SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

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

Saravanampatti , Coimbatore -641035

CURRICULA AND SYLLABI

REGULATION 2019

CHOICE BASED CREDIT SYSTEM

DEPARTMENT OF MECHANICAL ENGINEERING

M.E – THERMAL ENGINEERING

SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

DEPARTMENT OF MECHANICAL ENGINEERING

R 2019 –CURRICULUM & SYLLABUS

M. E. THERMAL ENGINEERING

SEMESTER I										
S No.	**Course Code**	**Course**	**L**	**T**	**P**	**J**	**CH/ W**	**Credit**	**Int./Ext**	**Category**
Theory Courses										
1.	19MAT606	Advanced Mathematics for Thermal Engineers	3	0	0	0	3	3	50/50	PCC
2.	19TET601	Advanced Thermodynamics	3	0	0	0	3	3	50/50	PCC
3.	19TET602	Advanced Fluid Mechanics	3	0	0	0	3	3	50/50	PCC
4.	19TET603	Advanced IC Engines	3	0	0	0	3	3	50/50	PCC
5.	19TET604	Research Design and IPR	3	0	0	0	3	3	50/50	PCC
6.		Professional Elective I	3	0	0	0	3	3	50/50	PEC
7.		Audit Course - I	2	0	0	0	2	0	-	EEC
Theory Integrated Practical Courses										
8.	19GEB601	Design Thinking	1	0	0	4	5	3	100/0	EEC
Practical Course										
9.	19TEP601	Thermal Engineering Laboratory	0	0	4	0	4	2	60/40	PCC
		Total	21	0	4	4	29	23		

SEMESTER II										
S No.	**Course Code**	**Course**	**L**	**T**	**P**	**J**	**CH/ W**	**Credit**	**Int./Ext**	**Category**
Theory Courses										
1.	19TET605	Advanced Heat Transfer	3	0	0	0	3	3	50/50	PCC
2.	19TET606	Steam Engineering	3	0	0	0	3	3	50/50	PCC
3.	19TET607	Computational Fluid Dynamics	3	0	0	0	3	3	50/50	PCC
4.	19TET608	Cogeneration and Waste Heat Recovery Systems	3	0	0	0	3	3	50/50	PCC
5.		Professional Elective II	3	0	0	0	3	3	50/50	PEC
6.		Professional Elective III	3	0	0	0	3	3	50/50	PEC
7.		Career Course – I	2	0	0	0	2	2	100/0	EEC
8.		Audit Course - II	2	0	0	0	2	0	-	EEC
Practical Course										
10	19TEP602	Computational Fluid Dynamics Laboratory	0	0	2	0	2	1	60/40	PCC
		Total	22	0	2	0	24	21		

SEMESTER III										
S No.	**Course Code**	**Course**	**L**	**T**	**P**	**J**	**CH/ W**	**Credit**	**Int./Ext**	**Category**
Theory Courses										
1		Professional Elective IV	3	0	0	0	3	3	50/50	PEC
2		Open Elective	3	0	0	0	3	3	50/50	OE
3		Career Course- II	2	0	0	0	2	2	100/0	EEC
Practical courses										
4	19TEP701	Project Work – Phase I	0	0	0	16	16	8	60/40	EEC
		Total	8	0	0	16	24	16		

SEMESTER IV										
S No.	**Course Code**	**Course**	**L**	**T**	**P**	**J**	**CH/ W**	**Credit**	**Int/Ext**	**Category**
Practical courses										
1	19TEP702	Project Work – Phase II	0	0	0	24	24	12	60/40	EEC
		Total	0	0	0	24	24	12		

PROFESSIONAL ELECTIVE I

Sl. No	Course Code	Course	L/T/P/J	CH/W	Credits
1	19TEE610	Nuclear Engineering	3/0/0/0	3	3
2	19TEE611	Energy Conservation and Management	3/0/0/0	3	3
3	19TEE612	Fuels and Combustion	3/0/0/0	3	3
4	19TEE613	Hybrid Energy Technology	3/0/0/0	3	3
5	19TEE622	High Temperature Materials	3/0/0/0	3	3

PROFESSIONAL ELECTIVE II

Sl. No	Course Code	Course	L/T/P/J	CH/W	Credits
1	19TEE614	Design of Refrigeration Equipment	3/0/0/0	3	3
2	19TEE615	Gas Turbines	3/0/0/0	3	3
3	19TEE616	Advanced Thermal Storage Technologies	3/0/0/0	3	3
4	19TEE617	Refrigeration Machinery and Components	3/0/0/0	3	3

5	19TEE623	Theory of Heat Pipes	3/0/0/0	3	3

PROFESSIONAL ELECTIVE III

Sl. No	Course Code	Course	L/T/P/J	CH/W	Credits
1	19TEE618	Cryogenic Engineering	3/0/0/0	3	3
2	19TEE619	Fuel Cell Technology	3/0/0/0	3	3
3	19TEE620	Design of Heat Exchangers	3/0/0/0	3	3
4	19TEE621	Design of Fluidized Bed Systems	3/0/0/0	3	3
5	19TEE624	Heat and mass transfer in biological systems	3/0/0/0	3	3

PROFESSIONAL ELECTIVE IV

Sl. No	Course Code	Course	L/T/P/J	CH/W	Credits
1	19TEE701	Design of Solar and Wind System	3/0/0/0	3	3
2	19TEE702	Finite Element Method in Heat Transfer Analysis	3/0/0/0	3	3
3	19TEE703	Manufacturing and Testing of IC Engine Components	3/0/0/0	3	3
4	19TEE704	Food Processing, Preservation and transport	3/0/0/0	3	3
5	19TEE705	Convective Heat Transfer	3/0/0/0	3	3

OPEN ELECTIVES COURSES OFFERED TO OTHER PG PROGRAMMES

Sl. No	Course Code	Course	L/T/P/J	CH/W	Credits
1	19TEO701	Fire and Safety Engineering	3/0/0/0	3	3
2	19TEO702	Energy and Environment	3/0/0/0	3	3
3	19TEO703	Logistics and Supply Chain Management	3/0/0/0	3	3

CAREER COURSE

Sl. No	Course Code	Course	L/T/P/J	CH/W	Credits
1	19GET601	Professional Development	2/0/0/0	2	2
2	19GET602	Quality Assurance & Accreditation in Engineering Education	2/0/0/0	2	2

3	19GET603	Holistic Education	2/0/0/0	2	2

AUDIT COURSE

Sl. No	Course Code	Course	L/T/P/J	CH/W	Credits
1	19GEA601	English for Research Paper Writing	2/0/0/0	2	0
2	19GEA602	Disaster Management	2/0/0/0	2	0
3	19GEA603	Value Education	2/0/0/0	2	0
4	19SEA714	Constitution of India	2/0/0/0	2	0
5	19GEA605	Pedagogy Studies	2/0/0/0	2	0

S.No.	SUBJECT AREA	CREDITS PER SEMESTER				TOTAL CREDITS
		I	II	III	IV	
1	PCC	17	13			30
2	PEC	3	6	3		12
3	OE			3		3
4	EEC	3	2	10	12	27
		23	**21**	**16**	**12**	**72**

19MAT606	ADVANCED MATHEMATICS FOR THERMAL ENGINEERS	L	T	P	J	C
	(M.E. Thermal Engineering)	3	1	0	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 - Case studies based on design thinking

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

UNIT III FINITE DIFFERENCE METHODS FOR ONE DIMENSIONAL PARABOLIC EQUATIONS 9+3

One dimensional parabolic equation – Explicit and Crank-Nicolson Schemes – Thomas Algorithm – Weighted average approximation - Applications based on design thinking

UNIT IV FINITE DIFFERENCE METHODS FOR TWO DIMENSIONAL PARABOLIC EQUATIONS 9+3

Dirichlet and Neumann conditions – Two Dimensional parabolic equations – ADI method.- Applications of parabolic equations - Case studies based on design thinking

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 J: 0 Total: 60 PERIODS

REFERENCES

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

COURSE OUTCOMES

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

- **CO1** Understand the advanced topics like Fourier transform, Calculus of variance.
- **CO2** Know the problem on calculus of variations and its techniques.
- **CO3** Apply the knowledge of solving the problems in Finite difference methods.
- **CO4** Demonstrate a deep understanding of one form of parabolic equation.
- **CO5** Solve the engineering Problems by using Laplace and Poisson equations.

19TET601	ADVANCED THERMODYNAMICS (Use of standard thermodynamics tables, Charts, HMT data books are permitted)	L	T	P	J	C
		3	0	0	0	3

UNIT I THERMODYNAMIC PROPERTY RELATIONS 9

Fundamental postulate of thermodynamics, fundamental differential equations of thermodynamics. Cyclic relations, Clausius Clayperon equation, Joule – Thomson coefficient, Bridgeman tables for thermodynamic relations.

UNIT II REAL GAS BEHAVIOUR AND MULTI–COMPONENT SYSTEMS 9

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.

UNIT III CHEMICAL THERMODYNAMICS AND EQUILIBRIUM 9

Thermo chemistry - First law analysis of reacting systems - Adiabatic flame temperature –adiabatic changes- 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

Exergy, Reversible work, irreversibility, derivation of availability functions for closed and open systems, Thermodynamics and Efficiency Calculations, and applications to various thermodynamic processes.

UNIT V ADVANCED COGENERATIVE CYCLES 9

Cycles – Brayton and Rankine cycles, Reheating and Inter cooling- Regenerative cycles -Cogenerative cycles for regenerative power plants. Applications and Case studies on cogenerative cycle.

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

REFERENCES

1. P.K.Nag, Engineering Thermodynamics, Mc-Graw Hill Education India, Pvt.Ltd.7th Edition, 2017.
2. Yunus Cengel, Thermodynamics – An Engineering Approach, Tata McGraw Hill, New Delhi, 9th Edition 2019.
3. ValanArasu,A, Engineering Thermodynamics, Vijay Nicole Imprint Pvt. Ltd., 2017.
4. Sonntag, R.E., and Van Wylen, Introduction to Thermodynamics, Classical and Statistical Thermodynamics, Third Edition, John Wiley and Sons, 2007.
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, Laura L. Pauley, Thermodynamic concepts and applications, Cambridge University Press,2nd Edition, 2020.

COURSE OUTCOMES

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

CO1 Get Knowledge of fundamental postulates and cyclic & property relations.
CO2 Understand the advanced concepts on real gas behaviour and multi component systems
CO3 Present chemical thermodynamics advanced topics, adiabatic flame temperature and entropy change also their equilibrium conditions in gases
CO4 Differentiate and deliberate about the availability and exergy and their calculations
CO5 Present on the advanced co generative cycles and their importance with case study

19TET602 ADVANCED FLUID MECHANICS

L	T	P	J	C
3	0	0	0	3

UNIT I BASIC EQUATIONS OF FLOW **9**

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

UNIT II POTENTIAL FLOW THEORY **9**

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 stationery and rotating cylinders in a uniform flow

UNIT III VISCOUS FLOW THEORY **9**

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

UNIT IV BOUNDARY LAYER CONCEPT AND INCOMPRESSIBLE **9**

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.

UNIT V CREEPING FLOWS **9**

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: 0 P: 0 J: 0 Total: 45 PERIODS

REFERENCES

1. Yunus Cengel & John M Cimbala, "Advanced Fluid Mechanics", 4th Edition, McGraw Hill 2019.
2. Pijush K. Kundu., & Ira M. Cohen, "Fluid Mechanics", 3rd Edition, Elsevier Academic Press, 2015.
3. E. L. Houghton & P. W. Carpenter, "Aerodynamics for Engineering Students", Butterworth Heinemann, 7th edition, 2016.
4. John D Anderson Jr., "Fundamentals of Aerodynamics", Tata McGraw Hill, 2017.
5. Victor L Streeter, E Benjamin Wylie and Keith W Bedford, "Fluid Mechanics", WCB McGraw Hill, Boston, 9th Edition, 2017.
6. Faith A.Morrison. "An Introduction to Fluid Mechanics", Cambridge university press, 2014.

COURSE OUTCOMES

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

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

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

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

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

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

19TET603 ADVANCED IC ENGINES

L	T	P	J	C
3	0	0	0	3

UNIT I SPARK IGNITION ENGINES **9**

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

UNIT II COMPRESSION IGNITION ENGINES **9**

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

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, Bio fuels, 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. Hydrogen-fuel cells, batteries, super capacitors and hybrids. Application and case study.

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

REFERENCES

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

COURSE OUTCOMES

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

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

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

CO3 Present pollution measurement and norms and its controlling techniques

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

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

19TET604 RESEARCH DESIGN AND IPR

L	T	P	J	C
3	0	0	0	3

UNIT I RESEARCH CONCEPTS **9**

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

UNIT II TOOLS & TECHNIQUES OF LITERATURE SURVEY **9**

Effective literature studies approaches, analysis, Need of Plagiarism software, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and Tools Available for assisting to write reports

UNIT III DOE & REPORT WRITING **9**

Definition of Experimental Design, Examples, Guidelines for designing experiments. Process Optimization and Designed experiments, Taguchi approach to parameter design. Types of reports, layout of research report, interpretation of results, style manual, layout and format, style of writing, typing, References, tables, figures, conclusion, appendices.

UNIT IV OVERVIEW TO IPR **9**

Introduction - Meaning, Relevance, - Novelty & Originality - Business Impact -patentable inventions- Patent Search Engines- Patent Components - Title - Field and Background of Invention - objective - statement of invention - brief summary of drawings - detailed description of invention - Working - Patent claim construction - Abstract – Case Study of Patent Documents & Procedure to apply for the patents.

UNIT V OTHER IP RIGHTS **9**

IP – Patents – Copyrights and related rights – Trade Marks and rights - Trademark registration – Definitions – Industrial Designs and Integrated circuits –Geographical Indications - Application Procedures- Case Study of various IP Disputes in India.

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

REFERENCES

1. R. Panneerselvam, "Research Methodology " PHI Learning -2016.
2. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students, 2016 .
3. Subbaram N.R. “Handbook of Indian Patent Law and Practice “, S. Viswanathan Printers and Publishers Pvt. Ltd., 2016.
4. C.R.Kothari , “Research Methodology – Methods & Techniques” - New Age International Publishers- 2015.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step-by-Step Guide for beginners”-2016.
6. M.M.S. Karki, “Intellectual Property Rights: Basic Concepts”, Atlantic Publishers & Distributors (P) Ltd 2018.
7. VK Ahuja, “Intellectual Property Rights in India” Lexis Nexis, 2019.

COURSE OUTCOMES

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

CO1 Characterise the research problem based on scope and objective pertaining to the design thinking concept with necessary instrumentation

CO2 Prepare research and funding proposals based on literature review

CO3 Write the project report based on experimentation and guidelines studied

CO4 Prepare IPR proposal and file the same with guidance

CO5 Present the guidelines and regulations and applications based on case study

19TEE610 NUCLEAR ENGINEERING

L	T	P	J	C
3	0	0	0	3

UNIT I BASICS OF NUCLEAR FISSION AND POWER FROM FISSION **9**

Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion and breeding. Case study on Nuclear engineering prospects.

UNITII NEUTRON TRANSPORT AND DIFFUSION **9**

Neutron transport equation, diffusion theory approximation, Fick's law, solutions to diffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutron slowing down

UNIT III MULTIGROUP, MULTIREGION DIFFUSION EQUATION, CONCEPT OF CRITICALITY **9**

Solution of multigroup diffusion equations in one region and multiregion reactors, concept of criticality of thermal reactors, applications.

UNIT IV REACTOR KINETICS AND CONTROL **9**

Derivation of point kinetics equations, in hour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients, case study on reactor.

UNIT V HEAT REMOVAL FROM REACTOR CORE AND REACTOR SAFETY **9**

Solution of heat transfer equation in reactor core, temperature distribution, critical heat flux, Reactor safety philosophy, defence in depth, units of radioactivity exposure, radiation protection standards, case study on reactor failure and learning from the past.

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

REFERENCES

1. Introduction to Nuclear Engineering (3rd Edition) by John R. Lamarsh, Anthony J.Barrata, Prentice Hall, 2001
2. Introduction to Nuclear Reactor Theory, by John R. Lamarsh, Addison-Wesley, 1966
3. Nuclear Reactor Analysis, by James J. Duderstadt and Lewis J. Hamilton, John Wiley, 1976

COURSE OUTCOMES

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

CO1 Differentiate fusion and fission and its advancements study based on literature

CO2 Study the equations and its formulation idea on formulation of electron slow down

CO3 Study advancement on Multi group and multi region reactors and their criticality with applications

CO4 Understand the kinetics and its control techniques based on reactivity coefficients and case study on reactivity addition

CO5 Present on heat transfer analysis on the reactor core for the safety measurement and appropriate operation with case study analysis

19TEE611 ENERGY CONSERVATION AND MANAGEMENT

L	T	P	J	C
3	0	0	0	3

UNIT I INTRODUCTION **9**

Energy Conservation and Management: general principles of energy management and energy management planning, conducting energy audit (pre-audit, audit and post-audit), energy audit instruments, energy audit report, monitoring, evaluating, case study on energy management success theory.

UNIT II IMPORTANCE OF ENERGY MANAGEMENT **9**

Management of electrical load and lighting: Management opportunities with electric drives, Energy Efficiency in motors, pumps and fans, lighting, electrical load analysis, and peak demand control and Demand Response

UNIT III ECONOMIC PERFORMANCE INDICES **9**

Economics of power factor improvement: reactive power management, capacitor sizing, location, placement, maintenance, case study. Computer -aided energy management, energy efficiency policy initiatives.

UNIT IV ENERGY ECONOMICS **9**

Payback - Simple and Discounted, Net Present Value, Internal Rate of Return, Benefit to Cost Ratio, E/D ratio, Life cycle/ levelized cost. Financial evaluation of energy projects, evaluation of proposals, profitability index, life cycle costing approach, investment decision and uncertainty.

UNIT V ENERGY CONSERVATION - CASE STUDIES **9**

Energy conservation in vehicles, energy conservation in buildings, Power quality issues related to Energy Efficient Technologies, Energy Conservation Practice – Case Studies.

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

REFERENCES

1. L.C. Witte, P.S. Schmidt, D.R.Brown, “Industrial Energy Management and Utilization”, Hemispherical Publication, 1988
2. D.A. Reeg, “Industrial Energy Conservation”, Pergamon Press, 1980.
3. L.J. Nagrath, “Systems Modeling and Analysis”, Tata McGraw Hill, 1982.
4. W.C. Turner, “Energy Management Handbook “, Wiley, New York, 1982
5. R. Loftnen, Van Nostrarid Reinhold C. “Energy Handbook”, 1978.TERI Publications.

COURSE OUTCOMES

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

CO1 Understand the energy management and prepare report on pre and post audit with case study knowledge

CO2 Understand the importance of energy management and machines like motors pump, fans and load demand response

CO3 Present the economics and cost indices and influence of machine and cost and energy demand control techniques

CO4 Understand about the economics of power factor improvement with case study knowledge to analyse the computer energy management systems

CO5 To compare the energy conservation in buildings and vehicles and power plants with case study approach

19TEE612 FUELS AND COMBUSTION

L	T	P	J	C
3	0	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, case study on fuels.

UNIT III GASEOUS FUELS **7**

Classification - Composition & Properties - Estimation of Calorific Value – Gas Calorimeter.

Rich & Lean Gas - Wobbe Index - Natural Gas and its types- Methane - Producer Gas –Gasifiers- Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non -Thermal Route - Biogas - Digesters - Reactions - Viability – Economics.

UNIT IV COMBUSTION: STOICHIOMETRY & KINETICS **12**

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

UNIT V COMBUSTION EQUIPMENTS **8**

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

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

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

REFERENCES

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 2003,
2. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 2004.
3. BlokhAG,Heat 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.

COURSE OUTCOMES

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

CO1 Analyse the fuel characterisation and fuel cycle analysis
CO2 Understand and differentiate the solid and liquid fuels
CO3 Present the details of gaseous fuels on chemical-combustion in to thermal aspects
CO4 Understand the combustion process with knowledge on calculations, chemical mechanisms and conservation equations using simplified analysis
CO5 Present complete details on Coal burning combustion equipments, oil burners and their factors

19TEE613 HYBRID ENERGY TECHNOLOGY

L	T	P	J	C
3	0	0	0	3

UNIT I ENERGY STORAGE BATTERIES **9**

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

UNIT II FUEL CELL TECHNOLOGY **9**

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

UNIT III HYBRID VEHICLE **9**

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

UNIT IV HYDROGEN GENERATION TECHNOLOGIES **9**

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

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

UNIT V HYDROGEN STORAGE TECHNOLOGIES **9**

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

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

REFERENCES

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

COURSE OUTCOMES

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

CO1 Understand the complete technical details of energy storage batteries
CO2 Understand the need of fuel cell technology and their cells types
CO3 Analyse the need of hybrid vehicle and its recent trend and its train mechanism
CO4 Understand the oxidative processing of hydrocarbons and environmental process of hydrocarbons
CO5 Present the need of the hydrogen storage and its applications in cryogenics with case study knowledge

19TEE622 HIGH TEMPERATURE MATERIALS

L	T	P	J	C
3	0	0	0	3

UNIT I HIGH TEMPERATURE FRACTURE MECHANICS 9

Factors influencing life of components at elevated temperatures, brittle to ductile from low temperature to high temperature, fracture maps for different alloys and oxides, creep curve and mechanism, expressions of rupture life of creep, Monkman-Grant relationship, oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion.

UNIT II SUPERALLOYS 9

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, Application of Super Alloys on Engine Components and other thermal systems. Introduction on phase change materials.

UNIT III CERAMICS, POLYMERS, COMPOSITES FOR HIGH TEMPERATURE APPLICATIONS 9

Typical example of conventional and advanced ceramics, boron nitride, silicon carbide, sialon - technical applications, cermets, high temperature polymers and its applications, carbon – carbon composites, ceramic matrix composites for high temperature applications. Case study on high temperature materials.

UNIT IV MATERIALS FOR NUCLEAR AND AERO SPACE APPLICATIONS 9

Use of low alloy steel, stainless steel, Zirconium alloys and moderator materials, Use of Ti to AISI316 and its effect on properties with low nitrogen content. Use of 9 Cr. Mo. Steel for fusion reactors. Reactor materials, data of aircraft materials Y-S Vs test temperature properties of low density materials such as Al-Li, Al- Mg. Al-Li, MG- Al-Cu alloys- Materials used in Nuclear Fission and Fusion.

UNIT V MATERIALS FOR POWER PLANTS AND PETROCHEMICAL INDUSTRIES 9

Carbides and their stability at high temperature steels for power turbine, Austenitic steels and oxide dispersion strengthened materials for power plant application. Use of Nickel base alloys for gas turbines development, Pipe line steels for oil and gas sector, Latest trend in the development of ultra-high strength line pipe steel with improved toughness. Use of High Temperature Alloys in Petroleum Refining Process. Case studies on materials in various thermal industries.

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

REFERENCES

1. Courtney T.H, “Mechanical Behaviour of Materials”, McGraw-Hill, USA, 1990
2. Roger C Reed,” The super alloys Fundamentals and applications”, Cambridge university press, 2006
3. Van Vlack L K “Physical Ceramics for Engineers”, Addison Wesley, Massachusetts, 1964
4. Bressers. J., “Creep and Fatigue in High Temperature Alloys”, Applied Science, 1981
5. McLean D., “Directionally Solidified Materials for High Temperature Service”, The Metals Society, USA, 1985

COURSE OUTCOMES

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

CO1 Acquire technical knowledge about High Temperature Materials and their Applications.
CO2 Understand the super alloys for high temperature usage.
CO3 Apply the materials utility in nuclear and aerospace industry.
CO4 Suggest a material for various High temperature applications.
CO5 Interpret the various materials and its compositions with respect to different applications

19GEB601	DESIGN THINKING	L	T	P	J	C
	(Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	1	0	0	4	3

UNIT I INTRODUCTION TO DESIGN THINKING 3+12

An brief insight to Design Thinking and Innovation- People Centered Design & Evoking the 'Right Problem'- Purpose of Design Thinking- Design Thinking Framework

UNIT II PROCESS IN DESIGN THINKING (EMPATHY, DEFINE 3+12

Design Thinking Process – Empathy – Uncovering and Investigating Community Concerns - Define : Examine and Reflect on the problem - Reconsider and arrive at the right problem to solve - Research with the users and Context - Question Framing and Conducting Research - User Stories and Design Strategy

UNIT III CONCEPTING AND BUILDING (IDEA, CREATE) 3+12

Generating Ideas-Identifying top three ideas-Bundling the Ideas and create an concepts-Stories and Scenarios to that concepts-Rapid Prototyping

UNIT IV TESTING, REFINING AND PITCHING THE IDEAS 3+12

Importance of Testing with People-Testing our Design with People-Conducting the usability Test-Record Results, Enhance, Retest and Redefine Results-Creating a Pitch for our design.

UNIT V VALUE PROPOSITION DESIGN 3+12

Introduction-Key Partners- Key Activities- Key Resources- Value Propositions- Customer Relationship- Customer Segments- Channels- Cost Structure- Revenue Streams-Case study.

L :15 T: 0 P: 0 J: 60 T:75 PERIODS

REFERENCES

1. Idris Mootee, Design Thinking for Strategic Innovation - What They Can't Teach You at Business or Design School, 1st Edition, 2017, Wiley
2. Yves Pigneur, Greg Bernarda, Alan Smith, Trish Papadakos Alex Osterwalder, Value Proposition Design: How to Create Products and Services Customers Want, 2015, Wiley
3. Brown, Tim, and Barry Katz. Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, 2009, Harper Business.

COURSE OUTCOMES :

At the end of the course students should be able to

CO1 Able to empathize with a broad group of stakeholders to understand their needs through the ethnographic method.

CO2 Able to define and re-define innovation challenges by asking the right questions, and not necessarily focusing on the right answers.

CO3 Able to develop many creative ideas through structured brainstorming sessions

CO4 Able to develop rapid prototypes to bring their ideas into reality as quickly as possible, and obtain feedback.

CO5 Able develop visual literacy and articulacy to explain design decisions

19TEP601 THERMAL ENGINEERING LABORATORY

L	T	P	J	C
0	0	4	0	2

LIST OF EXPERIMENTS

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

MAJOR EQUIPMENTS / SOFTWARE REQUIRED

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

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

COURSE OUTCOMES

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

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

19TET605	ADVANCED HEAT TRANSFER (Use of standard thermodynamics table, HMT data books are permitted)	L	T	P	J	C
		3	0	0	0	3

UNIT I CONDUCTION **9**

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 **9**

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.

UNIT III FREE CONVECTIVE HEAT TRANSFER **9**

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**

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**

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.

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

REFERENCES

1. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley &Sons, 5th Edition 2017.
2. Yunus Cengel , Heat and Mass Transfer A Practical approach , Tata McGraw Hill, 3rd Edition, 2007.
3. Adrain Bejan , Convective Heat Transfer , John Wiley &Sons, 4th edition 2013.
4. Vedat S. Arpaci , Conduction heat transfer, Addision Wesley Co,1996.
5. Ozisik. M.N., Heat Transfer – A Basic Approach, Mc Graw-Hill Co., 1985.
6. Nag.P.K, Heat &Mass Transfer, Tata McGraw-Hill, 3rd edition 2020.
7. J.P.Holman, Heat transfer, Mc Graw Hill company,10th edition, 2017.

COURSE OUTCOMES

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

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

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

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

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

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

19TET606 STEAM ENGINEERING

L	T	P	J	C
3	0	0	0	3

UNIT I INTRODUCTION **12**

Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart Boilers ,Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down; IBR, Boiler standards, Case study on boilers in steam power plant.

UNITII PIPING & INSULATION **9**

Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss. Case study and application of piping and insulation.

UNIT III STEAM SYSTEMS, BOILER PERFORMANCE ASSESSMENT **12**

Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems. Performance Test codes and procedure, Boiler Efficiency.

UNIT IV ENERGY CONSERVATION AND WASTE MINIMIZATION **7**

Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization, case study on waste management in power plant sector.

UNIT V INSTRUMENTATION & CONTROL **7**

Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection, case study on failure analysis in instrumentation.

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

REFERENCES

1. T. D. Estop, A. McConkey, Applied Thermodynamics, Parson Publication,1993.
2. Domkundwar; A Course in Power Plant Engineering; Dhanapat Rai and Sons,1988.
3. Yunus A. Cengel and Boles, "Engineering Thermodynamics ",Tata McGraw-Hill Publishing Co. Ltd,2018.
4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency,2015.
5. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency, 2015.
6. J. B. Kitto & S C Stultz; Steam: Its Generation and Use; The Babcock and Wilcox Company,2005
7. P. Chatopadhyay; Boiler Operation Engineering: Questions and Answes; Tata McGraw Hill Education Pvt Ltd, N Delhi, 2020.

COURSE OUTCOMES

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

CO1 Explain working of different boilers and significance of mountings and accessories with case study knowledge.

CO2 Use techniques, skills, and modern engineering tools necessary for boiler performance assessment with case study knowledge

CO3 Students will have a theoretical and practical background in thermal systems, and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation

CO4 Analyze a thermal system for sources of waste heat design a system for waste heat recovery

CO5 Design and develop controls and instrumentation for effective monitoring of the process

19TET607	COMPUTATIONAL FLUID DYNAMICS	L	T	P	J	C
		3	0	0	0	3

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD **9**

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

UNIT II CONDUCTION HEAT TRANSFER **9**

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**

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**

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**

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

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

REFERENCES

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

COURSE OUTCOMES

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

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

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

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

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

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

19TET608 COGENERATION AND WASTE HEAT RECOVERY SYSTEMS

L	T	P	J	C
3	0	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. Case study and application of cogeneration.

UNIT II 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.

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 J: 0 Total: 45 PERIODS

REFERENCES

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984.
2. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London,1963.
3. David flin,Cogeneration-A user guide, IET, 2009.
4. V.Ganapathy, Industrial Boilers and Heat recovery-steam generators, Marcel Dekker Co. 2003.
5. 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.

COURSE OUTCOMES

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

CO1 Understand the principles of cogeneration, cycle and generations, types and sources with case study approach

CO2 Understand the advanced thermodynamic performance of cycles involved in cogeneration

CO3 Present the concepts pertaining to electrical and interconnection issues and its various applications

CO4 Analyse the criteria for waste heat recovery on boilers heat pipes, pumps and absorption systems

CO5 Do the cost analysis, optimise the parameters selection based on financial and environmental considerations

19TEE614 DESIGN OF REFRIGERATION EQUIPMENT

L	T	P	J	C
3	0	0	0	3

UNIT I REFRIGERATION CYCLES – ANALYSIS **9**

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 **9**

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 **9**

Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal / Kyoto protocols-Eco Friendly Refrigerants. Case study on 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 **9**

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

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

REFERENCES

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

COURSE OUTCOMES

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

CO1 Understand the vapour compression refrigeration cycle analysis with cascade system

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

CO3 Present various environment friendly refrigerants with case study knowledge

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

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

19TEE615 GAS TURBINES

L	T	P	J	C
3	0	0	0	3

UNIT I GAS TURBINE CYCLES **9**

Gas turbine cycles – Air Standard Analysis, Different configurations, Gas Turbine Types and Applications. Effect of design pressure ratio and turbine temperature on the basic gas turbine cycle – 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.

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. Applications and Case studies on turbines and combustion machines.

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

REFERENCES

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

COURSE OUTCOMES

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

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

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

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

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

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

19TEE616 ADVANCED THERMAL STORAGE TECHNOLOGIES

L	T	P	J	C
3	0	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. Case study on energy storage.

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. Waste heat recovery systems.

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.

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. Cooling technologies for heat rejection.

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

REFERENCES

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

COURSE OUTCOMES

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

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

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

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

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

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

19TEE617 REFRIGERATION MACHINERY AND COMPONENTS **L T P J C**

(Use of standard Refrigeration tables, Charts and data books are permitted) **3 0 0 0 3**

UNIT I REFRIGERANT COMPRESSORS **10**

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

UNIT II REFRIGERATION SYSTEM COMPONENTS **10**

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. Case study on modernization of components.

UNIT III HYDRONIC SYSTEMS **9**

Water piping in Chilled Water Systems, Multiple Fan Coil Units, Condensers - Multiple Condensers and Cooling Towers. System components – Expansion tank, Balancing valves, Pumping systems, Pump selection, Freeze prevention

UNIT IV APPLIANCES & ACCESSORIES **7**

Air Conditioning in Automobiles, Railway Wagons, Marine Vessels, Aircraft and Other Commercial Applications and with necessary case study.

UNIT V SYSTEM ACCESSORIES AND CONTROLS **9**

Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalising in multiple evaporators. Different Defrosting and capacity control methods and their implications.

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

REFERENCES

1. Cooper &Williams, B. “Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting” Eagle Wood Cliffs (NT) Prentice Hall, 1989.
2. Dosset, R.J. “Principles of Refrigeration”, John Wiley & Sons, 2001
3. Hains, J.B, “Automatic Control of Heating & Air conditioning” Mc Graw Hill, 1981.
4. Althose, A.D. & Turnquist, C.H. “Modern Refrigeration and Air conditioning” Good Heart-Wilcox Co. Inc., 1985.
5. Recent release of BIS Code for relevant testing practice. ASHRAE Hand book (Fundamentals & Equipments, 2005.

COURSE OUTCOMES

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

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

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

CO3 Present various chilling water piping systems, components and pumps

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

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

19TEE623	THEORY OF HEAT PIPES	L	T	P	J	C
		3	0	0	0	3

UNIT I INTRODUCTION **9**

Basic concepts, need of heat pipes - heat transfer rate - thermodynamic efficiency - influencing factors-wick design - heat recovery from exhaust air, classification of heat pipes, practical applications. Case study on heat pipe evolution.

UNIT II TYPES AND LIMITATIONS **9**

Operating principle, Working fluids and its temperature ranges, Heat transfer limits and Heat pipe characteristics, Standard Heat Pipes & Vapor Chambers, Variable Conductance Heat Pipes (VCHP), Thermosyphon & Loop Thermosyphon, Loop Heat Pipes, Rotating Heat Pipes, Oscillating / Pulsating Heat Pipes, Various Applications.

UNIT III HEAT PIPE ENERGY BALANCE **9**

Interfacial heat and mass transfer, Physical surface phenomena, Capillary and disjoining forces – Interfacial resistance in vaporization and condensation process, Interfacial mass, Momentum, energy, pressure balance – Interfacial phenomena in grooved structures.

UNIT IV HEAT PIPE ANALYSIS AND DESIGN **9**

Steady hydrodynamics –Thermal Fluid phenomena in capillary media, Vapor flow Analysis, Thermal characteristics including the wall effects and effect of vapor flow - Area temperature relations -Heat pipe dimensions and structural considerations - Heat pipe heat exchanger – Design procedures.

UNIT V HEAT PIPE BEHAVIOUR AND APPLICATIONS **9**

Transient response to sudden change in temperature heat input, Numerical and Analytical model for Frozen start up. Two phase closed Thermosyphon – Reflux condensation heat transfer in Analysis, Evaporation heat transfer Analysis, Thermosyphon with capillary wicks. Case study on application in electronic cooling.

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

REFERENCES

1. S.W. Chi, Heat Pipe Theory and Practice, Hemisphere publishing corporation, Washington, 1976.
2. Amir Faghri, Heat Pipe Science and Technology, Taylor and Francis, 1995.
3. Dunn, P.D and Reay, D.A, 1982, Heat Pipes, Third Edition, Pergamon Press, 1994.
4. M.N. Ivanovskii, V.P. Sorokin and I.V. Yagodkin, 1982, The Physical Principles of Heat Pipes, Clarendon press, Oxford, 1982.
5. I.B. Ivanov, Thin Liquid films: Fundamentals and Application – Marcel Dekkar, New York, 1988.

COURSE OUTCOMES

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

CO1 Gain the basic knowledge on heat pipe and its need.

CO2 Understand the working of various heat pipes.

CO3 Analyse the heat transfers and energy balance in the heat pipe.

CO4 Understand the limitations of heat pipe**.**

CO5 Behaviour of heat pipe in various applications and case studies.

19TEE618	CRYOGENIC ENGINEERING	L	T	P	J	C
		3	0	0	0	3

UNIT I INTRODUCTION **9**

Introduction to Cryogenic Systems, Historical development, Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties.

UNIT II CRYOGENIC SYSTEMS **9**

Liquefaction systems ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers. Applications and Case studies on cryogenic systems.

UNIT III CRYOGENIC REFRIGERATION SYSTEMS **9**

Ideal Refrigeration systems- Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media.

UNIT IV CRYOGENIC FLUID STORAGE AND TRANSFER SYSTEMS **9**

Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems.

UNIT V CRYOGENIC INSTRUMENTATION **9**

Pressure flow-level and temperature measurements. Types of heat exchangers used in cryogenic systems (only description with figure) Cryo pumping Applications. Applications and -Case study on cryogenic success from failure.

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

REFERENCES

1. Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.
2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co.,1959
3. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986
4. J. H. Boll Jr, Cryogenic Engineering,2018

COURSE OUTCOMES

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

CO1 Learn the basics of refrigeration and cryogenics and its application area

CO2 Understand the refrigeration cycles for domestic and industrial applications with case study

CO3 Present the need of ideal refrigeration systems, liquid, gas and solid as working medium

CO4 Understand the cryogenics storage vessels and transportation techniques

CO5 Present the instrumentations involved in cryogenics and types of HX with case study knowledge.

19TEE619 FUEL CELL TECHNOLOGY

L	T	P	J	C
3	0	0	0	3

UNIT I INTRODUCTION **7**

Basic Principles – Classification – Alkaline, Proton Exchange Membrane, Direct Methanol, Phosphoric Acid & Molten Carbonate – Parts – Fuel cell poisoning, Case study on fuel Cells and Mobile Batteries.

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 – lonic 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, Hydrogen, fuel cells, batteries, super capacitors, and hybrids. Case study on fuel cell – learning from the past.

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

REFERENCES

1. Fuel Cell Systems Explained, James Larminie and Andrew Dicks, 2nd Edition, John Wiley & Sons Inc., 2000
2. PEM Fuel Cells Theory and Practice, Frano Barbir, Elsevier Academic Press, 2005
3. Fuel Cell Technology Handbook, Gregor Hoogers, SAE International, 2003
4. Fuel Cell principles and Applications, B.Viswanathan and M Aulice cibioh, Universities Press 2006
5. Hydrogen and Fuel Cells, Bent Sorenson, Elsevier Academic Press, 2005.

COURSE OUTCOMES

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

CO1 Understand the basic on fuel cell principles and batteries

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

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

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

CO5 Present the application of fuel call base on case study

19TEE620	DESIGN OF HEAT EXCHANGERS	L	T	P	J	C
	(Use of standard Data books are permitted)	3	0	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. Introduction on thermosiphons and heat pipes and.

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. Process heat analysis in heat exchanger design and storage options.

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. Case study on heat exchanger evaluation.

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 J: 0 Total: 45 PERIODS

REFERENCES

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

COURSE OUTCOMES

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

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

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

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

CO4 Present the compact and plate HX with case study analysis

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

19TEE621	DESIGN OF FLUIDIZED BED SYSTEMS	L	T	P	J	C
		3	0	0	0	3

UNIT I FLUIDIZED BED BEHAVIOUR 12

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

UNIT II HEAT TRANSFER 7

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

UNIT III COMBUSTION AND GASIFICATION 7

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

UNIT IV SOLIDS MIXING AND SEGREGATION 9

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

UNIT V INDUSTRIAL APPLICATIONS 10

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

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

REFERENCES

1. Howard,J.R.,Fluidized Bed Technology: Principles and Applications, Adam b Hilger , New York, 1989.
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.

COURSE OUTCOMES

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

CO1 Understand the characteristics and fluidisation phenomenon in design of FBS

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

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

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

CO5 Present the industrial Application of FBS and its accessories transporting

19TEE624	HEAT AND MASS TRANSFER IN BIOLOGICAL SYSTEMS	L	T	P	J	C
	(Use of standard thermodynamics table, HMT data books are permitted)	3	0	0	0	3

UNIT I INTRODUCTION TO BIOLOGICAL SYSTEMS **9**

Human body – Physiological aspects – Biothermofluidics: Renal System, Blood Circulation and Lungs – Heat Transfer and Temperature Distribution in the Human body – Mass, energy, and flow transport in bio systems and biotechnology – Biothermology: Major Challenges.

UNIT II THERMAL CONTROL **9**

Cell – Cellular energy production – Energetics of Cell Growth and Division – Energetics of Body Metabolism – Body Temperature – Temperature Regulation – Pathologic Variations in Body Temperature. Case study on human comfort in the extreme weather.

UNIT III HEAT TRANSFER MODELING **9**

A Bioheat Equation – The Pennes Bioheat Equation – Wulff Continuum Model – The Klinger Continuum Model – The Continuum Model by Chen and Holmes (1980) – Counter-current Heat Transfer: The Mitchel and Myers model – Model of Keller and Seiler – Weinbaum-Jiji Bioheat Transfer Models – Rhythms and Hemodynamic Parameters – porous medium approach to tissue and blood flow through capillaries.

UNIT IV MASS TRANSFER MODELING **9**

mass diffusion in tissues – porous medium approach to bio mass transfer – lungs – Respiratory System – Alveolar Gas Transport – Lung Diffusing Capacity – Modeling Alveolar Gas Transport – Microscopic – macroscopic – unification – introduction to nephrology.

UNIT V APPLICATIONS **9**

Extreme temperatures – Biothermal Cooling – freezing and thawing – Cryosurgery – Biothermal Heating – Radiofrequency thermotherapy – Thermal injury – modeling – lasers and tissue heating – Cell Surgery – Modeling of specific human body functions – measurement of thermophysical properties – transient bioheat equation modelling laser surgery in eye. Case study on biological heat transfer.

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

REFERENCES

1. Heat and Mass Transfer A Biological Context, Ashim K. Datta, CRC Press, 2017.
2. S. Becker, “Heat Transfer and fluid flow in biological processes”, Elsevier, 2014.
3. K. R. Sharma, “Transport Phenomena in Biomedical Engineering”, Mc Graw Hill, 2010.
4. I. P. Herman, “Physics of the human body”, Springer, 2016.
5. A. Datta, “Biological and bioenvironmental Heat and Mass Transfer”, Marcel Dekker, 2002.

COURSE OUTCOMES

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

CO1 Understand the need of the biothermology concept and flow transport in bio systems

CO2 Understand the human body temperature regulation

CO3 Analyse the counter current interaction in human body parts

CO4 Differentiate the mass transfer in micro and macro level inhuman body

CO5 Apply the knowledge of biological heat transfer with case studies

19TEP602 COMPUTATIONAL FLUID DYNAMICS LABORATORY

L	T	P	C
0	0	2	1

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.

MAJOR EQUIPMENTS / SOFTWARE REQUIRED

Hardware: 18 Systems with Latest configuration.

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

L : 0 T: 0 P: 30 C: 1 Total:30 PERIODS

REFERENCES

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

COURSE OUTCOMES

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

CO1 Acquire experience on heat transfer modeling and meshing using ANSYS fluent and gambit
CO2 Analyse the modelling of elbow fins and circular tubes
CO3 Understand the convection simulation in rectangular enclosures
CO4 Simulate the convection and radiation in circular enclosures
CO5 Present simulation model on Heat exchangers

19TEE701 DESIGN OF SOLAR AND WIND SYSTEM

L	T	P	J	C
3	0	0	0	3

UNIT I INTRODUCTION **9**

Conventional sources of energy, nuclear, alternative energy sources, Needs and fundamentals of solar and wind energy. Possibility of energy utilization from solar and wind in comparison with all conventional and non-conventional energies. The importance of solar and wind energy. Case studies and applications based on design thinking concepts.

UNIT II HEAT EXCHANGER DESIGN IN SOLAR POWER SYSTEMS **9**

Types - Solar Radiation-estimation, prediction & measurement, Fresnel Reflectors and Lenses. Heat-Exchanger Design: Packed bed –pressure drop in design bed-flow across tubes. Energy transport systems-piping systems-pressure drop – heat loss. Case studies and applications based on design thinking concepts.

UNIT III COLLECTOR AND PV DESIGN OF SOLAR POWER SYSTEMS **9**

Performance of Solar flat plate collectors, concentrating collectors, thermal storage. Design Fundamentals. Design of-Storage-Containment-Heat-Exchanger-liquid-based Heating-Parabolic Trough-Holistic field-PV systems. Methods of Modeling and – Day lighting. Case studies and applications based on design thinking concepts.

UNIT IV WIND POWER SYSTEM AND CASE STUDIES **9**

Wind energy – India –ongoing research and development. Wind Speed and Energy Distributions-Speed and Power Relations- Power Extracted - Air Density- Global Wind Patterns- Digital Data Loggers- Wind Speed Prediction. Case studies and applications based on design thinking concepts.

UNIT V DESIGN OF WIND POWER SYSTEMS **9**

System Components- Tower -Turbine Blades-Yaw Control-Speed Control. System Design Features-Number of Blades- Rotor Upwind or Downwind- Horizontal Axis Versus Vertical Axis- Spacing of the Towers- Maximum Power Operation- Constant Tip-Speed Ratio Scheme-Peak Power Tracking Scheme-System Control Requirements- Speed Control- Rate Control- Environmental Aspects-Audible Noise-Electromagnetic Interference (EMI).

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

REFERENCES

1. D.Yogi goswami,"Principles of solar engineering", CRC press-Washington DC.2015.
2. Sukhatme S.P., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
3. Bansal N K, Kleeman M and Mells M , "Renewable Energy Sources and Conversion Technology", 460 pp. New Delhi: Tata McGraw-Hill.1990.
4. J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 1981
5. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.
6. Mukund R. Patel "Wind and solar power systems",CRC press-Washington DC.1999
7. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principle of Solar Engineering", Taylor and Francis, 2000.

COURSE OUTCOMES

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

CO1 Understand the need of study on solar and wind energy systems.

CO2 Analyse the solar energy system design on the pressure and radiation purview with design thinking concept.

CO3 Understand the design of solar flat plates and advanced concepts like Fresnel lenses.

CO4 Understand the wind power systems with case study knowledge.

CO5 Present the design concepts on wind power systems and its advancements.

19TEE702	FINITE ELEMENT METHOD IN HEAT TRANSFER ANALYSIS	L	T	P	J	C
		3	0	0	0	3

UNIT I INTRODUCTION **9**

Introduction, Weighted Residual Methods, Shape functions, Coordinate systems, Numerical Integration. Applications and Case studies.

UNIT II MODELLING **9**

Modelling of Heat Conduction, Variational Formulation, Galerkin's Approach for one dimensional and two dimensional problems. Applications and Case studies.

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. Applications and Case studies.

UNIT IV NON LINEAR HEAT TRANSFER **9**

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

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. Applications and Case studies.

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

REFERENCES

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

COURSE OUTCOMES

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

CO1 Understand the weighted residual method and numerical integration

CO2 Understand the modelling of heat conduction in 1D & 2D approach with case study

CO3 Solve problems on one dimensional approach with various element study

CO4 Solve nonlinear transient problems of heat transfer with case study approach

CO5 Understand the Galerkins method of steady convection methods with applications

19TEE703	MANUFACTURING AND TESTING OF IC ENGINE COMPONENTS	L	T	P	J	C
		3	0	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. Mechanism of heat transfer in IC engine combustion. Applications and Case studies.

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. Applications and Case studies of drive system modernization.

UNIT IV COMPUTER INTEGRATED MANUFACTURING 9

Integration of CAD, CAM and Business functions in CIM- Networking, CNC programming for machining of I.C.Engines Components. Applications and Case studies on CIM and IC engines.

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, equipment 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 J: 0 Total: 45 PERIODS

REFERENCES

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

COURSE OUTCOMES

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

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

CO2 Understand the advanced topic like piston assembly

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

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

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

19TEE704	FOOD PROCESSING, PRESERVATION AND TRANSPORT	L	T	P	J	C
		3	0	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 Applications and Case studies.

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. Applications and Case studies.

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. Applications and Case studies.

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

REFERENCES

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

COURSE OUTCOMES

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

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

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

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

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

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

19TEE705	CONVECTIVE HEAT TRANSFER (Use of standard thermodynamics table, HMT data books are permitted)	L	T	P	J	C
		3	0	0	0	3

UNIT I EQUATIONS OF CONVECTIVE HEAT TRANSFER 9

Convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers. Continuity, Navier-Strokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations.

UNIT II FLOW AND ANALOGY SOLUTIONS 9

Similarity solution for flow over an isothermal plate – integral equation solutions – Numerical solutions – Viscous dissipation effects on flow over a flat plate. External Turbulent Flows: Analogy solutions for boundary layer flows – Integral equation solutions – Effects of dissipation on flow over a flat plate.

Internal Turbulent Flows: Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.

UNIT III NATURAL CONVECTION 9

Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations. Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection.

UNIT IV COMBINED CONVECTION 9

Governing parameters & equations – laminar boundary layer flow over an isothermal vertical plate – combined convection over a horizontal plate – correlations for mixed convection – effect of boundary forces on turbulent flows – internal mixed convective flows – Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct.

UNIT V CONVECTIVE HEAT TRANSFER THROUGH POROUS MEDIA 9

Area weighted velocity – Darcy flow model – energy equation – boundary layer solutions for 2-D forced convection – Fully developed duct flow – Natural convection in porous media – filled enclosures – stability of horizontal porous layers. Case studies on convective heat transfer.

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

REFERENCES

1. Patrick H. Oosthuigen & David Naylor, Introduction to Convective Heat Transfer Analysis, McGraw Hill, 1999.
2. Kays & Crawford, Convective Heat & Mass Transfer, TMH, 2017.
3. Adrian Bejan, Convection Heat Transfer, Wiley, 2013.
4. Michel favre-Marinet sedat tardu, Convection Heat Transfer, Wiley, 2009.
5. I. Pop, Derek Ingham, Convective Heat Transfer, Mathematical and Computational Modelling of Viscous Fluids and Porous Media, Elsevier.2001.

COURSE OUTCOMES

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

CO1 Recall the basic equations of the Convective heat transfer

CO2 Understand the heat transfer over plate in both laminar and turbulent

CO3 Analyse the boundary layer concept in the free convection

CO4 Understand the correlations related to the combined convection flow

CO5 Understand Convection in a porous media and interpret case studies

19TEO701 FIRE & SAFETY ENGINEERING

L	T	P	J	C
3	0	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. Applications and Case studies.

UNIT II FIRE PREVENTION AND PROTECTION **9**

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

UNIT III INDUSTRIAL FIRE PROTECTION SYSTEMS **9**

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO_2 system, foam system, dry chemical powder (DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms – indices of inflammability.

UNIT IV SAFETY IN FINISHING, INSPECTION AND TESTING **9**

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

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

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

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

REFERENCES

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

COURSE OUTCOMES

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

CO1 Understand the physics and chemistry of fire with case studies example
CO2 Analyse the fire prevention and protection with fire aid needed
CO3 Present the industrial protection systems like boiler and radiography with boiler regulation knowledge
CO4 Analyse the safety in heat treatment finishing and testing of steam and administrative controls with Boiler regulation knowledge
CO5 Understand the importance of metal working and wood working in CNC and modern machines

19TEO702	ENERGY AND ENVIRONMENT	L	T	P	J	C
		3	0	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. Case study on environmental impact and its assessments.

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

REFERENCES

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

COURSE OUTCOMES

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

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

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

CO3 Analyse the air pollution, characteristics sampling techniques and minimisation

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

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

19TEO703	LOGISTICS AND SUPPLY CHAIN MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

UNIT I LOGISTICS AND SUPPLY CHAIN MANAGEMENT 9

Supply chain management and logistics – Lean Supply chain management and logistics - Competitive advantage - Cyclic view of supply chain - value chain - logistics management - competitive performance - changing competitive environment - marketing and logistics interface.

UNIT II CUSTOMER ORIENTED SUPPLY CHAIN MANAGEMENT 9

Delivering customer value - customer service –Make to order versus make to stock - the impact of out-of-stock - Customer service and customer retention - Market-driven supply chains - Defining customer service objectives - Setting customer service priorities - Setting service standards - Case study (Flipkart, Amazon and Shopclues)

UNIT III MEASURING LOGISTICS COSTS AND PERFORMANCE 9

Logistics and the bottom line - Logistics and shareholder value - Logistics cost analysis - The concept of total cost analysis - Principles of logistics costing - Customer profitability analysis - Direct product profitability - Cost drivers and activity-based costing – Case study

UNIT IV SUPPLY CHAIN RESPONSIVENESS 9

The lead-time gap - Improving the visibility of demand - The supply chain fulcrum - Forecast for capacity, execute against demand - Demand management and planning - Collaborative planning, forecasting and replenishment - Product 'push' versus demand 'pull' - The Japanese philosophy -The foundations of agility - A route map to responsiveness – Case study

UNIT V ROLE OF INFORMATION TECHNOLOGY 9

The role of information in the virtual supply chain - 'Quick response' logistics - Production strategies for quick response - Product design and supply chain complexity - The trend towards globalisation in the supply chain - The future of global sourcing

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

REFERENCES

1. Paul Myerson, “Lean Supply Chain and Logistics Management”, Mc Graw Hill 2012.
2. Sunil Chopra and Peter meindl, “Supply Chain Management, Prentice Hall Publications, U.S.A, Edition V, 2014.
3. James B.Ayers, “Handbook of Supply Chain Management”, St.Lucle press, 2013.
4. Shari.P.B and Lassen.T.S, “Managing the global supply chain”, Viva books, New Delhi, 2015.
5. Robert B. Handfield, Ernest L. Nichols Jr. “Introduction to Supply Chain Management” Pearson, 1999.
6. Martin Christopher, “Logistics and supply chain management”, Pearson Education, 2013.
7. Simchi and Levi Davi, “Designing and managing the Supply Chain”, 2014.

COURSE OUTCOMES

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

CO1 Describe the basic concept of the logistics and lean supply chain management

CO2 Demonstrate activities and decisions for customer oriented supply chain

CO3 Estimate logistics costs and performance

CO4 Reorganize supply and demand for supply chain responsiveness

CO5 Explain the role of information in the supply chain

19TEP701 PROJECT WORK – PHASE- I

L	T	P	J	C
0	0	0	16	8

PROJECT WORK – PHASE- I

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

L : 0 T: 0 P: 0 J:16 Total:240 PERIODS

COURSE OUTCOMES

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

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

19TEP702	PROJECT WORK - PHASE II	L	T	P	J	C
		0	0	0	24	12

PROJECT WORK - PHASE II

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

L : 0 T: 0 P: 0 J:24 Total:360 PERIODS

COURSE OUTCOMES

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

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

19GET601	PROFESSIONAL DEVELOPMENT	L	T	P	J	C
	(Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	2	0	0	0	2

UNIT I PROFESSIONAL COMMUNICATION 6

Importance of communication- Types of communication- Verbal and Non-verbal Communication - Barriers to communication.

UNITII PERSONALITY DEVELOPMENT 6

Significance of Personality development- Attitude - Motivation-Self Esteem-Body language - Problem-solving- Decision-making skills- Leadership qualities-Character building -Team-work -Work ethics - Good manners and etiquette.

UNIT III PUBLIC SPEAKING 6

Introduction to public speaking- Barriers- Speech organization-Understanding audience-Information & Communicative Technologies (ICT)-Effective power point presentation-feedback.

UNIT IV NETWORKING 6

Introduction to networking-Types of networking- Business Card- strategies for networking-networking database-Role of social media& internet.

UNIT V SOCIALIZATION 6

Importance of socialization-Theories of self-development-Agents of socialization-socialization across the life.

L :30 T: 0 P: 0 J: 0 T:30 PERIODS

REFERENCES

1. Personality development- 1. Hurlock, E.B (2006). Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill.
2. Stephen P. Robbins and Timothy A. Judge(2014), Organizational Behaviour 16th Edition: Prentice Hall.
3. R. Panneerselvam, 2nd Edition, "Research Methodology " PHI Learning -2016.
4. C.R.Kothari , “Research Methodology – Methods & Techniques” - New Age International Publishers-2015.
5. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015.

COURSE OUTCOMES :

At the end of the course students should be able to

CO1 Aware about the professional communication and barriers to communication.

CO2 Know about personality development

CO3 Understand about the barriers of public speaking

CO4 Know about the strategies of networking

CO5 Understand the importance of socialization.

19GET602	QUALITY ASSURANCE & ACCREDITATION IN ENGINEERING EDUCATION	L	T	P	J	C
	(Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	2	0	0	0	2

UNIT I CENTER FOR LEARNING AND TEACHING (CLT) 7

Learning Resources-Model & Mini project- Industry Specific Assignment - Industrial case study - MOOC-Teachers Manual-Workbook-LMS & Quality Assurance in Academic Performance-GATE.

UNIT II CENTRE FOR CREATIVITY (CFC) 6

Project-Product Development-Patent-Consultancy-Books/Book chapter- Research/Seminar Grant-Publications - Industry collaborated laboratories - Foreign collaboration & Exchange.

UNIT III SKILL AND CAREER DEPARTMENT (SCD) 5

Hackathon/Industrial contest- Project Proposal- Certification courses-Placement training-Schemes for student motivation-Clubs-Sports

UNIT IV SOCIAL RESPONSIBILITY INITIATIVE (SRI) 4

Need for outreach-Types of outreach –Stake holder communication-website-newsletter-magazine-meetings.

UNIT V INDUSTRY INSTITUTE PARTNERSHIP CELL (IIPC) 4

Industrial networking- MoU-Industrial delivery -workshop- Internship/Training-Partial delivery-Adjunct Professor- Placement- Campus companies-Start-Up.

UNIT VI INTERNAL QUALITY ASSURANCE CELL (IQAC) 4

Importance of IQAC- members- Goal setting-Audit-Feedback system-Governing bodies-Accreditation bodies - process-Ranking.

L :30 T: 0 P: 0 J: 0 T:30 PERIODS

REFERENCES

1. João Rosa, Maria, Amaral, A. (Eds.) “Quality Assurance in Higher Education “ Editors: Palgrave Macmillan publications, 2014.
2. Stuart Walesh,”Introduction to Creativity and Innovation for Engineers” , Pearson’s education, 2017.
3. Borich, “Effective Teaching Methods: Research-Based Practice”, Pearson education, 2016.

COURSE OUTCOMES :

At the end of the course students should be able to

CO1 Aware about the learning and teaching process.

CO2 Enrich their creative ability through research, product development, consultancy etc.

CO3 Know about the skills related to career development.

CO4 Understand the needs of societal responsibilities of an individual.

CO5 Collaborate industry institute partnership through various activities.

19GET603	HOLISTIC EDUCATION	L	T	P	J	C
	(Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	2	0	0	0	2

UNIT I TEACHING, LEARNING & RESEARCH 6

Basics of Teaching & Learning- Blooms Taxonomy-Role of facilitator - Instruction planning and delivery methods- Technology Enabled Learning-Evaluation techniques-Meaningful R&D- Institutional management and Administrative procedures.

UNIT II JOB SEARCH & INTERVIEW 6

Job Search- Types of Job search- Channels-Role of Internet- Interview- Modes of Interview- MNC Interview- Industrial contest.

UNIT III WORK FOR LIFE BALANCE. 6

Benefits of a Healthy Balance- Signs of an Imbalance- Employer Resources- Tip in Time Management- Goal Setting- Optional Ways to Work- Stress Management- Home office

UNIT IV STUDENT RELATIONSHIP MANAGEMENT. 6

Introduction-Key Partners- Key Activities- Key Resources- Value Propositions- Customer Relationship- Customer Segments- Channels- Cost Structure- Revenue Streams-Case study.

UNIT V BUSINESS MODEL CANVAS (BMC) 6

Introduction-Key Partners- Key Activities- Key Resources- Value Propositions- Customer Relationship- Customer Segments- Channels- Cost Structure- Revenue Streams-Case study.

L :30 T: 0 P: 0 J: 0 T:30 PERIODS

REFERENCES

1 Alexander Osterwalder, Yves Pigneur, " Business Model Generation", Jon Wiley& sons Inc., 2010

2 John P. Miller,Kelli Nigh, Marni J, Binder, Bruce Novak,Sam Crowell, "International Handbook of Holistic Education", CRCP, 2018.

COURSE OUTCOMES :

At the end of the course students should be able to

CO1 Know about the technology enabled learning and teaching.

CO2 Conscious about job searching and modes of interview

CO3 Aware about stress management and balancing work at office and home.

CO4 Know about the customer segments and relationship.

CO5 Understand the importance business model canvas.

19GEA601	ENGLISH FOR RESEARCH PAPER WRITING (Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	L	T	P	J	C
		2	0	0	0	0

UNIT I **4**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNITII **4**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III **4**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV **4**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT V **4**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT VI **4**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

L :24 T: 0 P: 0 J: 0 T:24 PERIODS

REFERENCES

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

COURSE OUTCOMES :

At the end of the course students should be able to

CO1 Understand that how to improve your writing skills and level of readability
CO2 Learn about what to write in each section
CO3 Understand the skills needed when writing a Title
CO4 Write the result and discussion with conclusion
CO5 Write a journal paper for peer review in a standard

19GEA602	DISASTER MANAGEMENT	L	T	P	J	C
	(Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	2	0	0	0	0

UNIT I INTRODUCTION **4**

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS **4**

Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA **4**

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **4**

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V RISK ASSESSMENT **4**

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.

UNIT VI DISASTER MITIGATION **4**

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

L :24 T: 0 P: 0 J: 0 T:24 PERIODS

REFERENCES

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi.

COURSE OUTCOMES :

At the end of the course students should be able to

CO1 Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response

CO2 Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives

CO3 Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations

CO4 Critically understand the strengths and weaknesses of disaster management approaches

CO5 Do planning and programming in different countries, particularly their home country or the countries they work

19GEA603	VALUE EDUCATION	L	T	P	J	C
	(Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	2	0	0	0	0

UNIT I **4**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements.

UNIT II **6**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline.

UNIT III DISASTER PRONE AREAS IN INDIA **6**

Personality and Behaviour Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness.Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship.Happiness Vs suffering, love for truth. Aware of self-destructive habits.Association and Cooperation. Doing best for saving nature.

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT **6**

Character and Competence –Holy books vs Blind faith.Self-management and Good health.Science of reincarnation.Equality, Nonviolence, Humility, Role of Women.All religions and same message. Mind your Mind, Self-control.Honesty, Studying effectively.

L :22 T: 0 P: 0 J: 0 T:22 PERIODS

REFERENCES

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi
2. Gerald Collier, John Wilson and Peter Tomlinson, “Values and Moral Development in Higher Education” CRC press, 1974.
3. N. Venkataiah, Value Education, APH Publishing, 1998

COURSE OUTCOMES :

At the end of the course students should be able to

CO1 Understand value of education and self- development
CO2 Gain Knowledge of self-development
CO3 Learn the importance of Human values
CO4 Develop the overall personality
CO5 Present value of education with self confidence

19SEA714	CONSTITUTION OF INDIA	L	T	P	J	C
	(Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	2	0	0	0	0

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION 4

History Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION 4

Preamble salient features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES 4

Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights ,Right to Constitutional Remedies ,
Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE 4

Parliament ,Composition ,Qualifications and Disqualifications ,Powers and Functions ,Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION 4

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

Panchayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT VI ELECTION COMMISSION 4

Election Commission: Role and Functioning. ,Chief Election Commissioner and Election Commissioners. ,State Election Commission: Role and Functioning. ,Institute and Bodies for the welfare of SC/ST/OBC and women

L :24 T: 0 P: 0 J: 0 T:24 PERIODS

REFERENCES

1 The Constitution of India, 1950 (Bare Act), Government Publication

2 Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.

3 M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014

4 D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015

COURSE OUTCOMES :

At the end of the course students should be able to

CO1 Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

CO2 Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

CO3 Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

CO4 Discuss the passage of the Hindu Code Bill of 1956.

19GEA605	PEDAGOGICAL STUDIES	L	T	P	J	C
	(Common to M.E CSE, ST, SW, PSE, VLSI, TE & M.Tech IT)	2	0	0	0	0

UNIT I INTRODUCTION AND METHODOLOGY 4

Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW 2

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT III PEDAGOGICAL PRACTICES 4

Evidence on the effectiveness of pedagogical practices. Methodology for the in-depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT 4

Professional development: alignment with classroom practices and follow-up support ,Peer support Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS 2

Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

L :16 T: 0 P: 0 J: 0 T:16 PERIODS

REFERENCES

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

COURSE OUTCOMES :

At the end of the course students should be able to

- **CO1** Understand that how to improve your writing skills and level of readability
- **CO2** Learn about what to write in each section
- **CO3** Understand the skills needed when writing a Title
- **CO4** Ensure the good quality of paper at very first-time submission