ANNA UNIVERSITY, CHENNAI
NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY

M.E. THERMAL ENGINEERING

REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA & SYLLABI

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. Analyze, design and evaluate thermal systems using state of the art engineering tools and techniques

II. Develop methods of energy conservation for sustainable growth

III. Communicate effectively and support constructively towards team work

IV. Pursue lifelong learning for professional growth with ethical concern for society and environment

PROGRAMME OUTCOMES:

On successful completion of the programme,

1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. Demonstrate a degree of mastery over thermal engineering at a level higher than the Bachelor's program.
4. Design, develop and analyze thermal systems for improved performance
5. Identify viable energy sources and develop effective technologies to harness them
6. Engage in lifelong learning adhering to professional, ethical, legal, safety, environmental and societal aspects for career excellence

PEO / PO Mapping

Programme Educational Objectives	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
I	3	3	3	3	3	2
II	3	2	3	2	2	2
III	2	2	2	2	2	3
IV	3	3	3	3	3	3

Semester Course wise PEO mapping

YEAR	SEM	Subject Name	PO1	PO2	PO3	PO4	PO5	PO6
YEAR I	SEM 1	Advanced NumericalMethods	3	3	3	1	2	1
		Advanced Heat Transfer	3	3	3	2	3	3
		Advanced Thermodynamics	3	3	3	2	3	3
		Advanced FluidMechanics	3	3	3	2	1	3
		Research Methodology and IPR	3	1	3	1	1	1
		Aircraft and JetPropulsion	3	3	3	3	3	3
		Hydrogen and Fuel CellTechnologies	3	3	3	3	3	3
		Energy Resources	3	2	3	2	3	3
		Advanced Internal Combustion Engines	3	3	3	3	3	3
		Cryogenic Engineering	3	3	3	2	3	3
		Refrigeration Systems	2.5	2	3	2	2	2
		Electronic Engine Management Systems	2	2	3	2	1	2
		Cogeneration and Waste Heat Recovery Systems						
		Thermal EngineeringLaboratory	2	3	3			3
	SEM 2	Instrumentation for Thermal Engineering	2	2	3	3	3	3
		Computational Fluid Dynamics	3	3	3	3	2	2
		Fuels, Combustion and Pollution Control	3	3	3	3	1	3
		Fans, Blowers andCompressors	3	3	3	3	1	3
		Food Processing, Preservation and Transport						
		Air ConditioningSystems	3	3	3	3	2	2
		Energy Management inThermal Systems	2	2	3	2	1	3

		Alternative Fuels for IC Engines	3	2	3	2	3	3
		Design of HeatExchangers	3	3	3	3	2	3
		Heat Transfer Enhancement Techniques	3	3	3	3	3	3
		Electronic Packaging And Cooling Of Electronic Systems	2	1	3	3	1	3
		Battery Thermal Management Systems	2	2	3	2	1	3
		Energy Storage Technologies	3	2	2	2	3	2
		Electric And Hybrid Vehicles	3	2	3	3	3	3
		Advanced power plant engineering	3	3	3	3	2	3
		Thermal Systems Simulation Laboratory	2	3	3	2	3	2
		Technical Seminar – I	2	3	2	3	2	3
YEAR 2	**SEM 3**	Design and Optimizationof Thermal Energy Systems	3	3	2	3	3	3
		Design and Analysis ofTurbomachines	3	3	3	3	3	3
		Boundary Layer Theory and Turbulence	3	3	3	3	2	2
		Steam Generator Technology	3	3	3	3	3	3
		Fluidized Bed Systems	3	2	3	3	3	3
		Data analytics and IOT for thermal systems	2	3	2	3	2	1
		Energy Efficient Building	3	3	3	2	3	3
		Engine Pollution And Control	2	3	2	1	1	3
		Solar Energy Technologies	3	3	3	3	3	3
		Industrial Safety Engineering	2	2	2	2	2	3
		Technical Seminar – II	3	3	3	2	3	2
		Project work – I	3	3	3	3	3	3
	SEM 4	Project work Phase – II	3	3	3	3	3	3

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M.E. THERMAL ENGINEERING

REGULATIONS 2021

CHOICE BASED CREDIT SYSTEM

I - IV SEMESTERS CURRICULA AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4154	Advanced Numerical Methods	FC	4	0	0	4	4
2.	TE4151	Advanced Heat Transfer	FC	4	0	0	4	4
3.	TE4152	Advanced Thermodynamics	PCC	3	1	0	4	4
4.	TE4101	Advanced Fluid Mechanics	PCC	3	0	0	3	3
5.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Professional Elective - I	PCC	3	0	0	3	3
7.		Professional Elective - II	PCC	3	0	0	3	3
8.		Audit Course I*	AC	2	0	0	2	0
PRACTICAL								
9	TE4111	Thermal Engineering Laboratory	PCC	0	0	4	4	2
			TOTAL	**24**	**1**	**4**	**29**	**25**

* Audit Course is optional

PROGRESS THROUGH KNOWLEDGE

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	TE4201	Instrumentation for Thermal Engineering	PCC	3	0	0	3	3
2.	IC4291	Computational Fluid Dynamics	PCC	3	0	0	3	3
3.	TE4202	Fuels, Combustion and Emission Control	PCC	4	0	0	4	4
4.		Professional Elective - III	PEC	3	0	0	3	3
5.		Professional Elective - IV	PEC	3	0	0	3	3
6.		Professional Elective - V	PEC	3	0	0	3	3
7.		Audit Course II*	AC	2	0	0	2	0
PRACTICAL								
8.	TE4211	Thermal Systems Simulation Laboratory	PCC	0	0	4	4	2
9.	TE4212	Technical Seminar – I	EEC	0	0	2	2	1
			TOTAL	**21**	**0**	**6**	**27**	**22**

* Audit Course is optional

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	TE4301	Design and Optimization of Thermal Energy Systems	PCC	3	0	0	3	3
2.		Professional Elective - VI	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICAL								
4.	TE4311	Technical Seminar – II	EEC	0	0	2	2	1
5.	TE4312	Project Work - I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**14**	**23**	**16**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICAL								
1.	TE4411	Project Work - II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75 CREDITS

PROFESSIONAL ELECTIVES
SEMESTER I, ELECTIVE I & II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	TE4001	Aircraft and Jet Propulsion	PEC	3	0	0	3	3
2.	TE4073	Hydrogen and Fuel Cell Technologies	PEC	3	0	0	3	3
3.	TE4002	Energy Resources	PEC	3	0	0	3	3
4.	TE4003	Advanced Internal Combustion Engines	PEC	3	0	0	3	3
5.	TE4004	Cryogenic Engineering	PEC	3	0	0	3	3
6.	TE4005	Refrigeration Systems	PEC	3	0	0	3	3
7.	IC4252	Electronic Engine Management Systems	PEC	3	0	0	3	3
8.	TE4006	Cogeneration and Waste Heat Recovery Systems	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III, IV & V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	TE4007	Design of Turbo Machines	PEC	3	0	0	3	3
2.	TE4008	Electronics Cooling and Packaging	PEC	3	0	0	3	3
3.	TE4009	Air Conditioning Systems	PEC	3	0	0	3	3
4.	IC4151	Alternate Fuels for IC Engines	PEC	3	0	0	3	3
5.	TE4092	Design of Heat Exchangers	PEC	3	0	0	3	3
6.	TE4010	Battery Thermal Management System	PEC	3	0	0	3	3
7.	EY4091	Advanced Energy Storage Technologies	PEC	3	0	0	3	3
8.	IC4092	Hybrid and Electric Vehicles	PEC	3	0	0	3	3
9.	TE4091	Advanced Power Plant Engineering	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	IC4071	Boundary Layer Theory and Turbulence	PEC	3	0	0	3	3
2.	TE4011	Steam Generator Technology	PEC	3	0	0	3	3
3.	EY4093	Fluidized Bed Systems	PEC	3	0	0	3	3
4.	TE4012	Energy Efficient Buildings	PEC	3	0	0	3	3
5.	IC4091	Engine Pollution and Control	PEC	3	0	0	3	3
6.	TE4013	Solar Thermal Technologies	PEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX4091	English for Research Paper Writing	2	0	0	0
2.	AX4092	Disaster Management	2	0	0	0
3.	AX4093	Constitution of India	2	0	0	0
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0

PROGRESS THROUGH KNOWLEDGE

MA4154 ADVANCED NUMERICAL METHODS L T P C
4 0 0 4

COURSE OBJECTIVES :

- To study various numerical techniques to solve linear and non-linear algebraic and transcendental equations.
- To compare ordinary differential equations by finite difference and collocation methods.
- To establish finite difference methods to solve Parabolic and hyperbolic equations.
- To establish finite difference method to solve elliptic partial differential equations.
- To provide basic knowledge in finite elements method in solving partial differential equations.

UNIT I ALGEBRAIC EQUATIONS 12

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

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 12

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

UNITIII FINITE DIFFERENCE METHOD FOR TIME DEPENDENT PARTIAL DIFFERENTIAL EQUATIONS 12

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

UNIT IV FINITE DIFFERENCE METHODS FOR ELLIPTIC EQUATIONS 12

Laplace and Poisson's equations in a rectangular region : Five point finite difference schemes, Leibmann's iterative methods, Dirichlet's and Neumann conditions – Laplace equation in polar coordinates : Finite difference schemes – Approximation of derivatives near a curved boundary while using a square mesh.

UNIT V FINITE ELEMENT METHOD 12

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

TOTAL : 60 PERIODS

COURSE OUTCOMES :

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

- Solve an algebraic or transcendental equation, linear system of equations and differential equations using an appropriate numerical method.
- Solving the initial boundary value problems and boundary value problems using finite difference and finite element methods.
- Solving parabolic and hyperbolic partial differential equations by finite difference methods.
- Compute solution of elliptic partial differential equations by finite difference methods.

- Selection of appropriate numerical methods to solve various types of problems in engineering and science in consideration with the minimum number of mathematical operations involved, accuracy requirements and available computational resources.

REFERENCES :

1. Burden, R.L., and Faires, J.D., "Numerical Analysis – Theory and Applications", 9th Edition, Cengage Learning, New Delhi, 2016.
2. Gupta S.K., "Numerical Methods for Engineers",4th Edition, New Age Publishers, 2019.
3. Jain M. K., Iyengar S. R., Kanchi M. B., Jain, "Computational Methods for Partial Differential Equations", New Age Publishers ,1993.
4. Sastry, S.S., "Introductory Methods of Numerical Analysis", 5th Edition, PHI Learning, 2015.
5. Saumyen Guha and Rajesh Srivastava, "Numerical methods for Engineering and Science", Oxford Higher Education, New Delhi, 2010.
6. Smith, G. D., "Numerical Solutions of Partial Differential Equations: Finite Difference Methods", Clarendon Press, 1985.

TE4151	ADVANCED HEAT TRANSFER	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES

1.To impart knowledge on conduction heat transfer associated with radiation.
2.To impart knowledge on the turbulent forced convective heat transfer.
3.To impart knowledge on the significance of Phase Change Heat Transfer and Mass Transfer.
4.To teach the heat exchanger design aspects including compact heat exchangers.
5.To impart knowledge on Mass transfer as an engineering phenomenon.

UNIT I CONDUCTION AND RADIATION HEAT TRANSFER 12

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer- various pin profiles- pin optimization - transient conduction-- conduction with moving boundaries - radiation in gases and vapour. Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection

UNIT II TURBULENT FORCED CONVECTIVE HEAT TRANSFER 12

Momentum and energy equations - turbulent boundary layer heat transfer - mixing length concept - turbulence model – k Є model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

UNIT – III PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER 12

Condensation on bank of tubes - boiling – pool and flow boiling - heat Transfer Enhancement Techniques.

UNIT – IV HEAT EXCHANGERS 12

Heat Exchanger – Є- NTU approach and design procedure – compact heat exchangers – Plate heat exchangers– Mini and Micro Channel heat exchangers, Heat transfer correlations for specific cases.

UNIT – V MASS TRANSFER 12

Mass transfer - vaporization of droplets - combined heat and mass transfers applications – Cooling Towers, Evaporative condensers, solar pond, Cooling and dehumidification systems – porous media heat transfer

TOTAL : 60 PERIODS

COURSE OUTCOMES:

1. Upon completion of this course, the students will be able to:
2. Analyse problems on heat transfer associated with conduction and convection and radiation through vapours and gases.
3. Analyse problems on turbulent heat transfer and also solve high speed flow problems.
4. Analyse problems on phase change heat transfer.
5. Estimate the performance of compact heat exchangers and also understand the use of correlations to predict heat transfer from specific devices
6. Understand and analyse the mass transfer associated with heat transfer in engineering systems

REFERENCES

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

PO &CO Mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	1	3	-	-	-
2	2	2	3	-	-	-
3	2	1	3	-	-	-
4	2	2	3	-	-	-
5	2	2	2	-	-	-
Avg	2	1.6	2.6	-	-	-

TE4152 ADVANCED THERMODYNAMICS L T P C
3 1 0 4

COURSE OBJECTIVES:

- To achieve an understanding of basic principle and scope of thermodynamics.
- To predict the availability and irreversibility associated with the thermodynamic processes.
- To analyse the properties of ideal and real gas mixtures and to understand the basic concepts of thermal systems

UNIT I THERMODYNAMIC PROPERTY RELATIONS 12

Thermodynamic Potentials, Maxwell relations, Generalised relations for changes in Entropy, Internal Energy and Enthalpy, Generalised Relations for C_p and C_v, Clausius Clapeyron Equation, Joule Thomson Coefficient, Bridgeman Tables for Thermodynamic Relations.

UNIT II REAL GAS BEHAVIOUR AND MULTI-COMPONENT SYSTEMS 12

Equations of State (mention three equations), Fugacity, Compressibility, Principle of Corresponding States, use of generalised charts for enthalpy and entropy departure, fugacity coefficient, Lee-Kesler generalised three parameter tables. Fundamental property relations for systems of variable composition, partial molar properties, Real gas mixtures, Ideal solution of real gases and liquids, Equilibrium in multi-phase systems, Gibb's phase rule for non-reactive components.

UNIT III AVAILABILITY ANALYSIS 12

Introduction, Reversible work, Availability, Irreversibility and Second - Law Efficiency for a closed System and Steady-State Control Volume. Availability Analysis of Simple Cycles. Chemical availability of closed and control volume. Fuel Chemical availability, Evaluation of the availability of hydrocarbon fuels.

UNIT IV FUEL – AIR CYCLES AND THEIR ANALYSIS 12

Ideal Models of Engine Processes, Fuel–Air Cycle Analysis – SI Engine Cycle Simulation, CI Engine Cycle Simulation, Results of Cycle Calculations, Availability Analysis of Engine Processes – Availability Relationships – Entropy changes in Ideal Cycles – Availability Analysis of Ideal Cycles.

TOTAL : 60 PERIODS

UNIT V THERMO CHEMISTRY 12

Ideal gas laws and properties of Mixtures, Combustion Stoichiometry, Application of First Law of Thermodynamics – Heat of Reaction – Enthalpy of Formation – Adiabatic flame temperature. Second law of Thermodynamics applied to combustion – entropy, maximum work and efficiency Chemical equilibrium: - Equilibrium constant evaluation K_p&K_f, Equilibrium composition evaluation of ideal gas and real gas mixtures.

COURSE OUTCOMES:

On successful completion of this course the student will be able to

1. Apply the law of thermodynamics to thermal systems.
2. Analyse the actual thermodynamic cycles
3. Design and analyse a multi component thermodynamic system
4. Apply the thermodynamics concepts in automotive systems
5. Understand and analyse the combustion of different fuels

REFERENCES:

1. Kenneth Wark., J.R, Advanced Thermodynamics for Engineers, McGraw-Hill Inc., 1995.
2. K.Annamalai, I.K.Puri, M.A.Jog, Advanced Thermodynamics Engineering, Second Edition, CRC Press, 2011.
3. Advanced Thermodynamics, S.S. Thipse, Narosa Publishing Home Pvt. Ltd., 2013
4. Yunus A. Cengel and Michael A. Boles, Thermodynamics, McGraw-Hill Inc., 2006.
5. B.P. Pundir, I.C. engine combustion and emissions. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Sons, 1988.
6. Holman,J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1988.

PO & CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	2	-	3	-	-	-
2	2	1	3	-	-	-
3	2	-	3	-	-	-
4	2	1	3	-	-	-
5	2	1	3	-	-	-
Avg	2	1	3	-	-	-

TE4101 ADVANCED FLUID MECHANICS L T P C
3 0 0 3

COURSE OBJECTIVES

- To understand the laws of fluid flow for ideal and viscous fluids.
- To represent the real solid shapes by suitable flow patterns and to analyze the same for aerodynamics performances.
- To understand the changes in properties in compressible flow and shock expansion.

UNIT I BASIC EQUATIONS OF FLOW 9

Three dimensional continuity equation - differential and integral forms – equations of motion momentum and energy - Reynolds transport theorem – Navier – Stokes equation - Engineering Applications

UNIT II POTENTIAL FLOW THEORY 9

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

UNIT III VISCOUS FLOW THEORY 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 – losses during flow through pipes. Pipes in series and parallel – transmission of power through pipes.

UNIT IV BOUNDARY LAYER CONCEPT 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.

UNIT V COMPRESSIBLE FLUID FLOW 9

One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers – fundamentals of supersonics – normal and oblique shock waves and calculation of flow and fluid properties over solid bodies (like flat plate, wedge, diamond) using gas tables

TOTAL: 45 PERIODS

COURSE OUTCOME

- After the completion of the syllabus students able to familiarized about the ideal and viscous fluid flow, boundary layer concepts and changes in properties in compressible flow and shock expansion.

REFERENCES

1. Anderson J.D., Fundamentals of Aerodynamics, McGraw Hill, Boston, 2001.
2. Bansal R.K., Fluid Mechanics, Saurabh and Co., New Delhi, 1985.
3. Houghten E.L. and Carruthers N.B., Aerodynamics for Engineering Students, Arnold Publishers, 1993.
4. Kumar K.L., Engineering Fluid Mechanics, Eurasia Publishing House, New Delhi, 2002.
5. Munson B.R., Young D.F. and Okiisi, T.H., Fundamentals of Fluid Mechanics, John Wiley and Sons Inc., NewYork, 1990.
6. Schlichting H., Boundary layer theory, Mc Graw Hill Book Company, 1979

7. Shames, Mechanics of Fluids, Mc Graw Hill Book Company, 1962.
8. Streeter V.L., Wylie E.B. and Bedford K.W., Fluid Mechanics, WCB McGraw Hill, Boston, 1998.

Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	3	-	3	-	2	2
2	3	-	3	-	2	2
3	2	-	3	-	2	2
4	3	-	2	-	2	1
5	2	-	3	-	3	2
AVg.	2.6	-	2.8	-	2.2	1.8

RM4151 RESEARCH METHODOLOGY AND IPR **L T P C**
2 0 0 2

UNIT I RESEARCH DESIGN **6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES **6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING **6**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS **6**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS **6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL : 30 PERIODS

REFERENCES

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

TE4111	THERMAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To conduct experiments on various Thermal Engineering devices to study the performance and its applications.

LIST OF EXPERIMENTS

1. Performance and emission characteristics of multi cylinder Spark Ignition and Compression Ignition engines using alternate fuels.
2. Thermal performance of variable compression ratio engines.
3. Thermal analysis of natural / forced draught cooling towers.
4. Thermal analysis of heat pumps systems.
5. Experimental studies on vapour compression refrigeration systems using natural refrigerants
6. Overall performance of solar water heating system.
7. Physical, Chemical and thermal Properties of any liquid and gas fuels.
8. Experimental analysis of a Boiler.
9. Calibration of Temperature sensors (RTD / any thermocouple)
10. Calibration of Pressure sensors
11 Experimental studies on axial / centrifugal fan characteristics

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able to:

- Know the various alternate fuels are available for IC engines
- Understand the thermodynamic relations for thermal engineering devices.
- Understand the working principle of different renewable energy sources.
- Measure the properties of different fuels

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Single cylinder / multi cylinder Automotive Engine with data acquisition system - 1 No
2. Flue gas analyzer - 1 No
3. Smoke meter - 1 No
4. Single cylinder variable Compression ratio petrol engine - 1 No
5. Single cylinder variable Compression ratio Diesel engine - 1 No
6. Cooling tower test rig - 1 No
7. Refrigeration cum Heat Pump test rig - 1 No
8. 100 LPD Solar flat plate water heater test rig - 1 No
9. Pyranometer - 1 No
10. Redwood / Saybolt viscometer - 1 No
11. Bomb calorimeter apparatus - 1 No
12. Gas calorimeter - 1 No
13. Cloud & Pour point apparatus - 1 No
14. IBR / Non-IBR Boiler test rig - 1 No
15. Fan test rig
16. Pressure Calibrator - 1 No
17. Temperature Calibrator - 1 No

Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	3	-	3	3	2	2
2	3	-	2	3	2	3
3	3	-	2	2	2	2
4	2	-	2	2	2	1
5	2	-	3	2	3	2
AVg.	2.6	-	2.4	2.4	2.2	2.0

TE4201 INSTRUMENTATION FOR THERMAL ENGINEERING L T P C
3 0 0 3

OBJECTIVES

•To classify various measuring instruments.
•To categorise temperature sensors and their applications in measurement.
•To outline the advancements in pressure and volume measurements.
•To explore the various measurement techniques for thermos physical properties.
•To compare the different data acquisition systems.

UNIT I MEASUREMENT CHARACTERISTICS 9

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

UNIT II TEMPERATURE MEASUREMENT 9

Temperature, Types, materials, Accuracy - Selection of Temperature sensors - Effect of length of sensor on temperature measurements- calibration of thermocouple, RTD's & Thermistors- Standards for temperature measurement - Cryogenic & High Temperature measurement techniques.

UNIT III PRESSURE FLOW & VOLUME MEASUREMENTS 9

Pressure Sensors: Types & materials - piezoelectric transducers- calibration of pressure sensors- selection of pipes & fittings for pressure sensors.
Volume sensors: Standard volumetric flask- Types, Density measurement instruments for liquids & gases.
Flow Sensors: Caroli's mass flow measurements - flow measurements for water, gases, other oils & other chemicals.

UNIT IV MEASUREMENT OF THERMO PHYSICAL PROPERTIES 9

Thermal Conductivity measurement of solids - liquids & gases- Sensors & calibration methods- Thermal conductivity of microbar nano composites - Specific heat of liquids, solids through DSC Analysis - viscosity measurement of Newtonian & non-Newtonian fluids through rheological analysis

UNIT V DATA ACQUISITION SYSTEM 9

Data acquisition systems, Evolution of SCADA, Communication technologies, Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries - SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Communication Network, SCADA Server, SCADA/HMI Systems Various SCADA architectures.

TOTAL: 45 PERIODS

OUTCOMES

On successful completion of this course the students will be able to:

1. Infer the role of uncertainty analysis in measuring instruments.
2. Select the appropriate temperature sensors based on specific applications.
3. Identify the suitable sensors for pressure and volume measurements.
4. Evaluate thermos physical properties of media.
5. Appraise the advantages of data acquisition systems.

REFERENCES

1. Holman J.P., Experimental methods for engineers, McGraw-Hill, 2012.
2. .Barnery, Intelligent Instrumentation, Prentice Hall of India, 2010.
3. .Bolton.W, Industrial Control & Instrumentation, Universities Press, Second Edition, 2001.
4. John G Webster, The measurement, Instrumentation and sensors Handbook, CRC and IEE Press, 2014.
5. Morris A.S, Principles of Measurements and Instrumentation Prentice Hall of India, 2004.
6. Nakra, B.C., Choudhry K.K., Instrumentation, Measurements and Analysis Tata McGraw Hill, New Delhi, 2nd Edition 2003.
7. T.G.Beekwith R.D., Marangoni and J.H. Lienhard, Mechanical Measurements, Pearson Education, 2001

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	-	1	-	-
2	2	-	2	1	2	1
3	2	-	2	1	2	1
4	2	-	2	2	2	1
5	2	-	1	1	2	-
Avg.	1.8	1	1.4	1.2	1.6	0.6

IC4291 COMPUTATIONAL FLUID DYNAMICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

- This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion. It will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
- To develop finite volume discretised forms of the governing equations for diffusion processes.
- To develop finite volume discretised forms of the convection-diffusion processes.
- To develop pressure-based algorithms for flow processes.
- To introduce various turbulence models, Large Eddy Simulation and Direct Numerical Simulation.

UNIT – I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES 9

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT – II DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

Steady one-dimensional diffusion, Two- and three-dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes.

UNIT – III CONVECTION-DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme.

UNIT – IV FLOW PROCESSES: FINITE VOLUME METHOD 9

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.

UNIT – V TURBULENCE MODELS 9

Turbulence – RANS equation - Algebraic Models, One equation model, Two equation models – k & standard k – ϵ model, Low Reynold number models of k- ϵ, Large Eddy Simulation (LES), Direct Numerical Simulation (DNS) - Introduction. Solving simple cases using standard CFD codes.

TOTAL:45 PERIODS

COURSE OUTCOMES:

On successful completion of this course the students will be able to:

- Analyse the governing equations and boundary conditions.
- Analyse various discretization techniques for both steady and unsteady diffusion problems.
- Analyse the various convection-diffusion problems by Finite-Volume method.
- Analyse the flow processes by using different pressure bound algorithms.
- Select and use the different turbulence models according to the type of flows.

PO &CO Mapping:

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	1	3	-	-	-
2	2	1	3	-	-	-
3	3	1	3	-	3	-
4	3	1	3	-	3	-
5	3	1	3	-	3	-
Avg	2.6	1	3	-	3	-

REFERENCES:

1. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014.
2. Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.

3. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2003.
4. Subas and V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
5. JiyuanTu, Guan Heng Yeoh, Chaogun Liu, “Computational Fluid Dynamics A Practical Approach” Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008
6. John D. Anderson. JR. “Computational Fluid Dynamics the Basics with Applications” McGraw-Hill International Editions, 1995.

TE4202 FUELS, COMBUSTION AND EMISSION CONTROL L T P C
4 0 0 4

OBJECTIVES

- To understand the types of fuels.
- To compare the fuels in specific point •
- To understand the principles of combustion and combustion equipment’s.
- To understand the thermodynamic process behind the combustion.
- To Identify the level of emission standards

UNIT I SOLID FUELS 9

Solid Fuel 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.

UNIT II LIQUID AND GASEOUS FUELS 9

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

Gaseous Fuel Classification - Composition & Properties - Estimation of Calorific Value - Gas Calorimeter. Rich & Lean Gas - Wobbe Index - Natural Gas - Dry & Wet Natural Gas - Stripped NG - Foul & Sweet NG - LPG - LNG - CNG - Methane - Producer Gas - Gasifiers - Water Gas - Town Gas - Coal Gasification - Gasification Efficiency - Non - Thermal Route - Biogas - Digesters - Reactions - Viability - Economics.

UNIT III COMBUSTION: STOICHIOMETRY & KINETICS 9

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. Mechanism of Combustion – Ignition & Ignition Energy – Spontaneous Combustion – Flame Propagation – Solid, Liquid & Gaseous Fuels Combustion – Flame Temperature – Theoretical, Adiabatic & Actual – Ignition Limits – Limits of Inflammability. Thermo Chemistry - Equilibrium combustion products. Low temperature combustion products – High temperature combustion products.

UNIT IV COMBUSTION EQUIPMENTS 9

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.

UNIT V EMISSION CONTROL METHODS 9

Emissions - Emission index - Corrected concentrations - Control of emissions for premixed and non-prefixed combustion**.** Flue gas Desulphurization**,** Coal Beneficiation, Coal Blending, Efficiency Improvement Methods (CO_2 reduction)– Super critical boilers, Integrated Gasification Combined Cycle Power Plant, Carbon Capture & Storage (CCS)

TOTAL: 45 PERIODS

OUTCOMES

On successful Completion of this course the student will be

1. Identify to enable the fuels used for different purposes.
2. Examine the fuels at different conditions.
3. Summarize the fuels and its combustion levels.
4. Select the correct Equipments on combustion techniques.
5. Illustrate the emission control at a standard rate.

REFERENCES

1. B.I. Bhatt and S.M. Vora, Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 2010.
2. Blokh A.G., Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988.
3. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966.
4. Holman J.P., Thermodynamics, Fourth Edition, McGraw-Hill Inc., 1988.
5. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990.
6. Sharma SP., Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984.
7. Yunus A. Cengel and Michael A. Boles, Thermodynamics, McGraw-Hill Inc., 2006.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	-	2	1	-	3
2	1	-	2	2	-	1
3	1	-	2	1	-	1
4	-	-	2	1	-	1
5	-	-	-	-	-	-
Avg.	1	-	1.6	1		1.2

TE4211 THERMAL SYSTEMS SIMULATION LABORATORY

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

OBJECTIVES:

1. To learn the modeling and simulation analysis of various thermal engineering application using analysis softwares.
2. To educate the students about calibration and its essentiality in thermal systems.

LIST OF EXPERIMENTS

1. Heat exchanger analysis – NTU method
2. Heat exchanger analysis – LMTD method
3. Convection heat transfer analysis – Velocity boundary layer.
4. Convection heat transfer analysis – Internal flow
5. Radiation heat transfer analysis – Emissivity

6. Critical radius of insulation
7. Lumped heat transfer analysis
8. Conduction heat transfer analysis
9. Condensation heat transfer analysis

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course the student will have

- knowledge in various heat transfer simulation study on different thermal engineering applications by using analysis softwares.
- Analyze the critical/influential properties of thermal systems

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

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

SIMULATION LAB – REQUIREMENT:

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

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	2	2	3	2	1
2	1	2	2	3	2	1
Avg.	1	2	2	3	2	1

TE4212 **TECHNICAL SEMINAR - I** **L T P C**
0 0 2 1

OBJECTIVES:

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

GUIDELINES

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

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

EVALUATION

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

TOTAL: 30 PERIODS

OUTCOMES:

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

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

Mapping of CO with PO

CO	PC					
	1	**2**	**3**	**4**	**5**	**6**
1	1	-	-	1	2	1
2	1	-	-	1	1	-
3	1	1	-	1	-	-
4	1	1	-	-	-	-
5	-	2	-	-	3	3
Avg.	0.8	0.8	-	0.6	1.2	0.8

TE5301 **DESIGN AND OPTIMIZATION OF THERMAL ENERGY SYSTEMS** **L T P C**

3 0 0 3

OBJECTIVES

- To learn basic principles underlying pumping, heat exchangers; modeling and optimization in design of thermal systems.
- To develop representational modes of real processes and systems.
- To optimization concerning design of thermal systems.

UNIT I DESIGN CONCEPTS **9**

Design Principles, Workable Systems, Optimal Systems, Matching of System Components, Economic Analysis, Depreciation, Gradient Present Worth factor, modelling overview – levels and steps in model development - Examples of models – curve fitting and regression analysis

UNIT II MODELLING AND SYSTEMS SIMULATION **10**

Modelling of thermal energy systems – heat exchanger - solar collectors – distillation - rectification turbo machinery components - refrigeration systems - information flow diagram - solution of set of nonlinear lgebraic equations - successive substitution - Newton Raphson method- examples of thermal systems simulation

UNIT III OPTIMIZATION 10

Objectives - constraints, problem formulation - unconstrained problems - necessary and sufficiency conditions. Constrained optimization - Lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis - New generation optimization techniques – examples

UNIT IV DYNAMIC BEHAVIOUR 8

Steady state Simulation, Laplace Transformation, Feedback Control Loops, Stability Analysis, Non-Linearities

UNIT V APPLICATIONS AND CASE STUDIES 8

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

TOTAL: 45 PERIODS

OUTCOME

- On successful Completion of this course the student will be understand modeling and optimization of Thermal systems.

REFERENCES

1. B.K.Hodge, Analysis and Design of Thermal Systems, Prentice Hall Inc., 1990.
2. Bejan A., George Tsatsaronis , Michael J. Moran , Thermal Design and Optimization, Wiley , 1996.
3. D.J. Wide, Globally Optimal Design, Wiley- Interscience, 1978.
4. Kapur J. N., Mathematical Modelling , Wiley Eastern Ltd , New York , 1989.
5. Rao S. S., Engineering Optimization Theory and Practice, New Age Publishers, 2000.
6. Stoecker W. F., Design of Thermal Systems, McGraw Hill Edition, 1989.
7. YogeshJaluria , Design and Optimization of Thermal Systems , CRC Press , 2007.

TE4311	TECHNICAL SEMINAR - II	L	T	P	C
		0	0	2	1

OBJECTIVES:

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

GUIDELINES

- The student is expected to present a seminar in one of the current topics in the field of Thermal Engineering related issues / technology.
- The seminar shall be of 30 minutes duration and give presentation to the Seminar Assessment Committee (SAC).
- The committee shall evaluate the seminar based on the style of presentation, technical context, and coverage of the topic, adequacy of references, depth of knowledge and the overall quality.
- A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain attendance also.
- Each student has to submit a seminar report in the prescribed format given by the Institution.

- In a session of three periods per week, 4 students are expected to present the seminar.
- Students are encouraged to use various teaching aids such as power point presentation and demonstrative models.
- It is recommended that the report for Technical Seminar II may be in the form of a technical paper which is suitable for publishing in Conferences / Journals as a review paper.

EVALUATION

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

TOTAL: 30 PERIODS

OUTCOMES:

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

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

Mapping of CO with PO

CO	PC					
	1	**2**	**3**	**4**	**5**	**6**
1	1	-	-	1	2	1
2	1	-	-	1	1	-
3	1	1	-	1	-	-
4	1	1	-	-	-	-
5	-	2	-	-	3	3
Avg.	0.8	0.8	-	0.6	1.2	0.8

TE4312 **PROJECT WORK – I** **L T P C**
0 0 12 6

OBJECTIVES:

- To improve the skills in reading technical magazines, conference proceedings and journals.
- To develop the skill of identifying research problems/projects in the field of Thermal Engineering.
- To familiarize with the design and analysis tools required for the project work and plan the experimental platform, if any, required for project work.

GUIDELINES

- Each student has to identify the topic of project related to the field of Thermal Engineering.
- The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student
- The topic has to be approved by a review committee constituted by the department.
- The work has to be presented periodically in front of the review committee.

- The preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- The project report should be presented in standard format as provided by the Anna University.

EVALUATION

Project Work Phase - I evaluation is based on Regulations of Post graduate programmes of Anna University.

TOTAL: 90 PERIODS

OUTCOMES:

The students would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated in their project work phase – II.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	-	-	1	2	3
2	1	-	-	-	1	3
3	1	-	-	-	2	3
4	1	-	-	-	2	3
5	1	-	-	3	2	-
Avg.	1	-	-	0.8	1.8	2.4

TE4411 **PROJECT WORK – II** **L T P C**

0 0 24 12

OBJECTIVES:

- To improve the skills in publishing technical papers in conference proceedings and journals.
- To produce factual results of their applied research idea in the Thermal engineering, from phase – I.

GUIDELINES

- Each student has to complete project (phase II) under the guidance of a faculty member, as specified in Phase I.
- The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student
- The topic has to be approved by a review committee constituted by the department.
- The work has to be presented periodically in front of the review committee.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion.
- The report must bring out the conclusions of the work and future scope for the study.
- The project report should be presented in standard format as provided by the Anna University.

EVALUATION
Project Work Phase - II evaluation is based on Regulations of Post graduate programmes of Anna University.

TOTAL: 180 PERIODS

OUTCOMES:
The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	1	-	-	1	2	3
2	1	-	-	-	1	3
3	1	-	-	-	2	3
4	1	-	-	-	2	3
5	1	-	-	3	2	-
Avg.	1	-	-	0.8	1.8	2.4

TE4001 AIRCRAFT AND JET PROPULSION L T P C
3 0 0 3

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

UNIT I GAS DYNAMICS 8
Wave motion - Compressible fluid flow through variable area devices – Stagnation state Mach Number and its influence and properties, Isentropic Flow, Rayleigh and Fanno Flow. Deflagration and Detonation – Normal shock and oblique shock waves.

UNIT II THERMODYNAMICS OF AIRCRAFT ENGINES 9
Theory of Aircraft propulsion – Thrust – Various efficiencies – Different propulsion systems – Turboprop – Ram Jet – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft. Variable thrust- nozzles – vector control.

UNIT III PERFORMANCE CHARACTERISTICS OF AIRCRAFT ENGINES 9
Engine - Aircraft matching – Design of inlets and nozzles – Performance characteristics of Ramjet, Turbojet, Scramjet and Turbofan engines.

UNIT IV ROCKET PROPULSION 9
Theory of rocket propulsion – Rocket equations – Escape and Orbital velocity – Multi-staging of Rockets – Space missions – Performance characteristics – Losses and efficiencies.

UNIT V ROCKET THRUST CHAMBER 10
Combustion in solid and liquid propellant classification – rockets of propellants and Propellant Injection systems – Non-equilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer.

TOTAL = 45 PERIODS

COURSE OUTCOME

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

REFERENCES

1. Bonney E.A., Zucrow N.J,. Principles of Guided Missile Design, Van Nostranc Co., 1956.
2. Khajuria P.R. and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai Publications, 2003.
3. Mattingly J.D., Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition, 1997.
4. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 2009.
5. S.M.Yahya, Fundamentals of Compressible Flow, Third edition, New Age International Pvt Ltd, 2003.
6. Zucrow N.J., Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons, New York, 1970.
7. Zucrow N.J., Aircraft and Missile Propulsion, Vol. I and Vol. II, John Wiley and Sons Inc, New York, 1975.

TE4073 HYDROGEN AND FUEL CELL TECHNOLOGIES L T P C
3 0 0 3

COURSE OBJECTIVES

- To study in detail on the hydrogen production methodologies, possible applications and various storage options.
- To understand the working principle of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics.
- To study the cost effectiveness and eco-friendliness of Fuel Cells.

UNIT I HYDROGEN – BASICS AND PRODUCTION TECHNIQUES 9

Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water.

UNIT II HYDROGEN STORAGE AND APPLICATIONS 9

Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons. Safety and management of hydrogen. Applications of Hydrogen.

UNIT III FUEL CELLS 9

History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell.

UNIT IV FUEL CELL – TYPES 9

Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – relative merits and demerits.

UNIT V APPLICATION OF FUEL CELL AND ECONOMICS 9

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space. Economic and environmental analysis on usage of Hydrogen and Fuel cell. Future trends in fuel cells.

TOTAL: 45 PERIODS

COURSE OUTCOME

After completion of the syllabus student able to :

Know the working of various fuel cells, their relative advantages / disadvantages and hydrogen generation/storage technologies.

REFERENCES

1. Viswanathan B. and Aulice Scibioh.M, Fuel Cells – Principles and Applications, Universities Press, 2006.
2. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
3. Bent Sorensen (Sørensen), Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, UK 2005.
4. Kordesch K. and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany 1996.
5. Hart A.B. and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, New York Ltd., London 1989.
6. Jeremy Rifkin, The Hydrogen Economy, Penguin Group, USA 2002.
7. Barclay F.J., Fuel Cells, Engines and Hydrogen, Wiley, 2009.

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3		3	1	1	2
2	3		3	1	1	2
3	2		2	2		1
4	2		2	1		2
5	2		2	1	3	2
Avg.	2.4		2.4	1.2	1.66	1.8

TE4002 **ENERGY RESOURCES** **L T P C**

3 0 0 3

COURSE OBJECTIVES

- To explain concept of various forms of Non-renewable and renewable energy.
- To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications.
- To study the environmental and cost economics of using renewable energy sources compared to fossil fuels.

UNIT I COMMERCIAL ENERGY **9**

Coal, Oil, Natural gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India.

UNIT II SOLAR ENERGY **9**

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells - Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

UNIT III WIND ENERGY 9

Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection - wind energy conversion devices - classification, characteristics, applications – offshore wind energy - Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.

UNIT IV BIO-ENERGY 9

Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - direct combustion – biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - types of biogas Plant - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

UNIT V OTHER TYPES OF ENERGY 9

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plant - ocean wave energy conversion - tidal energy conversion – small hydro - geothermal energy - geothermal power plant – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.

TOTAL = 45 PERIODS

COURSE OUTCOMES

After completion of the syllabus student able to :

- Understand the commercial energy and renewable energy sources.
- Know the working principle of various energy systems.

REFERENCES

1. Sukhatme S.P., “Solar Energy”, Tata McGraw Hill, 1984.
2. Twidell J.W. and Weir A., “Renewable Energy Sources”, EFN Spon Ltd., 1986.
3. Kishore V.V.N., “Renewable Energy Engineering and Technology”, Teri Press, New Delhi, 2012
4. Peter Gevorkian, “Sustainable Energy Systems Engineering,” McGraw Hill,2007.
5. Kreith F. and Kreider J.F., “Principles of Solar Engineering”, McGraw-Hill, 1978.
6. Godfrey Boyle, “Renewable Energy Power for a Sustainable Future”, Oxford University Press, U.K, 1996.
7. Veziroglu T.N., Alternative Energy Sources”, Vol 5 and 6, McGraw-Hill, 1990.
8. Anthony San Pietro, “Biochemical and Photosynthetic aspects of Energy Production”, Academic Press, 1980.
9. Bridgurater A.V., “Thermochemical processing of Biomass”, Academic Press, 1981.
10. Bent Sorensen , “Renewable Energy”, Elsevier, Academic Press, 2011.

TE4003 ADVANCED INTERNAL COMBUSTION ENGINES L T P C

3 0 0 3

COURSE OBJECTIVES

- To gain insight on the working principle of spark ignition engines and compression ignition engines.
- To study the pollutant formation and its control in IC engines.
- To study the recent technologies adopted in IC engine applications.

UNIT I SPARK IGNITION ENGINES 9

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

UNIT II COMPRESSION IGNITION ENGINES 9

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

UNIT III POLLUTANT FORMATION AND CONTROL 9

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

UNIT IV ALTERNATIVE FUELS 9

Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

UNIT V RECENT TRENDS 9

Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – laser Doppler, Anemometry. Use of nano technology in IC Engines.

TOTAL = 45 PERIODS

COURSE OUTCOME

On successful completion of this course the student will be able to understand the working principle of IC engines, source of pollution formation and its control and recent trends in IC engines.

REFERENCES

1. Duffy Smith, Auto fuel Systems, The Good Heart Willox Company, Inc., 1989.
2. Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, 1988.
3. K.K. Ramalingam, Internal Combustion Engine fundamentals, Scitech Publications, 2002.
4. Kirpal Singh, Automobile Engineering Vol - I, Standard Publishers, Delhi 2013.
5. R.B. Mathur and R.P.Sharma, Internal Combustion Engines, Dhanapat Rai Publications,1993.
6. V. Ganesan, Internal Combustion Engines, II Edition, Tata McGraw-Hill Education, 2002.
7. Willard W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, 1997.

PROGRESS THROUGH KNOWLEDGE

TE4004 CRYOGENIC ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES

- To give introductory knowledge of cryogenic Engineering.
- To impart knowledge in liquefaction, separation of cryogenics gases and working of cryocoolers.
- To embark on a research career in Cryogenic Engineering.

UNIT I INTRODUCTION 9

Insight on Cryogenics, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Applications of Cryogenics in Space Programs, Superconductivity, Cryo Metallurgy, Medical applications.

UNIT II LIQUEFACTION CYCLES 9

Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle Dual Cycle, Ortho-Para hydrogen conversion, Eollins cycle, Simpson cycle, Critical Components in Liquefaction Systems.

UNIT III SEPARATION OF CRYOGENEIC GASES 9

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

UNIT IV CRYOGENIC REFRIGERATORS 9

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

UNIT V HANDLING OF CRYOGENS 9

Cryogenic Dewar, Cryogenic Transfer Lines. Insulations used in Cryogenic Systems, Instrumentation to measure Flow, Level and Temperature.

TOTAL = 45 PERIODS

COURSE OUTCOME

On successful completion of this course the student will be able to understand Concepts of cryogenic, cryogenic refrigeration and handling of the cryogens.

REFERENCES

1. Klaus D. Timmerhaus and Thomas M. Flynn, Cryogenic Process Engineering,PlenumPress,New York, 1989.
2. Randall F. Barron, Cryogenic Systems, McGraw-Hill, 1985.
3. Scott R.B., Cryogenic Engineering, Van Nostrand and Co., 1962.
4. Herald Weinstock, Cryogenic Technology, Boston Technical Publishers, inc., 1969.
5. Robert W. Vance, Cryogenic Technology, John wiley & Sons, Inc., New York, London.
6. G.Venkatarathnam, Cryogenic Mixed Refrigerant Processes, Springer Publication, 2010.
7. J.G.Weisend, Hand Book of Cryogenic Engineering —II, Taylor and Francis, 1998.

TE4005 REFRIGERATION SYSTEMS L T P C

3 0 0 3

COURSE OBJECTIVES

- To study the cycle analysis pertaining to Refrigeration systems.
- To study the performance of system components and their balancing in cycles.
- To study the significance of Refrigerants and their impact on the environment.

UNIT I INTRODUCTION AND REFRIGERANTS 9

Applications, Unit of refrigeration – Ideal cycles - Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal / Kyoto protocols-Eco Friendly Refrigerants, alternatives to HCFCS, Secondary Refrigerants.

UNIT II REFRIGERATION CYCLES – ANALYSIS 9

Development of Vapor Compression Refrigeration Cycle from Reverse Carnot Cycle- conditions for high COP-deviations from ideal vapor compression cycle, Multipressure System, Cascade Systems-Analysis. Vapor Absorption Systems-Aqua Ammonia & Li-Br Systems, Steam Jet Refrigeration Thermo Electric Refrigeration, Air Refrigeration cycles, Heat pumps.

UNIT III REFRIGERATION SYSTEM COMPONENTS 9

Compressor- Types, performance, Characteristics, Types of Evaporators & Condensers and their functional aspects, Expansion Devices and their Behaviour with fluctuating load, cycling controls, other components such as Accumulators, Receivers, Oil Separators, Strainers, Driers, Check Valves, Solenoid Valves Defrost Controllers, etc.

UNIT IV SYSTEM BALANCING 9

Balance points and system simulation - compressor, condenser, evaporator and expansion devices performance – Complete system performance; graphical and mathematical analysis – sensitivity analysis.

UNIT V ELECTRICAL DRIVES & CONTROLS 9

Electric circuits in Refrigeration systems, Refrigerant control devices, Types of Motors, Starters, Relays, Thermostats, Microprocessor based control systems, Pressure controls and other controls, Acoustics and noise controls.

TOTAL = 45 PERIODS

COURSE OUTCOME

- The student will be able to understand different refrigeration systems and do the design of the same for a particular applications.

REFERENCES

1. Arora C.P., Refrigeration and Air conditioning, McGraw Hill, 3rd Ed., 2010.
2. Dossat R.J., Principles of refrigeration, John Wiley, S.I. Version, 2001.
3. Jordan and Priester, Refrigeration and Air conditioning 1985.
4. Kuehn T.H., Ramsey J.W. and Threlkeld J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.
5. Langley Billy C., 'Solid state electronic controls for HVACR, Prentice-Hall 1986.
6. Rex Milter, Mark R.Miller., Air conditioning and Refrigeration, McGraw Hill, 2006.
7. Stoecker W.F., Refrigeration and Air conditioning, McGraw-Hill Book Company, 1989.

IC4252 ELECTRONIC ENGINE MANAGEMENT SYSTEMS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

1. To provide basic grounding on electronics
2. To learn the various sensors used in engine management systems
3. Give an overview of different types of ignition systems
4. To understand the significance of gasoline injection systems
5. To know the latest advancements in Diesel injection systems

UNIT I FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS 9

Components for Electronic Engine Management System- Open and Closed Loop Control Strategies- PID Control- Look Up Tables- Introduction to Modern Control Strategies Like Fuzzy Logic and Adaptive Control. Switches- Active Resistors- Transistors- Current Mirrors/Amplifiers- Voltage and Current References- Comparator- Multiplier. Amplifier- Filters- A/D and D/A Converters.

UNIT II SENSORS AND ACTUATORS 9

Inductive- Hall Effect- Thermistor- Piezo Electric- Piezoresistive- Based Sensors. Throttle Position- Mass Air Flow- Crank Shaft Position- Cam Position- Engine Speed Sensor- Exhaust Oxygen Level (Two Step- Linear Lambda and Wideband)- Knock- Manifold Temperature and Pressure Sensors. Solenoid- Relay (Four and Five Pin)- Stepper Motor

UNIT III SI ENGINE MANAGEMENT 9

Layout and Working of SI Engine Management Systems. Group and Sequential Injection Techniques. MPFI- GDI- Advantages of Electronic Ignition Systems. Types of Solid State Ignition Systems and Their Principle of Operation- Contactless (BREAKERLESS) Electronic Ignition System- Electronic Spark Timing Control

UNIT IV CI ENGINE MANAGEMENT 9

Fuel Injection System Parameters Affecting Combustion- Noise and Emissions in CI Engines. Electronically Controlled Unit Injection System. Common Rail Fuel Injection System. Working of Components Like Fuel Injector- Fuel Pump- Rail Pressure Limiter- Flow Limiter- EGR Valve.

UNIT V DIGITAL ENGINE CONTROL SYSTEM 9

Cold Start and Warm Up Phases- Idle Speed Control- Acceleration and Full Load Enrichment- Deceleration Fuel Cut-off. Fuel Control Maps- Open Loop and Closed Loop Control – Integrated Engine Control System- Electromagnetic Compatibility – EMI Suppression Techniques – Electronic Dash Board Instruments – Onboard Diagnosis System.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- Understand the basic electronic components and controls used in Sensors
- Explain the different types of sensors used in an automobile engine
- Describe the ignition and injection methods used in an SI engine
- Describe the fuel injection systems in a diesel engine and the emission control systems
- Explain the electronic systems used in the fuel control system and the dash board unit.

REFERENCES:

1. Understanding Automotive Electronics William B Ribbens, SAE 1998
2. Automobile Electronics by Eric Chowanietz SAE
3. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
4. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition, 2004

PO & CO Mapping:

CO	PO					
	1	2	3	4	5	6
1	2	2	3	-	2	-
2	3	2	3	-	3	-
3	3	2	3	-	3	-
4	3	2	3	-	3	-
5	3	-	3	-	2	-
Avg	2.8	2	3	-	2.6	-

TE4006 COGENERATION AND WASTE HEAT RECOVERY SYSTEMS **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To analyze the basic energy generation cycles.
- To detail about the concept of cogeneration, its types and probable areas of applications.
- To study the significance of waste heat recovery systems and carry out its economic analysis.

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 and quad generation.

UNIT II COGENERATION TECHNOLOGIES **9**

Configuration and thermodynamic performance – steam turbine congeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

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 – sorption 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.

TOTAL: 45 PERIODS

COURSE OUTCOME

- On completing of the syllabus students can able understand the principles of cogeneration systems, waste heat recovery systems, applications of cogeneration and economis analysis of waste heat recovery systems.

REFERENCES

1. Charles H. Butler, Cogeneration, McGraw Hill Book Co., 1984.
3. De Nevers, Noel, Air Pollution Control Engineering, McGraw Hill, New York,1995.
2. EDUCOGEN – The European Educational tool for cogeneration, Second Edition, 2001.
4. Energy Cogeneration Hand book, George Polimveros, Industrial Press Inc, New yark 1982.
5. Horlock JH., Cogeneration - Heat and Power, Thermodynamics and Economics, Oxford,1987.
6. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers,London, 1963.
7. Seagate Subrata, Lee SS EDS, Waste Heat Utilization and Management, Hemisphere, Washington, 1983.

TE4007 **DESIGN OF TURBO MACHINES** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

1. To elucidate the energy transfer process, Fans laws in Turbo machines.
2. To illustrate the selection and working of Centrifugal Blowers.
3. To classify different types of axial fans and rotor design.
4. To outline the working different compressors and its performance characteristics.
5. To select different fans / blowers / compressors for specific applications.

UNIT – I INTRODUCTION 9

Energy transfer between fluid and rotor velocity triangles for a generalised turbo machines – velocity triangle. Euler's equation for turbo machines and its different forms. Degree of reaction in turbo-machines – various efficiencies – isentropic, mechanical, thermal, overall and polytropic – fan laws – Dimensionless parameters – Specific speed – Cordier Diagram.

UNIT – II CENTRIFUGAL BLOWERS 9

Centrifugal Blowers: Theoretical characteristic curves, velocity triangles, losses and hydraulic efficiency, flow through impeller casing, inlet, nozzle, volute, diffusers. Leakage losses, mechanical losses, multi-vane impellers, cross flow fans. Selection of Centrifugal blower for duct flow.

UNIT – III AXIAL FLOW FANS 9

Rotor design using airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist, stage design, surge and stall, stator and casing, mixed flow impellers. Selection of axial fans / blower for duct flow.

UNIT – IV COMPRESSORS 9

Reciprocating compressors, Construction Type – open, hermetic and semi sealed, effect of cylinder cooling, heating and friction. Dynamic compressor - centrifugal compressor, velocity triangles, performance characteristics, part load operation, Capacity control. Selection of compressor for different applications.

UNIT – V DESIGN AND APPLICATIONS 9

Special design and applications of blowers / compressors for air conditioning plants, cooling towers, ventilation systems, booster systems - turbocharger.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Analyse the fundamentals of Turbo machinery and solve the problems on Energy Transfer.
2. Categorise the Centrifugal Blowers and Fans for various applications.
3. Summarise the different types of axial fan design and performance.
4. Analyse various compressors based on its performance.
5. Select fans / blowers /compressors for the given applications.

REFERENCES:

1. Austin H. Church, Centrifugal pumps and blowers, John Wiley and Sons, 2017
2. Dixon, Fluid Mechanics, Thermodynamics of turbo machinery Pergamon Press, 1984.
3. Fans & Ventilation A practical guide (Bill) cory WTW, Elsevier, 2005.

4. Jay Matley., Fluid Movers: Pumps, Compressors, Fans and Blowers, McGraw-Hill Publications, 1990.
5. Royce N. Brown, Compressors: Selection and Sizing, Elsevier, 2005.
6. Tony Giampaolo, Compressor Hand Book Principles and Practice, The Fairmont Press, 2010.
7. Yahya S. M., Turbines compressors and fans(4th Edition), Tata McGraw-Hill, 2010.
8. Forsthoffer's rotating equipment handbooks Volume 3: Compressors, Elsevier Advanced Technolgy, UK, 2005

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	1	-	-	1
2	1	-	-	-	-	-
3	-	2	1	-	-	-
4	1	1	1	-	-	-
5	-	1	-	-	-	2
Avg.	0.6	1	0.6	-	-	0.6

TE4008 ELECTRONICS COOLING AND PACKAGING L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To provide a basic knowledge of the technologies and processes required for the packaging.
2. To expose the students to all aspects of electronic equipment and components including electrical, thermal, fluid dynamics and reliability issues
3. To illustrate Radiation on the surface through electronic components
4. To analyze the effect of electronics equipment at different modes
5. To provide a vision for cooling systems and its packaging devices

UNIT I INTRODUCTION 9

Electronic Equipment, Components of Electronic Systems, Thermal management in electronic devices - Packaging Trends. Electronic packaging and interconnection technology. Conduction in Electronic Equipment: Thermal Conductivity, Thermal Resistances, Conductivity in Solids, Conductivity in Fluids, Conduction—Steady State, Conduction in Simple Geometries, Conduction through a Plane Wall, Conduction through Cylinders and Spheres.

UNIT-II ELECTRONICS ASSISTED IN THERMAL COMPONENTS 9

Conduction—Transient, Lumped Capacitance Method, Conduction in Extended Surfaces. Fin Efficiency, Fin Optimization, Fin Surface Efficiency, Thermal Contact Resistance in Electronic Equipment, Discrete Heat Sources and Thermal Spreading. Fluid Dynamics for Electronic Equipment- Boundary Layer Theory, Turbulent Flow, Loss Coefficients and Dynamic Drag, Fans and Pumps, Electronic Chassis Flow.

UNIT-III IMPACT OF RADIATION ON SURFACE 9

Radiation Heat Transfer in Electronic Equipment, The Electromagnetic Spectrum, Radiation Equations, Stefan-Boltzmann Law, Surface Characteristics, Emittance, Emittance Factor, Emittance from Extended Surface, Absorptance, Reflectance, Specular Reflectance, Heat Transfer with Phase Change. Combined Modes of Heat Transfer for Electronic Equipment, Radiation and Convection in Parallel.

UNIT-IV ANALYSIS OF ELECTRONIC EQUIPMENT 9

Introduction to Thermal Design of Electronic Equipment. Analysis of Thermal Failure of Electronic Components. Analysis of Thermal Stresses and Strain, Effect of PCB Bending Stiffness on Wire Stresses, Vibration Fatigue in Lead Wires and Solder Joints. Electronics Cooling Methods in Industry. Heat Sinks, Heat Pipes, Heat Pipes in Electronics Cooling, Thermoelectric Cooling, Immersion Cooling, Cooling Techniques for High Density Electronics.

UNIT-V COOLING SYSTEMS FOR ELECTRONIC PACKAGES 9

Cooling systems for electronics packages – heat sinks, heat spreaders, heat pipes, microchannels, actuators, fans, cold plates; Thermo-mechanical issues in electronic packages Effects of Vibration – vibrating systems, vibration of axially loaded components, circuit boards, Theorem of Castigliano; Reliability Metrology and Analysis, Environmental Stress Screening

TOTAL 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Identify the basic knowledge about the packaging of electronics
2. Utilise the ability of electronic cooling system.
3. Analyse the radiation through multi electronic devices
4. Evaluate the performance calculation of Electronics Equipment.
5. Applying cooling systems for different thermal sourcing agents

REFERENCES:

1. Rao R. Tummala : Fundamentals of Microsystem Packaging, McGraw Hill, 2001.
2. Richard K. Ulrich &William D. Brown Advanced Electronic Packaging - 2nd Edition : IEEE Press,2006.
3. Yunus A. Cengel : Heat Transfer – A Practical Approach, McGraw Hill, 2003. 4. The Electronic Packaging Handbook- Glenn R. Blackwell, 1st Edition, 2000

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	3	-	2	2	-
2	1	3	-	3	2	-
3	1	1	-	2	2	-
4	2	2	-	1	2	-
5	1	1	-	3	1	-
Avg.	1.2	2	-	2.2	1.8	-

PROGRESS THROUGH KNOWLEDGE

TE4009 AIR CONDITIONING SYSTEMS L T P C
3 0 0 3

OBJECTIVES

- To learn the psychometric concepts underlying Air conditioning process.
- To learn the design features and load estimation principles of specific Air conditioning system.
- To learn about the critical auxiliary systems
- To learn about the air distribution circuits, water distribution circuits etc.
- To learn about the HVAC systems in air conditioning systems

UNIT I PSYCHROMETRY AND AIR CONDITIONING PROCESSES 9

Moist Air properties, use of Psychrometric Chart, Various Psychrometric processes, Air Washer, Adiabatic Saturation. Summer and winter Air conditioning, Enthalpy potential and its insights.

UNIT II LOAD ESTIMATION 9

Thermal comfort – Design conditions – Solar Radiation-Heat Gain through envelopes – Infiltration and ventilation loads – Internal loads – Procedure for heating and cooling load estimation.

UNIT III AIR CONDITIONING SYSTEMS 9

Thermal distribution systems – Single, multi zone systems, terminal reheat systems, Dual duct systems, variable air volume systems, water systems and Unitary type systems.

UNIT IV AIR DISTRIBUTION AND CONTROL 9

Flow through Ducts , Static & Dynamic Losses , Diffusers , Duct Design–Equal Friction Method, System Balancing , Fans & Duct System Characteristics , Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units – Control of temperature, humidity, air flow and quality.

UNIT V HVAC SYSTEM IN AUTOMOBILES 9

Automotive System layout and Components- Commonly used Refrigerants- Safety devices – Climate control – Fuel efficiency aspects.

TOTAL 45 PERIODS

OUTCOMES

1. Analyse psychrometrically the Air conditioning processes.
2. Estimate the heat load for summer and winter Air conditioning applications.
3. Understand and appreciate the utility of different Air conditioning systems for different applications.
4. Design a fan-duct system for Air conditioning application.
5. Understand and appreciate the individual components of an automobile Air conditioning system. various HVAC system components for various applications in the building requirements.

REFERENCES

1. ALI VEDAVARZ, SUNIL KUMAR, Mohammed Iqbal, Hussain Handbook of Heating**,** Ventilation and Air conditioning for Design Implementation, Industrial press Inc, 2007.
2. Arora C.P., Refrigeration and Air Conditioning, Tata McGraw Hill Pub. Company, 2010.
3. ASHRAE , Fundamentals and equipment , 4 volumes-ASHRAE Inc. 2005.

4. Carrier Air Conditioning Co., Handbook of Air Conditioning Systems design, McGraw Hill, 1985.
5. Jones, Air Conditioning Engineering, Edward Amold pub. 2001.
6. Kuehn T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998
7. Langley, Billy C. ,Refrigeration and Air Conditioning Ed. 3, Engie wood Cliffs (N.J) Prentice Hall 1986.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	-	1	1	-
2	2	2	-	1	2	-
3	1	2	-	1	2	-
4	1	1	-	1	1	-
5	1	2	-	1	2	-
Avg.	1.2	1.6	-	1	1.6	-

IC4151 ALTERNATE FUELS FOR IC ENGINES **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1 To expose potential alternate fuels and their characteristics
2 To use appropriate synthetic fuels and fuel additives for better combustion characteristics
3 To utilise alcohol fuels effectively for lower emissions
4 To elaborate on the utilisation of Bio-Diesel and its types as a suitable fuel in CI engines
5 To utilise different gaseous fuels and predict their performance and combustion characteristics

UNIT I INTRODUCTION **9**

Availability, Suitability, Properties, Merits and Demerits of Potential Alternative Fuels – Alcohols, Biodiesel, Hydrogen, Liquefied Petroleum Gas, Natural Gas, Biogas, Fuel standards – ASTM & EN.

UNIT II SPECIAL AND SYNTHETIC FUELS **9**

Different synthetic fuels, Merits, and demerits, Dual, Bi-fuel and Pilot injected fuel systems, Fuel additives – types and their effect on performance and emission characteristics of engines, Flexi-fuel systems, Ethers - as fuel and fuel additives, properties and characteristics.

UNIT III ALCOHOL FUELS **9**

Alcohols – Properties, Production methods and usage in engines. Blending, dual fuel operation, surface ignition, spark ignition and oxygenated additives. Performance, combustion and emission Characteristics in engines. Issues & limitation in alcohols

UNIT IV BIO-DIESEL FUELS 9

Vegetable oils and their important properties. Fuel properties characterization. Methods of using vegetable oils – Blending, preheating, Transesterification and emulsification – Performance, combustion and emission characteristics in diesel engines. Third generation biofuels, Ternary and Quaternary fuels, Issues & limitation of using vegetable oils in IC engines

UNIT V GASEOUS FUELS 9

Biogas, Natural gas, LPG, Hydrogen – Properties, problems, storage and safety aspects. Methods of utilisation in engines. Performance, combustion and emission characteristics in engines. Issues & limitation in Gaseous fuels

TOTAL:45 PERIODS

COURSE OUTCOMES :

The students will be able to

1 Expose potential alternate fuels and their characteristics
2 Use appropriate synthetic fuels and fuel additives for better combustion characteristics
3 Utilise alcohol fuels effectively for lower emissions
4 Elaborate on the utilisation of Bio-Diesel and its types as a suitable fuel in CI engines
5 Utilise different gaseous fuels and predict their performance and combustion characteristics

REFERENCES:

1. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications, 1990.
2. Pundir B.P, I.C. Engines Combustion and Emission, 2010, Narosa Publishing House.
3. Pundir B.P , Engine Combustion and Emission, 2011, Narosa Publishing House Keith
4. Richard L. Bechtold, Automotive Fuels Guide Book, SAE Publications, 1997

CO	PO					
	1	2	3	4	5	6
1	1	-	2	-	1	-
2	2	2	2	-	2	-
3	2	2	2	-	1	-
4	2	3	3	-	2	2
5	2	3	2	-	2	2
Avg	1.8	2.5	2.2	-	1.6	2

TE4092 DESIGN OF HEAT EXCHANGERS L T P C
3 0 0 3

COURSE OBJECTIVES:

1 To make students familiarize with the various types of heat exchangers
2 To explain the importance of thermal and stress analysis of heat exchangers
3 To inculcate the thermal design aspects of tubular heat exchangers
4 To provide the details of design aspects of compact heat exchangers
5 To explain the function and design aspects of condensers and cooling towers

UNIT- I FUNDAMENTALS OF HEAT EXCHANGER 9

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

UNIT- II STRESS ANALYSIS 9

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

UNIT- III DESIGN ASPECTS 9

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

UNIT- IV COMPACT AND PLATE HEAT EXCHANGERS 9

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

UNIT- V CONDENSERS AND COOLING TOWERS 9

Design of surface and evaporative condensers–cooling tower –performance characteristics

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to

1. Classify heat exchangers and illustrate the applications of various types of heat exchangers
2. Interpret the significance of stress analysis of heat exchangers
3. Analyse the design of tubular heat exchangers for various applications
4. Appraise the design of compact heat exchangers for industrial requirements
5. Evaluate the performance calculation of condensers and cooling towers

REFERENCES:

1. SadikKakac, Hongtan Liu, Anchasa Pramuanjaroenkij, “Heat Exchangers Selection, Rating and Thermal Design”, CRC Press,Third Edition,2012.
2. Ramesh K.Shah, Dušan P.Sekulić, ”Fundamentals of heat exchanger design”, John Wiley & Sons, 2003.
3. Robert W. Serth, “Process heat transfer principles and applications”, Academic press, Elesevier, 2010.
4. T. Kuppan, “Heat exchanger design hand book”,New York: Marcel Dekker,2009.
5. Arthur.P Frass, “Heat Exchanger Design”, John Wiley & Sons,1989.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3		1	3	1	
2	3		1	3	1	
3	3		3	2	1	
4	3		2	2	1	
5	3		3	1	1	
Avg.	3		2	2.2	1	

TE4010 BATTERY THERMAL MANAGEMENT SYSTEM L T P C
3 0 0 3

OBJECTIVES:

1. The objective of this course is to introduce learner to batteries, its parameters, modelling and charging requirements.
2. The course will help learner to develop battery management algorithms for batteries
3. To analyse the battery state of charge and its functions
4. To evaluate models using the range of simulation.
5. To Examine the design standards of a battery.

UNIT- I INTRODUCTION 9

Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithiumion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging

UNIT-II BATTERY MANAGEMENT SYSTEM REQUIREMENT 9

Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of- charge estimation, Cell total energy and cell total power.

UNIT-III BATTERY STATE OF CHARGE AND STATE OF HEALTH ESTIMATION, CELL BALANCING 9

Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium-ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing

UNIT- IV MODELLING AND SIMULATION 9

Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, simulating an electric vehicle, Vehicle range calculations, simulating constant power and voltage, Simulating battery packs,

UNIT-V DESIGN OF BATTERY BMS: 9

Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system

TOTAL 45 PERIODS

COURSE OUTCOMES:

After completion of this course, student will be able to

1. Interpret the role of battery management system
2. Identify the requirements of Battery Management System
3. Interpret the concept associated with battery charging / discharging process
4. Calculate the various parameters of battery and battery pack
5. Design the model of battery pack

REFERENCES:

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods, Artech House, 2015.
3. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L "Battery Management Systems -Design by Modelling" Philips Research Book Series 2002.
4. Davide Andrea," Battery Management Systems for Large Lithium-ion Battery Packs" Artech House, 2010
5. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery powered applications. Vol. 9. Springer Science & Business Media, 2008.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	2	-	3	-
2	-	-	-	-	2	-
3	2	3	1	-	-	-
4	1	-	-	-	-	-
5	1	1	-	-	1	-
Avg.	1	1	0.6	-	1.2	-

EY4091 ADVANCED ENERGY STORAGE TECHNOLOGIES L T P C

3 0 0 3

COURSE OBJECTIVES:

1. To understand the various types of energy storage technologies and its applications.
2. To study the various modeling techniques of energy storage systems using TRNSYS.
3. To learn working concepts and types of batteries.
4. To make the students to get understand the concepts of Hydrogen and Biogas storage.
5. To provide the insights on super capacitor, Fly wheel and compressed energy storage system.

UNIT– I INTRODUCTION 9

Necessity of energy storage–types of energy storage–comparison of energy storage technologies– Applications.

UNIT– II THERMAL STORAGE SYSTEM 9

Thermal storage–Types–Modelling of thermal storage units–Simple water and rock bed storage system–pressurized water storage system–Modelling of phase change storage system –Simple units, packed bed storage units – Modelling using porous medium approach, Use of TRNSYS.

UNIT–III ELECTRICAL ENERGY STORAGE 9

Fundamental concept of batteries–measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel–Cadmium, Zinc Manganese di oxide and modern batteries for example(i)zinc-Air(ii)Nickel Hydride,(iii)Lithium Battery.

UNIT– IV HYDROGEN AND BIOGAS STORAGE 9

Hydrogen storage options–compressed gas–liquid hydrogen–Metal Hydrides, chemical Storage, Biogas storage-comparisons. Safety and management of hydrogen and Biogas storage- Applications.

UNIT– V ALTERNATE ENERGY STORAGE TECHNOLOGIES 9

Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Identify the energy storage technologies for suitable applications.
2. Analyze the energy storage systems using TRNSYS.
3. Summarise the concepts and types of batteries.
4. Examine the principle of operation of Hydrogen and Biogas storage systems.
5. Explain the working of super capacitor, Flywheel and compressed energy storage systems

REFERENCES:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2010.
2. Viswanathan, Fuel cell principle and applications university press,2006.
3. Luisa F.Cabeza, Advances in Thermal Energy Storage Sy stems: Methods and Applications, Elsevier Wood head Publishing, 2015
4. Robert Huggins, Energy Storage: Fundamentals, Materials andApplications,2nd edition, Springer,2015.
5. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion,,Wileypublications,2012.
6. National Energy Technology Laboratory, U.S. Department of Energy, Fuel Cell Handbook (Seventh Edition).

CO	PO					
	1	2	3	4	5	6
1	2		1	2		
2	2		3	3		
3	2		1	2		
4	2		1	2		
5	2		1	2		
Avg.	2		1.4	2.2		

IC4092	HYBRID AND ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concept of hybrid and electric drive trains.
- To elaborate on the types and utilisation of hybrid and electric drive trains
- To expose on different types of AC and DC drives for electric vehicles.
- To understand and utilise different types of energy storage systems
- To introduce concept of energy management strategies and drive sizing

UNIT I INTRODUCTION 9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II HYBRID ELECTRIC DRIVE TRAINS 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III CONTROL OF AC & DC DRIVES 9

Introduction to electric components used in hybrid and electric vehicles, Configuration and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT IV ENERGY STORAGE 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.

UNIT V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES 9

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification and comparison of energy management strategies, implementation issues.

TOTAL : 45 PERIODS

COURSE OUTCOMES :

On successful completion of this course, the students will be able to:

1. Characterise and configure hybrid drivetrains requirement for a vehicle
2. Design and apply appropriate hybrid and electric drive trains in a vehicle
3. Design and install suitable AC and DC drives for electric vehicles.
4. Arrive at a suitable energy storage system for a hybrid / electric vehicle
5. Apply energy management strategies to ensure better economy and efficiency

REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. MehrdadEhsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998

CO	PO					
	1	2	3	4	5	6
1	-	2	3	-	2	-
2	3	2	3	-	2	2
3	3	2	3	-	2	2
4	2	2	3	-	2	3
5	2	2	3	-	2	3
Avg	2.5	2	3	-	2	2.5

TE4091 ADVANCED POWER PLANT ENGINEERING L T P C

3 0 0 3

COURSE OBJECTIVES:

1. Understand the thermodynamics associated with power plants
2. Detail on the role of various utilities in coal based thermal power plants
3. Acquire know-how on the working of gas turbine and diesel power plants
4. Appreciate the concept of Poly generation for total energy recovery from a system
5. Brief on the working of hydro electric and nuclear power plants

UNIT– I INTRODUCTION 9

Energy scenario: India Vs. World – Load curves and–thermodynamic analysis of Conventional Power Plants (Coal, Gas Turbine and Diesel)-Advanced Power Cycles-Kalina Cycle, IGCC.

UNIT– II COAL BASED THERMAL POWER PLANTS 9

Basics of typical power plant utilities – Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system – steam rate and heat rate – mean temperature of heat addition-Rankine cycle improvements–Superheat, Reheat, Regeneration, Supercritical, AFBC/PFBC – computation of per unit cost of power generation from coal/biomass

UNIT–III GAS TURBINE AND DIESEL POWER PLANTS 9

Brayton cycle – Open and Closed – Improvements – Intercooler, Reheating and Regeneration. Diesel power plant – Layout – Performance analysis and improvement – Techniques for starting, cooling and lubrication of diesel engines-computation of per unit cost of power generation

UNIT– IV CHP AND MHD POWER PLANTS 9

Cogeneration systems–types-heat to power ratio-Thermodynamic performance of steam turbine gas turbine and IC engine-based cogeneration systems–Poly Generation-Binary Cycle-Combined cycle. MHD –Open cycle and closed cycle-Hybrid MHD & steam power plants

UNIT– V HYDRO ELECTRIC & NUCLEAR POWER PLANTS 9

Hydroelectric Power plants – classifications – essential elements – pumped storage systems – micro and mini hydel power plants. General aspects of Nuclear Engineering – Components of nuclear power plants – Nuclear reactors & types – PWR, BWR, CANDU, Gas Cooled, Liquid Metal Cooled and Breeder reactor-nuclear safety–Environmental Issues-Computation of per Unit cost of power generation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Evaluate appropriate power generation technologies for mitigating the energy gap
2. Appraise the steam rate, heat rate and cost for generating electricity from coal based thermal power plants
3. Analyse and suggest measures for improving the performance of gas turbine and diesel power plants
4. Assess the applicability and performance of a cogeneration system
5. Decide a suitable type of hydroelectric/nuclear power plant commensurate with the prevailing conditions

REFERENCES:

1. Nag, P.K., Power Plant Engineering, Tata McGraw Hill Publishing Co Ltd, New Delhi,1998.
2. Haywood, R.W., Analysis of Engineering Cycles,4th Edition, Pergamon Press,Oxford,1991.
3. Wood, A.J., Wollen berg, B.F., Power Generation, operation and control, John Wiley, New York,1984.
4. Gill, A.B., Power Plant Performance, Butter worths,1984.
5. Lamarsh, J.R., Introduction to Nuclear Engg. 2nd edition, Addison-Wesley, 1983.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2		2			
2	2		2	2		1
3	2		2	2		1
4	2		2	2		1
5	2		2	1	2	
Avg.	2		2	1.75	2	1

IC4071 BOUNDARY LAYER THEORY AND TURBULENCE L T P C
3 0 0 3

COURSE OBJECTIVES:

1) To introduce the fundamental concepts of boundary layer in real flows.
2) To distinguish between turbulent and laminar boundary layers.
3) To model turbulent flows using various approaches.
4) To analyse various flow parameters using statistical principles.
5) To introduce the types, characteristics of wall shear flows from free shear flows.

UNIT I FUNDAMENTALS OF BOUNDARY LAYER THEORY 9

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

UNIT II TURBULENT BOUNDARY LAYERS 9

Internal Flows – Couette flow – Two-Layer Structure of the velocity Field – Universal Laws of the wall– Friction law – Fully developed Internal flows – Channel Flow, Couette – Poiseuille flows, Pipe Flow

UNIT III TURBULENCE AND TURBULENCE MODELS 9

Nature of turbulence – Averaging Procedures – Characteristics of Turbulent Flows – Types of Turbulent Flows – Scales of Turbulence, Prandtl's Mixing length, Two-Equation Models, Low – Reynolds Number Models, Large Eddy Simulation

UNIT IV STATISTICAL THEORY OF TURBULENCE 9

Ensemble Average – Isotropic Turbulence and Homogeneous Turbulence – Kinematics of Isotropic Turbulence – Taylor's Hypothesis – Dynamics of Isotropic Turbulence – Grid Turbulence and decay – Turbulence in Stirred Tanks.

UNIT V TURBULENT FLOWS 9

Wall Turbulent shear flows – Structure of wall flow – Turbulence characteristics of Boundary layer – Free Turbulence shear flows – Jets and wakes – Plane and axi-symmetric flows.

TOTAL : 45 PERIODS

COURSE OUTCOMES :

On successful completion of this course, the students will be able to:

1) Analyse flow with the principles of boundary layer theory
2) Distinguish turbulent boundary layer for various types of flows
3) Select and use various turbulence models for the appropriate applications.
4) Apply the statistical theory for averaging various flow parameters.
5) Differentiate the characteristics of wall shear and free shear flows.

CO	PO					
	1	2	3	4	5	6
1	-	-	1	-	2	-
2	2	2	2	1	2	-
3	2	2	2	2	2	-
4	2	2	2	2	2	-
5	2	2	2	2	2	-
Avg	2	2	1.8	1.7	2	-

REFERENCES:

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

TE4011 STEAM GENERATOR TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

- To educate the students on the types of boilers with their constructional and functional significance.
- To understand the working and design of fuel preparation units and boilers.
- To introduce the concept of boiler design, emission aspects.
- To Classify the auxiliary Equipments in design.
- To enumerate the technological design aspect in steam generator

UNIT I BASICS 9

Steam Cycle for Power Generation – Fuel Stoichiometry - Boiler Classification & Components – Specifications - Boiler Heat Balance – Efficiency Estimation (Direct & Indirect) – Sankey Diagram

UNIT II FUELS AND BOILER TYPES 9

Solid Fuel: Coal Preparation – Pulverization – Fuel feeding arrangements, Fuel Oil: Design of oil firing system – components – Air regulators, Types of Boilers – Merits & Limitations – Specialty of Fluid Bed Boilers – Basic design principles (Stoker, Travelling Grate etc).

UNIT III COMPONENTS DESIGN 9

Furnace– Water Wall – Steam Drum – Attemperator - Superheaters – Reheaters – Air Preheaters – Economisers - Steam Turbines: Design Aspects of all these.

UNIT IV AUXILIARY EQUIPMENTS – DESIGN & SIZING 9

Forced Draft & Induced Draft Fans – PA / SA Fans – Water Pumps (Low Pressure & High Pressure) – Cooling Towers – Softener – DM Plant.

UNIT V EMISSION ASPECTS 9

Emission Control – Low NO_x Burners– Boiler Blow Down - Control & Disposal: Feed Water Deaeration & Deoxygenation – Reverse Osmosis - Ash Handling Systems Design – Ash Disposal– Chimney Design to meet Pollution std – Cooling Water Treatment & Disposal.

TOTAL = 45 PERIODS

OUTCOMES

1. Familiarization with Boiler cycles, components and will have specialized knowledge in steam boiler performance evaluation.
2. Emission related aspects in terms of CO_2 NOx emission, mitigation etc will make them to realize the impact of Coal / fuel burning in the society.
3. Familiarization with Boiler cycles, components and in Design.
4. Illustrate a specialized knowledge in steam boiler performance evaluation.
5. Emission related aspects in terms of CO2 NOx emission, mitigation etc will make them to realize the impact of Coal / fuel burning in the society

REFERENCES

1. Blokh A.G.,Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corporation, 2017
2. Carl Schields, Boilers: Type, Characteristics and Functions, McGraw Hill Publishers, 1982.
3. David Gunn and Robert Horton, Industrial Boilers, Longman Scientific and Technical Publication, 1986.
4. Ganapathy V., Industrial Boilers and Heat Recovery Steam Generators, Marcel Dekker Ink, 2003. 5. Howard J.R., Fluidized Bed Technology: Principles and Applications, Adam Hilger, NewYork, 1983.
6. Mosoon Kwauk, Fluidization Idealized and Bubbleless, with Applications, Science Press, 1992.
7. PrabirBasu, Cen Kefa and Louis Jestin, Boilers and Burners: Design and Theory, Springer, 2000.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	2	-	-	-	-
2	2	-	-	-	-	-
3	1	-	-	-	-	-
4	-	-	-	1	2	-
5	-	-	1	-	2	-
Avg.	0.8	0.4	0.2	0.2	0.8	-

EY4093 FLUIDIZED BED SYSTEMS

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

COURSE OBJECTIVES:

1. To understand the behavior of fluidized beds
2. To learn about the heat transfer process
3. To differentiate the combustion and gasification, and appreciate the relative merits
4. To design components of fluidized bed systems
5. To understand the industrial applications of fluidized bed systems

UNIT– I FLUIDIZED BED BEHAVIOUR **9**

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

Different modes of heat transfer in fluidized bed– 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

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

UNIT– IV DESIGN CONSIDERATIONS

Design of distributors–stoichiometric calculations–heat and mass balance–furnace design–design of heating surfaces–gas solid separators.

UNIT– V INDUSTRIAL APPLICATIONS

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.

TOTAL:45PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

1. Illustrate the behavior of fluidized bed particles and explain the theory of fluidization.
2. Analyze the heat transfer process in fluidized beds
3. Apply concepts of combustion and gasification in fluidized beds
4. Interpret the design consideration for components of fluidized bed system.
5. Evaluate fluidized bed systems for various industrial applications.

REFERENCES:

1. Howard,J.R.,FluidizedBedTechnology:PrinciplesandApplications,AdamHilger,NewYork,1983.
2. Geldart, D., Gas Fluidization Technology, John Willey and Sons, 1986.
3. Kunii,D and Levespiel,O., Fluidization Engineering, John Wiley and Son Inc, New York,1969.
4. Howard,J.R.(Ed), Fluidized Beds: Combustion and Applications, Applied Science Publishers, New York, 1983.
5. Botteril,J.S.M., Fluid Bed Heat Transfer, Academic Press, London,1975.

CO	PO					
	1	2	3	4	5	6
1	3		2	3		
2	3		3	3		
3	3		2	3	2	2
4	3		3	3	2	2
5	3		2	3	2	2
Avg.	3		2.4	3	2	2

TE4012 **ENERGY EFFICIENT BUILDINGS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To learn the green buildings concepts applicable to alternate design
2. To be familiar with basic terminologies related to buildings
3. To learn the building (air) conditioning techniques
4. To know the methods to evaluate the performance of buildings
5. To incorporate Renewable energy systems in buildings

UNIT I INTRODUCTION **9**

Climate and Building, Historical perspective, Aspects of green building design – Sustainable Site, Water, Energy, Materials and IAQ, ECBC Standards

UNIT II LANDSCAPE AND BUILDING ENVELOPES **9**

Energy efficient Landscape design – Microclimate, Shading, Arbors, Windbreaks, Xeriscaping, Building envelope – Thermal comfort, Psychrometry, Comfort indices, Thermal Properties of Building Materials – Thermal Resistance, Thermal Time Constant (TTC), Diurnal Heat Capacity (DHC), Thermal Lag, Decrement Factor, Effect of Solar Radiation – Sol-air Temperature, Processes of heat exchange of building with environment, Insulation

UNIT III PASSIVE HEATING AND COOLING **9**

HVAC introduction, Passive Heating – Solar radiation basics, Sun Path Diagram, Direct Heating, Indirect Heating and Isolated heating, Concept of Daylighting, Passive Cooling – Natural Ventilation (Stack and Wind), Evaporative Cooling and Radiative Cooling.

UNIT IV THERMAL PERFORMANCE OF BUILDINGS **9**

Heat transfer due to fenestration/infiltration, Calculation of Overall Thermal Transmittance, Estimation of building loads: Steady state method, network method, numerical method, correlations, Thermal Storage integration in buildings

UNIT V RENEWABLE ENERGY IN BUILDINGS **9**

Introduction of renewable sources in buildings, BIPV, Solar water heating, small wind turbines, standalone PV systems, Hybrid system – Economics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the students:

1. Will be familiar with climate responsive building design and basic concepts
2. Will Know the basic terminologies related to buildings
3. Will Know the passive (air) conditioning techniques
4. Will be able to evaluate the performance of buildings 5. Gets acquainted with Renewable energy systems in buildings

REFERENCES:

1. ASHRAE Handbook -2009 - Fundamentals.
2. Baruch Givoni: Climate considerations in building and Urban Design, John Wiley & Sons, 1998
3. Baruch Givoni: Passive Low Energy Cooling of Buildings by, John Wiley & Sons, 15-Jul-1994
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
5. Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press, 28-Dec-2009.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	1	2	-	1
2	-	1	1	2	-	1
3	-	-	2	3	-	1
4	-	-	2	2	-	3
5	1	-	2	1	-	3
Avg.	0.8	0.6	1.6	2	-	1.8

IC4091 ENGINE POLLUTION AND CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES

1. To provide an insight about effect of engine out emissions on human health and environment
2. To impart the knowledge on various pollutant species formations in SI and CI engine
3. To divulge about various emission measurement techniques in engines and its significance
4. To provide a discernment about various emission control methods
5. To impart the knowledge about international and national driving cycles and emission standards

UNIT I AIR POLLUTION – ENGINES 9

Atmospheric pollution from automotive, stationary engines and gas turbines, Global warming – Greenhouse effect, Effects of engine pollution on human health and environment.

UNIT II POLLUTANT FORMATION 9

Formation of Oxides of nitrogen, Carbon monoxide, Hydrocarbon, Aldehydes, Smoke and Particulate matter emissions. Effects of Engine design and operating variables on emission formation, Noise pollution.

UNIT III EMISSION MEASUREMENT TECHNIQUES 9

CO, CO2 - Non dispersive infrared gas analyzer, NOx - Chemiluminescent analyzer, HC - Flame ionization detector, Smoke – Opacity and filter paper measurements, Particulate Matter – Full flow and Partial flow dilution tunnel, Gas chromatography, Noise measurement.

UNIT IV EMISSION CONTROL T*E*CHNIQUES 9

Engine design modifications, Fuel modification, Evaporative emission control, EGR, Air injection, Thermal reactors, Water injection, Common rail direct injection and Gasoline direct injection system, After treatment systems - Catalytic converters, Diesel oxidation catalyst, Particulate traps, De-NOx catalysts, SCR systems. Low temperature combustion concepts

UNIT V DRIVING CYCLES AND EMISSION STANDARDS 9

Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students will be able to

1. Understand about atmospheric pollution from engines and its impact on human health and environment.
2. Understand the formation of emissions in both SI and CI engines.
3. Understand the various measurement techniques used globally for the measurement of automotive and stationary engine out emissions.
4. Learn the various control methods/techniques used in IC engine to control the engine out emissions
5. Learn the transient and steady state driving cycles performed on automotive and stationary engines and emission standards that are followed in the national and international level.

TEXT BOOKS:

1. Ganesan V., “Internal Combustion Engines”, V Edition, Tata McGraw Hill, 2012.
2. John. B. Heywood, “Internal Combustion engine fundamentals” McGraw – Hill, 1988.

REFERENCES:

1. Crouse William, Automotive Emission Control, Gregg Division /McGraw-Hill,1980
2. Ernest, S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 1980.
3. George Springer and Donald J Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum press, 2013
4. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational Publishers, Third Edition, 1973.
5. Pundir B. P., “IC Engines Combustion and Emission” Narosa publishing house, 2010.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	1	1	-	1	1	3
2	1	-	-	1	1	2
3	1	-	-	-	2	-
4	1	-	-	1	2	1
5	1	-	-	1	2	-
Avg.	1	0.2	-	0.8	1.6	1.2

TE4013 SOLAR THERMAL TECHNOLOGIES L T P C
3 0 0 3

OBJECTIVES:

1. To clarify impression of various solar thermal energy collectors
2. To delineate the other applications and the devices used to collect solar energy 3. To study the various types and configurations of solar space conditioning system
4. To learn the various solar applications.
5. To summarize the basic economics of solar energy collection system.

UNIT – I SOLAR COLLECTORS 9

Collectors: Flat plate: Water, Air - Evacuated tube – Concentrated – Construction – Function - Suitability – Comparison – Design of Storage Tank - Solar Fluids.

UNIT – II SOLAR WATER HEATING SYSTEMS 9

Integral Collector Storage System - Thermosyphon System - Open Loop, Drain Down, Drain Back, Antifreeze Systems - Refrigerant Solar Water Heaters - Solar Heated Pools - Solar Heated Hot Tubs and Spas.

UNIT – III SOLAR SPACE CONDITIONING SYSTEMS 9

Liquid Type Solar Heating System With / Without Storage - Heat Storage Configurations – Heat Delivery Methods - Air-Type Solar Heating Systems - Solar Refrigeration and Air Conditioning.

UNIT – IV OTHER SOLAR APPLICATIONS 9

Solar Cooking – Distillation - Desalination - Solar Ponds – Solar Passive Architecture – Solar Drying – Solar Chimney.

UNIT – V SOLAR ECONOMICS 9

Application of economic methods to analyze the feasibility of solar systems to decide project / policy alternatives - Net energy analysis - and cost requirements for active and passive heating and cooling - for electric power generation - and for industrial process-heating. Economics – Fixed and variable cost - Payback period - Net Present Value - Internal Rate of Return - Carbon credit – Embodied energy analysis.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students will be able to:

1. Explain the technical and physical principles of different solar collectors
2. Measure and evaluate different solar energy technologies through knowledge of the physical function of the devices
3. Articulate the technical and economic fundamentals of solar thermal energy conversion useful to society and industry
4. Describe the spectrum of possible solar thermal technologies to assist industrial processing or power production
5. Communicate technological and socio-economic issues around solar energy in a concise and an accessible way to a target group with basic technical skills.

REFERENCES:

1. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process - 4 th Edition (2013), John Wiley and Sons, New York, ISBN: 978-0-470-87366-3, Solar Energy Laboratory, University of Wisconsin-Madison, pp. 944.
2. H P Garg, M Dayal, G Furlan, Physics and Technology of Solar Energy- Volume I: Solar Thermal Applications, Springer, 2007.

3. Sukhatme S.P. J K Nayak, Solar Energy, Tata McGraw Hills P Co., ISBN: 9789352607112, 4th Edition, 2017, pp. 568.
4. Charles Christopher Newton - Concentrated Solar Thermal Energy- Published by VDM Verlag, 2008.
5. H.P.Garg, S.C.Mullick, A.K.Bhargava, D.Reidal, Solar Thermal Energy Storage Springer, 2005

Mapping of CO with PO

CO	PC					
	1	**2**	**3**	**4**	**5**	**6**
1	1	-	1	-	1	1
2	1	2	-	-	2	-
3	-	-	-	-	1	-
4	-	-	-	-	3	-
5	-	-	3	-	-	-
Avg.	0.4	0.4	0.5	-	1.4	0.2

AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING **L T P C**
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING **6**

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

UNIT II PRESENTATION SKILLS **6**

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

UNIT III TITLE WRITING SKILLS **6**

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, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

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 V VERIFICATION SKILLS 6

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

TOTAL: 30 PERIODS

COURSE OUTCOMES

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 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

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

AX4092 DISASTER MANAGEMENT L T P C
2 0 0 0

COURSE OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

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 6

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 6

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 6

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 6

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

TOTAL : 30 PERIODS

COURSE OUTCOMES

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi, 2001.

PROGRESS THROUGH KNOWLEDGE

AX4093 CONSTITUTION OF INDIA L T P C
2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.

- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

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

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

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: 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

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

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- 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.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

- The Constitution of India,1950(Bare Act),Government Publication.
- Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX4094 **நற்றமிழ் இலக்கியம்** **L T P C**
2 0 0 0

UNIT I சங்க இலக்கியம் **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
   – எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
   - இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
   - போரை நிறுத்திய ஔவையார்

UNIT II அறநெறித் தமிழ் **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
   அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புரவறிதல் அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   – ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

UNIT III இரட்டைக் காப்பியங்கள் **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

UNIT IV அருள்நெறித் தமிழ் **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு

- சிறுவனே வள்ளலானான்

6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

UNIT V நவீன தமிழ் இலக்கியம் 6

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
   4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

<u>தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்</u>

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org
   2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   -https://ta.wikipedia.org
3. தர்மபுர ஆதீன வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்