

SNS COLLEGE OF TECHNOLOGY, COIMBATORE – 641035**(AN AUTONOMOUS INSTITUTION)****REGULATION – 2016****CHOICE BASED CREDIT SYSTEM****SUGGESTED CURRICULAM & SYLLABI****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.	16TE607	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
		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
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
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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 PartialDifferential 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.

WEB RESOURCES	
1.	http://search.mit.edu
2.	http://www.educatorstechnology.com/2012/08/a-list-of-great-free-math-websites-for.html

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 C_p and C_v , 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 AND EXERGY	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
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REFERENCES	
1.	P.K.Nag, Engineering Thermodynamics, Mc-GrawHill Education India,Pvt.Ltd.7 th 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.

WEB RESOURCES

1. <http://ocw.mit.edu>
2. <http://www.nptel.iitm.ac.in>
3. <http://www.gobooke.net/advanced-thermodynamics-for-engineers-kenneth-wark-solution>

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.		

UNIT II	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
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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, Addison 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,Heattransfer,McGraw Hill company,10th edition, 2009.

WEB RESOURCES

1. <http://ocw.mit.edu>
2. <http://www.nptel.iitm.ac.in>
3. <http://ebooks.cambridge.org>
4. <http://books.google.com/books/Advanced heat Transfer .html>

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 – Combustionchambers – 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, TataMcGrawHill, 2008.
2. R.B.Mathur and R.P. Sharma, Internal combustion Engines, DhanpatRai 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.
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WEB RESOURCES

1. <http://www.kinindia.com/university/advanced-ic-engines-notes-me2041-notes/>
2. <http://www.gobookee.net/advanced-ic-engines/>
3. <http://alternativefuels.about.com/od/researchdevelopment/a/HCCIbasics.html>

16TE607	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

SI.NO	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

L: 0	T: 0	P:60	TOTAL: 60 PERIODS
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SI.NO	LIST OF EQUIPMENTS REQUIRED (Each 1 No.)
1.	Spark Ignition engines-Test Rig.
2.	Compression Ignition Engine- Test Rig
3.	Research EngineMulti 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

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
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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.	SamwelS.Lee,Subratasengupta,Waste heat management and utilization, hemisphere publishing corporation 1979.
6.	ArnicZageris, 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.

WEB RESOURCES

1. http://www.dieselserviceandsupply.com/cogeneration_technology.aspx.
2. <http://www.wasteheatrecovery.co.in/waste-heat-recovery.html>.
3. <http://www.thermaxindia.com>
4. <http://www.cogeneration.org>

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 nonuniform 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 - ϵ 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
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REFERENCES	
1.	John D Anderson, "Computational Fluid Dynamics-The Basics with Applications", McGraw -Hill Education, New York, 2012.
2.	Suhas, Patankar V, "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 2004.
3.	Versteeg H K and Malalasekara W, "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.	Ghoshdasdar, P.S., "Computer Simulation of flow and heat transfer" Tata McGrawHill Publishing Company Ltd., 1998.
7.	Chung, T.J. "Computational Fluid Dynamics", Cambridge University Press, 2002.

WEB RESOURCES	
1.	http://www.cfd-online.com
2.	http://www.cfdrc.com
3.	http://nptel.iitm.ac.in
4.	http://www.cfdnotes.com
5.	http://www.slideshare.net/zoo66class/importanceofcfd

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 patterns. Pressure distribution over stationary 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
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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.

WEB RESOURCES	
1.	http://www.nptel.iitm.ac.in/courses/112105171/
2.	http://www.freestudy.co.uk/fluid%20mechanics/t5203.pdf
3.	http://books.google.com/books/Viscous_Flow_Theory_Turbulent_flow.html
4.	http://www.engineering.uiowa.edu/~fluids1/creeping_flow_1

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
Artificial 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.

WEB RESOURCES	
1.	www.nptel.ac.in
2.	www.googlebooks.com

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

S.NO.	OBJECTIVE IS TO ENHANCE THE PRESENTATION SKILLS ON
1.	Real world Case studies related to thermal engineering like study of a thermal power plant boilers, solar desalination plant, solar pumps in agriculture, etc.
2.	Application of Recent Thermal trends in the case studies by analyzing and relating the Journals, Monographs, standard Papers, etc.
3.	Innovative ideas on new thermal science & technology.
4.	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

WEB RESOURCES	
1.	http://www.india-seminar.com
2.	http://www.seminaronly.com
3.	http://www.micab.umn.edu/news/Seminartips.html
4.	http://www.gift.edu.in/Guidelines_for_Seminars.doc

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

S.NO.	PROJECT WORK – PHASE- I
1.	Shall consist of identification of the project after literature survey.
2.	Students should present a review paper & submit it to the internal examiners.
3.	Report should include full Introduction, Literature Review, details of the 25% of the 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 TOTAL : 180 PERIODS
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16TE701	COMPUTATIONAL FLUID DYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

S.NO.	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

L: 0 T: 0 P: 60 TOTAL : 60 PERIODS
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LIST OF EQUIPMENTS REQUIRED
Hardware: 18 Systems with Latest configuration. Software : CFD soft wares like ANSYS, ANSYS FLUENT, etc.

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

WEB RESOURCES

1. <http://www.tchpc.tcd.ie/fluent>
2. <http://www.cfd-online.com>
3. <http://www.cfdrc.com>

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

S.NO.	PROJECT WORK - PHASE II
1.	Work Projected in Project Phase I should be continued.
2.	The students should publish at least one paper in National / International conference or Journal before submission of the thesis.
3.	Report should be submitted as prescribed in the regulation.

L: 0 T: 0 P: 360 TOTAL : 360 PERIODS

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 – GasCalorimeter. 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
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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
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REFERENCES

1.	Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 2003,
2.	Bhatt, Vora, Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 2004.
3.	BlokhAG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing 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.

WEB RESOURCES

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| <ol style="list-style-type: none"> 1. http://www.nd.edu/~powers/ame.60636/notes.pdf 2. http://www.ems.psu.edu/~radovic/Combustion2013.html 3. http://www.spe.org/atce/2011/pages/schedule/tech.../spe146089%201.pdf 4. http://www.cerfacs.fr/~cfdbib/repository/WN_CFD_10_17.pdf 5. http://www.personal.utulsa.edu/~kenneth-weston/chapter3.pdf |
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16TE610	COMBUSTION ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I	INTRODUCTION	9
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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 heating values – calorimetry, DuLong’s formula for H estimation, Flue gas analysis – Orsat apparatus.

UNIT II	FUEL TYPES	9
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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
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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
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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
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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
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REFERENCES	
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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.

WEB RESOURCES	
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1.	http://www.scribd.com/doc/76250242/Flue-Gas-Analysis
2.	http://nptel.iitm.ac.in/courses/101104014/41
3.	http://books.google.co.in
4.	http://www.cast-safety.org/pdf/3_engine_fundamentals.pdf
5.	http://my.safaribooksonline.com

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

UNIT I	SUPERCHARGING	8
Objectives - Effects on engine performance – engine modification required - Thermodynamics 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
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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.

WEB RESOURCES	
1.	http://www.marinediesels.info/Basics/uniflow_and_loop_scavenging.htm
2.	http://www.intechopen.com/download/pdf/33077
3.	http://www.dieselnet.com/tech/air_scavenge.php

4. http://www.princeton.edu/~achaney/tmve/.../Two-stroke_engine.html
5. <http://www.tpub.com/engine3/en32-1.htm>

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
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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.	Douglas.C.Mentgomery, Statistical Quality Control, Wiley India Pvt.Ltd., 2009.,

WEB RESOURCES	
1.	http://www.automotivedesign.eu.com/.../IC-Engine-Components.aspx
2.	http://www.hindustanuniv.ac.in/M.%20Tech.%20Internal%20Combustion%20Engineering.pdf
3.	http://www.web.iitd.ac.in/~ravimr/courses/mel345/ignou-notes.pdf

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.		

UNITII	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 SponLtd.,UK, 1996.
5.	G.N. Tiwari, Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002.

WEB RESOURCES	
1.	www.ngridenergyworld.com/environment/t_rew_book.html
2.	www.wiley.com/WileyCDA/.../productCd-3527657037.html
3.	www.inference.phy.cam.ac.uk/sustainable/book/tex/cft.pdf

16TE614	DESIGN OF FLUIDIZED BED SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I	FLUIDIZED BED BEHAVIOUR	12
<p>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.</p>		

UNIT II	HEAT TRANSFER	7
<p>Different modes of heat transfer in fluidized bed – to wall heat transfer – gas to solid heattransfer – radiant heat transfer – heat transfer to immersed surfaces. Methods for improvement – external heat exchangers – heat transfer and part load operations.</p>		

UNIT III	COMBUSTION AND GASIFICATION	7
<p>Fluidized bed combustion and gasification – stages of combustion of particles –Performance – start-up methods. Pressurized fluidized beds.</p>		

UNIT IV	SOLIDS MIXING AND SEGREGATION	9
<p>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.</p>		

UNIT V	INDUSTRIAL APPLICATIONS	10
<p>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.</p>		

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.	PrabirBasu, Combustion and Gasification in Fludized Beds, CRC Press, 2006.

WEB RESOURCES	
1.	http://www.appliedchemical.com/products/fluid_bed_systems/
2.	http://www.fluidizedbedboilers.ca/
3.	http://www.Books.google.com/.../handbook_of_fluidization_and_fluid_parti.html

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 CONSERVATION	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
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REFERENCES	
1.	Smith, CB Energy Management Principles, Pergamon Press, New York, 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.

WEB RESOURCES	
1.	www.mecoinst.com
2.	www.energymanagertraining.com .

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
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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, FranoBarbir, Elsevier Academic Press, 2005.
3.	Fuel Cell Technology Handbook, GregorHoogers, SAE International, 2003.
4.	Fuel Cell principles and Applications, B.Viswanathan and M AuliceScibioh,UniversitiesPress, 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.

WEB RESOURCES	
1.	http://www.fuelcells.si.edu/basics.html
2.	http://www.fuelcelltechnologies.com
3.	http://www.auto.howstufforks.com/fuel...fuels/fuel-cell.html
4.	http://www.books.sae.org/book-r-305/

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, Viscoolers, Cold rooms, Calorimetric tests		

L:45	T:0	P : 0	TOTAL : 45 PERIODS
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REFERENCES	
1.	Althose, A.D. & Turnquist, C.H. "Modern Refrigeration and Airconditioning" 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.

WEB RESOURCES	
1.	http://nptel.iitm.ac.in/courses/Webcourse.../Ref%20and%20Air%20Cond/New_index1.html
2.	http://nptel.iitm.ac.in/courses/Webcourse.../Ref%20and%20Air%20Cond/.../RAC%20%20Lecture%201.pdf
3.	http://www.gobookee.net/refrigerations-and-air-conditioning/

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		

UNITII	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.

WEB RESOURCES	
1.	http://www.gobookee.net/refrigerations-and-air-conditioning
2.	http://nptel.iitm.ac.in/courses/Webcourse
3.	http://nptel.iitm.ac.in/courses/Webcourse

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
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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 ,2 nd edition, 2007.

WEB RESOURCES	
1.	http://books.google.co.in/books
2.	http://nptel.iitm.ac.in/courses/Webcourse

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
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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

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1.	http://www.onlinevideolecture.com
2.	http://www.learningace.com/doc/2741267/abde71bb9c70e922408c322fa0fd3d6c/lecture-8-thermal-power-plants
3.	http://freevideolectures.com/Course/2342/Energy-Resources-and-Technolog
4.	http://nptel.ac.in/video.php?subjectId=108105058
5.	http://www.cosmolearning.com/video-lectures/thermal-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
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REFERENCES	
1.	Ibrahim Dincer, Heat Transfer in Food Cooling Applications, Taylor & 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.

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1.	http://books.google.co.in/books?id=k4J172xZ0REC&printsec=frontcover&dq=food+processing+preservation+and+transport&hl=en&sa=X&ei=5LHvUbreLcTtrAfxmYC4Aw&ved=0CCMQ6AEwAA#v=onepage&q&f=false
2.	http://iitm.ac.in/courses/Web course

16TE622	HYBRID ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

UNIT I	ENERGY STORAGE BATTERIES	9
<p>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.</p>		

UNIT II	FUEL CELL TECHNOLOGY	9
<p>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.</p>		

UNIT III	HYBRID VEHICLE	9
<p>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.</p>		

UNIT IV	HYDROGEN GENERATION TECHNOLOGIES	9
<p>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.</p> <p>Environmental aspects of hydrogen productions: Hydrogen productions by steam methane reforming with CO₂ sequestration. Technologies for producing hydrogen from coal: Entrained –bed gasification technology</p>		

UNIT V	HYDROGEN STORAGE TECHNOLOGIES	9
<p>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 H₂ storage system engineering: Direct H₂ refueling, Engineering Assessments of condensed-Phase hydrogen storage systems. Development of on-Board reversible complex metal hydrides for hydrogen storage.</p>		

L: 45 T: 0 P: 0	TOTAL : 45 PERIODS
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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.

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1. <http://ocw.mit.edu>
2. <http://energy.gov/eere/transportation/hydrogen-and-fuel-cells>
3. <http://www.fuelcellenergy.com>
4. <http://electricvehicle.ieee.org>

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
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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.

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2. <http://edn.com/design/power-management/4425346/Energy-storage-devices-are-powering-up>
3. <http://www.energystorage.org.uk/types-of-energy-storage.html>
4. <http://www.energystorage.org.uk/>

16TE624	INSTRUMENTATION FOR THERMAL SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I | MEASUREMENT 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 MEASUREMENT

7

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

UNIT III | MEASUREMENT 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 MEASUREMENT TECHNIQUES

7

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

UNIT V | MEASUREMENT 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.

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2. <http://www.gobookee.net/thermal-power-plant-instrumentation-and-control/>
3. <http://www.Books.google.co.in/books?isbn=1435488881>
4. <http://www.scribd.com/doc/.../instrumentation-for-thermal-system-unit4>

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.		

UNITII	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.

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2. <http://www.heliosat3.de/e-learning/METR443/chapter2.pdf>
3. http://www.nptel.iitm.ac.in/.../lecture.../28-4_boundary_layer_condn.html
4. <http://www.gobookee.net/boundary-layer-theory-lecture-notes/>

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.		

UNITII	MODELLING	9
Modelling of Heat Conduction, Variational Formulation, Galerkin's Approach for onedimensional 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. (UnitI,II,III,IV)
2.	Roland W. Lewis, PerumalNithiarasu and K.N. Seetharamu, "Fundamentals of the Finit 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 Sohailusmani, Finite element analysis for heat transfer, Springer-Verlag, 1994.
6.	Gianni Comini, Stefano Del Giudice, Carlo Nino, The finite element analysis for heat transfer, Taylor & Francis, 1994.
7.	E.L. Cussler, Diffusion, Cambridge University Press, 3rd edition, 2009.

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2. http://www.books.google.com/.../The_finite_element_method_in_heat_transf.html.
3. <http://www.ncbi.nlm.nih.gov/pubmed/11264854>
4. http://www.nasa.gov/centers/dryden/pdf/88035main_h-1236.pdf

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 heat 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.

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16TE705	DESIGN OF HEAT EXCHANGERS	L	T	P	C
	(Use of standard Data books are permitted)	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
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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.
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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.

WEB RESOURCES

1.	http://www.wileyindia.com/fundamentals-of-heat-exchanger-design.html
2.	http://www.books.google.com/bookd/about/heat_exchanger_design_handbook.html
3.	http://www.nptel.iitm.ac.in/courses/103103027/pdf/mod1.pdf
4.	http://www.begellhouse.com/books/3b6dd99666136e42.html

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
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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.

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3.	http://www.Irees.de/.../herbdt-et-al-2012_introduction-to-energy-syatemsmodelling_sjes.pdf
4.	http://www.eolss.net/sample-chapters/c08/e6-106-52.pdf

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 – Turbo prop – Ram Jet – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft.		

UNIT III	PERFORMANCE CHARACTERISTICS 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 – Multistaging 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
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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.

WEB RESOURCES

1. <http://www.nptel.iitm.ac.in/courses>
2. <http://www.books.google.com>

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, polytropic 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, DhanpatRai Publications, 2003.
2.	Ganesan, V. Gas Turbines, Tata McGrawHill, 1999.
3.	Cohen, H., Rogers, G F C and Saravanmotto, H I H, Gas Turbine Theory, JohnWiely, 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.

WEB RESOURCES

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|----|---|
| 1. | http://www.nptel.iitm.ac.in/courses |
| 2. | http://www.books.google.com |

16GE701	ENGINEERING EDUCATIONAL MANAGEMENT	L	T	P	C
		3	0	0	3

UNIT I	EDUCATIONAL MANAGEMENT	9
<p>Meaning, Definitions, Principles of good management, Functions of Management - POSDCORB (Planning, Organization, Staffing, Direction, Coordination, 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.</p>		

UNIT II	INSTITUTIONAL PLANNING	9
<p>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.</p>		

UNIT III	MODERN TECHNIQUES IN EDUCATIONAL MANAGEMENT AND THEIR APPLICATIONS IN EDUCATIONAL ORGANIZATION & STRUCTURE	9
<p>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.</p>		

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
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REFERENCES	
1	Aggarwal, J. C.. Development and planning of modern education. Vikas Publishing House Pvt Ltd. 2008.
2	Aggarwal, J. C.. Theory & Principles of Education. Vikas Publishing House Pvt Ltd. 2008.
3	Hemlata, T., &Ruhela, S. P..Educational management-innovative global patterns. Regency Publication. 1997.
4	Robert, G. W., & Robert, D. Management: Comprehension, analysis, and application. Richard D .Irwin Inc. Publication. 1995.
5	Kumar A. Personal Management, Theory and Practice, DVS Publication, 2001.

WEB RESOURCES	
1.	http://www.fuelcells.si.edu/basics.html
2.	http://www.fuelcelltechnologies.com
3.	http://www.auto.howstufforks.com/fuel...fuels/fuel-cell.html
4.	http://www.books.sae.org/book-r-305/

16TE709	GAS TURBINES	L	T	P	C
		3	0	0	3

UNIT I	GAS TURBINE CYCLES	9
Gas turbine cycles – Air Standard Analysis, Different configurations – Re-heater, 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
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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 Turbomachinery, Pergamon Press, 1978.
5.	Ganesan, V., Gas Turbines, Tata McGraw-Hill Pub.Co.Ltd. New Delhi, 1999.

WEB RESOURCES	
1.	www.nptel.ac.in
2.	www.googlebooks.com

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
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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
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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
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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
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REFERENCES	
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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

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1.	http://www.iftcentre.com
2.	www.fireengineering.com/fire-prevention-protection.html
3.	www.nwgc.gov/pms/pubs
4.	https://books.google.co.in/books?isbn=1449670822

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
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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.

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1.	www.ocw.mit.edu/courses/mechanical-engineering
2.	www.engineering.uiowa.edu
3.	www.bookboon.com/en/environmental-engineering-ebooks