GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

Regulations, Curriculum And Syllabi For

M.E. (THEMAL ENGINEERING)

(Full Time)

2012

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS,
GOVERNMENT COLLEGE OF TECHNOLOGY
THADAGAM ROAD, COIMBATORE - 641 013

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Curriculum

CURRICULUM FOR CANDIDATES ADMITTED
DURING 2012-2013 AND ONWARDS
BRANCH: M.E. (THERMAL ENGINEERING) - (FULL TIME)

FIRST SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		THEORY							
1.	12TE01	NUMERICAL METHODS IN THERMAL ENGINEERING	25	75	100	3	1	0	4
2.	12TE02	ADVANCED THERMODYNAMICS	25	75	100	3	0	0	3
3.	12TE03	FINITE ELEMENT METHODS IN THERMAL ENGINEERING	25	75	100	3	0	0	3
4.	12TE04	DESIGN OF CONDENSERS, EVAPORATORS AND COOLING TOWERS	25	75	100	3	0	0	3
5.	E1	ELECTIVE: 1	25	75	100	3	0	0	3
6.	E2	ELECTIVE: 2	25	75	100	3	0	0	3
		TOTAL			600				19

SECOND SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		THEORY							
1.	12TE05	ADVANCED HEAT AND MASS TRANSFER	25	75	100	3	0	0	3
2.	12TE06	ADVANCED ENGINEERING FLUID MECHANICS	25	75	100	3	0	0	3
3.	12TE07	COMBUSTION IN ENGINES	25	75	100	3	0	0	3
4.	12TE08	INSTRUMENTATION IN THERMAL ENGINEERING	25	75	100	3	0	0	3
5.	E3	ELECTIVE: 3	25	75	100	3	0	0	3
6.	E4	ELECTIVE: 4	25	75	100	3	0	0	3
		TOTAL			600				18

THIRD SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		THEORY							
1.	E5	ELECTIVE: 5	25	75	100	3	0	0	3
2.	E6	ELECTIVE: 6	25	75	100	3	0	0	3
3.	12TE09	ADVANCED THERMAL ENGINEERING LABORATORY	25	75	100	0	0	3	2
4.	12TE10	PROJECT WORK-PHASE I	50	150	200	0	0	12	6
		TOTAL			500				14

FOURTH SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12TE11	PROJECT WORK-PHASE II	100	300	400	0	0	24	12
		TOTAL			400				12

CURRICULUM FOR CANDIDATES ADMITTED
DURING 2012-2013 AND ONWARDS
BRANCH: M.E. (THERMAL ENGINEERING) – PART TIME

FIRST SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12TE01	NUMERICAL METHODS IN THERMAL ENGINEERING	25	75	100	3	1	0	4
2.	12TE02	ADVANCED THERMODYNAMICS	25	75	100	3	0	0	3
3.	12TE03	FINITE ELEMENT METHODS IN THERMAL ENGINEERING	25	75	100	3	0	0	3
		TOTAL			300				10

SECOND SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12TE05	ADVANCED HEAT AND MASS TRANSFER	25	75	100	3	0	0	3
2.	12TE06	ADVANCED ENGINEERING FLUID MECHANICS	25	75	100	3	0	0	3
3.	12TE07	COMBUSTION IN ENGINES	25	75	100	3	0	0	3
		TOTAL			300				9

THIRD SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12TE04	DESIGN OF CONDENSERS, EVAPORATORS AND COOLING TOWERS	25	75	100	3	0	0	3
2.	E1	ELECTIVE: 1	25	75	100	3	0	0	3
3.	E2	ELECTIVE: 2	25	75	100	3	0	0	3
		TOTAL			300				9

FOURTH SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12TE08	INSTRUMENTATION IN THERMAL ENGINEERING	25	75	100	3	0	0	3
2.	E3	ELECTIVE: 3	25	75	100	3	0	0	3
3.	E4	ELECTIVE: 4	25	75	100	3	0	0	3
		TOTAL			300				9

FIFTH SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
		THEORY							
1.	E5	ELECTIVE: 5	25	75	100	3	0	0	3
2.	E6	ELECTIVE: 6	25	75	100	3	0	0	3
3.	12TE09	ADVANCED THERMAL ENGINEERING LABORATORY	25	75	100	0	0	3	2
4.	12TE10	PROJECT WORK-PHASE I	50	150	200	0	0	12	6
		TOTAL			500				14

SIXTH SEMESTER

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12TE11	PROJECT WORK-PHASE II	100	300	400	0	0	24	12
		TOTAL			400				12

LIST OF ELECTIVES FOR M.E. THERMAL ENGINEERING

S. No.	Subject Code	Course title	Sessional marks	Final Exam marks	Total marks	Credits			
						L	T	P	C
1.	12TE12	SOLAR ENERGY AND WIND ENERGY	25	75	100	3	0	0	3
2.	12TE13	ENERGY AUDITING AND MANAGEMENT	25	75	100	3	0	0	3
3.	12TE14	BOILER TECHNOLOGY	25	75	100	3	0	0	3
4.	12TE15	FLUIDISED BED SYSTEMS	25	75	100	3	0	0	3
5.	12TE16	ADVANCED GAS DYNAMICS AND SPACE PROPULSION	25	75	100	3	0	0	3
6.	12TE17	FUELS AND COMBUSTION	25	75	100	3	0	0	3
7.	12TE18	COMPUTATIONAL FLUID DYNAMICS	25	75	100	3	0	0	3
8.	12TE19	ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL	25	75	100	3	0	0	3
9.	12TE20	SUPERCHARGING AND SCAVENGING	25	75	100	3	0	0	3
10	12TE21	CRYOGENIC ENGINEERING	25	75	100	3	0	0	3
11	12TE22	GAS TURBINES	25	75	100	3	0	0	3
12.	12TE23	FOOD PROCESSING, PRESERVATION AND TRANSPORT	25	75	100	3	0	0	3
13.	12TE24	REFRIGERATION MACHINERY AND COMPONENTS	25	75	100	3	0	0	3
14	12TE25	THERMAL ENERGY SYSTEMS	25	75	100	3	0	0	3
15.	12TE26	FANS, BLOWERS AND COMPRESSORS	25	75	100	3	0	0	3
16.	12TE27	DIESEL EMISSION CHARACTERISTICS	25	75	100	3	0	0	3
17.	12TE28	MODELING OF CI ENGINE PROCESSES	25	75	100	3	0	0	3
18.	12TE29	ENGINE ELECTRONICS	25	75	100	3	0	0	3
19.	12TE30	ENGINE POLLUTION AND CONTROL	25	75	100	3	0	0	3
20.	12TE31	MANUFACUTURING AND TESTING OF IC ENGINES AND COMPONENTS	25	75	100	3	0	0	3
21.	12TE32	ENGINE AUXILIARY SYSTEMS	25	75	100	3	0	0	3
22.	12TE33	AUTOMOTIVE ENGINE SYSTEMS	25	75	100	3	0	0	3
23.	12TE34	ALTERNATIVE FUELS FOR IC ENGINES	25	75	100	3	0	0	3
24.	12TE35	BIO-ENERGY CONVERSION TECHNIQUES	25	75	100	3	0	0	3

12TE01 NUMERICAL METHODS IN THERMAL ENGINEERING

L	T	P	C
3	1	0	4

NUMERICAL SOLUTIONS OF SYSTEM OF LINEAR AND NON-LINEAR EQUATIONS (9)

System of linear equation: Gauss Elimination Method, Gauss Jordan Method, Choleski Method, Gauss-Seidel Method – System of Non-Linear equations : Method of Iteration, Newton-Raphson Method.

EIGEN VALUE PROBLEMS AND CURVE FITTING (9)

Eigen value problem: Power Method – Curve fitting: Least Square approximations – Fitting a straight line – Regression Lines – Non-Linear curve fitting – Method of least square for continuous functions.

NUMERICAL INTEGRATION (9)

Trapezoidal Rule - Simpson's Rules-Adaptive Quadrature Method – Gaussian Quadrature-Double integrals using Trapezoidal and Simpson's rule.

NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS (9)

Single step methods: Euler's Methods – Modified Euler's Method - Runge-Kutta Method of fourth order – Multi Step methods: Milne's and Adam's Predictor and Corrector Methods. Numerical solution of Ordinary Differential Equation by Finite Difference Method.

NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS (9)

Laplace Equation : Gauss Jacobi Method, Gauss Seidel Method – Poisson Equation:Finite difference method.Parabolic Equation : Crank Nicholson Method – Hyperbolic Equation: Explicit method.

Lecture : 45 Tutorial : 15 Total : 60

Reference :

1. *P.Kandasamy, K.Thilagavathy, K.Gunavathy,* ***"Numerical Methods",*** *S.Chand and Company Ltd.,Ramnagar, New Delhi, 2010.*
2. *Veerarajan.T and Ramachandran.T.,* ***"Numerical Methods with Programming C"****, Tata McGraw Hill Publishers, New Delhi, 2007.*
3. *S.S.Sastry,* ***"Introductory Methods of Numerical Analysis"****, Prentice Hall of India, New Delhi,2005.*
4. *Balagurusamy .E.,* ***"Numerical Methods"****, Tata Mc.Graw Hill Publishers, New Delhi,1999, reprint 2007.*
5. *S.R.K.Iyengar, R.K.Jain,* ***"Numerical Methods"****, NewAge International Publishers, New Delhi, 2009.*
6. *Grewal. B. S., and Grewal. J.S.,* ***"Numerical Methods in Engineering and Science"****,Seventh Edition, Khanna Publishers, New Delhi, 2007.*
7. *C.F. Gerald and Wheatley. P.O.,* ***"Applied Numerical Analysis"****, (Sixth Edition), Pearson Education,Asia, New Delhi,2006.*

8 *M.K.Jain, S.R.K. Iyengar and R.K.Jain,* ***"Numerical Methods for Scientific and Engineering Computation"****, Wiley Eastern Limited ,New Delhi,2004.*

12TE02 - ADVANCED THERMODYNAMICS

L	T	P	C
3	0	0	3

AVAILABILITY AND THERMODYNAMIC PROPERTY RELATIONS (9)

Reversible work, Availability, Irreversibility and Second-Law Efficiency for a closed System and Steady-State Control Volume. Thermodynamic Potentials, Maxwell relations, Generalized relations for changes in Entropy, Internal Energy and Enthalpy, C_p and C_v, Clausius Clayperon Equation, Joule-Thomson Coefficient, Bridgman Tables for Thermodynamic relations.

REAL GAS AND MULTI-COMPONENT SYSTEMS (10)

Different Equations of State, Fugacity, Compressibility, Principle of Corresponding States, Use of generalized charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kessler 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.

CHEMICAL THERMODYNAMICS AND EQUILIBRIUM (9)

Thermo chemistry, First Law analysis of reacting systems, Adiabatic Flame temperature, Entropy change of reacting systems, Second Law analysis of reacting systems, Criterion for reaction equilibrium, Chemical availability, Equilibrium constant for gaseous mixtures, evaluation of equilibrium composition, Availability of reacting systems.

STATISTICAL THERMODYNAMICS (9)

Microstates and Macrostates, Thermodynamic probability, Degeneracy of energy levels, Maxwell-Boltzman, Fermi-Dirac and Bose-Einstein Statistics, Microscopic Interpretation of heat and work, Evaluation of entropy, Calculation of the Macroscopic properties from partition functions, Equilibrium constant statistical thermodynamics approach.

IRREVERSIBLE THERMODYNAMICS (8)

Conjugate Fluxes and Forces, Entropy Production Onsager's Reciprocity relations, Thermoelectric phenomena, formulations, Power Generation, Refrigeration.

TOTAL:45

Reference :

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

12TE03-FINITE ELEMENT METHODS IN THERMAL ENGINEERING

L	T	P	C
3	0	0	3

INTRODUCTION (5)

Overview of numerical methods - Discretised representation of physical systems - thermal resistance - Governing equations and Boundary conditions for thermal and flow systems.

ONE DIMENSIONAL HEAT CONDUCTION (6)

Principles of variations calculus - applications of variational approach to one dimensional heat conduction – element matrix contribution and assembly.

HEAT FUNCTIONS AND ANALYSIS (10)

Weighted residual methods - Galerkin's approach - Shape functions. Application of Galerkin's weighted residual approach to one dimensional heat conduction - Three nodded triangular elements- 2-D steady state conduction using triangular elements - Radiation and natural convective boundary conditions –incorporation of variations in thermal properties.

CONVECTIVE HEAT TRANSFER (12)

Higher order elements and numerical integration solution of heat conduction and creeping flow using higher order element - Solution of convective heat transfer.

HEAT EXCHANGER APPLICATIONS (12)

Incompressible laminar flow simulation - Stream function / Vorticity methods, Velocity Pressure formulation, mixed order interpolation for incompressible flow modifications for turbulent flow. Application to heat exchanger.

TOTAL: 45

Reference :

1. ***The Finite Element Method in Engg****., 2nd ed. S.S.Rao Pergamon Press, 2005.*
2. ***Applied Finite Element Analysis****, 2nd ed, Larry Segerlind John Wiley & Sons, 2005.*
3. ***Finite Element Analysis Theory and Programming*** *2nd ed, C.S.Krishnamoorthy, Tata McGraw-Hill 2005.*
4. ***Finite Elements Methods****, J.N.Reddy, McGraw-Hill 2005.*
5. ***Finite Element Methods*** *O.C.Zienkiewiez, McGraw-Hill 2002.*
6. ***Introduction to Finite Elements in Engg****., T.R.Chandrapatla and Belegundu, Prentice Hall of India 2002.*
7. ***Finite Element Computational Fluid Mechanics*** *- A.J.Baker, McGraw-Hill,2003.*

12TE04- DESIGN OF CONDENSERS, EVAPORATORS AND COOLING TOWERS

L	T	P	C
3	0	0	3

INTRODUCTION (9)

Principles of heat transfer, Types of heat exchangers, Standard Representation, Parts description, TEMA lassifications, Applications.

CONDENSERS (9)

Estimation of heat transfer coefficient, Fouling factor, Friction factor. Design procedures, Wilson plots, Design of different types of condensers, BIS Standards.

EVAPORATORS (9)

Different types of evaporators, Design procedure, Factors affecting the evaporator capacity, Thermal Stress calculations, matching of components, Design of evaporative condensers.

COOLING TOWERS (9)

Types of Cooling towers, Analytical and graphical design procedures, Tower Characteristics Parametric analysis, Range of cooling tower, Tower efficiency, cooling tower load, Energy conservation.

SELECTION OF CONDENSERS, EVAPORATORS AND COOLING TOWER (9)

Condenser selection – Water cooled – Air cooled, Selection of evaporators, Selection of cooling tower, Selection of Pumps and Fans.

TOTAL: 45

Reference :

1. *Ozisik, M.N.,* ***Design of Heat exchangers , condensers and evaporators*** *, John Wiley , New York , 1985.*
2. *Kern K.H.,* ***Process heat transfer****, McGraw-Hill, 2002.*
3. *Ozisik M.N.,* ***Heat transfer****, McGraw-Hill, 1993.*
4. *Nicholas Cheremisioff ,* ***Cooling tower*** *, Ann Arbor Science pub. 1981.*
5. *TEMA Hand book,* ***Tubular Exchanger Manufacturer Association****, New York, 2004.*
6. *Andrew.D.Althouse, Carl.H.Turnquist,* ***Modern Refrigeration and Air Conditioning****, GoodHeard-Wilcox Company, Inc, Publishers, 2000.*

12TE05-ADVANCED HEAT AND MASS TRANSFER

L	T	P	C
3	0	0	3

CONDUCTION AND RADIATION HEAT TRANSFER (9)

One dimensional energy equations and boundary condition, three dimensional heat conductionequations, extended surface heat transfer, Conduction with moving boundaries, Porous-media heat transfer, Radiation in Gases and vapor.

TURBULENT FORCED CONVECTIVE HEAT TRANSFER (9)

Momentum and Energy Equations, Turbulent Boundary Layer Heat Transfer, Mixing lengthconcept, Turbulence Model - k-ε Model, Analogy between Heat and Momentum Transfer –Reynolds, Colburn, Von Karman, Turbulent flow in a Tube, High speed flows.

PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER (9)

Condensation with shear edge on bank of tubes, Boiling – pool and flow boiling, Heat exchanger, ε – NTU approach and design procedure, compact heat exchangers.

NUMERICAL METHODS IN HEAT TRANSFER (9)

Finite difference formulation of steady and transient heat condition problems – Discretizationschemes – Explicit, Crank Nicolson and Fully implicit schemes, Control volume formulation,Steady one dimensional convection and Diffusion problems, Calculation of the flow field – Simpler Algorithm.

MASS TRANSFER AND ENGINE HEAT TRANSFER CORRELATION (9)

Mass Transfer, Vaporization of droplets, combined heat and mass transfer problems, Heat Transfer Correlations in I.C.Engines.

TOTAL: 45

Reference :

1. *Incropera F.P. and DeWitt.D.P,* ***Fundamentals of Heat & Mass Transfer****, John Wiley & Sons, Seventh edition.*
2. *Eckert.E.R.G., and Drake.R.M,* ***Analysis of Heat and Mass Transfer****, McGraw Hill Co., 1980.*
3. *Ozisik.M.N.,* ***Heat Transfer - Basic Approach****, McGraw-Hill Co., 1985.*
4. *Bejan.A.,* ***Convection Heat Transfer****, John Wiley and Sons, 1984.*
5. *Rohsenow.W.M., Harnett.J.P, and Ganic.E.N,* ***Handbook of Heat Transfer Applications****, McGraw-Hill, NY 1985.*
6. *Patankar.S.V.,* ***Numerical heat Transfer and Fluid Flow****, Hemisphere Publishing Corporation, 1980.*
7. *Carnahan.B., Luther.H.A, and Wilkes, J.O.,* ***Applied Numerical Methods****, Wiley & Sons, 1976.*

12TE06-ADVANCED ENGINEERING FLUID MECHANICS

L	T	P	C
3	0	0	3

INTRODUCTION (9)

Ideal and non-ideal flows, general equations of fluid motion, Navier - stokes equations and their exact solutions. Boundary layer theory, wedge flows, laminar flow over plates and through cylinders.

TWO DIMENSIONAL FLOW (9)

Subsonic flow, physical significance of irrotational motion – Kelvin's theorem – Differentialequation in terms of velocity Potential and stream function – Flow with small perturbation – flow past a wave shaped wall – Gothert's rule – Prandtl Glanert rule – Hodograph method.

TURBULENT FLOW (9)

Turbulence, models and flow equations: steady and unsteady turbulent boundary layers.

COMPRESSIBLE FLOW THROUGH DUCTS (9)

Introduction to compressible viscous flow, governing equations, flow with friction - flow withheat transfer flow though nozzle and diffuser.

SHOCK WAVE (9)

Normal and oblique shocks – Prandtl – Meyer expansion – Rankine Hugnoit relation. Application of method of characteristics applied to two dimensional case – simple supersonic wind tunnel Design of supersonic wind tunnel and nozzle.

TOTAL: 45

Reference :

1. *Mohanty, A. K., **Fluid Mechanics**, Prentice Hall of India, 1986*
2. *Shapiro, A. F., **The Dynamics of Compressible flow** Vol. 1, The Ronald Press Company 1963*
3. *Shames, **Mechanics of Fluids**, Mc Graw Hill 1962 Book Company, 1962*
4. *Schlichting, H., **Boundary layer theory**, Mc Graw Hill Book Company, 1979*
5. *T. Radhakrishnan, **Gas Dynamics**, Prentice Hall, New Delhi.*
6. *Yahya S.M, **Fundamentals of Compressible flow**, New Age International (P) Ltd.New Delhi, 1996.*
7. *Yunus A Cengel, John M.Cimbala, **Fluid Mechanics: Fundamentals and Applications**, McGraw-Hill, Second Edition.*

12TE07-COMBUSTION IN ENGINES

L	T	P	C
3	0	0	3

COMBUSTION PRINCIPLES (9)

Thermodynamics, concepts of combustion – Combustion equations, heat of combustionTheoretical flame temperature, chemical equilibrium and dissociation.

CHEMICAL KINETICSR (9)

Theories of Combustion, Pre-flame reactions, Reaction rates, Rankine-Hugoniot relations - detonation branch - Analysis of the deflagration - Chapman-Jouguet waves, Laminar and Turbulent Flame propagation in Engines.

COMBUSTION IN S.I. ENGINES (10)

Initiation of combustion, flame velocities, normal and abnormal combustion, knocking combustion, pre-ignition, knock and engine variables, features and design consideration of combustion chambers, stratified charge combustion, concepts of lean burn engines, heat release correlations.

COMBUSTION IN C.I. ENGINES (9)

Various stages of combustion, vaporization of fuel droplets and spray formation, air motion, swirl, squish, tumble flow, velocities, swirl measurement, delay period correlations, diesel knock and engine variables, features and design considerations of combustion chambers, heat release correlations.

COMBUSTION IN GAS TURBINE (8)

Flame stability, Combustion efficiency, Diffusion zone, re-circulation zone and requirements, Combustion chamber - configuration - Materials.

TOTAL: 45

Reference :

1. *Forman A Williams,**Combustion Theory**, The Benjamin/Cummings Publishing Company Inc,1985.*
2. *Ganesan, V, **Internal Combustion Engines**, Tata McGraw Hill Book Co., 1995.*
3. *John B.Heywood, **Internal Combustion Engine Fundamentals**, McGraw Hill Book, 1998*
4. *Ramalingam, K.K., **Internal Combustion Engines**, SciTech Publications (India) Pvt. Ltd.,2009.*
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.,1980*

12TE08-INSTRUMENTATION IN THERMAL ENGINEERING

L	T	P	C
3	0	0	3

MEASUREMENT CHARACTERSTICS (9)

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

MICROPROCESSORS AND COMPUTERS IN MEASUREMENT (9)

Data logging and acquisition, use of intelligent instruments for error reduction, elements of micro-computer interfacing, intelligent instruments in use.

MEASUREMENT OF PHYSICAL QUANTITIES (9)

Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of intelligent instruments for the physical variables.

FLOW VISUALISATION (9)

Techniques, shadow graph, Schlieren, interferometer, Laser Doppler anemometer, heat flux measurement, Telemetry in engines.

MEASUREMENT ANALYSIS (9)

Chemical, thermal, magnetic and optical gas analyzers, measurement of smoke, dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.

TOTAL: 45

Reference :

1. *Holman, J.P.,* ***Experimental methods for engineers****, McGraw-Hill, 1988.*
2. *Barney,* ***Intelligent Instrumentation****, Prentice Hall of India, 1988.*
3. *Prebrashensky, V.,* ***Measurements and Instrumentation in Heat Engineering****, Vol.1 and 2, MIR Publishers, 1980.*
4. *Raman, C.S., Sharma, G.R., Mani, V.S.V.,* ***Instrumentation Devices and Systems****, Tata McGraw Hill, New Delhi, 1983.*
5. *Doeblin,* ***Measurement System Application and Design****, McGraw Hill, 1978.*
6. *Morris.A.S,* ***Principles of Measurements and Instrumentation****, Prentice Hall of India, 1998.*

12TE09-ADVANCED THERMAL ENGINEERING LABORATORY

L	T	P	C
0	0	3	2

PART- A PERFORMANCE TESTS

1. Performance test on Spark Ignition engines using Alternate fuels such as ethanol and Bio-fuels.2. Emission measurement in Spark Ignition and Compression Ignition Engines.3. Performance test using pressure transducers in SI engines.4. Performance test using pressure transducers in CI Engines.5. Performance test on variable compression ratio petrol and diesel engines.6. Performance test on Solar Collector.7. Performance test on Computerised I.C. Engine Test Rig.8. Performance test on Computerised Two Stage Air Compressor Test Rig.

PART- B SIMULATION STUDIES

1. Simulation studies of Vapour Absorption Systems.2. Simulation studies of Petrol and Diesel engine cycles.3. Simulation of Gas Turbine Cycles.4. Simulation of Adiabatic flame temperature in constant volume heat addition process.5. Simulation of Adiabatic flame temperature in constant pressure heat addition process.6. CFD analysis for a fluid flow problem with heat transfer.7. Computer Aided Design of Piston.8. Computer Aided Design of Connecting Rod.9. Computer Aided Design of Crank Shaft.

Note: *The end semester examination shall be conducted in both Part-A and Part- B.*

TOTAL: 45

12TE12-SOLAR ENERGY AND WIND ENERGY

L	T	P	C
3	0	0	3

SOLAR RADIATION (9)

Availability - Measurement and Estimation - Isotropic and an isotropic models - Introduction to solar collectors flat - plate collectors, Air heater and Concentrating collectors and Thermal storage - Steady state transient analysis - Solar Pond - Solar Refrigeration.

MODELLING OF SOLAR THERMAL SYSTEMS AND SIMULATIONS IN PROCESS DESIGN (9)

Design of active systems by f-chart and utilizability methods - water heating systems - Active and passive - Passive heating and cooling of buildings - Solar distillation - Solar Drying.

PHOTOVOLTAIC SOLAR CELL (9)

P-N Junction – Metal – Schottky junction, Electrolyte – Semiconductor Junction, Types of solar cell - their Applications – Experimental Techniques to determine the characteristics of Solar cells Photovoltaic Hybrid Systems Photovoltaic Thermal Systems – Storage Battery – Solar Array Characteristics, Evaluation – Solar Chargeable Battery.

WIND TURBINE (9)

Structure – Statistics – Measurements and Data Presentation – Wind Turbine Aerodynamics –Momentum Theories – Basics Aerodynamics – Airfoils Characteristics – HAWT – Blade Element Theory – Prandt'ls Lifting Line Theory (prescribed wake analysis) – VAWT Aerodynamic Loads in Steady Operation – Wind Turbulence – Yawed Operation and Tower Shadow.

WIND ENERGY CONVERSION SYSTEM (WECS) (9)

Sitting – Rotor Selection – Annual Energy Output – Horizontal Axis Wind Turbine (HAWT) Vertical Axis Wind Turbine – Rotor Design Considerations – Number of Blades – Blade Profile – 2/3 Blades and Teetering – Coning – Upwind/ Downwind – Power Regulation – Yaw system – Tower – Synchronous and Asynchronous Generators and Loads – Integration of Wind Energy Converters to Electrical Networks – Inverters – Testing of WECS – WECS Control System-Requirements and Strategies – Miscellaneous Topics – Noise – Other Applications.

TOTAL: 45

References :

1. *L.L.Freis,* ***Wind Energy Conversion Systems****, Prentice Hall, 2000.*
2. *D.A.Spera,* ***Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering****, ASME Press.*
3. *S.P.Sukhatme-****Solar Energy:Principles of Thermal Collection and Storage****, Tata McGraw-Hill (1984).*
4. *F.A.Duffie and W.A.Beckman-****Solar Engineering of Thermal Processes****-John Wiley (1991).*
5. *J.F.Krider and F.Kreith-****Solar Energy Handbook*** *McGraw-Hill (1981).*

Web References :

1. http://www.ises.ors
2. http://www.windpower-monthly.com
3. http://www.solarpv.com

12TE13 – ENERGY AUDITING AND MANAGEMENT

L	T	P	C
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INTRODUCTION (8)

Energy Scenario – Principles and Imperatives of Energy Conservation – Energy Consumption Pattern – Resource – Availability – Role of Energy Managers in Industries.

THERMAL ENERGY AUDITING (12)

Energy Audit-Purpose, Methodology with respect to process Industries –Power plants, Boilers, Characteristic method Employed in Certain Energy Intensive Industries – Various Energy Conservation Measures in Steam System – Losses in Boiler, Methodology of Upgrading Boiler Performance – Energy Conservation in pumps, Fans and Compressors, Air Conditioning and Refrigerating systems, Steam Traps – Types, Function, Necessity.

ROLE OF INSTRUMENTATION IN ENERGY CONSERVATION (10)

Total Energy Systems – Concept of Total Energy – Advantages and Limitations – Total Energy System and Application – Various Possible Schemes Employing Steam Turbines Movers Used in Total Energy Systems – Potential and Economical of Total Energy Systems.

ELECTRICAL ENERGY AUDITING (10)

Potential Areas for Electrical Energy Conservation in various Industries – Energy Management Opportunities in Electrical Heating, Lighting system, Cable Selection – Energy Efficient Motors – Factors involved in Determination of Motor Efficiency Adjustable AC Drives, Applications and its use variable speed Drives/Belt Drives.

ENERGY MANAGEMENT (5)

Importance of Energy Management, Energy Economics – Discount Rate, Payback period, Internal rate of Return, Life Cycle Costing.

TOTAL: 45

References :

1. *CB Smith,* ***Energy Management Principles****, Pergamon Press, NewYork, 1995.*
2. *Hamies,* ***Energy Auditing and Conservation; Methods, Measurements, Management & Case study****, Hemisphere, Washington, 2000.*
3. *Trivedi, PR, Jolka KR,* ***Energy Management****, Commonwealth Publication, New Delhi, 2000.*
4. *Witte, Larry C,* ***Industrial Energy Management & Utilization****, Hemisphere Publishers, Washington, 2000.*
5. *Diamant, RME,* ***Total Energy, Pergamon****, Oxford, 1970.*

12TE14 - BOILER TECHNOLOGY

L	T	P	C
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INTRODUCTION (10)

Parameter of a steam Generator – Thermal calculations of Modern steam Generator – Tube Metal Temperature Calculation and choice of Materials – Steam purity Calculations and Water treatment.

HEAT BALANCE (10)

Heat transfer in Furnace – Furnace Heat Balance –Calculation of Heating Surfaces – Features of Firing systems for solid – Liquid and Gaseous Fuels – Design of Burners.

BOILER DESIGN (10)

Design of Boiler Drum – Steam Generator Configurations for Industrial Power and Recovery Boiler – Pressure Loss and circulation in Boilers.

DESIGN OF ACCESSORIES (8)

Design of Air Preheaters – Economisers and Super heater for high pressure steam Generators – Design Features of Fuel Firing Systems and Ash Removing Systems.

BOILER CODE (7)

IBR and International Regulations – ISI Code's Testing and Inspection of Steam Generator – Safety Methods in Boilers – Factor of safety in the Design of Boiler Drum and Pressure parts-Safety of Fuel Storage and Handling – Safety Methods of Automatic Operation of Steam boilers.

TOTAL: 45

References :

1. ***David Gunn, Robert Horton,*** *Industrial Boilers* ***– Longman Scientific & Technical Publication, 2000.***
2. ***Carl schields,*** *Boilers – Type Characteristics and function****, McGraw Hull Publishers,2000.***
3. *Modern Power Station Practice(8 vol)* ***–Central Electricity Generation Board ,2000.***
4. *Large Boiler Furnaces****, Richard Dolezal Elsevier Company, 2000.***

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3. *http://www.thermomax.com*
4. *http://www.pages.hotbot.com*

12TE15 - FLUIDISED BED SYSTEMS

L	T	P	C
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INTRODUCTION (9)

The fluidized state, Nature of hydro dynamic suspension particle-particle forces, species of fluidization, Regimization of the fluidized state, operating models for fluidizations systems, Application of fluidization systems

HYDRODYNAMICS OF FLUIDIZATION SYSTEMS (9)

General bed behavior pressure drop, Flow regimes, Incipient fluidization, pressure fluctuations, phase holdups, Measurement techniques, Empirical correlations for solids holdup, liquid holdup and gas holdup, Flow models - generalized wake model, structural wake model and other important models.

SOLIDS MIXING AND SEGREGATION (9)

Phase juxtaposition operation shifts, Reversal points, Degree of segregation, Mixing – segregation equilibrium, Generalized fluidization of poly disperse systems, liquid phase mixing and gas phase mixing.

HEAT AND MASS TRANSFER FLUIDIZATION SYSTEMS (9)

Mass transfer - gas-liquid mass transfer, Liquid solid mass transfer and wall to bed mass transfer, Heat transfer - column wall - to - bed heat transfer, Immersed vertical cylinder-to-bed heat transfer, Immersed horizontal cylinder to-bed heat transfer.

MISCELLANEOUS SYSTEMS (9)

Conical fluidized bed, Moving bed, Slurry bubble columns, Turbulent bed contactor, Two phase and three phase inverse fluidized bed, Draft tube systems, Semi fluidized bed systems, Annular systems, typical applications, Geldart's classification for power assessment, Powder characterization and modeling by bed collapsing.

TOTAL: 45

REFERENCES:

1. ***Gas-Liquid-Solid Fluidization Engineering***, *Liang-Shih Fan, Butterworths, 1989.*
2. ***Fluidization Idealized and Bubbleless, with Applications***, *Mosoon Kwauk, Science Press, 1992.*
3. ***Fluidization Engineering***, *O. Levenspiel and D. Kunii, John Wiley, 1972.*

12TE16 – ADVANCED GAS DYNAMICS AND SPACE PROPULSION

L	T	P	C
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INTRODUCTION (9)

Application of general differential equation of continuity, momentum and energy to compressible inviscid fluids; Compressible Bernoulli's equation; Irrotational flow; Velocity potential and Stream function.

SHOCK WAVE IN SUPERSONIC FLOW (9)

A review of normal shock relation; Mach waves; Equation for finite strength shock waves; Rankine-Hugenit relation; Extended Prandtl relation; Hodograph shock polar reflection and interaction of shock, Curved shocks.

SMALL PERTURBATION THEORY (9)

Liberalization; Small perturbation equation; Pressure coefficient, Subsonic flow a wave shaped wall, General solution of supersonic flows; Supersonic flow past a curve-shaped wall; Elements of supersonic thin aerofoil theory. Similarity rules between two-dimensional subsonic compressible flows and incompressible flows; Gothert rule; Prandtl Glauert rule; Application of supersonic flow.

INTRODUCTION TO GAS TURBINE ENGINES (9)

Classification of air breathing engines – Principle of turbojet, turbo-prop, turbo-jet with reheat, by-pass and turbo fan concepts – Thrust augmentation in jet engines and its application to aircraft. Thermodynamic analysis of jet engine – components of a jet engine – Compressor, combustion chamber, turbine and jet nozzle – their efficiencies – Introduction to ramjet, pulse jet and their application.

ROCKET PROPULSION (9)

Introduction to rocket propulsion – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance.

TOTAL: 45

References :

1. ***Gas Dynamics***, *E Rathakrishnan, Prentice Hall of India*
2. ***Introduction to Gas Dynamics***, *Zucker R. D. and Biblarz Oscar, John Wiley and Sons. Inc.,Second Edition[2002]*
3. ***Dynamics and Thermodynamics of Compressible Fluid Flow***, *A. H. Shapiro, MIT Pres.*
4. ***Aircraft Propulsion system technology & design***, *G.C. Oates, AIAA Education Series, 1989.*
5. ***Rocket Propulsion Elements***, *G.P.Sutton, John Wiley & Sons Inc., New York, 5th Edition, 1986.*
6. ***Gas turbine theory***, *H.Cohen, G.F.C.Rogers and H.I.H.Saravana muttoo Longman Co., ELBS Ed., 1982.*

12TE17- FUELS AND COMBUSTION

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INTRODUCTION (9)

General, Conventional Energy Sources, Solar Energy, Nuclear Power, Energy from Biomass, Wind Power, Tidal Power, Geothermal Energy, Energy Survey of India , Rocket Fuels.

SOLID, LIQUID AND GASEOUS FUELS (9)

Coal - Analysis and Properties of Coal, Classification of Coal, Oxidation of Coal, Hydrogenation of Coal, Efficient use of Solid Fuels, Manufactured Fuels, Agro Fuels, Solid Fuel Handling, Properties Related to Combustion, Handling Storage, Origin and Classification of Petroleum, Refining and Other Conversion Processes, Composition of Petroleum Various Petroleum Products, Storage and Handling of Liquid Fuels, Liquid Fuel Combustion Equipment, Gaseous Fuels, Through Non-Thermal Route-Biogas, Refinery Gas, LPG, Cleaning and Purification of Gaseous Fuels.

THEORY OF COMBUSTION PROCESS (9)

Stoichiometry and Thermodynamics, Combustion Stoichiometry General, Rapid Methods of Combustion Stoichiometry, Combustion Thermodynamics, Problem, Combustion Problems with Chemical Reactions Burners.

STOICHIOMETRY (9)

Stoichiometry Relations, Theoretical Air Required for Complete Combustion, Calculation of Minimum Amount of Air Required for a Fuel of Known Composition, Calculation of Dry Flue Gases If Fuel Combustion is Known, Calculation of the Composition of Fuel and Excess Air Supplied from Exhaust Gas Analysis, Dew Point of Products, Flue Gas Analysis(0_2, CO_2, CO, NOx, SOx).

BURNER DESIGN (9)

Ignition, Concept of Ignition, Auto Ignition, Ignition Temperature, Flame Propagation, Various Methods of Flame Stabilization, Incorporation in Burner Design, Basic Features and Types of Solids, Liquid and Gaseous Fuel Burner, Design Consideration of Different Types of Coal-Oil and Gas Burners, Recuperative and Regenerative Burners.

TOTAL: 45

References :

1. ***Samir Sarkar,*** *Fuels & Combustion****, 2nd Edition, Orient Logman,latest Edition***
2. ***Bhatt, Vora*** *Stoichiometry****,2nd Edition, tata Mcgraw Hill, 2000.***
3. ***Blokh AG,*** *Heat Transfer in Steam Boiler Furance****, Hemisphere Publishing Corpn,2000.***
4. ***Civil Davies,*** *Calculations in Furance Technology****, Pergamon Press,Oxford,2000***
5. ***Sharma SP,Mohan Chander,****Fuels & Combustion****, Tata Mcgraw Hill,2000.***

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2. *http://opus.utah.edu.*
3. *http://www.creada..org.*

12TE18 COMPUTATIONAL FLUID DYNAMICS

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GOVERNING EQUATIONS AND BOUNDARY CONDITIONS (9)

Basics of CFD, Governing equations of Fluid Dynamics – Continuity, Momentum and EnergyEquations, Physical Boundary conditions, Mathematical behavior of PDEs on CFD – Elliptic,Parabolic and Hyperbolic equations.

DISCRETISATION TECHNIQUES AND SOLUTION METHODOLOGIES (9)

Methods of deriving discretisation equations – Finite difference & Finite volume methods, Finite difference discretisation of wave equation, Laplace equation, Burger's equation, numerical error and stability analysis. Time dependent methods – Explicit, Implicit – Crank – Nicolson methods, time split methods.

CALCULATION OF FLOW – FIELD FOR N – S EQUATIONS (9)

Finite volume formulation of steady one-dimensional convection and Diffusion problems,Central, upwind, hybrid and power-law schemes – Discretization equations for two dimensional convection and diffusion. Representation of the pressure – Gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and velocity corrections – Pressure – Correction equation. SIMPLE algorithm and its variants.

TURBULENCE MODELING (9)

Time – averaged equation for turbulent flow, Turbulence models – Zero equation model, oneequation model, two equation K-I models, and advanced models.

GRID GENERATION (9)

Algebraic Methods – Methods – Differential Equation methods – Adaptive grids.

TOTAL: 45

***References* :**

1. ***Versteeg, H.K, and Malalasekera, W.,*** *"An Introduction to Computational Fluid Dynamics: The Finite Volume Method"****, Longman, 1998***
2. ***D. A, Anderson, John C. Tanne hill, Richard H. Pletcher –*** *Computational Fluid Mechanics and Head Transfer****, Hemisphere publishing corporation, McGraw – Hill book company.***
3. ***Muralidhar, K., and Sundararajan, T.,*** *Computational Fluid Flow and Heat Transfer****, NarosaPublishing House, New Delhi, 1995.***
4. ***Ghoshdasdidar, P.S.,*** *Computer Simulation of flow and heat transfer* ***Tata McGraw- HillPublishing Company Ltd., 1998.***
5. ***Subas, V.Patankar,*** *Numerical heat transfer fluid flow****, Hemisphere Publishing Corporation,1980.***
6. ***Taylor, C and Hughes, J.B.*** *Finite Element Programming of the Navier Stock Equation****,Pineridge Press Limited, U.K., 1981.***
7. ***Fletcher, C.A.J.,*** *Computational Techniques for Fluid Dynamics 1, Fundamental and GeneralTechniques****, Springer – Verlag, 1987.***

12TE19 – ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL

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AIR POLLUTION (10)

Definition - sources and effect - air sampling and measurements – dispersion of air pollutants – diurnal effects on the air pollutants dispersion – meteorological aspects – analysis of air pollutants - control methods and equipments - issues in air pollution control

SOLID WASTE MANAGEMENT (10)

Sources and Classification - Characteristics of solid waste-Potential methods of solid waste Disposal – Process and Equipments for Energy Recovery from Municipal Solid Waste and Industrial Solid Waste – Hazardous waste disposal – Secure landfill.

WATER POLLUTION AND TREATMENT (10)

Water and waste water – standards of potable water for various purposes - Sources and Classification of Water Pollutants - Characteristics wastewater - Waste Water Sampling techniques – types of treatment and choice of wastewater treatment – utilization and Disposal of Sludge.

OTHER TYPES OF POLLUTION AND LEGISLATIONS (7)

Sources, health impact on humans, animals and plants, control strategies – for noise pollution Oil Pollution – Pesticides pollution - Radioactivity Pollution – laws governing air, water and soil pollution

CASE STUDIES (8)

Industrial process description – pollution sources – methods available in abatement of pollution – treatment technologies – for thermal power, nuclear power, automobile, aeronautical and mining plants

TOTAL: 45

References **:**

1. ***Environmental Considerations in Energy Development, Asian Development Bank (ADB), Manilla(1991)***
2. *G.Masters (1991):* ***Introduction to Environmental Engineering and Science,*** *Prentice -Hall International Editions.*
3. *H.S.Peavy, D.R..Rowe, G.Tchobanoglous (1985):* ***Environmental Engineering*** *- McGraw- Hill Book Company, NewYork.*
4. *H.Ludwig, W.Evans (1991):* ***Manual of Environmental Technology in Developing Countries,*** *W.Y. Brockelman and B.N.Lohani, International Book Company, Absecon Highlands, N.J*

12TE20-SUPERCHARGING AND SCAVENGING

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SUPERCHARGING (8)

Objectives - Effects on engine performance – engine modification required - Thermo-dynamics of Mechanical supercharging and Turbo charging - Turbo charging methods - Engine exhaust manifolds arrangements.

SUPERCHARGERS (10)

Types of compressors - Positive displacement blowers - Centrifugal compressors - Performance characteristic curves - Suitability for engine application - Surging - Matching of supercharger compressor and Engine – Matching of compressor, Turbine Engine.

SCAVENGING OF TWO STROKE ENGINES (12)

Peculiarities of two stroke cycle engines - Classification of scavenging systems - Mixture control through Reed valve induction - Charging Processes in two stroke cycle engine - Terminologies - Shankey diagram – Relation between scavenging terms - scavenging modeling - perfect displacement, Perfect mixing Complex scavenging models.

PORTS AND MUFFLER DESIGN (8)

Porting - Design considerations - Design of intake and Exhaust Systems - Tuning.

EXPERIMENTAL METHODS (7)

Experimental techniques for evaluating scavenging - Firing engine tests - Non firing engine tests – Port flow characteristics - Kadenacy system - Orbital engine combustion system, Sonic system.

TOTAL: 45

***References* :**

1. *Obert, E.F.,* ***Internal Combustion Engines and Air Pollution,*** *Intext Education Publishers,1980.*
2. *Richard Stone,* ***Internal Combustion Engines****, SAE,1992.*
3. *Vincent,E.T.,* ***Supercharging the I.C.Engines,*** *McGraw-Hill,2002.*
4. *Watson,N. and Janota, M.S.,* ***Turbocharging the I.C. Engine,*** *MacMillan Co.,2000.*
5. *Schweitzer, P.H.,* ***Scavenging of Two Stroke Cycle Diesel Engine****, MacMillan Co.1996.*
6. *John B.Heywood,* ***Two Stroke Cycle Engine****, SAE Publications,1997.*

12TE21 - CRYOGENIC ENGINEERING

L	T	P	C
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INTRODUCTION (9)

Insight on Cryogenics, Methods of producing cold - thermodynamic basis, first and second law analyses, Vapour compression systems, Properties of Cryogenic fluids, and Material properties at Cryogenic temperatures.

LIQUEFACTION CYCLES (9)

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles, Inversion Curve-JouleThomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Dual Cycle, Helium Regrigerated Hydrogen Liquefaction Systems. Critical components in Liquefaction Systems.

SEPARATION OF CRYOGENIC GASES (9)

Binary Mixtures, T-C and H-C Diagrams, Principle of Rectification, Rectification Column Analysis – McCabe Thiele Method. Adsorption Systems for purification.

CRYOGENIC REFRIGERTORS (9)

J.T.Cryocoolers, Stiriling Cycle Refrigerators, G.M.Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators.

HANDLING OF CRYOGENS AND APPLICATIONS (9)

Cryogenic Dewar Construction and Design, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Different Types of Vacuum Pumps, Instrumentation to measure Flow, Level and Temperature. Applications of Cryogenics in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications

TOTAL: 45

***References* :**

1. *Thomas M.Flynn, **Cryogenic Engineering**, Marcel Dekker, New York, 2005.*
2. *Klaus D.Timmerhaus and Thomas M.Flynn, **Cryogenic Process Engineering**, Plenum Press, New York, 1989.*
3. *Randall F.Barron, **Cryogenic Systems**, McGraw Hill, 2002.*
4. *Scott R.B., **Cryogenic Engineering**, Van Nostrand and Co., 1962.*
5. *Robert W. Vance, **Cryogenic Technology**, Johnwiley & Sons, Inc.2002, New York, London*
6. *G.Venkatarathnam, Cryogenic Mixed Refrigerant Processes, Springer Publication, 2010.*

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1. *http://www.wiley-vch.de/contents/ullmann/ull_10211.html.*
2. *http://www.onecro.com*
3. *http://www.caddet-ee.org/search/produce.cfm?ID=R072*
4. *http://www.sumkasons.20m.com/In2.htm*
5. *http://www.thtcryogenics.freeserve.co.uk/crogenics.htm*

12TE22 GAS TURBINES

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INTRODUCTION (9)

Power plant cycles for stationary and aircraft applications, component behaviors, Industrial applications, Marine and land transportation, Environmental issues, analysis of ramjet, turbojet and turbo-propeller, Inlets and nozzles.

COMPRESSORS (9)

Principle and operations of Centrifugal and axial flow compressors momentum and energy transfer in rotors, velocity diagrams, calculation of stage performance, compressibility effects, cascade testing and characteristics.

AXIAL AND RADIAL FLOW TURBINE (9)

Elementary theory of axial and radial flow turbine, Vortex theorem, choice of blade profile, Pitch and Chord Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, materials, testing and performance characteristics.

COMBUSTORS (9)

Different types and flow pattern, material requirement and cooling systems, air pollution and reduction.

MATCHING (9)

Matching procedure of power plant components, engine off-design performance.

TOTAL: 45

REFERENCES:

1. *Cohen, H., Rogers, G.E.C., and Saravanamuttoo, H.I.H.,* ***Gas Turbine Theory****, Longman Group Ltd, 1989.*
2. *Gordon C, Dates,* ***Aero-thermodynamics of Gas Turbine and Rocket Propulsion*** *– AIAA Education Series, NY 1984.*
3. *Kerrebrock, J.L.,* ***Aircraft engines and gas turbines****, The MIT Press.*
4. *Yahya, S.H.,* ***Turbines, Compressors and Fans****, Tata McGraw-Hill, 1983.*
5. *Earl Logan, Jr.,* ***Hand book of Turbo machinery****, Marcel Dekker, Inc., USA, 19926. Dixon, S.L.,* ***Fluid Mechanics and Thermodynamics of Turbo machinery****, Pergamon Press, 1978.*

12TE23 - FOOD PROCESSING, PRESERVATION AND TRANSPORT

L	T	P	C
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INTRODUCTION (10)

Microbiology of Food Products, Mechanism of Food Spoilage, Refrigeration Technologies of Food Products. Thermodynamic Properties, Cooling Process and Heat Transfer Parameters of Food products – Their Effect on Quality. Moisture Losses from Respiration of Food Products, Optimum Cold Storage Conditions.

PROCESSING AND PRESERVATION (9)

Food Processing Techniques, Standard Norms for Processing, Plant Layout, Preservation of Milk, Butter, Fruits, Vegetables, Meat Products. Environment Friendly Food Processing Techniques, Cryofreezing, Energy Conservation in Food Industries.

FREEZING AND DRYING (8)

Precooling, Quick Freezing, Freeze Drying Principles, Techniques and Equipments. Cold Storage and Freezers. Freezing and Drying Limitations. Irradiation Techniques. Food Preserving Techniques for Remote Areas.

COLD STORAGE DESIGN AND INSTRUMENTATION (9)

Design, Selection, Matching, Installation and Maintenance of Cold Storage and Freezers. Insulation, Instrumentation and Control. Energy Conservation Techniques for Freezers and Cold Storages.

TRANSPORT (9)

Refrigerated Transportation, Refrigerated Containers and Trucks. Design Features, Piping and Role of Cryogenics in Freezing and Transport, Basic packaging materials, types of packaging, packaging design, packaging for different types of foods

TOTAL: 45

References :

1. *Alan Rodes,* ***Principles of Industrial Microbiology****, Pregmon International Pub., 2000.*
2. *Ibrahim Dincer,* ***Heat Transfer in Food Cooling Applications****, Tailor & Francis Pub. 1997.*
3. *Stanley E. Charm,* ***Fundamentals of Food Engineering****, 3Edition. AVI Pub. Company Inc.1989.*
4. *Clive V.I.Dellino,* ***Cold and chilled Storage Technology****, Van Nostrand Reinhold Pub, NewYork 1991.*
5. *Arora C.P.* ***Refrigeration and Airconditioning****, 2 Edition. McGraw Hill, Pub. 2000.*
6. *ASHRAE Handbook,* ***Cold Storage Application – Collection of papers from ASHRAE Winter meeting at Delirious and Chicago****, Jan 1988 and 1989.*
7. *Fellows, P. J. "****Food Processing Technology: Principles and Practices****", Wood Head Publishing, 1997.*

12TE24 REFRIGERATION MACHINERY AND COMPONENTS

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REFRIGERATION SYSTEM COMPONENTS (9)

Refrigeration Compressors, Different Types, Performance, Capacity Control – Evaporators, Evaporators Circuitry, Applications and Different Types – Condensers, Types, Evaporative Condenser, Optimum Cooling Water Rate and Velocity, Cooling Towers, Range and Approach, Air Washers, Spray Ponds, Natural and Induced Draught System – Expansion Devices.

COMPONENTS TESTING AS PER (BIS CODES) (9)

Testing of Condensers and Evaporators, Testing of Cold Storages – Code of Practice for Fire Safety in General Storage. Specification and Testing of Room Air conditioners.

AIR CONDITIONING EQUIPMENTS AND ACCESSORIES (9)

Construction Details of Room Air Conditioner – Window Type, Package Type, Split ype Central Units – Air Distribution Devices – Air Circuits – Air Supply System.

APPLICATIONS OF AIR CONDITIONING (9)

Air Conditioning in Automobiles, Railway Wagons, Marine Vessels, Aircraft and Other Commercial Applications .

REFRIGERATION ACCESSORIES & CONTROL (9)

Piping System, Valves, Receivers, Oil Trap, Oil Regenerators, Driers and Strainers. ControlSystem of Temperature, Pressure, Oil Flow, Compressor Motor – Protection Devices.

TOTAL: 45

References :

1. *Dossat, R. J.* ***"Principles of Refrigeration"****, John Wiley & Sons, 1989.*
2. *Hains, J.B.* ***"Automatic Control of Heating & Air conditioning"*** *McGraw-Hill, 1981.*
3. *Althouse, A.D. & Turnquist, C.H.* ***"Modern Refrigeration and Air conditioning"*** *Heart – Wilcox Co. Inc.,1985.*
4. ***Recent release of BIS Code for relevant testing practice.***
5. ***ASHRAE Hand book (Fundamentals & Equipments)***
6. *Cooper & Williams, B.* ***"Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting"*** *Eagle Wood Cliffs (NT) Prentice Hall, 1989.*

12TE25 THERMAL ENERGY SYSTEMS

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DESIGN OF THERMAL SYSTEM (6)

Design systems, Workable Systems, Optimal Systems, Matching of system Components, Economic analysis, Depreciation, gradient present worth factor.

MATHEMATICAL MODELLING (8)

Equation fitting – Nomography, Empirical equation, Regression analysis, Different modes of mathematical models, selection, computer programmes for models.

MODELLING THERMAL EQUIPMENTS (8)

Modelling heat exchangers. Evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

SYSTEMS OPTIMIZATION (15)

Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, programming, Linear programming methods, solution procedures.

DYNAMIC BEHAVIOUR OF THERMAL SYSTEM (8)

Steady state simulation, Laplace transformation, Feedback control loops, Stability analysis, Non linearities.

TOTAL: 45

References :

1. *J.N.Kapur,* ***Mathematical Modelling****, Willey Eastern Ltd., New York, 2002.*
2. *W.F.Stoecker,* ***Design of Thermal Systems****. McGraw Hill, 2002.*
3. *W.F.Stoecker,* ***Refrigeration and Airconditioning****, TMH, 2005.*
4. *Fanger P.O.,* ***Thermal Comfort****, McGraw Hill, USA, 1972.*
5. *McQuiston FC & Parker TD,* ***Heating, Ventilating and Air conditioning, Analysis and Design****, John Wiley & Sons, USA, 1988.*

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2. *http://at.yorku.ca/cgi-bin/amca/cadl-26*
3. *http://www.gre.ac.uk/research/cms/centre*
4. *http://naca.larc.nasa.gov*

08TE26- FANS, BLOWERS AND COMPRESSORS

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PRINCIPLES OF TURBO MACHINERY (10)

Introduction to turbo machines- Transfer of energy to fluids- performance characteristics- fan laws- dimensionless parameters- specific speed- selection of centrifugal, axial, mixed flow, Axial flow machines.

ANALYSIS OF CENTRIFUGAL BLOWERS (10)

Centrifugal blowers: Theoretical characteristic curves, Eulers characteristics and Eulers velocity triangles, losses and hydraulic efficiency, flow through impeller casing inlet nozzle. Volute, diffusers, leakage disc friction mechanical losses multivane impellers of impulse type, cross flow fans.

ANALYSIS OF AXIAL FLOW (10)

Axial flow fans: rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers.

TESTING AND CONTROL OF FANS (05)

Fan testing, noise control, material and components blower regulation, speed control, throttling control at discharge and inlet.

DESIGN AND APPLICATIONS OF BLOWERS (10)

Special design and applications of blower, induced and forced draft fans for air-conditioning plants, cooling towers, ventilation systems, booster systems.

TOTAL: 45

References :

1. *Stepanoff A.J.* ***Turboblowers****, John Wiley & sons, 2000*
2. *Brunocek,* ***Fans****, Pergamon Press, 1973.*
3. *Austin H. Chruch,* ***Centrifugal pumps and blowers****, John Wiley and sons, 1980.*
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5. *Dixon.* ***Worked examples in turbomachinery****, Pergamon press, 1984.*

References :

1. *http://www.petropager.com*
2. *http://www.tami.org*
3. *http://www.erichson.com*
4. *0http://www.apgate.com*

12TE27 DIESEL EMISSION CHARACTERISTICS

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DIESEL EMISSION CHARACTERISTICS (9)

Vehicle emission Test Programme - Effect of ambient Temperature on “HC”, “OC” and emission - Different fuel system.

EFFECT OF HIGH PRESSURE INJECTION ON SOOT FORMATION PROCESS (9)

High Pressure Injection - Experimental apparatus and measuring principles - Measurement of Non-Evaporating spray – Measurement of Evaporating spray and flame.

DIESEL SOOT SUPPRESSION (9)

Soot Suppression by kind and content of fuel additives - Under various operating conditions - Effect of combustion chamber type and swirl ratio.

SIMULTANEOUS REDUCTION OF SOOT AND NOx (9)

Experimental procedure - Steady state and test cycle - Transient test cycle.

EFFECTS OF DIESEL FUEL PROPERTY ON EXHAUST VALVE STICKING (9)

Test engine bench - Test fuel engine - ignition limit test - Investigation of white smoke - Measurement of valve sticking force - Valve Train fracture test.

TOTAL: 45

References :

1. *Satora, Yasuhiro Iton Gutaka Higuchi and Tateo Nagai,* ***SAE - 901608.***
2. *SW Cootes and G.G.Lassanska,* ***SAE - 901597.***
3. *G.Greeves and CHT Wang,* ***SAE – 810260.***
4. *Yuzo.Aoyagi, Takeyuki Kamimoto Yokio Matsui and Shim Matsuoka,* ***SAE – 800254.***
5. *Jeggetg cinoebtes and John H.Johnson,* ***SAE – 790815.***
6. *Harvet A. Bybket and Thoedore L.Rjosebrock,* ***SAE – 790923.***
7. *Charles M.Urban and Robert D.Waner,* ***SAE – 850147.***

12TE28 MODELING OF CI ENGINE PROCESSES

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GENERAL CONSIDERATIONS OF MODELING (5)

Governing equations, conservation of mass, conservation of energy, second law Analysis, Numerical methodology, computing mesh, Discretisation, Grid Formation.

SPRAY MODELING (5)

Spray equation Models, Thin spray models, Thick Spray Models, Droplet turbulence inter- actions, Droplet impingement on walls.

IN-CYLINDER FLOW MODELING (10)

Full Field Model, K-e Model, laminar flow modeling, probability density functions, Ekman layers roll-up vortex, vortex structures. Compression generated turbulence, effective viscosity turbulent diffusivity.

INTRODUCTION TO COMBUSTION MODELING (10)

Classification, zero-dimensional modeling, quasi-dimensional modeling, multidimensional modeling, comparison of different combustion systems, combustion efficiency, applications

COMBUSTION MODELS (15)

Multi zone Models, Kono's model, Cummins engine model, Hiroyasu's model,. Single zone models, Premixed diffusive models, Heat Transfer Cp-relations Weibe's function analysis, Whitehouse-way model, Two zone models, Mathematical modeling of Catalytic converters one dimensional model- 2D axi-symmetric model of monolithic reactor, Computation of chemical reactions, two dimensional transient temperature field.

TOTAL: 45

References :

1. *J.I.Ramos* ***"Internal Combustion Engine Modeling"*** *Hemisphere Publishing Corporation, 1989.*
2. *James N.Mattavi and Charles A.Amann* ***"Combustion Modeling in Reciprocating Engines"****. Plenum Press - 1980.*
3. *John.B.Heywood,* ***"Internal Combustion Engine Fundamentals"*** *McGraw-Hill International Editions, Automotive technology Series, 2000.*
4. *Pkandylas,G.C.Koltsakis and A.M.Stamatelos* ***"Mathematical Modeling of Precious Metals Catalytic Converters for Diesel Nox Reduction"****. Proc.Institution of Mechanical Engineers Vol. 213 Pard D.*
5. *Sandeep Maju, Robert I.Sager.Jr., and Benny J.Srider,* ***"Predicting Durability"*** *Mechanical ngineering Vol. 64, March 1999.*
6. *A.J.Baxendale* ***"Computational Fluid Dynamics in Exhaust System Design and Development"****, SAE Paper No. 931072, 1 993.*

12TE29 ENGINE ELECTRONICS

L	T	P	C
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SENSORS (9)

Types – Air flow, Pressure, Temperature, Speed Oxygen, Detonation, Position – Principle ofOperation, Arrangement and material.

GASOLINE INJECTION SYSTEM (9)

Open loop and closed loop systems, Mono point, Multi point and direct injection systems –Principles and Features, Bosch injection systems.

DIESEL INJECTION SYSTEM (9)

Inline injection pump, Rotary pump and injector – Construction and principle of operation,Common rail and unit injector system – Construction and principle of operation.

IGNITION SYSTEMS (9)

Ignition fundamentals, Types of solid state ignition systems, high energy ignition distributors, Electronic spark timing and control.

ENGINE MAPPING (9)

Combined ignition and fuel management systems. Digital control techniques – Dwell angle calculation, Ignition timing calculation and Injection duration calculation, Hybrid vehicles and fuel cells.

TOTAL: 45

References :

1. ***Bosch Technical Instruction Booklets.***
2. *Tom Denton,* ***Automotive Electrical and Electronic Systems****, Edward Arnold, 1995*
3. *Robert N.Brady,* ***Automotive Computers and Digital Instrumentation****, Prentice Hall, 1988.*
4. *Duffy Smith.,* ***Auto Fuel Systems****, The god Heart Willcox Company Inc., Publishers, 1987.*
5. *Heinz Heisler.,* ***Advanced Engine Technology****. SAE Publications, 19954. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.*

12TE30 – ENGINE POLLUTION AND CONTROL

L	T	P	C
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POLLUTION – ENGINES AND TURBINES (5)

Atmospheric Pollution from piston engines and gas turbines, global warming.

POLLUTANT FORMATION (10)

Formation of Oxides of Nitrogen, Carbon monoxide, hydrocarbon, aldehydes and Smoke Particulate emission, effects of pollutions on environment.

POLLUTION MEASUREMENT (10)

Non dispersive infrared gas analyzer, gas chromatography, chemiluminescent analyzer and flame ionization detector, smoke measurement, noise pollution, measurement and control.

CONTROL OF ENGINE POLLUTION (10)

Engine component, fuel modification, evaporative emission control, EGR, air injection in thermal reactors, In cylinders control of pollution, catalytic converters, application of microprocessors in emission control.

DRIVING CYCLES AND EMISSION STANDARDS (10)

Use of driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards.

TOTAL: 45

References :

1. *Crouse William,* ***Automotive Emission Control****, Gregg Division / McGraw-Hill 2000.*
2. *Ernest, S.,Starkman,* ***Combustion Generalized Air Pollutions****, Plenum Press, 1980.*
3. *George, Springer and Donald J.Patterson,* ***Engine emissions, pollutant Formation and Measurement****, Plenum Press, 2000.*
4. *Obert,E.F.,* ***Internal Combustion Engines and air Pollution****, Intext Educational Publishers, 2000.*

12TE31 MANUFACTURING AND TESTING OF IC ENGINES AND COMPONENTS

L	T	P	C
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CYLINDER BLOCK AND CYLINDER HEAD (9)

Casting practice and special requirements, materials, machining, methods of testing, Cylinderliners – Mat, Types and Manufacture.

PISTON ASSEMBLY (9)

Types, requirements, casting, forging, squeeze casting, materials, machining, testing, manufacture piston rings – material, types and manufacture – surface treatment, bimetallic pistons, articulated pistons.

DRIVE SYSTEMS (9)

Requirements, materials, forging practice, machining, balancing of crankshaft, testing, CR, CS, CAS, VT.

COMPUTER INTEGRATED MANUFACTURING (9)

Integration of CAD, CAM and Business functions CIM- Networking, CNC programming formachining of I.C.Engines Components.

QUALITY AND TESTING (9)

SPC - Introduction to ISO 9000, ISO 14000, TS 16949, its importance, BIS codes for testingvarious types of engines, equipments required, instrumentation, computer aided engine testing, metrology for manufacturing I.C.Engine Components, In site measurement – Telemetry and sensors.

TOTAL: 45

References :

1. *Grover, M.P., **CAD/CAM**, Prentice Hall of India Ltd., 1985.*
2. *Heldt, P.M**., High speed internal combustion engines**, Oxford & IBH Publishing Co., 1960.*
3. *Judge, A.W., **Testing of high speed internal combustion engines**, Chapman & Hall., 1960.*
4. *Richard, W., Heine Carl R. Loper Jr. and Philip, C., Rosenthal, **Principles of Metal Casting**, McGraw-Hill Book Co., 1980.*
5. ***IS: 1602 – 1960 Code for testing of variable speed internal Combustion engines for Automobile Purposes, 1966.***
6. ***SAE Handbook, 1994.***
7. *P.Radhakrishnan and S.Subramaniayn, **CAD/CAM/CIM**, New Age International (P) Limited, Publishers, 1997.*
8. *Mikett P.Groover**, Automation, production Systems and Computer – Integrated Manufacturing** Printice Hall of India Private Limited, 1999.*

12TE32 ENGINE AUXILIARY SYSTEMS

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CARBURETION (9)

Gasoline - air mixtures. Mixture requirements - Mixture formation - Carburetor, Chokes, Effect of altitude on carburation. Carburator systems for emission control.

GASOLINE INJECTION AND IGNITION SYSTEMS (9)

Petrol Injection, Pneumatic and Electronic Fuel Injection Systems, Ignition systems- requirements, Timing Systems, breaker mechanism. Energy requirement, Spark plug operation, Electronic Ignition Systems.

DIESEL FUEL INJECTION (9)

Atomization, penetration and dispersion, Rate and duration of injection, Fuel line hydraulics, Fuel pump, Injectors. Governors.

MANIFOLDS AND MIXTURE DISTRIBUTION (9)

Intake system components, Air filter, Intake manifold, Exhaust system components, Exhaust manifold and exhaust pipe, Spark arresters, Exhaust mufflers.

LUBRICATION AND COOLING SYSTEMS (9)

Lubricants, lubricating systems, Lubrication of piston rings, bearings, oil consumption, Oil cooling - Heat transfer coefficients, liquid and air cooled engines, additives and lubricity.

TOTAL: 45

REFERENCES:

1. *Ramalingam,K.K, " **Internal Combustion Engine"**, Scitech Publication (India) Pvt.Ltd.2004.*
2. *Domkundwar, V.M, "**A Course in Internal Combustion Engines"**, Dhanpat Rai and Co.,1999.*
3. *Mathur,M.L., and Sharma,R.P., "**A Course in Internal Combustion Engines"**, Dhanpat Rai Publications (P) Ltd., 1998.*
4. *4.Ganesan, V.,"**Internal Combustion Engines"**, Tata McGraw-Hill Book Co., 1995.*
5. *Duffy Smith, **"Auto Fuel Sytstems, The Good** "Heart Willcox Company Inc., Publishers, 1987.*

12TE33 AUTOMOTIVE ENGINE SYSTEMS

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AUTOMOTIVE ENGINE TYPES (8)

On-highway, Off-highway, Gasoline, Diesel and Alternate Fueled. Characteristics of automotive Engines - Power, Torque, Fuel Consumption, Pollutant Emission, Thermal Efficiency, Life Cycle Cost..

GASOLINE INJECTION (9)

TBI and Multipoint Injection, Engine Management System, Catalytic Conversion of Engine Pollutants, Electrical Catalyst Heaters, Diesel Particulate Trapping and Trap Regeneration, Gaseous fuel Injection, Dual Fueling and Controls - CNG and Gasoline, Hydrogen and Diesel, Alcohols and Diesels etc.

FUEL QUALITY (9)

Fuel quality standards for Automotive Engines - Lead free gasolines, low and ultra - low sulphur diesels, LPG, CNG, Alcohols, Biodiesels.

ENGINE ELECTRONIC (9)

Engine electrical and electronic system, Engine sensors, Distributorless ignition and Direct ignition systems, 12V, Dual voltage and 42V systems.

NEW ENGINE TECHNOLOGIES (10)

Current trends in engine technology - Multi-valving, Tuned main folding, camless valve gearing, variable valve timing, Turbo and supercharging - Waste gating, EGR, Part - load charge stratification in GDI systems, Current materials and production processes for engine components, ISO 9000, QS 9000 Certifications.

TOTAL: 45

References :

1. *Robert Bosch, GmbH, " **Automotive Hand Book "**, Germany, 2000.*
2. *Tom Denton, **" Automobile Electrical and Electronic Systems "**, SAE International USA, 2000.*
3. *Eric Chowanietz, **" Automoblie Electronics "**, SAE International, 1995.*
4. *SAE Inc., **" Advanced Power Plant Conpects "**, SP - 1325, 1998.*
5. *Micheal Plint and Anthony Martyr, **" Engine testing Theory and Practice "**(Second Edition) SAE International, 1999.*
6. *SAE Inc, **" Advancements in Electric and Hybird Electric Vehicle Technology "**, SP - 1023, 1994.*

12TE34 - ALTERNATIVE FUELS FOR IC ENGINES

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INTRODUCTION (9)

Need for alternate fuel, availability and properties of alternate fuels, general use ofalcohols, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, meritsand demerits of various alternate fuels, introduction to alternate energy sources.

ALCOHOLS (9)

Properties as engine fuel, alcohols and gasoline blends, performance in SI engine,methanol and gasoline blends, combustion characteristics in CI engines, emissioncharacteristics, DME, DEE properties performance analysis, performance in SI and CIEngines.

NATURAL GAS, LPG, HYDROGEN AND BIOGAS (9)

Availability of CNG, properties, modification required to use in engines, performance andemission characteristics of CNG using LPG in SI and CI engines, performance andemission of LPG. Hydrogen- storage and handling, performance and safety aspects.

VEGETABLE OILS (9)

Various vegetable oils for engines, esterification, performance in engines, performanceand emission characteristics, bio diesel and its characteristics.

ELECTRIC, HYBRID, FUEL CELL AND SOLAR CARS (9)

Layout of an electric vehicle, advantage and limitations, specifications, systemcomponents, electronic control system, high energy and power density batteries, hybridvehicle, fuel cell vehicles, solar powered vehicles.

TOTAL: 45

References :

1. *Richard.L.Bechfold – **Alternative Fuels Guide Book** - SAE International Warrendale, 1997.*
2. *Maheswar Dayal - "**Energy today a tomorrow**"- I and B Horishr India, 1982.*
3. *Nagpal - "**Power Plant Engineering**" - Khanna Publishers, 1991.*
4. *"**Alcohols as motor fuels progress in technology**" - Series No.19 - SAE Publication USE, 1980.*
5. *SAE paper nos. 840367, 841333, 841334, 841156, Transactions, SAE, USA*

Web References :

1.http://aimforhigh.blogspot.com/2011/12/at2022-alternate-fuels-and-energy.html#ixzz1uBElr9rW

12TE35 BIO-ENERGY CONVERSION TECHNIQUES

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INTRODUCTION (9)

Bio Energy - Bio Conversion Mechanism - Utilization of Photosynthate.

THERMAL BIOMASS CONVERSION (9)

Combustion, Pyrolysis, Gasification and Liguefaction - Biological Conversion - Methoanl, Ethanol Production - Fermention - Anaerobic Digestion Biodegradation and Biodegradability of Substrate - Hydrogen Generation from Algae – Biological Pathways.

POWER GENERATION TECHNIQUES (9)

Through Fermentation and Gasification - Biomass Production from differnet Oragnic Wastes - Effect of Additives on Biogas Yield - Biogas production from Dry Dung Cakes.

INDUSTRIAL APPLICATION (9)

Industrial Application - Viability of Energy Production - Wood Gasifier System, Operation of Spark Ignition and Compression Ignition with Wood Gas. Operation and Maintenance.

ECONOMICS AND ENVIRONMENTAL ASPECTS (9)

Energy Effectives and Cost Effectiveness - History of Energy Consumption andCost - Environmental Aspects of Bioenergy Conversion.

TOTAL: 45

References :

1. *David Boyles,* ***Bio Energy Technology Thermodynamics and costs****, Ellis Hoknood, Chichester, 1984*
2. *Khandelwal KC, Mahdi SS,* ***Biogas Technology - A Practical Handbook****, Tata McGraw Hill, 1986*
3. *R.C.Maheswari,* ***Bio Energy for Rural Energisation*** *, Concepts Publication, 1997*
4. *Anthony San Pietro,* ***Biochemical and Photosynthetic aspects of Energy Production****, Academic Press, New York, 1980*
5. *EL - Halwagi MM,* ***Biogas Technology : Transfer & Diffusio****, Elsevier Applied SC, London 1986*

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1. *http://www.bio-energy.at2. http://www.abchansen.dk.3. www.soest.hawaii.edu/csf*