.

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, Components and 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 & 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: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to understand the need and working various auxiliaries of engine systems.

REFERENCES

1. Duffy Smith, Auto Fuel Systems, Good Heart Wilcox Company Inc., Publishers, 1987.
2. Eric Chowanietz, Automobile Electronics, SAE International, 1995.
3. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., Third Edition, 2010.
4. Heinz Heisler, Advanced Engine Techology, Butterworth Heinmann Publishers, Second Edition, 2002.

IC5003 AIRCRAFT AND SPACE PROPULSION L T P C
3 0 0 3

AIM:

To enhance the knowledge of the students on aircrafts and space propulsion

OBJECTIVES:

- To gain insight on the working principle of rocket engines, different feed systems, propellants and their properties and dynamics of rockets.

UNIT I WAVE MOTION AND ISENTORPIC FLOW THROUGH DUCTS 8

Wave motion, Mach waves and Mach cone - Compressible fluid flow through variable area devices – Stagnation state Mach Number and its influence and properties, Isentropic Flow through variable area ducts.

UNIT II SHOCKWAVES 9

Normal shock waves – Introduction, Relation of physical properties across a normal shock, Normal Shock in a duct, Oblique shock waves - Introduction, Relation of physical properties across an oblique shock, Deflection Relations, Method of Characteristics - Applications, Expansion Waves – Introduction.

UNIT III THERMODYNAMICS OF AIRCRAFT ENGINES 10

Theory of Aircraft propulsion – Different propulsion systems – Turboprop – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft, RamJet, Scramjet, Thrust – Various efficiencies. Methods of Thrust augmentation - Thrust vector control. Engine - Aircraft matching – Design of inlets and nozzles – Performance characteristics of Ramjet, Turbojet, Scramjet and Turbofan engines.

UNIT IV ROCKET PROPULSION 10

Theory of rocket propulsion, Deflagration & Detonation, Combustion in solid and liquid propellant classification – rockets of propellants and Propellant Injection systems – Nonequilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer. Electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.

UNIT V ROCKET STAGING AND PERFORMANCE 8

Rocket equations – Escape and Orbital velocity – Multi-staging of Rockets – Space missions – Performance characteristics – Losses and efficiencies, Advances in Rocket Propulsion.

TOTAL: 45 PERIODS

OUTCOME:

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

REFERENCES

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H, Gas Turbine Theory, Longman,1989
2. G.C. Oates, “Aerothermodynamics of Aircraft Engine Components”, AIAA Education Series,1985.
3. George P. Sutton, Oscar Biblarz. Rocket Propulsion Elements, John Wiley & Sons, 8th Edition, 2010.
4. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 2009.
5. Ramamurthy, Rocket Propulsion, Pan Macmillan (India) Ltd, 2010.
6. S. M.Yahya, Fundamentals of Compressible Flow. Third edition, New Age International Pvt Ltd, 2003.
7. W.P.Gill, H.J.Smith& J.E. Ziurys, “Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants”, Oxford & IBH Publishing Co., 1980.

IC5004 MANUFACTURING AND TESTING OF ENGINE COMPONENTS L T P C
3 0 0 3

AIM:
To provide a comprehensive module on the aspects of materials, manufacture and testing of piston engine assemblies, components and subsystems.

OBJECTIVES:
- To equip the learners with necessary domain inputs such that they can pursue research, consultancy, academics or other avocation.

UNIT I MATERIALS 7
Selection – types of Materials – Ferrous – Carbon and Low Alloy steels, High Alloy Steels, Cast Irons – Nonferrous – Aluminium, Magnesium, Titanium, Copper and Nickel alloys, composites.

UNIT II ENGINE COMPONENTS 15
Cylinder Block, Cylinder Head, Crankcase and Manifolds, Piston Assembly, Connecting Rod, Crankshaft, Camshaft and Valve Train - Production methods – Casting, Forging, Powder Metallurgy – Machining – Testing Methodologies.

UNIT III ENGINE AUXILIARIES 7
Carburettors, fuel injection system components, radiators, fans, coolant pumps, ignition system, intake and exhaust systems, Catalytic converters

UNIT IV COMPUTER INTEGRATED MANUFACTURING 7
Integration of CAD, CAM and CIM- Networking, CNC programming for machining of Engine Components.

UNIT V QUALITY ASSURANCE AND TESTING 9
TS 16949, ISO and BIS codes for testing. Instrumentation, computer aided engine testing, metrology for manufacture of engine components, engine tribological aspects.

TOTAL: 45 PERIODS

OUTCOME:
- A course work, of this kind would have equipped a graduate student with the requisite skills needed for a practicing engineer.

REFERENCES

1. Bosch Automotive Handbook, (8th Edition) Robert Bosch GmbH, Germany, 2011.
2. Christopher Hadfield, Automotive Engineering : Engine Repair and Rebuilding, Delmar Learning (Cengage Learning India Private Ltd.), 2010.
3. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI Learning Private Ltd., 2010.
4. James D. Halderman and Chase D. Mitchell Jr. , Automotive Engines: Theory and Servicing, Pearson Education Inc., 2005.
5. Judge, A.W., Testing of high speed internal combustion engines, Chapman & Hall., 1960.
6. P. Radhakrishnan and S. Subramaniyan, CAD / CAM/CIM, New Age International (P) Ltd, Publishers, 1997.
7. Richard D. Atkins, An Introduction to Engine Testing and Development, SAE International, USA, 2009.
8. Richard W. Heine, Carl R. Loper Jr. and Philip, C., Rosenthal, Principles of Metal Casting, McGraw-Hill Book Co., 1980.

IC5005 **MARINE DIESEL ENGINES** **L T P C**
3 0 0 3

AIM:

To provide a first-hand knowledge about the marine diesel and allied engine systems.

OBJECTIVES:

- To give a broad outline about marine diesel and allied piston engine systems

UNIT I ENGINE RUDIMENTS 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 their Controls.

UNIT II MECHANICS 10

Dynamics of crank gear, Engine Vibration, Design, Engine Systems, Speed governors and Accessory equipment's.

UNIT III INSTRUMENTATION AND CONTROL 10

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

UNIT IV AUXILIARY SYSTEMS 10

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

UNIT V TYPICAL MODERN MARINE PROPULSION ENGINE SYSTEMS 5

Layout of Diesel Electric Engines - LNG Engines Gas turbines - Screws - Nuclear powered steam Turbines.

TOTAL : 45 PERIODS

OUTCOME:

- The aim and objectives would have been realized on completion of a course work on Marine Engine Systems.

REFERENCES

1. AkberAyub, Marine Diesel Engines, Ane Books Pvt. Ltd., New Delhi, 2010.
2. Doug Woodyard (Editor), Pounder's Marine Diesel Engines, Butterworth-Heinemann, UK (Seventh Edition), 1998.
3. George H.Clark, Industrial and Marine Fuels Reference Book, Butterworth and Company (Publishers) Ltd., U.K., 1998.
4. John Lamb, The Running and Maintenance of the Marine Diesel Engine, Charles Griffin and Company Ltd., U.K., (Sixth Edition), 1976.
5. N. Petrovsky, Marine Internal Combustion Engines, Translation from Russian by Horace E Isakson, MIR Publishers, Moscow,1974

IC5091 **AUTOMOBILE ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES

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

UNIT I VEHICLE STRUCTURE AND ENGINES 10

Layout, Vehicle construction, Chassis, Frame and Body, Engine - types, construction, operation, performance, Air pollution and Pollution standards.

UNIT II ENGINE AUXILIARY SYSTEMS 10

Carburetors, Electronic Fuel Injection Systems – Monopoint, Multipoint and Direct Injection Systems, Electrical Systems – Battery, Generator, Starting Motor, and Ignition (Battery and Electronic Types).

UNIT III TRANSMISSION SYSTEMS 10

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 SOURCES FOR AUTOMOBILES 7

Electric vehicles and Fuel cells – Types, construction, principle of operation and characteristics.

TOTAL = 45 PERIODS

OUTCOME

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

REFERENCES

1. Duffy Smith, Auto Fuel Systems, The Good Heat Willcox Company Inc., 1987.
2. Kirpal Singh, Automobile Engineering Vol - I, Standard Publishers, Delhi 2013.
3. Kirpal Singh, Automobile Engineering Vol - II, Standard Publishers, Delhi 2014.
4. N.K.Giri, Automobile Mechanics, Khanna Publishers, 2008.
5. Newton and Steeds, Motor Vehicles, ELBS, 1985.
6. R.B. Gupta, Automobile Engineering, Satya Prakashan, 1993.
7. R.K.Rajput, A Text Book of Automobile Engg, Laxmi Publishers, 2015.

IC5006 SIMULATION OF I.C. ENGINE PROCESSES L T P C
3 0 0 3

AIM:

To impart knowledge on simulation of various engine processes used in prime movers and power plants.

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 engines 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: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to simulate the different engine processes.

REFERENCES

1. Ashley S. Campbell, Thermodynamic Analysis of Combustion Engines, Krieger publication co, 1985.
2. Bordon P. Blair, The Basic Design of two-Stroke engines, SAE Publications, 1990.
3. Cohen H. Rogers GEC. – Gas Turbine Theory – Pearson Education India Fifth edition, 2001.
4. Horlock and Winterbone, The Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol. I & II, Clarendon Press, 1986.
5. J.I.Ramos, Internal Combustion Engine Modeling, Butterworth – Heinemann ltd, 1999.
6. J.N.Mattavi and C.A.Amann, Combustion Modeling in Reciprocating Engines, Plenum Press, 1980.
7. V. Ganesan, Computer Simulation of C.I. Engine Processes, Universities Press, 2000.
8. V.Ganesan, Computer Simulation of Spark Ignition Engine Processes, Universities Press, 2000.

IC5007 SUPERCHARGING AND SCAVENGING L T P C
3 0 0 3

AIM:
To gain knowledge in the field of turbo charging, supercharging and scavenging.

OBJECTIVES:
- To understand the supercharging and turbocharging effect on I.C engine performance and emissions, 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 of Mechanical Supercharging. Types of compressors – Positive displacement blowers – Centrifugal compressors – Performance characteristic curves – Surging and Choking - 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 –- 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: 45 PERIODS

OUTCOME:
- On successful completion of this course the student will be able to match turbochargers with engines and design two stroke cycle engines.

REFERENCES

1. G P Blair, Two stroke Cycle Engines Design and Simulation, SAE Publications, 1997.
2. Heinz Heisler, Advanced Engine Techology, Butterworth Heinmann Publishers, 2002.
3. John B. Heywood, Two Stroke Cycle Engine, SAE Publications, 1999.
4. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, 1980.Richard Stone, Internal Combustion Engines, SAE, 2012.
5. Schweitzer, P.H., Scavenging of Two Stroke Cycle Diesel Engine, MacMillan Co., 1949.
6. Watson, N. and Janota, M.S., Turbocharging the I.C. Engine, MacMillan Co., 1982.

IC5008 FLUID FLOW AND HEAT TRANSFER IN ENGINES L T P C
3 0 0 3

AIM:

To enrich the students' knowledge engines fluid flow and heat transfer

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, SURFACE TENSION EFFECTS, MICROSCALE EFFECTS 5

Lubrication, Surface Tension effects, Micro scale effects on CI & SI engine.

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: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to apply the fluid flow and heat transfer concepts in engine system.

REFERENCES

1. F.P. Incropera and B. Lavine, Fundamentals of Heat and Mass Transfer, 7th Edition, Willey, 2011.
2. Frank M. White, Viscous Fluid Flow, 3rd Edition, McGraw Hill, 2011.
3. I.G. Currie, Fundamental Mechanics of fluids, 4th Edition, McGraw Hill 2011.
4. K. Muralidhar and G. Biswas, Advanced Engg. Fluid Mechanics, Narosa Publishing House, 2005.
5. Ronald L. Panton, Incompressible flow, 3rd Edition, Wiley, 2005.
6. Warren M Rehsenow and Harry Y Choi, Heat and Mass Momentum Transfer, Prentice Hall, 1980.
7. Welty, C. Wicks, Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition, Wiley 2009.

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

OBJECTIVES:

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

UNIT I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES 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: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to apply concept of CFD to analyse flow in thermal systems.

REFERENCES

1. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer " Hemisphere Publishing Corporation, New York, USA, 2012.
2. Bose, T.K., "Numerical Fluid Dynamics" Narosa Publishing House, 1997.
3. Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1991.
4. Fletcher, C.A.J. "Computational Techniques for fluid Dynamics 2" Specific Techniques for Different Flow Categories, Springer – Verlag, 1988.
5. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
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.

IC5009 FLOW VISUALISATION TECHNIQUES FOR I.C. ENGINES L T P C
3 0 0 3

AIM:

To enhance students’ knowledge on flow visualisation techniques applied to ICE engine flow processes

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 – Illuminated Particle Visualisation Holography – 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, processing of materials – Optical techniques.

UNIT III IN-CYLINDER FLOW 9

Visual Experiment of In-cylinder flow by Laser sheet method. Intake flow visualization by light colour layer examination of principle and photographic measurement techniques.

UNIT IV COMBUSTION VISUALISATION 9

Endoscopes, Advanced cameras, Fiber Optic Tools, Laser diagnostics of Flames.

UNIT V NUMERICAL FLOW VISUALISATION 9

Direct, Geometric and Texture based flow visualization, Dense Geometric Flow visualization – Surface flow visualisation.

TOTAL: 45 PERIODS

OUTCOME:

- On successful completion of this course the student will be able to apply concept of flow visualisation techniques to IC engines.

REFERENCES

1. B.H. Lakshmana Gowda, A Kaleidoscopic view of Fluid Flow Phenomena, Wiley Eastern, 1992.
2. J.P. Holman, Experimental Methods for Engineers, McGraw – Hill Inc., 2001.
3. Marshall B. Long, Optical Methods in flow and Particle Diagnosis, Society of Photo Optics, 1989.
4. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill Book Co., 2008.
5. Will Schroeder, Ken Martin and Bill Lorensen, An Object – Oriented Approach to 3D Graphics, 2nd Edition, Prentice Hall, 1998.
6. Wolfgang Merzkirch, Flow Visualisation, 2nd Edition, Academic Press, 1987.

TE5073 BOUNDARY LAYER THEORY AND 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 = 45 PERIODS

OUTCOME

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

REFERENCES

1. David C. Wilcox, Turbulence Modeling for CFD, Publisher: D C W Industries, Nov 1, 2006.
2. G. Biswas and E. Eswaran, Turbulent Flows, Fundamentals, Experiments and Modelling,Narosa Publishing House, 2002.
3. H. Schlichting and Klaus Gersten, Boundary Layer Theory, Springer 2004.
4. Pope S B., Turbulent Flow, Cambridge University Press, Cambridge, U.K., 2001.
5. R.J. Garde,Turbulent Flow, New Age International (p) Limited, Publishers, 2006.
6. Schlichting H., Boundary layer theory, Mc Graw Hill Book Company, 1979.
7. Yunus A Cengel, John M.Cimbala, Fluid Mechanics: Fundamentals and Applications - Second Edition, McGraw-Hill,2013

IC5010 COMBUSTION AND REACTION KINETICS IN I.C. ENGINES L T P C
3 0 0 3

AIM:
To develop the knowledge about combustion kinetics in SI and CI engines.

OBJECTIVES:
- To understand the combustion reaction kinetics in SI and CI engines.

UNIT I INTRODUCTION 8
Gaseous, liquid and solid fuels, Application of the first and second laws of thermodynamics to combustion, – Low temperature reactions – Cool Flames – as applied to detonation. High temperature reactions – species concentration and products formation.

UNIT II CHEMICAL KINETICS OF COMBUSTION 9
Elementary reactions, Pre-ignition kinetics, Ignition delay Nitric Oxide Kinetics, Soot Kinetics, Calculations, – Reaction control effect on Engine performance and emissions.

UNIT III MODELLING 10
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 Modelling.

UNIT IV GASOLINE ENGINE COMBUSTION 8
Combustion in S.I. Engines, Laminar flame theory, Flame structure, Turbulent premixed flames, Homogeneous Combustion reactions between Gasoline and air – Reaction rate Constants – species determination. Burning rate estimation.

UNIT V DIESEL ENGINE COMBUSTION 10
Combustion in CI Engine, Spray formation, Spray dynamics, Spray models, Introduction to diesel engine combustion, Premixed and diffusion combustion reactions – Lean flame Reactions – Lean flame out reactions - Species determination. Emissions and Combustion, Burning rate estimation.

TOTAL: 45 PERIODS

OUTCOME:
- On successful completion of this course the student will be able to understand the combustion and reaction kinetics in IC Engines

REFERENCES:

1. A.F. Williams, combustion in flames, Oxford Press, Second Edition, 1978.
2. Combustion Engineering, Gary L Bormann, WCB Mc Graw Hill, 1998.
3. I R.S. Benson & N.D. Whitehouse, Internal Combustion Engines, First edition, Pergamon Press, England 1979.
4. J.F. Ferguson, Internal Combustion Engines, John Wiley and Sons, 2004.
5. John. B. Heywood, “Internal Combustion engine fundamentals” McGraw – Hill, 1988.
6. S.P. Sharma, Fuels and Combustion, S.P. Chand and Co., Sixth Edition, 1982.
7. S.W. Benson, The Foundations of Chemical Kinetics, McGraw-Hill, 1960.

IC5011 HOMOGENEOUS CHARGE COMPRESSION IGNITION COMBUSTION IN ENGINES **L T P C 3 0 0 3**

OBJECTIVES:

- This course aims to introduce fundamentals of HCCI and its benefits in IC Engines
- To develop the knowledge on HCCI combustion and its benefits and applications.

UNIT I HCCI ENGINE FUNDAMENTALS **8**

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

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 **10**

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 AL TERNATIVE FUELS **9**

Introduction, Background, Diesel fuel HCCI, HCCI fuel ignition quality, Gasoline HCCI, HCCI fuel Specification, Fundamental fuel factors. 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

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: 45 PERIODS

OUTCOME

- On successful completion of this course the student will be able to understand the concept of HCCI, its benefits and challenges.

REFERENCES:

1. B.P. Pundir I.C. Engines Combustion and Emission, 2010, Narosa Publishing House.
2. B.P. Pundir, Engine Combustion and Emission, 2011, Narosa Publishing House.
3. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2003
4. Hua Zhao “HCCI and CAI Engines for automotive industry” Wood Head Publishing in Mechanical Engineering, 2007.
5. John B Heywood, “Internal Combustion Engines Fundamentals”, McGraw Hill International Edition, 1988.

EY5092 DESIGN AND ANALYSIS OF TURBOMACHINES L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION 12

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

UNIT II CENTRIFUGAL AND AXIAL FLOW COMPRESSORS 9

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

UNIT III COMBUSTION CHAMBER 9

Basics of combustion. Structure and working of combustion chamber – combustion chamber arrangements - flame stability – fuel injection nozzles. Flame stabilization - cooling of combustion chamber

UNIT IV AXIAL AND RADIAL FLOW TURBINES 9

Elementary theory of axial flow turbines - stage parameters- multi-staging - stage loading and flow coefficients. Degree of reaction - stage temperature and pressure ratios – single and twin spool arrangements – performance. Matching of components. Blade Cooling. Radial flow turbines.

UNIT V GAS TURBINE AND JET ENGINE CYCLES 9

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

TOTAL: 45 PERIODS

OUTCOME:

When a student completes this subject, he / she can

- Understand the design principles of the turbomachines
- Analyse the turbomachines to improve and optimize its performance

REFERENCES:

1. Austin H. Chruch, Centrifugal pumps and blowers, John wiley and Sons, 1980.
2. Cohen H., Rogers, G F C. and Saravanmotto H I H., Gas Turbine Theory-5th Edition, John Wiely, 2001.
3. Csanady G.T., Theory of Turbo machines, McGraw Hill, 1964.
4. Ganesan V., Gas Turbines, Tata McGrawHill, 2011.
5. Hill P G. and Peterson C R., Mechanics and Thermodynamics of Propulsion, Addition-Wesley, 1970.

6. Khajuria P.R. and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003.
7. Mattingly J D., Elements of Gas turbine Propulsion-1st Edition, McGraw Hill, 1997.

MF5072 RESEARCH METHODOLOGY L T P C
3 0 0 3

OBJECTIVES

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

UNIT I INTRODUCTION TO RESEARCH 9

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

UNIT II EXPERIMENTAL DESIGN 9

Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.

UNIT III DATA COLLECTION METHODS 9

Interviewing, Questionnaires, etc. Secondary sources of data collection. Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques – Probabilistic and non-probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size.

UNIT IV MULTIVARIATE STATISTICAL TECHNIQUES 9

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

UNIT V RESEARCH REPORT 9

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

TOTAL = 45 PERIODS

OUTCOME

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

REFERENCES

1. C.R.Kothari, Research Methodology, WishvaPrakashan, New Delhi, 2001.
2. Donald H.McBurney, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 2002.

3. Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000
4. G.W.Ticehurst and A.J.Veal, Business Research Methods, Longman, 1999.
5. Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
6. Raymond-Alain Thie'tart, *et.al.,* Doing Management Research, Sage Publications, London, 1999
7. Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000.

MF5075 INDUSTRIAL SAFETY L T P C
3 0 0 3

OBJECTIVE:
To develop and strengthen the safety ideas and motivate the students to impart basic safety skills and understandings to run an industry efficiently and effectively

UNIT I OPERATIONAL SAFETY 9
Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipesmetal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

UNIT II SAFETY APPRAISAL AND ANALYSIS 9
Human side of safety – personal protective equipment – causes and cost of accidents. Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation. Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

UNIT III OCCUPATIONAL HEALTH 9
Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV SAFETY AND HEALTH REGULATIONS 9
Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

UNIT V SAFETY MANAGEMENT 9
Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the students are expected to gain knowledge and skills needed to run an industry with utmost safety precautions.

REFERENCES:

1. John V Grimaldi, Safety Management. AITB publishers, 2003.
2. John.V .Grimaldi and Rollin. H Simonds, “Safety Managenent”, All India traveler book seller, New Delhi – 1989.
3. Krishnan N.V, “Safety in Industry”, Jaico Publisher House, 1996.
4. Singh, U.K and Dewan, J.M., “Sagety, Security And Risk Management”, APH publishing company, New Delhi, 1996.