SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

Approved by AICTE, Recognized by UGC & Affiliated to Anna University
Accredited by NBA-AICTE, NAAC-UGC with 'A+' Grade

Saravanampatti , Coimbatore -641035

CURRICULA AND SYLLABI

REGULATION 2016

CHOICE BASED CREDIT SYSTEM

DEPARTMENT OF MECHANICAL ENGINEERING

M.E – THERMAL ENGINEERING

SNS COLLEGE OF TECHNOLOGY
(An Autonomous Institution)
COIMBATORE-35
DEPARTMENT OF MECHANICAL ENGINEERING
R 2016 –CURRICULUM & SYLLABUS

M. E. THERMAL ENGINEERING

SEMESTER I

S.NO.	COURSE CODE	COURSE TITLE	CAT	CONTACT PERIODS	L	T	P	C	PRE - REQUISITES
THEORY									
1.	16MA606	Advanced Mathematics For Thermal Engineers	FC	4	3	1	0	4	-
2.	16TE601	Advanced Thermodynamics	PC	4	3	1	0	4	-
3.	16TE602	Advanced Heat Transfer	PC	4	3	1	0	4	-
4.	16TE609	Advanced IC 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	-
PRACTICAL									
7.	16TE 607	Thermal Engineering Laboratory	PC	4	0	0	4	2	-
			TOTAL	**25**	**18**	**3**	**4**	**23**	

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CAT	CONTACT PERIODS	L	T	P	C	PRE-REQUISITES
THEORY									
1.	16TE603	Cogeneration and Waste Heat Recovery Systems	PC	3	3	0	0	3	-
2.	16TE604	Computational Fluid Dynamics	PC	4	3	1	0	4	16TE601 16TE602
3.	16TE605	Advanced Engineering Fluid Mechanics	PC	4	3	1	0	4	-
4.	16TE606	Design of Thermal Systems	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	-
PRACTICAL									
7.	16TE625	Technical Seminar	EEC	2	0	0	2	1	-
			TOTAL	**22**	**18**	**2**	**2**	**21**	

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CAT	CONTACT PERIODS	L	T	P	C	PRE-REQUISITES
THEORY									
1.		Professional Elective V	PE	3	3	0	0	3	-
2.		Open Elective**	OE	3	3	0	0	3	-
PRACTICAL									
3.	16TE710	Project Work - Phase I	EEC	12	0	0	12	6	-
4.	16TE701	Computational Fluid Dynamics Laboratory	PC	4	0	0	4	2	16TE604
			TOTAL	**22**	**6**	**0**	**16**	**14**	

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CAT	CONTACT PERIODS	L	T	P	C	PRE-REQUISITES
THEORY									
1.	16TE711	Project Work Phase -II	EEC	24	0	0	24	12	16TE710
			TOTAL	**24**	**0**	**0**	**24**	**12**	

****- Course from the curriculum of other PG programme.**

FOUNDATION COURSE (FC)

S.NO.	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	PRE-REQUISITES
1.	16MA606	Advanced Mathematics For Thermal Engineers	4	3	1	0	4	-

PROFESSIONAL CORE (PC)

S.NO.	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	PRE-REQUISITES
1.	16TE601	Advanced Thermodynamics	4	3	1	0	4	-
2.	16TE602	Advanced Heat Transfer	4	3	1	0	4	-
3.	16TE603	Cogeneration and Waste Heat Recovery Systems	3	3	0	0	3	-
4.	16TE604	Computational Fluid Dynamics	4	3	1	0	4	-
5.	16TE605	Advanced Engineering Fluid Mechanics	4	3	1	0	4	-
6.	16TE606	Design of Thermal Systems	3	3	0	0	3	-
7.	16TE607	Thermal Engineering Laboratory	4	0	0	4	2	-
8.	16TE609	Advanced IC Engines	3	3	0	0	3	
9.	16TE701	Computational Fluid Dynamics Laboratory	4	0	0	4	2	-

PROFESSIONAL ELECTIVES

S.NO.	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	PRE-REQUISITES
1.	16TE608	Fuels and Combustion	3	3	0	0	3	-
2.	16TE610	Combustion Engineering	3	3	0	0	3	-
3.	16TE611	Supercharging and Scavenging	3	3	0	0	3	-
4.	16TE612	Manufacturing and Testing of IC Engine Components	3	3	0	0	3	-
5.	16TE613	Renewable Energy Systems	3	3	0	0	3	-
6.	16TE614	Design of Fluidized Bed Systems	3	3	0	0	3	-
7.	16TE615	Energy Conservation in Thermal Systems	3	3	0	0	3	-
8.	16TE616	Fuel Cell Technology	3	3	0	0	3	-
9.	16TE617	Refrigeration Machinery and Components	3	3	0	0	3	-
10.	16TE618	Industrial Refrigeration Systems	3	3	0	0	3	-
11.	16TE619	Design of Refrigeration Equipment	3	3	0	0	3	-
12.	16TE620	Advanced Power Plant Engineering	3	3	0	0	3	-
13.	16TE621	Food Processing, Preservation and transport	3	3	0	0	3	-
14.	16TE622	Hybrid Energy Technology	3	3	0	0	3	-
15.	16TE623	Advanced Thermal Storage Technologies	3	3	0	0	3	-
16.	16TE624	Instrumentation for Thermal Systems	3	3	0	0	3	-
17.	16TE702	Boundary Layer Theory and Turbulence	3	3	0	0	3	-
18.	16TE703	Finite Element Method in Heat Transfer Analysis	3	3	0	0	3	-
19.	16TE704	Fluid Flow and Heat Transfer in Engines	3	3	0	0	3	-
20.	16TE705	Design of Heat Exchangers	3	3	0	0	3	-
21.	16TE706	Energy Systems Modeling and Analysis	3	3	0	0	3	-
22.	16TE707	Space Propulsion	3	3	0	0	3	-
23.	16TE708	Turbo Machines	3	3	0	0	3	-
24.	16GE701	Engineering Education Management	3	3	0	0	3	-
25.	16TE709	Gas Turbines	3	3	0	0	3	-

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.NO.	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	PRE-REQUISITES
1.	16TE625	Technical Seminar	2	0	0	2	1	-
2.	16TE710	Project Work - Phase I	12	0	0	12	6	-
3.	16TE711	Project Work - Phase II	24	0	0	24	12	16TE710

OPEN ELECTIVE OFFERED TO OTHER PG PROGRAMMES

S.NO.	COURSE CODE	COURSE TITLE	CONTACT PERIODS	L	T	P	C	PRE-REQUISITES
1.	16TE901	Fire and Safety Engineering	3	3	0	0	3	-
2.	16TE902	Energy and Environment	3	3	0	0	3	-

S.No.	SUBJECT AREA	Credits Per Semester				Total Credits
		I	II	III	IV	
1	**FC**	4	0	0	0	**4**
2	**PC**	13	14	2	0	**29**
3	**PE**	6	6	3	0	**15**
4	**EEC**	0	1	6	12	**19**
5	**OE**	0	0	3	0	**3**
	TOTAL	**23**	**21**	**14**	**12**	**70**

16MA606	ADVANCED MATHEMATICS FOR THERMAL ENGINEERS	L	T	P	C
	(M.E. Thermal Engineering)	3	1	0	4

UNIT I APPLICATIONS OF FOURIER TRANSFORM 9+3

Fourier Transform methods – one-dimensional heat conduction problems, infinite and Semi infinite rod – Laplace Equation – Poisson Equation.

UNIT II CALCULUS OF VARIATIONS 9+3

Concept of variation and its properties – Euler's equation – Functional dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables – Variational problems with moving boundaries – Direct methods – Ritz and Kantorovich methods.

UNIT III CONFORMAL MAPPING AND APPLICATIONS 9+3

One The Schwarz- Christoffel Transformation – Transformation of Boundaries In Parametric Form – Physical Applications: Fluid Flow And Heat Flow Problems.

UNIT IV FINITE DIFFERENCE METHODS FOR PARABOLIC EQUATIONS 9+3

One dimensional parabolic equation – Explicit and Crank-Nicolson Schemes – Thomas Algorithm – Weighted average approximation – Dirichlet and Neumann conditions – Two dimensional parabolic equations – ADI method.

UNIT V FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 9+3

Solutions of Laplace and Poisson equations in a rectangular region – Finite difference in polar coordinates – Formulae for derivatives near a curved boundary while using a square mesh.

L:45 T:15 P: 0 Total: 60 PERIODS

REFERENCES

1. Spiegel, M.R., Theory and Problems of Complex Variables and its Application (Schaum's Outline Series) , McGraw Hill Book Co., Singapore, 2009.
2. Mathews, J.H. and Howell, R.W., Complex Analysis for Mathematics and Engineering, Narosa Publishing House, New Delhi, 2013.
3. Jain, M. K., Iyengar, S. R. K. and Jain, R. K. " Computational Methods for Partial Differential Equations", New Age International (P) Ltd., 2007.
4. Erwin Kreyzig, Advanced Engineering Mathematics, 8th Edition, John Wiley & sons,2010.
5. Gupta, A.S., Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd , New Delhi. 2013.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the advanced topics like Fourier transform, Calculus of variance.

CO2 Know the problem on calculus of variations and its techniques.

CO3 Apply the knowledge of solving the problems in Finite difference methods.

CO4 Demonstrate a deep understanding of one form of parabolic equation.

CO5 Solve the engineering Problems by using Laplace and Poisson equations.

16TE601	ADVANCED THERMODYNAMICS	L	T	P	C
	(Use of standard thermodynamics tables, Charts, HMT data books are permitted)	3	1	0	4

UNIT I THERMODYNAMIC PROPERTY RELATIONS 9+3

Fundamental postulate of thermodynamics, fundamental differential equations of thermodynamics. Cyclic relations, Maxwell relations. Generalized relations for changes in entropy - internal energy and enthalpy - generalized 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 11+3

Different equations of state – fugacity – compressibility - principle of corresponding States – Use of generalized charts for enthalpy and entropy departure – fugacity coefficient, Lee – Kesler generalized three parameter tables. Fundamental property relations for systems of variable composition. Partial molar properties. Real gas mixtures -Ideal solution of real gases and liquid -activity - equilibrium in multi-phase systems -Gibbs phase rule, Raoult's law , estimation of dew point and bubble point for refrigerant mixtures

UNIT III CHEMICAL THERMODYNAMICS AND EQUILIBRIUM 9+3

Thermochemistry - First law analysis of reacting systems - Adiabatic flame temperature – entropy change of reacting systems - Second law analysis of reacting systems -Criterion for reaction equilibrium. Equilibrium constant for gaseous mixtures -evaluation of equilibrium composition.

UNIT IV AVAILABILITY ANDEXERGY 9+3

Exergy, Reversible work, irreversibility, derivation of availability functions for closed and open systems, second law efficiency, and applications to various thermodynamic processes.

UNIT V ADVANCED COGENERATIVE CYCLES 8+2

Cycles – Brayton and Rankine cycles, Reheating and Intercooling- Regenerative cycles - Cogenerative cycles for regenerative power plants.

L : 45 T: 15 P: 0 Total: 60 PERIODS

REFERENCES

1. P.K.Nag, Engineering Thermodynamics, Mc-GrawHill Education India, Pvt.Ltd.7th Edition, 2013.
2. YunusCengel, Thermodynamics – An Engineering Approach, Tata McGraw Hill, New Delhi, 7th Edition 2003.
3. ValanArasu,A, Engineering Thermodynamics, Vijay Nicole Imprint Pvt. Ltd., 2006.
4. Sonntag, R.E., and Van Wylen, G, Introduction to Thermodynamics, Classical and Statistical Thermodynamics, Third Edition, John Wiley and Sons, 1991.
5. Holman, J.P., Thermodynamics, 4th Edition, McGraw – Hill Inc., 1988.
6. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons, 1988.
7. Stefan R Turns, Thermodynamic concepts and applications, Cambridge University Press, 2006.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Get Knowledge of fundamental postulates and cyclic & property relations.

CO2 Understand the advanced concepts on real gas behaviour and multi component systems.

CO3 Present chemical thermodynamics advanced topics, adiabatic flame temperature and entropy change also their equilibrium conditions in gases.

CO4 Differentiate and deliberate about the availability and exergy and their calculations.

CO5 Present on the advanced co generative cycles and their importance with case study.

16TE602	ADVANCED HEAT TRANSFER	L	T	P	C
	(Use of standard thermodynamics table, HMT data books are permitted)	3	1	0	4

UNIT I CONDUCTION **9+3**

Three-dimensional heat conduction equations-Cartesian, cylindrical and spherical coordinates –Finite difference formulation of steady and transient three and one dimensional heat conduction problems –explicit and implicit schemes.

UNITII FORCED CONVECTIVE HEAT TRANSFER **11+3**

Convective heat transfer – Non Circular ducts, flow over banks of tubes, internal forced convection, Momentum and energy equations - turbulent boundary layer heat transfer – mixing length concept - turbulence model – analogy between heat and momentum transfer– Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

UNIT III FREE CONVECTIVE HEAT TRANSFER **7+3**

Natural convection from Vertical plates, Horizontal plates, Inclined plates, Horizontal cylinders and spheres, combined natural and forced convection, effective thermal conductivity applications of natural convection.

UNIT IV PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER **9+3**

Condensation with shears edge on bank of tubes - boiling – Boiling regimes ,Nucleate and Film Boiling- pool and flow boiling – heat exchanger – Effectiveness NTU approach and design procedure - compact heat exchangers.

UNIT V RADIATION AND HEAT TRANSFER CORRELATION **9+3**

Introduction -View Factor algebra, calculation of shape factors for simple geometries, radiation exchange between surfaces, thermal circuit analysis and radiation shields.– Heat transfer correlations in various applications like Solar parabolic dish and trough collector, IC Engines.

L : 45 T: 15 P: 0 Total: 60 PERIODS

REFERENCES

1. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley &Sons, 2002.
2. Yunus Cengel , Heat and Mass Transfer A Practical approach , Tata McGraw Hill, 3rd Edition, 2006.
3. Adrain Bejan , Convective Heat Transfer , John Wiley &Sons, 4th edition 2013.
4. Vedat S. Arpaci , Conduction heat transfer, Addision Wesley Co,1996.
5. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985.
6. Nag.P.K, Heat &Mass Transfer, Tata McGraw-Hill, 3rd edition 2011.
7. J.P.Holman, Heat transfer, McGraw Hill company,10th edition, 2009.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the advance concepts of 3D heat conduction and analyse the steady state and transient behaviour of analysis.

CO2 Analyse the forced convection on non-circular and energy equations, turbulence modelling and analogy on momentum transfer.

CO3 Understand the advanced concept of free convection on plates and cylinders and compare the natural and forced convection based on thermal conductivity and their applications.

CO4 Present the phase change behavior of heat exchangers and their regimes in a system.

CO5 Understand the advance concepts of radiation algebra, shape factor, view factor and heat transfer correlations pertaining to the radiation.

16TE609 **ADVANCED IC ENGINES** **L T P C**
3 0 0 3

UNIT I SPARK IGNITION ENGINES 9

Spark ignition Engine mixture requirements – Fuel – Injection systems – Nonpoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – factors affecting knock – Types and design of Combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES 9

States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behavior – spray structure, spray penetration and evaporation– air motion – Introduction to supercharging and Turbo charging.

UNIT III POLLUTANT FORMATION AND CONTROL 9

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

UNIT IV ALTERNATIVE FUELS AND TECHNOLOGIES 9

Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications. Fuel cell – types –Working principles- Performance evaluation.

UNIT V RECENT TRENDS 9

Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – laser Doppler, Anemometry.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. V. Ganesan, Internal Combustion Engines, II Edition, Tata McGraw Hill, 2008.
2. R.B.Mathur and R.P. Sharma, Internal combustion Engines, Dhanpat Rai Publishers, 2010.
3. K.K.Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2011.
4. FranoBabir, PEM Fuel cells -Theory and Application, Elsevier publication, 2000.
5. R.K.Rajput, A text book of Internal Combustion Engine, Lakshmi Publications, 2007.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand about advancement in SI engines based on Injection and types of Combustion systems.

CO2 Understand about advancement in CI engines based on Injection systems and advanced topics like super, turbo charging with case study knowledge.

CO3 Present pollution measurement and norms and its controlling techniques.

CO4 To understand the need of change in fuel and necessary modified engine and compare with SI and CI engines.

CO5 To implement the concept of Lean burn and stratified engines and new fuels like Hydrogen fuel in hybrid engine for their device development.

16TE607 THERMAL ENGINEERING LABORATORY

	L	T	P	C
	0	**0**	**4**	**2**

LIST OF EXPERIMENTS

1. Performance test on Spark Ignition engines.
2. Emission measurement in Spark Ignition and Compression Ignition Engines.
3. Performance test on variable compression ratio petrol and diesel engines.
4. Performance study in a refrigeration Systems.
5. Performance Study in a solar water heater.
6. Performance of Air compressors.
7. Properties of fuel oils, biomass, biogas.
8. Solar Radiation measurement.
9. Boiler efficiency testing.
10. Performance of Parallel / Counter flow Heat Exchangers using LMTD and Effectiveness –NTU method.
11. Study on Fuel Cell Systems.
12. Study on Thermal Storage Systems.

MAJOR EQUIPMENTS / SOFTWARE REQUIRED

1. Spark Ignition engines-Test Rig.
2. Compression Ignition Engine- Test Rig.
3. Research Engine Multi Compression, Fuel -Test Rig.
4. Refrigeration -Test Rig.
5. Air compressor.
6. Calorimeters.
7. Solarimeter.
8. Boiler -Test Rig.
9. Parallel / Counter Flow Heat Exchanger.

L : 0 T: 0 P: 60 Total:60 PERIODS

COURSE OUTCOMES

At the end of the course student should be able to:

CO1	Demonstrate and compare the SI and CI engine performance.
CO2	Understand the working of Refrigeration cycle and compressors and its parameters.
CO3	Study on measurement of the solar water heater using solar energy and solar energy measurement procedure.
CO4	Understand the Boiler efficiency performance and heat exchanger flow like parallel and counter flow .
CO5	Study on fuel cell and thermal storage systems.

16TE603 COGENERATION AND WASTE HEAT RECOVERY SYSTEMS

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **9**

Introduction – principles of thermodynamics – cycles – topping – bottoming – combined cycle – organic rankine cycles – performance indices of cogeneration systems – waste heat recovery –sources and types – concept of tri generation.

UNITII CONGENERATION TECHNOLOGIES **9**

Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: Stirling engines Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: Stirling engines.

UNIT III ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES **9**

Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment.

UNIT IV WASTE HEAT RECOVERY SYSTEMS **9**

Selection criteria for waste heat recovery technologies – recuperators – Regenerators – economizers – plate heat exchangers – thermic fluid heaters – Waste heat boilers classification, location, service conditions, design Considerations – fluidized bed heat exchangers – heat pipe exchangers – heat pumps – absorption systems.

UNIT V ECONOMIC ANALYSIS **9**

Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves – sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems. Environmental considerations for cogeneration and waste heat recovery - Pollution.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984.
2. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.
3. David flin, Cogeneration-A user guide, IET, 2009.
4. V.Ganapathy, Industrial Boilers and Heat recovery-steam generators, Marcel Dekker Co. 2003.
5. Samwel S.Lee, Subratasen gupta, Waste heat management and utilization, hemisphere publishing corporation 1979.
6. Arnic Zageris, Optimisation approaches for waste heat recovery system, Lambert Academic publishing, 2010.
7. Rolf Kehlhofer, Bert Rukrs Cogeneration cycle, Gas & Steam power plant, Penwell corporation,3rd edition, 2009.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the principles of cogeneration, cycle and generations, types and sources with case study approach.
CO2 Understand the advanced thermodynamic performance of cycles involved in cogeneration.
CO3 Present the concepts pertaining to electrical and interconnection issues and its various applications.
CO4 Analyse the criteria for waste heat recovery on boilers heat pipes, pumps and absorption systems.
CO5 Do the cost analysis, optimise the parameters selection based on financial and environmental considerations.

16TE604 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	1	0	4

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD 9+3

Basics of CFD, Governing equations of Fluid Dynamics – Continuity, Momentum and Energy Equations. Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II CONDUCTION HEAT TRANSFER 9+3

Introduction, discretization of governing partial differential equations of Heat transfer Steady one-dimensional conduction, Treatment of heat sources, Solution schemes for steady and unsteady heat conduction, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III CONVECTION HEAT TRANSFER AND FEM 9+3

Steady One-Dimensional and Two-Dimensional Convection – Diffusion, Unsteady one dimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady heat conduction by FEM – Incompressible flow – Simulation by FEM.

UNIT IV INCOMPRESSIBLE FLUID FLOW 9+3

Governing Equations, Stream Function – Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, Finite difference approach.

UNIT V TURBULENCE MODELS 9+3

Algebraic Models – One equation model, K - € Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

L : 45 T: 15 P: 0 Total: 60 PERIODS

REFERENCES

1. John D Anderson, "Computational Fluid Dynamics-The Basics with Applications", McGraw - Hill Education, NewYork, 2012.
2. Suhas,PatankarV, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,2004.
3. Versteeg H K and MalalasekaraW, "An Introduction to Computational Fluid Dynamics-The Finite Volume Method",Pearson Education,2nd Edition, 2007.
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Alpha Science International,2nd Edition,2003.
5. Anderson, D.A.,Tannehill,J.C and Pletcher,R.H.,"Computational fluid Mechanics and Heat Transfer ",CRC Press, 3rd Edition, 2012.
6. Ghoshdasdidar,P.S.," Computer Simulation of flow and heat transfer" Tata McGraw Hill Publishing Company Ltd.,1998.
7. Chung, T.J. "Computational Fluid Dynamics", Cambridge University Press, 2002.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand about the governing equation and their importance, boundary conditions and grid analysis.

CO2 Understand the partial differential equation and solution scheme for steady and unsteady analysis on 1D & 2D problems.

CO3 Understand the 1D&2D on steady state convection problems pertaining to the simulation using FEM .

CO4 Present the incompressible fluid flow procedure in viscous flow using computation of boundary layer finite difference method.

CO5 Understand the models like K - € Models and prediction of fluid flow heat transfer using standard codes.

16TE605 ADVANCED ENGINEERING FLUID MECHANICS

	L	T	P	C
	3	1	0	4

UNIT I BASIC EQUATIONS OF FLOW 7+2

Three dimensional continuity equation - differential and integral forms – equations of motion momentum and energy and their engineering applications.

UNIT II POTENTIAL FLOW THEORY 10+3

Rotational and irrotational flows - circulation – vorticity - stream and potential functions for standard flows and combined flows – representation of solid bodies by flow patters. Pressure distribution over stationery and rotating cylinders in a uniform flow -Magnus effect - Kutta – Zhukovsky theorem. Complex potential functions. Conformal transformation to analyze the flow over flat plate, cylinder, oval body and airfoils. Thin airfoil theory – generalized airfoil theory for cambered and flapped airfoils.

UNIT III VISCOUS FLOW THEORY 10+3

Laminar and turbulent Flow - laminar flow between parallel plates - Poiseuille's equation for flow through circular pipes. Turbulent flow - Darcy Weisbach equation for flow through circular pipe - friction factor - smooth and rough Pipes - Moody diagram – losses during flow through pipes. Pipes in series and parallel – transmission of power through pipes.

UNIT IV BOUNDARY LAYER CONCEPT AND INCOMPRESSIBLE 10+3

Boundary Layer - displacement and momentum thickness - laminar and turbulent boundary layers in flat plates - velocity distribution in turbulent flows in smooth and rough boundaries - laminar sub layer. A few exact solutions to the laminar Navier-stokes equations e.g. Couette- Poiseuille flow, Annulus flow, Similarity solutions for Blassius boundary layer analysis, Displacement and momentum thickness, Analysis of 2-D jets and wakes.

UNIT V CREEPING FLOWS 9+3

Introduction, Governing equations for creeping flow, Creeping flow around a sphere, Stokes solution, Drag on a sphere in creeping flow, Reynolds equation for slipper pad lubrication, Pressure distribution in a slipper pad bearing.

L : 45 T: 15 P: 0 Total: 60 PERIODS

REFERENCES

1. YunusCengel and John M.Cimbala, Advanced Fluid mechanics, 2nd Edition, McGraw Hill 2010.
2. PijushKundu& Ira M.Cohen, Fluid Mechanics, 3rd Edition, San Diego CA, Elsevier 2004.
3. Houghten, E.L. and Carruthers, N.B., Aerodynamics for Engineering Students, Arnold Publishers, 1993.
4. Anderson, J.D., Fundamentals of Aerodynamics, McGraw Hill, Boston, 2001.
5. Streeter, V.L., Wylie, E.B., and Bedford, K.W., Fluid Mechanics, WCB McGraw Hill, Boston, 1998.
6. Faith A.Morrison. An introduction to Fluid mechanics, Cambridge university press, 2013.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand and define the fluid flow problems along with range of governing Parameter in 3Dimension.

CO2 Shall be eligible to take up the fluid flow problems of industrial base on potential flow theory.

CO3 Able to devise the experiments in the field of fluid mechanics using poisulle and friction factor equations.

CO4 Able understand the flow patterns and differentiate between the flow regimes and its effects based on boundary layer concepts and N-S equation.

CO5 Present the concept on creeping flow and lubrication in the purview of industry as well academics.

16TE606 **DESIGN OF THERMAL SYSTEMS** **L T P C**
3 0 0 3

UNIT I DESIGN CONCEPTS 9

Design Principles, Workable Systems, Optimal Systems, Matching of System Components, Economic Analysis, Depreciation, Gradient Present Worth factor.

UNIT II MATHEMATICAL MODELLING 9

Equation Fitting, Nomography, Empirical Equation, Regression Analysis, Different Modes of Mathematical Models, Selection n, and Computer Programmes for Models.

UNIT III MODELLING AND SIMULATION 9

Modelling Heat Exchangers , Evaporators , Condensers , Compressors , Pumps , Simulation Studies , Information Flow Diagram, Solution Procedures

UNIT IV LINEAR OPTIMIZATION 9

Objective Function Formulation, Constraint Equations, Mathematical Formulation, Calculus Method, Search Methods, Linear programming methods, solution procedures

UNIT V NON-TRADITIONAL OPTIMIZATION TECHNIQUES 9

Artifical Neural Network, and Genetic Algorithm, Particle swarm optimization algorithm – models creation – solution procedures.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Stoecker W. F., Design of Thermal Systems, McGraw Hill Edition, 1989.
2. Kapur J. N., Mathematical Modelling, Wiley Eastern Ltd, New York, 1989.
3. YogeshJaluria , Design and Optimization of Thermal Systems , CRC Press , 2007.
4. Rao S. S., Engineering Optimization Theory and Practice, New Age Publishers, 2000.
5. Bejan A., George Tsatsaronis, Michael J. Moran, Thermal Design and Optimization, Wiley, 1996.
6. Klayanmoy Deb “Optimization For Engineering Design: Algorithms and Examples, PHI, 2012.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Know about the design process of thermal process.
CO2 Mathematical modeling of thermal stress.
CO3 Understand the simulation concepts and modeling of various components.
CO4 Know about various optimization techniques related to thermal design stress.
CO5 Know about various non traditional optimization techniques related to thermal design stress.

16TE625	TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

OBJECTIVE IS TO ENHANCE THE PRESENTATION SKILLS ON

- Real world Case studies related to thermal engineering like study of a thermal power plant boilers, solar desalination plant, solar pumps in agriculture, etc.
- Application of Recent Thermal trends in the case studies by analyzing and relating the Journals, Monographs, standard Papers, etc.
- Innovative ideas on new thermal science & technology.
- An at least 20 page report should be submitted and will be evaluated based on the Presentation of the topic by a panel of at least two faculty members.

L : 0 T: 0 P: 30 Total:30 PERIODS

COURSE OUTCOMES

At the end of the course student should be able to:

CO1	Identify and compare technical and practical issues related to the area of course specialization.
CO2	Outline annotated bibliography of research demonstrating scholarly skills.
CO3	Establish motivation for any topic of interest and develop a thought process for technical presentation.
CO4	Organize a detailed literature survey and build a document with respect to technical publications
CO5	Effective presentation and improve soft skills.

16TE710	PROJECT WORK – PHASE- I	L	T	P	C
		0	0	12	6

PROJECT WORK – PHASE- I

- Shall consist of identification of the project after literature survey.
- Students should present a review paper & submit it to the internal examiners.
- Report should include full Introduction, Literature Review, details of the 25% of project work and also summarize the methodology to be adopted, work plan for the proposed project work – Phase II

L : 0 T: 0 P: 180 C:8 Total:180 PERIODS

COURSE OUTCOMES

At the end of the course student should be able to:

CO1	Do Self-learning various areas to identify the topic of the project
CO2	Survey the literature such as books, national/international refereed journals and contact resource persons for the selected topic of research
CO3	Write technical reports on the topic chosen after literature survey
CO4	Develop oral and written communication skills in the reviews
CO5	To present and defend their work in front of technically qualified audience

16TE701	COMPUTATIONAL FLUID DYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

LIST OF EXPERIMENTS

1. Modeling and Meshing for simple geometry - Modeling using Gambit, Meshing - Staggered and Un-staggered, Laminar flow and Heat transfer analysis.
2. Fluid flow and heat transfer analysis in Mixing elbow pipe.
3. Modeling and heat transfer analysis in fins.
4. Modeling periodic flow and heat transfer analysis in a circular tube.
5. Modeling and analysis of natural convection in rectangular enclosure.
6. Modeling and analysis of Natural convection and radiation in square enclosure.
7. Modeling and heat transfer analysis in counter flow heat exchanger.
8. Modeling and analysis of external compressible flow in aerofoil blades.
9. Modeling transient compressible flow in Nozzles by using k-epsilon Model.
10. Modeling and heat transfer fluid flow through pipe for turbulent flow

MAJOR EQUIPMENTS / SOFTWARE REQUIRED

Hardware: 18 Systems with Latest configuration.

Software : CFD softwares like ANSYS, ANSYS FLUENT, etc.

L : 0 T: 0 P: 60 C: 1 Total:60 PERIODS

REFERENCES

1. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”Narosa Publishing House, New Delhi, 2015.
2. Ghoshdasdidar, P.S., “Computer Simulation of flow and heat transfer” Tata McGraw Hill Publishing Company Ltd., 1998.
3. Suhas, V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
4 ANSYS FLUENT 15.0 Manual ANSYS Corporation Ltd,.2015

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Acquire experience on heat transfer modeling and meshing using ANSYS fluent and gambit

CO2 Analyse the modelling of elbow fins and circular tubes

CO3 Understand the convection simulation in rectangular enclosures

CO4 Simulate the convection and radiation in circular enclosures

CO5 Present simulation model on Heat exchangers

16TE711	PROJECT WORK - PHASE II	L	T	P	C
		0	0	24	12

PROJECT WORK - PHASE II

- Work Projected in Project Phase I should be continued.
- The students should publish at least one paper in National / International conference or Journal before submission of the thesis.
- Report should be submitted as prescribed in the regulation.

L : 0 T: 0 P: 360 C:12 Total:360 PERIODS

COURSE OUTCOMES

At the end of the course student should be able to:

CO1	Continue use different experimental techniques like software/ Computational / analytical tools results after analyzing them
CO2	Conduct tests on existing set ups/ equipment and draw logical conclusions from the
CO3	Conversant with technical report writing to a peer reviewed national / International journal
CO4	Present and convince their topic of study to the engineering community.
CO5	Present and defend their work in front of technically qualified audience.

16TE608 **FUELS AND COMBUSTION**

L	T	P	C
3	0	0	3

UNIT I CHARACTERIZATION 8

Fuels - Types and Characteristics of Fuels - Determination of Properties of Fuels – Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination - Calorific Value – Gross & Net Calorific Values - Calorimetry - DuLong's Formula for CV Estimation – Flue gas Analysis -Fuel & Ash Storage & Handling - Spontaneous Ignition Temperatures, Fuel cycle analysis.

UNIT II SOLID FUELS & LIQUID FUELS 10

(a) Solid Fuels

Types - Coal Family - Properties - Calorific Value - ROM, DMMF, DAF and Bone Dry Basis - Ranking - Bulk & Apparent Density - Storage - Washability - Coking & Caking Coals Renewable Solid Fuels - Biomass - Wood Waste - Agro Fuels – Manufactured Solid Fuels.

(b) Liquid Fuels

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

UNIT III GASEOUS FUELS 7

Classification - Composition & Properties - Estimation of Calorific Value – Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas and its types- Methane - Producer Gas – Gasifiers- Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non -Thermal Route - Biogas - Digesters - Reactions - Viability - Economics.

UNIT IV COMBUSTION: STOICHIOMETRY & KINETICS 12

Stoichiometry - Mass Basis & Volume Basis - Excess Air Calculation - Fuel & Flue Gas Compositions - Calculations - Rapid Methods - Combustion Processes – Stationary Flame - Surface or Flameless Combustion - Submerged Combustion - Pulsating & Slow Combustion Explosive Combustion. Chemical kinetics - Important chemical mechanisms – Simplified conservation equations for reacting flows - Laminar premixed flames - Simplified analysis.

UNIT V COMBUSTION EQUIPMENTS 8

Coal Burning Equipments - Types - Pulverized Coal Firing - Fluidized Bed Firing – Fixed Bed &Recycled Bed - Cyclone Firing - Spreader Stokers - Vibrating Grate Stokers -Sprinkler Stokers, Traveling Grate Stokers.

Oil Burners - Vaporizing Burners, Atomizing Burners - Design of Burners. Gas Burners - Atmospheric Gas Burners - Air Aspiration Gas Burners – Burners Classification according to Flame Structures - Factors Affecting Burners & Combustion.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 2003,
2. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 2004.
3. BlokhAG, Heat Corpn,1988.
4. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966.
5. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984.
6. Kenneth.w.Ragland, Kenneth.M.Bryden, Combustion Engineering, Tayler & Francis group 2nd edition, 2011.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Analyse the fuel characterisation and fuel cycle analysis.

CO2 Understand and differentiate the solid and liquid fuels.

CO3 Present the details of gaseous fuels on chemical-combustion in to thermal aspects.

CO4 Understand the combustion process with knowledge on calculations, chemical mechanisms and conservation equations using simplified analysis.

CO5 Present complete details on Coal burning combustion equipments, oil burners and their factors.

16TE610 COMBUSTION ENGINEERING L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Thermodynamics, concepts of combustion – Combustion equations, Stoichiometric air ratio, heat of combustion: Theoretical flame temperature, chemical equilibrium and dissociation. Historical perspective of combustion science – perspective of fuels and combustion technology. Types and general characteristics of fuels – proximate and ultimate analysis of fuels. ROM, DMMF, DAF and bone dry basis. Moisture and heating value determination – gross and net hearting values – claorimetry, DuLong's formula for HVestimation, Flue gas analysis – Orsat apparatus.

UNIT II FUEL TYPES 9

Solid Fuels: Peat – coal – biomass – wood waste – agro fuels – refuse derived solid fuel – testing of solid fuels. Bulk and apparent density – storage – washability – coking and caking coals. Liquid Fuels: Refining – molecular structure – liquid fuel types and their characteristics –fuel quality. Liquefaction of solid fuels. Gaseous Fuels: Classification and characterization.

UNIT III THERMODYNAMICS AND KINETICS OF COMBUSTION 9

Properties of mixture – combustion stoichiometry – chemical energy – chemical equilibrium and criteria – properties of combustion products. First law combustion calculations – adiabatic flame temperature (analytical and graphical methods) – simple second law analysis.
Elementary reactions – chain reactions – pre-ignition kinetics –global reactions – kinetics – reaction at solid surface.

UNIT IV COMBUSTION OF SOLID FUELS AND GAS TURBINES 8

Drying - devolatilization - char combustion. Fixed bed combustion – suspension burning fluidized bed combustion and mechanism, PFBC and CFBC, Power plant cycles for stationary and aircraft applications, component behaviors, analysis of ramjet, turbojet and turbo-propeller. Flame stability, re-circulation zone and requirements. Combustion chamber configuration, materials.

UNIT V COMBUSTION OF LIQUID AND GASEOUS FUELS 10

Spray formation and droplet behavior - oil fired furnace combustion - gas turbine spray combustion – direct and indirect Injection combustion in IC engines. Energy balance and furnace efficiency – gas burner types - pulse combustion furnace. Premixed charge engine combustion. Detonation of gaseous mixtures.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Kuo, K.K., Principles of Combustion, 2nd Edition, John Wiley and Sons, Inc., 2005.
2. Samir Sarkar, Fuels and Combustion, 2nd Edition, Orient Longman, 2003.
3. Annamalai, K and Puri, I.K, Combustion science and Engineering, CRC Press, 2007.
4. Bhatt, B.I and Vora, S.M., Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 2004.
5. Kenneth W. Regland, Kenneth M.Brydon, Combustion Engineering, Taylor & Francis Group, 2011.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Know basic concepts of thermodynamics related to combustion engineering.
CO2 Understand different types of fuels, its characteristics.
CO3 Evaluate various laws related to combustion engineering.
CO4 Study related to the combustion of solid fuels and its behaviors.
CO5 Study related to the combustion of liquid and gaseous fuels and its behaviors.

16TE611 SUPERCHARGING AND SCAVENGING **L T P C**
3 0 0 3

UNIT I SUPERCHARGING 8

Objectives - Effects on engine performance – engine modification required - Thermo- dynamics of Mechanical supercharging - Types of compressors-positive displacement blowers-centrifugal compressors-performance characteristic curves-suitability for engine Application - matching of supercharger compressor and engine.

UNIT II TURBOCHARGING 10

Surging, Matching of compressor, Turbine Engine. Turbocharging- turbocharging methods thermodynamics- engine exhaust manifolds arrangements-waste gate, variable nozzle turbochargers and variable geometry turbocharging - Surging - Matching of compressor, Turbine Engine.

UNIT III 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.

UNIT IV PORTS AND MUFFLER DESIGN 8

Porting - Design considerations - Design of intake and Exhaust Systems - Tuning.-Vibration , Noise Damping, Types of Mufflers- Design consideration.

UNIT V 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.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Richard Stone, Internal Combustion Engines, SAE, 2012.
2. Schweitzer, P.H., Scavenging of Two Stroke Cycle Diesel Engine, MacMillan Co. 1996.
3. John B.Heywood, Two Stroke Cycle Engine, SAE Publications, 1999.
4. V.Gabesan, Internal Combustion Engine, Tata McGraw Hill, 2008.
5. Corky Bell, Supercharged: Design, Testing and Installation of Supercharged System, Bentley Robert publications, 2001.
6. Bavyaluczyk, How to supercharge and turbo charge, GM, LS series Engines, Cartech Publishers 2010.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand basic concept of supercharging.
CO2 Know basic concept of turbo charging..
CO3 Study about classification of scavenging systems, charging process.
CO4 Know the concept and design of ports and muffler design.
CO5 Understand the experimental techniques for evaluating scavenging.

16TE612 MANUFACTURING AND TESTING OF IC ENGINE COMPONENTS

	L	T	P	C
	3	0	0	3

UNIT I CYLINDER BLOCK AND CYLINDER HEAD **9**

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

UNIT II PISTON ASSEMBLY **9**

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

UNIT III DRIVE SYSTEMS **9**

Requirements, materials, forging practice, machining, balancing of crankshaft, testing, Connecting Rod, Crank shaft, Cam Shaft.

UNIT IV COMPUTER INTEGRATED MANUFACTURING **9**

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

UNIT V QUALITY AND TESTING **9**

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

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Grover, M.P., CAD/CAM, Prentice Hall of India Ltd., 2003.
2. Richard, W., Heine Carl R. Loper Jr. and Philip, C., Rosenthal, Principles of Metal Casting, McGraw-Hill Book Co., 2001.
3. P.Radhakrishnan and S.Subramaniayn, CAD/CAM/CIM, New Age International (P) Limited, Publishers, 2007.
4. A.J.Martyr, M.A.Plint, Engine Testing, Butterworth-Heinemann Publications, 2007.
5. Dougles.C.Mentgomery, Statistical Quality Control, Wiley India Pvt.Ltd., 2009.,

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Analyse the material requirement for IC engines design, mechanism with case study.

CO2 Understand the advanced topic like piston assembly.

CO3 Understand the need of drive mechanism modernised materials with case study knowledge.

CO4 Analyse the need of CIM testing IC engines using CAD, CAM and CNC techniques.

CO5 Understand the quality and testing of IC engines using ISO, TS and BS standards.

16TE613 RENEWABLE ENERGY SYSTEMS

	L	T	P	C
	3	**0**	**0**	**3**

UNIT I INTRODUCTION 9

World energy use – Reserves of energy resources – Environmental aspects of energy utilization – Renewable energy scenario in India – Basic Concepts of Energy audit- Different Energy Conservation Principles.

UNIT II SOLAR ENERGY 9

Solar thermal – Flat plate and concentrating collectors – Solar heating and cooling techniques – Solar desalination – Solar Pond – Solar cooker – Solar thermal power plant – Solar photo voltaic conversion – Solar cells – Applications of Solar Photovoltaic cells in Commercial and Industrial Sectors.

UNIT III WIND ENERGY 9

Basic Design Considerations for wind turbine- Wind energy scenario in India-Types of wind energy systems – Performance –Details of wind turbine generator – Safety and Environmental Aspects.

UNIT IV BIOMASS ENERGY 9

Biomass direct combustion – Biomass gasifier – Various Sources of Biomass- Various Types of Bio gas plant-Biogas plant – Ethanol production – Bio diesel – Cogeneration – Applications of Biogas and Biomass in Commercial Sectors.

UNIT V OTHER RENEWABLE ENERGY SOURCES 9

Tidal energy – Wave energy – Open and closed OTEC Cycles – Small hydro –Geothermal energy – Fuel cell systems. MHD generators- thermo electric generators.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers, New Delhi, 1999.
2. S.P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
3. Godfrey Boyle, Renewable Energy, Power for a Sustainable Future, Oxford University Press, U.K, 1996.
4. Twidell, J.W. & Weir, A., Renewable Energy Sources, EFN Spon Ltd.,UK, 1996.
5. G.N. Tiwari, Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand introduction about different types of renewable energy systems, energy auditing and its importance.

CO2 Study about solar energy and its types.

CO3 Know about wind energy and its types.

CO4 Study about biomass energy and its types.

CO5 Idea about tidal, wave, OTEC, Geothermal energy and its types.

16TE614 DESIGN OF FLUIDIZED BED SYSTEMS

L	T	P	C
3	0	0	3

UNIT I FLUIDIZED BED BEHAVIOUR 12

Characterization of bed particles – comparison of different methods of gas – solid contacts. Fluidization phenomena – regimes of fluidization – bed pressure drop curve. Two phase and well-mixed theory of fluidization. Particle entrainment and elutriation –unique features of circulating fluidized beds.

UNIT II HEAT TRANSFER 7

Different modes of heat transfer in fluidized bed – to wall heat transfer – gas to solid heat transfer – radiant heat transfer – heat transfer to immersed surfaces. Methods for improvement – external heat exchangers – heat transfer and part load operations.

UNIT III COMBUSTION AND GASIFICATION 7

Fluidized bed combustion and gasification – stages of combustion of particles –Performance – start-up methods. Pressurized fluidized beds.

UNIT IV 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.

UNIT V INDUSTRIAL APPLICATIONS 10

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

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Howard,J.R.,Fluidized Bed Technology: Principles and Applications, Adam B Hilger , New York, 1983.
2. Geldart, D., Gas Fluidization Technology, John Willey and Sons, 1986.
3. Howard, J.R. (Ed), Fluidized Beds: Combustion and Applications, Applied Science Publishers, New York, 1983.
4. Botteril, J.S.M., Fluid Bed Heat Transfer, Academic Press, London, 1975.
5. Yates, J.G. Fundamentals of Fluidized bed Chemical Processes, Butterworth, 1983.
6. Prabir Basu, Combustion and Gasification in Fluidized Beds, CRC Press, 2006.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the characteristics and fluidisation phenomenon in design of FBS.

CO2 Analyse the modes of heat transfer, part loads in design of FBS.

CO3 Understand the advanced topic in FBSs, gasification and pressurisation and case studies in FBC.

CO4 Understand the solid mixing and segregations with liquid and gas phase mixing.

CO5 Present the industrial Application of FBS and its accessories transporting.

16TE615 ENERGY CONSERVATION IN THERMAL SYSTEMS

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **9**

Energy Scenario – world and India. Energy Resources Availability in India. Energy - Consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries – an overview. Energy conservation and energy efficiency – needs and advantages. Energy auditing – types, methodologies, barriers. Role of energy manager – Energy audit questionnaire – energy Conservation Act 2003.

UNIT II INSTRUMENTS FOR ENERGY AUDITING **9**

Instrument characteristics – sensitivity - readability-accuracy - precision,- hysteresis. Error and calibration.- Measurement of flow – velocity – pressure - temperature, - speed - Lux - power and humidity Analysis of stack - water quality - power and fuel quality.

UNIT III THERMAL UTILITIES: OPERATION AND ENERGY CONSERVARTION **9**

Boilers -Thermic Fluid Heaters –- Furnaces– combustion – refrigeration & A.C system - Waste Heat Recovery Systems - Thermal Storage

UNIT IV THERMAL ENERGY TRANSMISSION / PROTECTION SYSTEMS **9**

Steam traps – refractories – optimum insulation thickness – insulation – piping design.

UNIT V FINANCIAL MANAGEMENT **9**

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

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Smith, CB Energy Management Principles, Pergamon Press, NewYork, 1981,
2. Hamies, Energy Auditing and Conservation; Methods Measurements Management and Case study, Hemisphere, Washington, 1980.
3. Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997.
4. Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington, 1988.
5. Kallrath, J., Pardalos, P., Rebennack, S., Scheidt, Optimization in the Energy Industry, 1991 springer ISBN 978-3-540-88965-6.
6. Diamant, RME, Total Energy, Pergamon, Oxford, 2000.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Introduction about energy conservation in thermal stress.

CO2 Know various equipments for energy auditing.

CO3 Understand energy conservation in various types of thermal utilities.

CO4 Study about the transmission of energy transmission systems.

CO5 Have knowledge on financial management related to energy conservation system.

16TE616 FUEL CELL TECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **7**

Basic Principles – Classification – Alkaline, Proton Exchange Membrane, Direct Methanol, Phosphoric Acid & Molten Carbonate – Parts – Fuel cell poisoning.

UNIT II THERMODYNAMICS **10**

Basic Reactions, Heat of reaction, Enthalpy of formation of substances – Enthalpy change of a reacting system – Gibbs free energy of substances – Gibbs free energy change of reacting system – Efficiency – Power, heat due to entropy change, and internal ohmic heating

UNIT III ELECTROCHEMISTRY **11**

Nernst equation and open circuit potential, pressure effect, temperature effect –Stoichiometric coefficients and reactants utilization – Mass flow rate calculation – voltage and current in parallel and serial connection – Over-potentials and polarizations –Activation polarization – Tafel equation and exchange current density –Ionic conductivity, catalysts, Temperature and humidification effect, electro-osmotic drag effect

UNIT IV DESIGN & OPTIMISATION **10**

Geometries of fuel cells and fuel cell stacks – Rate of Diffusion of reactants – Water flooding and water management – Gas delivery and current collection – Bipolar plates design – Flow uniformity consideration – Optimization of gas delivery and current collection/asymptotic power density-Heat Removal from Stack

UNIT V APPLICATIONS **7**

Automotive applications & issues – Micro fuel cells & Portable power – Distributed & Stationary power.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Fuel Cell Systems Explained, James Larminie and Andrew Dicks, 2nd Edition, John Wiley & Sons Inc., 2000.
2. PEM Fuel Cells Theory and Practice, Frano Barbir, Elsevier Academic Press, 2005.
3. Fuel Cell Technology Handbook, Gregor Hoogers, SAE International, 2003.
4. Fuel Cellprinciples and Applications, B.Viswanathan and MAulice Scibioh, Universities Press, 2006.
5. Hydrogen and Fuel Cells, Bent Sorenson, Elsevier Academic Press, 2005.
6. Colleen Spiegel, Designing & Building fuel cells, Mc- Graw hill professional, 2007.
7. Subramanian srinivasan, Fuel cells, Electro Chemical Society, 2006.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the basic on fuel cell principles and batteries

CO2 Understand and apply knowledge on fuel cell reactions based on thermodynamics

CO3 Understand the Nernst equations based thermo chemistry study on fuel cell

CO4 Design a fuel cell and optimise based on the performance, diffusion and water management heat removal etc.

CO5 Present the application of fuel call base on case study

16TE617 REFRIGERATION MACHINERY AND COMPONENTS

L	T	P	C
3	0	0	3

UNIT I REFRIGERANT COMPRESSORS 9

Hermetic compressors - Reciprocating, Rotary, Scroll Compressors, Open type compressors - Reciprocating, Centrifugal, Screw Compressors. Semi hermetic compressors - Construction, working and Energy Efficiency aspects. Applications of each type.

UNIT II DESIGN OF CONDENSERS 10

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

UNIT III DESIGN OF EVAPORATORS COOLING TOWERS 10

Different types of evaporators, Design procedure, Selection procedure, Thermal Stress Calculations, matching of components, Design of evaporative condensers. Types of Cooling towers, Analytical and graphical design procedures, Tower Characteristics Parametric analysis, Range of cooling tower, Tower efficiency, cooling tower load, Energy Conservation.

UNIT IV REFRIGERATION SYSTEM COMPONENTS 9

Evaporators and condensers - Different types, capacity control, circuitry, Oil return, Oil separators - Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers, Spray ponds.

UNIT V SYSTEM ACCESSORIES AND CONTROLS 7

Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalizing in multiple evaporators. Different Defrosting and capacity control methods and their implications - Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Althose, A.D. &Turnquist, C.H. “Modern Refrigeration and Air conditioning” Good Heart - Wilcox Co. 9th edition 2013.
2. S.N.Sapali “Text book of refrigeration & air conditioning”, PHI learning Pvt. LTD 2009.
3. Recent release of BIS Code for relevant testing practice-Hand book.
4. ASHRAE Hand book : system of Equipments, 2008
5. Bill Whitman., Bill Johnson., John tomczyk, Eugene silbertstein, Refrigeration & Air condition technology, Thomson Delmar Learning Ltd., 7th edition, 2012.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the compressors in refrigeration cycle on construction and energy efficiency view .

CO2 Understand the main system components like compressors, evaporators and Condensers with cases study knowledge on modernisation of the same.

CO3 Present various chilling water piping systems, components and pumps.

CO4 Explain the applications in automobile, railway, marine, aircraft and other commercial applications with case study knowledge.

CO5 Present the accessories and control needed for the evaporators and control methods.

16TE618 INDUSTRIAL REFRIGERATION SYSTEMS

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **6**

Introduction to industrial refrigeration - difference from conventional system -applications - industrial and comfort air - conditioning - conditions for high COP.

UNIT II COMPRESSORS **10**

Reciprocating and screw compressor: Multistage industrial applications, cylinder arrangement cooling methods - oil injection and refrigeration injection, capacity regulations - Economizers.

UNIT III DESIGN OF EVAPORATORS COOLING TOWERS **12**

Types of Evaporators, Liquid circulation: Mechanical pumping and gas pumping -advantage and disadvantage of liquid re-circulation - circulation ratio - top feed and bottom feed refrigerant -Net Positive Suction Head (NPSH) - two pumping vessel system - suction risers – design -piping loses. Different Industrial Condensers arrangement, Evaporators-Types and arrangement, liquid circulation, type of feed, refrigerant piping design, functional aspects.

Lubricating oil: types - physical properties, types of circulation and oil separator

UNIT IV VESSELS **8**

Vessels in industrial refrigeration: High pressure receiver - flash tank - liquid and vapour separator - separation enhancers - low pressure receivers - surge drum - surge line accumulator -thermo syphon receiver - oil pots.

UNIT V ENERGY CONSERVATION **9**

Energy conservation and design considerations - source of losses - energy efficient components -heat reclaim - thermal storage: ice builder and ice harvester. Insulation: critical thickness -insulation cost and energy cost - vapour barriers – construction methods of refrigerated spaces.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Wilbert F.Stoecker, Industrial Refrigeration Hand Book, McGraw-Hill, 1998.
2. ASHRAE Hand Book: Fundamentals, 1997.
3. ASHRAE Hand Book: Refrigeration, 1998.
4. ASHRAE Hand Book: HVAC Systems and Equipment, 1996.
5. Transport properties of SUVA Refrigerants Hand Book, Du-Pont Chemicals, 1993.
6. Luis Yanez, HVAC text book, 2009.
7. Edward G.Pita.P.E. Air conditioning principles & Systems: An energy approach, PHI Ltd, 2001.
8. Roger Haines, Michael Myers, HVAC system design hand book, 2009.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Study introduction about industrial refrigeration system.

CO2 Know about different types of compressors.

CO3 Know about design of evaporators cooling towers.

CO4 Understand basic concept of vessels in industrial refrigeration.

CO5 Have knowledge of energy conservation, energy losses.

16TE619 DESIGN OF REFRIGERATION EQUIPMENT

L	T	P	C
3	0	0	3

UNIT I REFRIGERATION CYCLES – ANALYSIS 10

Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle conditions for high COP-deviations from ideal vapor compression cycle, Multi-pressure Systems, Cascade Systems-Analysis.

UNIT II MAIN SYSTEM COMPONENTS 12

Compressor- Types, performance, Characteristics of Reciprocating Compressors, Capacity Control, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their Behavior with fluctuating load.

UNIT III REFRIGERANTS 8

Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal / Kyoto protocols-Eco Friendly Refrigerants.

UNIT IV SYSTEM BALANCING & CONTROLS 9

Estimation of Cooling Load, System Equilibrium and Cycling Controls, Electric Circuits in Refrigerators, Window A/C, Types of motors, Relays. Different Types of Refrigeration Tools, Evacuation and Charging Unit, Recovery and Recycling Unit, Vacuum Pumps.

UNIT V OTHER REFRIGERATION CYCLES 6

Vapor Absorption Systems-Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration, Thermo Electric Refrigeration, Air Refrigeration cycles.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Dossat R.J., Principles of refrigeration, John Wiley, S.I. Version, 2001.
2. Stoecker W.F., Refrigeration and Air conditioning, McGraw-Hill Book Company, 1989.
3. Langley, Billy C., 'Solid state electronic controls for HVACR' Prentice-Hall India Ltd., 1989.
4. C.P.Arora, Refrigeration & Air conditioning' McGraw-Hill , 3rd edition, 2008.
5. Arthur Bell, HVAC equation, Data & Rules of thumb", McGraw Hill ,2nd edition, 2007.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the vapour compression refrigeration cycle analysis with cascade system .

CO2 Understand the main system components like compressors, evaporators and condensers.

CO3 Present various environment friendly refrigerants with case study knowledge.

CO4 Calculate the load need in a system, control techniques on the metrology purview with tool knowledge.

CO5 Present and compare the VCS and VAS and thermoelectric system applications.

16TE620 ADVANCED POWER PLANT ENGINEERING

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **9**

Overview of the Indian power sector – load curves for various applications – types of power plants – merits and demerits – criteria for comparison and selection.

UNIT II STEAM AND GAS TURBINE POWER PLANTS **9**

Introduction to Fuels and combustion Rankine Cycle – Performance – thermodynamic analysis of cycles. Cycle improvements. Superheaters, reheaters – condenser and feed water heaters – operation and performance – layouts. Gas turbine cycles – optimization – thermodynamic analysis of cycles – cycle improvements – multi spool arrangement. Intercoolers, reheaters, regenerators – operation and performance – layouts.

UNIT III ADVANCED POWER CYCLES **9**

Binary and combined cycle – coupled cycles – comparative analysis of combined heat and power cycles – IGCC – AFBC/PFBC cycles – Thermionic steam power plant.

UNIT IV NUCLEAR AND MHD POWER PLANTS **9**

Overview of Nuclear power plants – radioactivity – fission process – reaction rates –diffusion theory, elastic scattering and slowing down – criticality calculations – critical heat flux – power reactors – nuclear safety. Introduction to non-conventional power generation, MHD and MHD – steam power plants.

UNIT V ENVIRONMENTAL ISSUES **9**

Air and water pollution – acid rains – thermal pollution – radioactive pollution – standardization – methods of control. Environmental legislations / Government policies.Economics of power plants.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Nag, P.K., Power Plant Engineering, Tata Mcgraw Hill Publishing Co Ltd, New Delhi, 2008.
2. Arora and Domkundwar, A course in power Plant Engineering, DhanpatRai & CO, 2004.
3. Wood, A.J., Wollenberg, B.F., Power Generation, operation and control, John Wiley, New York, 2009.
4. P.C. Sharma, power Plant Engineering, S. K. Kataria& Sons, 2009.
5. Gill, A.B., Power Plant Performance, Butterworths, 1984.
6. Lamarsh, J.R., Introduction to Nuclear Engg.2nd edition, Addison-Wesley, 2002

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the basic concepts of powerplants and its types.

CO2 Study about the steam and gas turbine powerplants.

CO3 Have knowledge about different types of power cycles.

CO4 Study about the Nuclear and MHD powerplants.

CO5 Understand different types of environmental issues related to power plants.

16TE621	FOOD PROCESSING, PRESERVATION AND TRANSPORT	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION **9**

Microbiology of Food Products, Mechanism of food spoilage critical microbial growth requirements, Design for control of microorganisms, The role of Hazard Analysis and critical control points (HACCP), Sanitation, Regulation and standards.

UNIT II PROCESSING & PRESERVATION **12**

Thermodynamic properties and Transfer properties, Water content, Initial freezing temperature, Ice fraction, Transpiration of fresh fruits & vegetables, Food processing techniques for Dairy products, Poultry, Meat, Fruits & Vegetables.

UNIT III FREEZING & DRYING **12**

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

UNIT IV COLD STORAGE DESIGN & INSTRUMENTATION **7**

Initial building consideration, Building design, Specialized storage facility, Construction methods, Refrigeration systems, Insulation techniques, Control & instrumentation, Fire protection, Inspection & maintenance.

UNIT V TRANSPORT **5**

Refrigerated transportation, Refrigerated containers & trucks, Design features, Piping & Role of cryogenics in freezing & transport. Basic packaging materials, types of packaging, packaging design.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Ibraham Dincer, Heat Transfer in Food Cooling Applications, Tailor & Francis Pub., 1997.
2. Clive V.I. Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub. New York, 1991.
3. Arora C.P., Refrigeration and Air conditioning III Ed. McGraw-Hill, Pub., 2008.
4. ASHRAE Handbook – HVAC System & equipments, 2012.
5. Jeffrey Kornacki & Michael P. Dolye "Principles of microbiological trouble shooting in the industrial food processing environment" Springer Science and Business Media, 2010.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the introduction on microbiology of food products **.**

CO2 Understand the need of food processing and preservation and their thermodynamics.

CO3 Analyse the freezing and drying of the food products for clean usage.

CO4 Present the cold storage design and instrumentations with case study knowledge.

CO5 Understand the advanced cold storage design of mobiles and packaging with case study.

16TE622 HYBRID ENERGY TECHNOLOGY

	L	T	P	C
	3	0	0	3

UNIT I ENERGY STORAGE BATTERIES 9

Electrochemical Batteries-Electrochemical Reactions-Thermodynamic Voltage-Specific Energy-Specific Power-Energy Efficiency-Battery Technologies-Lead-Acid Batteries- Nickel-based Batteries-Nickel/Iron System-Nickel/Cadmium System-Nickel–Metal Hydride (Ni–MH) Battery, Lithium-Based Batteries-Lithium–Polymer (Li–P) Battery-Lithium-Ion (Li-Ion) Battery. Hybridization of Energy Storages.

UNIT II FUEL CELL TECHNOLOGY 9

Operating Principles of Fuel Cells-Electrode Potential and Current–Voltage Curve-Fuel and Oxidant Consumption-Fuel Cell System Characteristics Fuel Cell Technologies: Proton Exchange Membrane Fuel Cells- Alkaline Fuel Cells-Phosphoric Acid Fuel Cells1-Molten Carbonate Fuel Cells-Solid Oxide Fuel Cells-Direct Methanol Fuel Cells.

UNIT III HYBRID VEHICLE 9

Hybrid Electric Vehicles: Concept of Hybrid Electric Drive Trains-Architectures of Hybrid Electric Drive Trains-Series Hybrid Electric Drive Trains-Parallel Hybrid Electric Drive Trains-Torque-Coupling Parallel Hybrid Electric Drive Trains , micro, mild, macro. Speed- Coupling Parallel Hybrid Electric Drive Trains - Torque-Coupling and Speed-Coupling Parallel -Hybrid Electric Drive Trains.

UNIT IV HYDROGEN GENERATION TECHNOLOGIES 9

Oxidative processing of hydrocarbons: steam methane reforming-partial oxidation of hydrocarbons-Auto thermal reforming. Non -oxidative processing of hydrocarbon: Thermal decomposition of methane, catalytic methane decomposition-catalytic decomposition of methane for fuel cell applications.

Environmental aspects of hydrogen productions: Hydrogen productions by steam methane reforming with CO_2 sequestration. Technologies for producing hydrogen from coal: Entrained –bed gasification technology.

UNIT V HYDROGEN STORAGE TECHNOLOGIES 9

Need of Hydrogen storage-Historical Perspectives on hydrogen, its storage and its applications, Hydrogen storage in pressure vessels: Liquid cryogenic, and compressed gas, solid state H_2 storage system engineering: Direct H_2 refueling, Engineering Assessments of condensed-Phase hydrogen storage systems. Development of on-Board reversible complex metal hydrides for hydrogen storage.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Ram B.Gupta "Hydrogen fuel production, transport, and storage" CRC press Taylor& Francis Group, 2009.
2. LennireKlebanoff "Hydrogen storage technology material and application" Taylor& Francis Group, 2009.
3. MehrdadEhsani ,YiminGao , Sebastien E. Gay , Ali Emadi "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles Fundamentals, Theory, and Design "2005 by CRC Press LLC.
4. Iqbalhusain "Electric and Hybrid Vehicles Design fundamentals "CRC press Taylor& Francis Group, 2011.
5. Mathew M.Mench "Fuel cell Engines" John Wiley 2008.
6. Ken S. Chen, Sun Chan Cho, Yun Wang , "PEM Fuel Cells: Thermal and Water. Management Fundamental" Momentum Press, 2013.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the complete technical details of energy storage batteries.

CO2 Understand the need of fuel cell technology and their cells types.

CO3 Analyse the need of hybrid vehicle and its recent trend and its train mechanism.

CO4 Understand the oxidative processing of hydrocarbons and environmental process of hydrocarbons.

CO5 Present the need of the hydrogen storage and its applications in cryogenics with case study knowledge

16TE623 ADVANCED THERMAL STORAGE TECHNOLOGIES

	L	T	P	C
	3	0	0	3

UNIT I INTRODUCTION 9

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

UNIT II SENSIBLE HEAT STORAGE SYSTEM 9

Modelling of heat storage units - modelling of simple water and rock bed storage system – pressurized water storage system for power plant applications – packed beds.

UNIT III REGENERATORS 9

Parallel flow and counter flow regenerators – finite conductivity model – non – linear model – transient performance – step changes in inlet gas temperature – step changes in gas flow rate – parameterization of transient response – heat storage exchangers.

UNIT IV LATENT HEAT STORAGE SYSTEMS 9

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

UNIT V APPLICATIONS 9

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

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
2. Schmidt.F.W and Willmott.A.J, Thermal Storage and Regeneration, Hemisphere Publishing Corporation, 1981.
3. Lunardini.V.J, Heat Transfer in Cold Climates, John Wiley and Sons 1981.
4. Frank Dinter, Michael A. Geyer, Rainer Tamme., Thermal Energy Storage for Commercial Applications: A Feasibility Study on Economic Storage Systems., Springer Berlin Heidelberg 1994.
5. D. C. Golibersuch., Thermal energy storage for utility applications., General Electric Co., Corporate Research and Development, 1975.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the need of thermal storage and its basics with case study knowledge

CO2 Understand the modelling of heat storage systems on latent heat purview and waste heat recovery techniques

CO3 Differentiate the parallel and counter flow HX using different refrigerants model analysis on transient performance

CO4 Present the latent heat storage systems in a system with temperature and enthalpy model analysis on a porous media in phase change analysis

CO5 Discuss on the specific application of the energy storages like food preservation, waste heat recovery, solar, green house, and all possible cooling technologies

16TE624 INSTRUMENTATION FOR THERMAL SYSTEMS

L	T	P	C
3	0	0	3

UNIT I MEASURMENT CHARACTERISTICS 11

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

UNIT II MICROPROCESSORS AND COMPUTERS IN MEASURMENT 7

Data logging and acquisition – use of sensors for error reduction, elements of micro computer Interfacing, intelligent instruments.

UNIT III MEASURMENT OF PHYSICAL QUANTITIES 10

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

UNIT IV ADVANCE MEASURMENT TECHNIQUES 7

Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement, Telemetry in engines.

UNIT V MEASURMENT ANALYSERS 10

Orsat apparatus, Gas Analyzers, Smoke meters, dust and moisture, gas chromatography, spectrometry, Measurement of pH, Review of basic measurement techniques Problems.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Raman, C.S., Sharma, G.R., Mani, V.S.V., Instrumentation Devices and Systems, Tata McGraw-Hill, New Delhi, 2001.
2. Holman, J.P., Experimental methods for engineers, McGraw-Hill, 2007.
3. Barney, Intelligent Instrumentation, Prentice Hall India, 1988.
4. Preobrazhensky. V., Measurement and Instrumentation in Heat Engineering, Vol.1 and MIR Publishers, 1980.
5. Morris.A.S. Principles of Measurements and instrumentation, Prentice Hall India, 1998.
6. R.S.Sirohi, H.C.Radha Krishna, Mechanical Measurements, 3rd edition, New age international Pvt.Ltd. New Delhi, 2004.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the measurement characteristics of thermal stress.

CO2 Know about the usage of microprocessors and computers in measurement.

CO3 Have understanding about the concept of measurement of physical quantities.

CO4 Be have an knowledge about the different types of advanced techniques and it's types.

CO5 Have better knowledge about the different types of measurement analyzers.

16TE702 BOUNDARY LAYER THEORY AND TURBULENCE

L	T	P	C
3	0	0	3

UNIT I FUNDAMENTALS OF BOUNDARY – LAYER THEORY 9

Boundary – Layer Concept, Laminar Boundary Layer on a Flat Plate at zero incidences, Turbulent Boundary Layer on a Flat plate at zero incidence, Fully Developed Turbulent Flow in a pipe, Boundary Layer on an air foil, Boundary Layer separation.

UNIT II TURBULENT BOUNDARY LAYERS 9

Internal Flows – Couette flow – Two-Layer Structure of the velocity Field – Universal Law of the wall – Friction law – Fully developed internal flows – Channel Flow, Couettee – Poiseuille flows, Pipe Flow. Flow over a flat plate and rectangular plate.

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 axisymmetric flows.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. G. Biswas and E. Eswaran, Turbulent Flows, Fundamentals, Experiments and Modelling, Narosa Publishing House, 2002.
2. H. Schlichting and Klaus Gersten, Boundary Layer Theory, Springer 2000.
3. R.J. Garde, Turbulent Flow, New Age International (p) Limited, Publishers, 2000.
4. P.A.Durbin, B.A. PetterssonReif, Statistical Theory and Modelling of Turbulent flows ,John Wiley and Sons Ltd.,2011.
5. John J.Nance, Turbulence, Jove books, 2003.
6. Lain .G.Currie,IGcurrie, Fundamental mechanics of fluids, CRC Press and Taylor and Francis Group, 3rd edition,2002.
7. Ian john sobey, Introduction to boundary layer theory, Oxford university press, 2000.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Provide a general review of basic concepts, physics and mathematical descriptions of viscous flow.
CO2 Introduce Navier-Stokes equations and some of the exact solutions.
CO3 Understand the boundary layer model and different analytic methods.
CO4 Introduce flow instability and transition from laminar flow to turbulence.
CO5 Have knowledge of turbulence and modeling.

16TE703 FINITE ELEMENT METHOD IN HEAT TRANSFER ANALYSIS

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION **9**

Introduction, Weighted Residual Methods, Shape functions, Coordinate systems, Numerical Integration.

UNIT II MODELLING **9**

Modelling of Heat Conduction, Variational one dimensional and two dimensional problems.

UNIT III ONE DIMENSIONAL STUDY **9**

Introduction – A one dimensional Problem solved using a single element – Linear element, Quadratic element, the use of numerical integration. A one dimensional problem solved using an assembly of elements.

UNIT IV NON LINEAR HEAT TRANSFER **9**

Time stepping methods for Heat Transfer – Galerkin's approach in Non-linear transient heat conduction problems.

UNIT V DIFFUSION **9**

Introduction, Basic Equations, Galerkin's Methods for steady Convection – Diffusion simple problems, Upwind Finite Elements in One Dimension, Heat Transfer in fluid flow between parallel planes, Convection on melting and solidification.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. H. R. Thomas, K. N. Seetharamu, Ken Morgan, R. W. Lewis, "The Finite Element Method in Heat Transfer Analysis", John Wiley & Sons Inc, 1996.
2. Roland W. Lewis, Perumal Nithiarasu and K.N. Seetharamu, "Fundamentals of the Finite Element Method for Heat and Fluid Flow", Wiley; 1st edition, 2004.
3. J.N. Reddy and D.K. Gartling, "The Finite Element Method", CRC Press 2010.
4. Jean-Michel berghean, Roland fortuiner, finite element simulation of heat transfer, John wiley & sons, 2010.
5. Hou-cheng Hueng, Asif sohilusmani, Finite element analysis for heat transfer, Springer- Verlag, 1994.
6. Gianni comini, Stefano Del giudicecarlononino, The finite element analysis for heat transfer, Taylor & Francis, 1994.
7. E.L.Cussler, Diffusion, Cambridge University Press, 3rd edition, 2009.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the weighted residual method and numerical integration
CO2 Understand the modelling of heat conduction in 1D & 2D approach with case study
CO3 Solve problems on one dimensional approach with various element study
CO4 Solve nonlinear transient problems of heat transfer with case study approach
CO5 Understand the Galerkins method of steady convection methods with applications

16TE704 FLUID FLOW AND HEAT TRANSFER IN ENGINES

	L	T	P	C
	3	0	0	3

UNIT I INTRODUCTION **8**

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

UNIT II LOW AND HIGH REYNOLDS NUMBER FLOWS **9**

Ideal flows and Boundary layers, Flows at Moderate Reynolds Numbers, Characteristics of High – Reynolds Number Flow, Ideal Flows in a plane, Axisymmetric and Three dimensional Ideal Flows and Boundary Layers, Low Reynolds Numbers Flows.

UNIT III HEAT TRANSFER IN IC ENGINE **9**

Water and air cooling of engines, combustion systems and variation of gas temperatures, heat transfer coefficient, calculation of hat rejection to coolant. Heat transfer, temperature distribution and thermal stress in piston, piston rings and cylinder liner. Heat transfer through cylinder head, fins and valves, effect of various operating parameter on engine heat transfer.

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 IN POROUS MEDIA **9**

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.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Ronald L. Panton, Incompressible flow, 3rd Edition, Wiley, 2005.
2. K. Muralikdhar and G. Biswas, Advanced Engineering Fluid Mechanics, Narosa Publishing house, 1999.
3. Frank M. White, Fluid Mechanics, 4th Edition McGraw Hill, 1999.
4. Frank M. White, Viscous Fluid Flow, 2nd Edition, McGraw Hill, 1991.
5. I.G. Currie, Fundamental Mechanics of fluids, 2nd Edition, McGraw Hill 1993.
6. F.P. Incropera and B. Lavine, Fundamentals of Heat and Mass Transfer, 6th Edition,Willey, 2006.
7. C.Baumgarten, Mixture formation in internal combustion engines, Springer-Verlag, 2006.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the basic equations of fluid flow and heat transfer.

CO2 Apply the appropriate fundamental laws of fluid dynamics.

CO3 Be confident on how to perform experiments related Fluid mechanics, different measurement systems.

CO4 Analyse various Compressible fluid flow problems.

CO5 Be familiar with various types fluid flow measurement systems.

16TE705 DESIGN OF HEAT EXCHANGERS

(Use of standard Data books are permitted)

L	T	P	C
3	0	0	3

UNIT I FUNDAMENTALS OF HEAT EXCHANGER **9**

Temperature distribution and its implications types – shell and tube heat exchangers – regenerators and recuperators – analysis of heat exchangers – LMTD and effectiveness method.

UNIT II FLOW AND STRESS ANALYSIS **9**

Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures.

UNIT III DESIGN ASPECTS **9**

Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe - finned tube - shell and tube heat exchangers - simulation of heat exchangers.

UNIT IV COMPACT AND PLATE HEAT EXCHANGERS **9**

Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters - limitations.

UNIT V CONDENSERS AND COOLING TOWERS **9**

Design of surface and evaporative condensers – cooling tower – performance characteristics. Condenser selection – Water cooled – Air cooled, Selection of evaporators, Selection of cooling tower, Selection of Pumps and Fans.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. SadikKakac and Hongtan Liu, Heat Exchangers Selection, Rating and Thermal Design, CRC Press, 2002.
2. Arthur. P Frass, Heat Exchanger Design, John Wiley & Sons, 2011.
3. Taborek.T, Hewitt.G.F and Afgan.N, Heat Exchangers, Theory and Practice, McGraw- Hill Book Co. 1980.
4. Hewitt.G.F, Shires.G.L and Bott.T.R, Process Heat Transfer, CRC Press, 1994.
5. Ramesh.K.Shah, Specifications of Fundamental of heat exchanger design, wileyindiaPvt.Ltd, 2013.
6. T.Kuppan, Heat Exchanger design hand book, Marcel Dekker.Inc.2000.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the basic understanding of several types of heat exchangers, respirators and heat pipes

CO2 Understand the effect of turbulence and flow and stress analysis of HX in the design aspect

CO3 Design a HX with pressure loss, effects on baffles and performance with case study

CO4 Present the compact and plate HX with case study analysis

CO5 Design of surface using condenser, evaporators with cooling tower and other cooling techniques

16TE706 ENERGY SYSTEMS MODELING AND ANALYSIS

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION 9

Primary energy analysis - Dead states and energy components-Exergy balance for closed and control volume systems-applications of exergy analysis for selected energy system design - Modelling overview- levels and steps in model development - examples of models – Curve fitting and regression analysis

UNIT II MODELLING AND SYSTEMS SIMULATION 10

Modelling of energy systems – Heat Exchanger, Solar collectors, Distillation, Rectifications, Turbo machinery components, Refrigeration systems - information flow diagram, Solution of set of nonlinear algebraic equations, Successive substitution, Newton Raphson Method. Examples of energy systems simulation

UNIT III OPTIMISATION 10

Objectives-constraints, Problem formulation - Unconstrained problems - Necessary and Sufficiency conditions. Constrained Optimization- Lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis

UNIT IV ENERGY- ECONOMY MODELS 9

Multiplier Analysis - Energy and Environmental Input / Output Analysis - Energy Aggregation– Econometric Energy, Demand Modeling - Overview of Econometric Methods –Dynamic programming - Search Techniques - Univariate / Multivariate.

UNIT V APPLICATIONS AND CASE STUDIES 7

Case studies of optimization in Energy systems problems- Dealing with uncertainty- probabilistic techniques - Trade-offs between capital and energy using Pinch Analysis

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. W.F. Stoecker, Design of Thermal Systems, McGraw Hill, 1989.
2. A.Bejan, G.Tsatsaronis and M.Moran, Thermal Design and Optimization, John Wiley &Sons, 1996.
3. S.S.Rao, Optimisation theory and applications, Wiley Eastern, 1990.
4. S.S. Sastry, Introductory methods of numerical Analysis, Prentice Hall, 1988.
5. P. Meier, Energy Systems Analysis for Developing Countries, Springer Verlag, 1984.
6. Beveridge and Schechter, Optimization Theory and Practice, McGraw Hill, 1970.
7. F.CarlKnopft, Modeling analysis & Optimization of process and energy system, John wiley& sons 2012.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Develop consistent energy and climate scenarios.

CO2 Have an knowledge of modeling and system simulation.

CO3 Utilize knowledge from various disciplines in order to perform techno-economic analyses of sustainable energy systems

CO4 Understand the different types of energy economy models.

CO5 develop and use energy system models in order to analyze various energy and climate scenarios

16TE707 SPACE PROPULSION

L	T	P	C
3	0	0	3

UNIT I GAS DYNAMICS **9**

Wave motion – Compressible fluid flow through variable area devices – Stagnation state and properties – Normal shock and oblique shock waves – Rayleigh and Fanno Flow. A review of normal shock relation; Mach waves; Equation for finite strength shock waves; Rankine - Hugenit relation; Extended Prandtl relation;

UNIT II THERMODYNAMICS OF AIRCRAFT ENGINES **9**

Theory of Aircraft propulsion – Thrust – Various efficiencies – Different propulsion systems – Turboprop – Ram Jet – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft.

UNIT III PERFORMANCE CHARCTERISTICS OF AIRCRAFT ENGINE **9**

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

UNIT IV ROCKET PROPULSION **9**

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

UNIT V ROCKET THRUST CHAMBER **9**

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

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Philip G. Hill and Carl R.Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 1992.
2. Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons Inc, New York, 1970.
3. Rocket Propulsion Elements, G.P.Sutton, John Wiley & Sons Inc., New York, 5th Edition, 1986.
4. Gas Dynamics, E Rathakrishnan, Prentice Hall of India.
5. Aircraft Propulsion system technology & design, G.C. Oates, AIAA Education Series, 1989.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Analyze the propulsion system along with the advanced propulsion system.

CO2 Demonstrate skills in working independently with minimal supervision

CO3 Understand and examine various parameters used in a chemical rockets, especially in solid rocket motor and a liquid rocket engine

CO4 Comprehend and illustrate the basics of thrust chamber in terms of their designing approach.

CO5 Relate the significance of test facilities and their associated parameters.

16TE708 TURBOMACHINES

	L	T	P	C
	3	0	0	3

UNIT I INTRODUCTION 9

Basics of isentropic flow – diffuser and nozzle configurations - static and stagnation properties – area ratio – mass flow rate – critical properties - operating characteristics of diffuser and Nozzle. Various types of subsonic and supersonic inlets. Basics of Fanno and Rayleigh flow. Use of gas tables. Energy transfer between fluid and rotor velocity triangles for a generalized turbo machine -methods of representing velocity diagrams - Euler turbine equation and its different forms - degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, polytrophic etc.

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.

UNIT III COMBUSTION CHAMBER 9

Basics of combustion and chamber – chamber arrangements - flame stability – fuel injection nozzles. Swirl for stability - 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 – Reheater, Regenerator and Intercooled cycles. Working principles of Turbojet, Turbofan, Turboprop, Ramjet, Scramjet and Pulsejet Engines and cycle analysis – thrust, specific impulse, SFC, thermal and propulsive efficiencies.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Khajuria P.R and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003.
2. Ganesan, V. Gas Turbines, Tata McGraw Hill, 1999.
3. Cohen, H., Rogers, G F C and Saravanmotto, H I H, Gas Turbine Theory, John Wiely, 5th Edition 2001.
4. Hill P G and Peterson C R, Mechanics and Thermodynamics of Propulsion, Addition- Wesley, 1970.
5. Mattingly J D, Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition. 1997.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Apply thermodynamics and kinematics principles to turbo machines.

CO2 Analyze the performance of turbo machines.

CO3 Ability to select turbo machine for given application.

CO4 Understand mechanisms behind working of Turbines.

CO5 Predict performance of turbo machine using model analysis.

16GE701	ENGINEERING EDUCATIONAL MANAGEMENT	L	T	P	C
	(Common to all M.E. / M. Tech. Courses)	3	0	0	3

UNIT I EDUCATIONAL MANAGEMENT 9

Meaning, Definitions, Principles of good management, Functions of Management - POSDCORB (Planning, Organization, Staffing, Direction, Co ordination, Reporting, Budgeting Theories of Management, General principles of Educational management Leadership in Educational Organizations: meaning and nature, nature of Leadership, - Styles of Leadership and development of Leadership, Types of Educational Management - Centralized and decentralized.

UNIT II INSTITUTIONAL PLANNING 9

Institutional Planning – meaning, nature and characteristics, Types of Institutional Planning, Steps in Institutional Planning, Importance of Institutional Planning, Educational planning – School Time table and co-curricular activities, Planning,-Six elements- Objectives, Policies ,Procedures, Programmes, Budgets and Strategies, Long term and Short term Perspectives, Academic : curricular and co curricular activities – Time table –assignment of work to teachers.

UNIT III MODERN TECHNIQUES IN EDUCATIONAL MANAGEMENT AND THEIR APPLICATIONS IN EDUCATIONAL ORGANIZATION & STRUCTURE 9

Programme Evaluation and Review Technique (PERT), Planning Programming Budgeting System (PPBS), - Management by Objectives (MBO) - Total Quality Management (TQM) Quality in Education- Input –Process –Output Analysis – Concept of Total Quality Management, Supervision and Inspection – functions - Accreditation and certification, Educational structure of education in the Central Government- role of MHRD, Central –State relation in Education in India Statutory/Autonomous Organization.

UNIT IV MANAGING CHANGE IN EDUCATION 9

Need for change- Population growth, technological & scientific development educational growth & diffusion of knowledge, Planning for change: concept and objectives of planned change process, Approaches to change: Need oriented, people oriented, and task oriented, The stages of Change Process: awareness, interest, conviction, evaluation, trial, acceptance and adoption (Rogers, Ryan and Gross.)

UNIT V MANAGEMENT OF EDUCATIONAL SKILLS 9

Meeting skills - Why of meetings, Delegating responsibility, Prepare for and organize meetings, Chairing and minting, Following-up, interaction, Time Management - Planning, Dealing with stress, Systems for time Management, Presentation Skills - Planning, Delivery use of media , External representation of organization, Team Building – Working under pressure , Working with people, Negotiating , Team processes (storm, norm, etc.), Taking responsibility - Handling conflict, Transactional Mode. (The course would be transacted through participatory approach including group discussion; self study, seminar/presentations by students etc)., Controlling Management skills: Conceptual skills, Human skills, Technical skills, : Duties and responsibilities- Leadership-Meaning – styles -Management Grid – Morale – Organizational commitments, Academic freedom –Professional development, Classroom management –Management of school building –equipments –library –records and registers – hostel.

L:45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1 Aggarwal, J. C. (2008). Development and planning of modern education. UP: Vikas Publishing House Pvt Ltd.

2 Aggarwal, J. C. (2008). Theory & Principles of Education. UP: Vikas Publishing House Pvt Ltd.

3 Lal, R. B., &Palod, S. (2008). Educational Thought and Practice. Meerut: R.Lall Books Depot.

4 Richard, L.D. (2000). Management.NewYork : The Dryden Press.

5 Prakash, S. (1999).Educational planning. New Delhi: Gyan Publishing House.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Know how to expose their innovative ideas to run an successful institution.

CO2 Acquire the knowledge about various funding agencies.

CO3 Use the techniques, skills, and modern engineering tools necessary to solve technical and business problems.

CO4 Plan the budget for all the requirements for an organization.

CO5 Understand the structure of education at different levels.

16TE709 GAS TURBINES

	L	T	P	C
	3	**0**	**0**	**3**

UNIT I GAS TURBINE CYCLES **9**

Gas turbine cycles – Air Standard Analysis, Intercooler, Heat Exchanger; Component behavior.

UNIT II AXIAL FLOW COMPRESSORS **9**

Momentum and energy transfer in rotors - Velocity triangles - Stage performance -Degree of reaction - Three-dimensional analysis - Cascade testing – Compressor Characteristic curves – Howell's Correlation - Surging and stalling.

UNIT III AXIAL FLOW TURBINES **9**

Stage velocity triangles - impulse and reaction turbines, losses and co-efficient – blade design principles - three-dimensional analysis - testing and performance characteristics – Compounding methods - blade cooling.

UNIT IV CENTRIFUGAL COMPRESSORS AND RADIAL TURBINES **9**

Construction and working principle - velocity triangles - backward, forward and radially swept blades - losses and coefficients- performance characteristics. Types of inward flow radial (IFR) turbine – velocity triangles – thermodynamics of the 900 IFR turbine – optimum design solution of 900 IFR turbines – stage losses –Performance characteristics.

UNIT V COMBUSTORS AND MATCHING **9**

Different types – Annular, Can-annular types - Flow pattern - Cooling methods – Material requirement – Gas turbine pollution and its reduction. Matching procedure of power plant components, engine off-design performance.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Cohen, H., Rogers, G.E.C., and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd, 1989.
2. Yahya, S.M., Turbines, Compressors and Fans, Tata McGraw-Hill, 1983.
3. Earl Logan, Jr., Hand book of Turbo machinery, Marcel Dekker, Inc., USA, 1992
4. Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbo machinery, Pergamon Press, 1978.
5. Ganesan, V., Gas Turbines, Tata McGraw-Hill Pub.Co.Ltd. New Delhi, 1999.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand construction and design features of gas turbines as used for power generation

CO2 Understand the axial flow compressors and performance calculations for optimised performance

CO3 Understand the axial flow turbines and performance calculations for optimised Performance using velocity triangle study

CO4 Compare the construction and working principles of centrifugal compressor and radial turbines

CO5 Understand the advance topics like patterns and cooling methods pollution control using case study and application knowledge

16TE901	FIRE & SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I PHYSICS AND CHEMISTRY OF FIRE 9

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion – vapour clouds – flash fire – jet fires – pool fires – unconfined vapour cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapour explosion – case studies – Flixborough, Mexico disaster, Pasedena Texas.

UNIT II FIRE PREVENTION AND PROTECTION 9

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E – types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – notice-first aid for burns.

UNIT III INDUSTRIAL FIRE PROTECTION SYSTEMS 9

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO2 system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms – indices of inflammability.

UNIT IV SAFETY IN FINISHING, INSPECTION AND TESTING 9

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation.

UNIT V SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES 9

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines, Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Akhil Kumar Das, “Principles of Fire Safety engineering” PHI Publishers-New Delhi, 2014.
2. Dave Mac Donald “Industrial safety Risk Assessment and shut down systems”, an imprint of Elsevier-Newnes, IDC Technologies, Great Britain, 2004.
3. Trade, “Handbook of industrial fire protection and security “.Trade and technical press Ltd. the University of Wisconsin - Madison 2009.
4. Lon H , Ferguson , Christopher , Janicack, “ fire Protection for the safety Professionals“ an imprint of the Scare crow press -Government Institutes –United States of America, 2005.
5. Krishnan N.V, “Safety management in Industry”, Jaico Publisher House, 1996

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the physics and chemistry of fire with case studies example

CO2 Analyse the fire prevention and protection with fire aid needed

CO3 Present the industrial protection systems like boiler and radiography with boiler regulation knowledge

CO4 Analyse the safety in heat treatment finishing and testing of steam and administrative controls with Boiler regulation knowledge

CO5 Understand the importance of metal working and wood working in CNC and modern machines

16TE902 ENERGY AND ENVIRONMENT

L	T	P	C
3	0	0	3

UNIT I OVERVIEW- ENERGY 7

Basics of energy – Types of energy and its utilization – Energy characteristics – Energy Measures – global energy scenario – India energy scenario – Types of energy and its utilization – Energy characteristics – Energy measures.

UNIT II ENVIRONMENT POLLUTION 6

Fundamentals of environment – Water cycle – Oxygen cycle – Carbon cycle – Nitrogen cycle – Phosphorous cycle – Bio-diversity – Environmental aspects of energy utilization – Public health issues related to environmental Pollution.

UNIT III AIR POLLUTION 12

Classification of air pollutants, sources of emission and air quality standards – Physical and chemical characteristics – Meteorological aspects of air pollutant dispersion – Temperature lapse rate and stability – Factors influencing dispersal of air pollutant – Air pollution dispersion models – Air pollution sampling and measurement – types – Ambient air sampling – Gaseous air pollutants – Particulate air pollutants – Analysis of air pollutants.

UNIT IV AIR POLLUTION CONTROL METHODS AND WATER POLLUTION 12

Types of controls – Particulate emission control – Gaseous emission control in IC engines and Boilers– Sources and classification of water pollutants – Waste water sampling and analysis – Basic process of waste water treatment – Primary treatment – Secondary treatment – Advanced treatment Methods of feed water treatment.

UNIT V ENVIRONMENTAL IMPACT ASSESSMENT 8

Air quality and water quality standards – Pollution prevention and control acts – Principles and methodology of Environmental impact assessment, Air and water quality impacts by project types.

L : 45 T: 0 P: 0 Total: 45 PERIODS

REFERENCES

1. Abbasi and Abbasi: Renewable Energy Sources: Their Impact on Global Warming and Pollution, PHI, Eastern Economy Edition, 2012.
2. C.S. Rao: Environmental Pollution Control Engineering, Wiley Eastern, 1992.
3. Daniel Vallero “Fundamentals of air Pollution” Elsevier, 2014.
4. J.Jefferypeirce “Environmental Engineering” , Elsevier , 2004.
5. N.N.Basak“Environmental Engineering “ , Tata McGraw Hill , 2007.

COURSE OUTCOMES

At the end of the course student should be able to:

CO1 Understand the basic need of the energy, types and its characteristics in Indian scenario

CO2 Understand the basics of environment pollution and its importance and public health issues

CO3 Analyse the air pollution, characteristics sampling techniques and minimisation

CO4 Understand the reason for air and water pollution, advanced water treatment

CO5 Present air and water quality standards, impacts and case study assessment