PROGRAM CURRICULUM

THERMAL ENGINEERING

for

M. TECH. TWO YEAR DEGREE PROGRAM

(Applicable for the batches admitted from A.Y 2024-25)

ADITYA UNIVERSITY

Aditya Nagar, ADB Road, Surampalem - 533 437

VISION & MISSION OF THE UNIVERSITY

VISION :

Aditya University aspires to be a globally recognised academic institution dedicated to quality education, cutting-edge research, and technological service to our country, and envisions itself as a beacon of holistic advancement and long-term impact, remaining dynamic in the ever-changing worlds of society, ecology, and economics..

MISSION:

- Aditya University pushes boundaries to design high-quality curricula and to provide students with a vibrant and relevant education that prepares them for a changing world. Our industry insights and creative teaching methods attempt to equip our students to be lifelong learners.
- Aditya University's learning environment encourages intellectual curiosity, critical thinking, and cooperation, with the goal of providing students with an immersive education that fosters creativity and innovation. Our cutting-edge facilities, interactive classrooms, and supportive faculty aim to motivate students to realise their full potential and contribute to society.
- Aditya University promotes cross-disciplinary inquiry and discovery and leads cutting-edge research and innovation. Through strategic partnerships, research grants, and a dedicated faculty, we aim to advance science, technology, and social sciences and empower students and faculty to conduct transformative research that solves real-world problems and elevates our institution globally.
- Aditya University is committed to producing world-changing business leaders and entrepreneurs through its emphasis on entrepreneurship, mentoring, and business incubation programmes.

VISION MISSION OF THE DEPARTMENT

VISION:

To be a preferred knowledge hub in Mechanical Engineering towards critical thinking, quality research and innovation.

MISSION:

M1: Provide infrastructure for design and development of modern-day solutions.
M2: Impart leadership & interpersonal skills towards critical thinking and innovation.
M3: Collaborate with industry, academia, & R&D organizations for excellence in teaching, Research and consultancy services.

PROGRAM OUTCOMES (POs)

After successful completion of the program, the graduates will be able to

PO 1	Independently carry out research /investigation and development work to solve practical problems
PO 2	Write and present a substantial technical report/document
PO 3	Demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.
PO 4	Learn, keep up with contemporary technologies and ways of working.
PO 5	Communicate effectively as an individual or a team leader in diverse and multidisciplinary groups.
PO 6	Use the principles of project management such as scheduling, work breakdown structure and be conversant with the principles of finance for profitable project management.

PROGRAM SPECIFIC OUTCOMES (PSO's)

After successful completion of the program, the graduates will be able to

PSO 1	Demonstrate the essential skills towards design, synthesis and analysis of thermal engineering systems through the detailed project reports.
PSO 2	Apply thermal engineering knowledge in multi-disciplinary areas for sustainable solutions.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

After successful completion of the program, the graduates will be able to

PEO 1	Choose Professional Career with a solid foundation in mathematics, Science and engineering
PEO 2	Solve real time engineering problems using professional knowledge and skills resulting in significant societal development.
PEO 3	Demonstrate multidisciplinary skills to analyze engineering issues in a broader perspective with ethical responsibility towards sustainable development.
PEO 4	Adapt interpersonal skills, leadership and team building to achieve their career goals and pursue lifelong learning and higher education necessary for successful profession.

ADITYA UNIVERSITY

Department of Mechanical Engineering

Master of Technology in Thermal Engineering

Program Curriculum - 2024

Credit Division:

S.No	Broad Category of Course	Credits
1	Program Core Courses (PCC)	30
2	Program Elective Courses (PEC)	15
3	University Elective Courses (UEC)	03
4	Summer Internship (SI)	02
5	Technical Paper Publication (TPP)	02
6	Project Part- I & II (PROJ)	28
7	Audit Courses (AUC)	0
	Total Credits	**80**

Program Core Courses (PCC):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242ME001	Advanced Thermodynamics	4	0	1	5	50	50	100	-
242ME002	Advanced Heat and Mass Transfer	4	0	1	5	50	50	100	AT
242ME003	Advanced Fluid Mechanics	3	0	0	3	50	50	100	-
242ME004	Computational Fluid Dynamics	3	0	2	5	50	50	100	AFM
242ME005	Design and Optimization of Thermal Systems	3	0	0	3	50	50	100	-
242ME006	Energy Systems and Management	3	0	0	3	50	50	100	-
242ME007	Fuels Combustion and Emission Control	3	0	0	3	50	50	100	-
242ME008	Advanced Power Plant Engineering	3	0	0	3	50	50	100	AT
	Total	**26**	**0**	**04**	**30**				

Program Elective Courses (PEC):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242ME009	Measurements in Thermal Engineering	3	0	0	3	50	50	100	AT
242ME010	Gas Turbines and Jet Propulsion	3	0	0	3	50	50	100	AT
242ME011	Energy Conservation and Waste Heat Recovery	3	0	0	3	50	50	100	AT
242ME012	Heating, Ventilation and Air-Conditioning	3	0	0	3	50	50	100	-
242ME013	Convective Heat Transfer	3	0	0	3	50	50	100	AHMT
242ME014	Renewable Sources of Energy	3	0	0	3	50	50	100	-
242ME015	Design of Heat Exchangers	3	0	0	3	50	50	100	AHMT
242ME016	Combustion, Emissions and Environment	3	0	0	3	50	50	100	FCEC
242ME017	Alternative Fuels	3	0	0	3	50	50	100	FCEC
242ME018	Cryogenic Engineering	3	0	0	3	50	50	100	-
242ME019	Solar Energy Technologies	3	0	0	3	50	50	100	-
242ME020	Advanced Fuel Cell Technologies	3	0	0	3	50	50	100	FCEC
242ME021	Advanced I.C. Engines	3	0	0	3	50	50	100	AT
242ME022	Optimization Techniques and Applications	3	0	0	3	50	50	100	-
242ME023	Finite Element Method in Heat Transfer Analysis	3	0	0	3	50	50	100	CFD
	Total	**24**	**02**	**04**	**30**				

University Elective Courses (UEC):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Offered to PG Program
242CE028	Metro Rail Transportation Design and Construction (L&T EduTech)**	3	0	0	3	50	50	100	All, except SE
242CE029	Building Information Modeling in Architecture, Engineering and Construction (L&T EduTech)**	3	0	0	3	50	50	100	All, except SE
242CE030	Basic Concrete Technology	3	0	0	3	50	50	100	All, except SE
242CE031	Repair and Rehabilitation of Structures	3	0	0	3	50	50	100	All, except SE
242EE028	Neural Networks and Fuzzy Logic	3	0	0	3	50	50	100	All, except PED
242EE029	Hybrid Electric Vehicles	3	0	0	3	50	50	100	All, except PED
242EE030	Electrical Power Distribution and Automation (L&T EduTech)**	3	0	0	3	50	50	100	All, except PED
242EE031	Renewable Energy & Power Evacuation (L&T EduTech)**	3	0	0	3	50	50	100	All, except PED
242ME028	Design of fire and life safety systems(L&T EduTech)**	3	0	0	3	50	50	100	All, except TE
242ME029	Green Engineering Systems	3	0	0	3	50	50	100	All, except TE
242ME030	IC Engines	3	0	0	3	50	50	100	All, except TE
242EC028	CAD Tools for VLSI Design	3	0	0	3	50	50	100	All, except VLSID
242EC029	FPGA Design for Embedded Systems	3	0	0	3	50	50	100	All, except VLSID
242CS030	Artificial Intelligence	3	0	0	3	50	50	100	All, except CSE
242CS031	Machine Learning Techniques	3	0	0	3	50	50	100	All, except CSE
	Total	**24**	**02**	**04**	**30**				

** The syllabus for the industry partner courses will be released in the department as and when required

Summer Internship (SI):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242ME024	Summer Internship	0	0	2	2	100	-	100	-

Technical Paper Publication (TPP):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242ME025	Technical Paper Publication	0	0	2	2	100	-	100	-

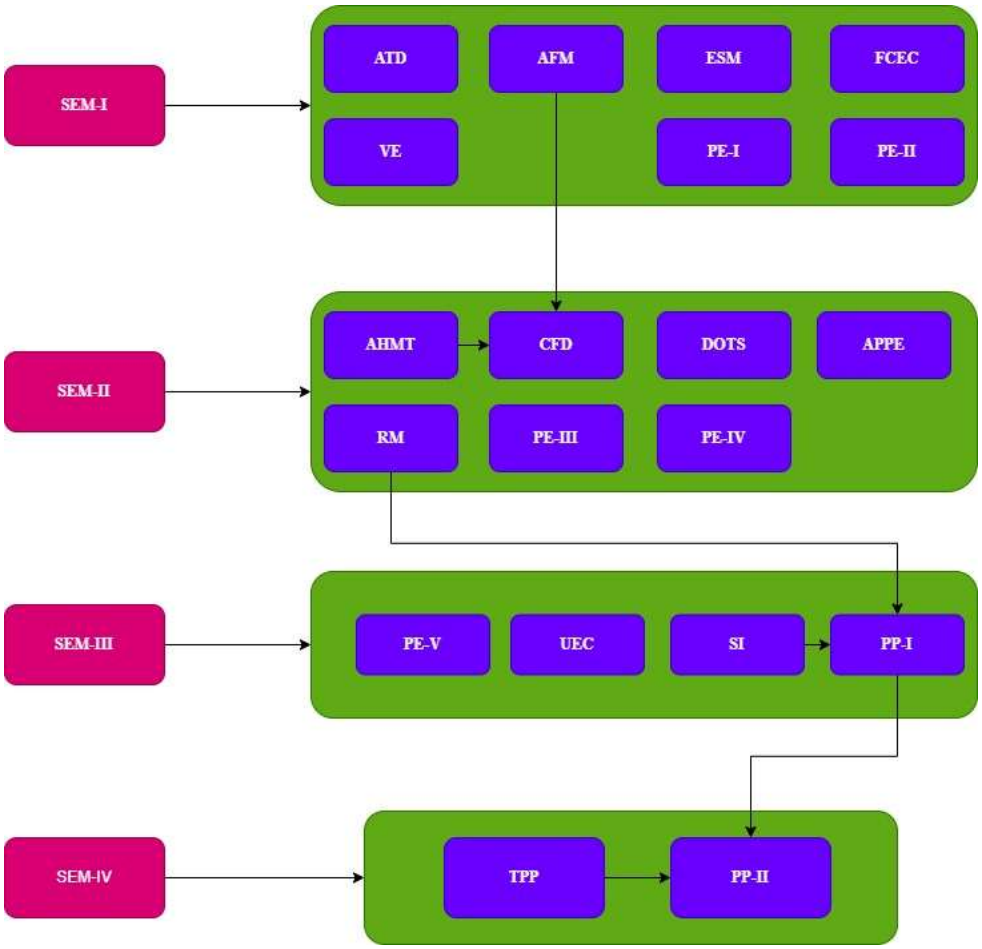
Project (PROJ):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242ME026	Project part-I	0	0	10	10	100	-	100	-
242ME027	Project part-II	0	0	18	18	50	50	100	-

Audit Courses (AUC):

Course Code	Course Title	L	T	P	C	CIE	SEE	Total	Pre-requisite
242AC001	Value Education	2	0	0	0	100	-	100	-
242AC002	Research Methodology	2	0	0	0	100	-	100	-

2024 M.Tech (TE) CURRICULAM
PRE-REQUISITE FLOW CHART



S.No	Course name	
1	ATD	Advanced Thermodynamics
2	AFM	Advanced Fluid Mechanics
3	ESM	Energy System Management
4	FCEC	Fuels Combustion and Emission Control
5	VE	Value Education
6	AH&MT	Advanced Heat and Mass Transfer
7	CFD	Computational Fluid Dynamics
8	DOTS	Design and Optimization of Thermal Systems
9	APPE	Advanced Power Plant Engineering

S.No	Course name	
10	RM	Research Methodology
11	UEC	University Elective Course
12	SI	Summer Internship
13	PP-I	Project Part-I
14	PP-II	Project Part-II with full time Internship
15	TPP	Technical Paper Publication
16	PE-I	Program Elective Course -I
17	PE-II	Program Elective Course -II
18	PE-III	Program Elective Course -III
19	PE-IV	Program Elective Course -IV
20	PE-V	Program Elective Course -V

Suggestive Semester wise Curriculum

I Semester

Course Code	Course Title	Course Category	Credits				Total Hours
			L	T	P	C	
242ME001	Advanced Thermodynamics	PCC	4	0	1	5	5
242ME003	Advanced Fluid Mechanics	PCC	3	0	0	3	3
242ME006	Energy Systems and Management	PCC	3	0	0	3	3
242ME007	Fuels Combustion and Emission Control	PCC	3	0	0	3	3
-----	Program Elective Courses-I	PEC	3	0	0	3	3
-----	Program Elective Courses-II	PEC	3	0	0	3	3
242AC001	Value Education	AUC	2	0	0	0	2
Total			**21**	**0**	**1**	**20**	**22**

II Semester

Course Code	Course Title	Course Category	Credits				Total Hours
			L	T	P	C	
242ME002	Advanced Heat and Mass Transfer	PCC	4	0	1	5	5
242ME004	Computational Fluid Dynamics	PCC	3	0	2	5	5
242ME005	Design and Optimization of Thermal Systems	PCC	3	0	0	3	3
242ME008	Advanced Power Plant Engineering	PCC	3	0	0	3	3
-----	Program Elective Courses-III	PEC	3	0	0	3	3
-----	Program Elective Courses-IV	PEC	3	0	0	3	3
242AC002	Research Methodology	AUC	2	0	0	0	2
Total			**21**	**0**	**3**	**22**	**24**

III Semester

Course Code	Course Title	Course Category	Credits				Total Hours
			L	T	P	C	
----	Professional Elective – V	PEC	3	0	0	3	3
----	University Elective Course	UEC	3	0	0	3	3
242ME024	Summer Internship	SI	0	0	2	2	-
242ME026	Project Part-I	PROJ	0	0	10	10	20
Total			**6**	**0**	**12**	**18**	**24**

IV Semester

Course Code	Course Title	Course Category	Credits				Total Hours
			L	T	P	C	
242ME025	Technical Paper Publication	TPP	0	0	2	2	4
242ME027	Project Part -II	PROJ	0	0	18	18	36
Total					**20**	**20**	**40**

Program Elective Course –I		
S.No	**Course code**	**Course name**
1	242ME009	Measurements in Thermal Engineering
2	242ME012	Heating, Ventilation and Air-Conditioning
3	242ME016	Combustion, Emissions and Environment

Program Elective Course -II		
S.No	**Course code**	**Course name**
1	242ME014	Renewable Sources of Energy
2	242ME017	Alternative Fuels
3	242ME018	Cryogenic Engineering

Program Elective Course -III		
S.No	**Course code**	**Course name**
1	242ME010	Gas Turbines and Jet Propulsion
2	242ME011	Energy Conservation and Waste Heat Recovery
3	242ME015	Design of Heat Exchangers

Program Elective Course -IV		
S.No	**Course code**	**Course name**
1	242ME013	Convective Heat Transfer
2	242ME019	Solar Energy Technologies
3	242ME021	Advanced I.C. Engines

Program Elective Course -V		
S.No	**Course code**	**Course name**
1	242ME020	Advanced Fuel Cell Technologies
2	242ME022	Optimization Techniques and Applications
3	242ME023	Finite Element Method in Heat Transfer Analysis

ADVANCED THERMODYNAMICS

Course Code: 242ME001	L	T	P	C
	4	0	1	4

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyse Entropy balance and Exergy balance.
- **CO2:** Apply thermodynamic property relations to analyze entropy, energy changes, and thermodynamic potentials
- **CO3:** Analyse the Availability of simple thermodynamic cycles and chemical availability.
- **CO4:** Analyse the Real Gases and Mixtures.
- **CO5:** Analyse the concept of Thermo-chemistry.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	-	-	-	-
CO2:	3	2	-	-	-	-
CO3:	3	2	-	-	-	-
CO4:	3	2	-	-	-	-
CO5:	3	2	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Review of I and II Laws of Thermodynamics: Transient flow analysis, entropy balance, entropy generation.

Exergy Analysis: Concepts, exergy balance, exergy transfer, exergetic efficiency, exergy analysis of power and refrigeration cycles.

Practices:

1. Heat Balance sheet, Volumetric Efficiency and air fuel ratio estimation of an I.C. Engine.
2. Performance test and analysis of exhaust gases of an I.C. Engine

UNIT – II

Thermodynamic property relations

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

Practice:

1. Evaluation of Performance of a Nozzle and Determination of Nozzle Pressure Distribution

UNIT – III

Availability Analysis

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.

Practice:

1. Simulation of Flow Network and Performance Evaluation of Rankine Cycle with Reheat and Regeneration

UNIT – IV

Real Gases and Mixtures: Equations of state, thermodynamic property relations, residual property functions, properties of saturation states.

Thermodynamic Properties of Homogeneous Mixtures: Partial molal properties, chemical potential, fugacity and fugacity coefficient, fugacity relations for real gas mixtures, ideal solutions, phase equilibrium, Rault's law.

Practice:

1. Simulation of Flow and Thermal Networks and Performance Evaluation of a Boiler along with Boiler, Economizer, Super heater and Reheater

UNIT – V

Thermo Chemistry

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 Kp & Kf, Equilibrium composition evaluation of ideal gas and real gas mixtures.

Practice:

1. Simulation of Flow Network and Performance Evaluation of Brayton Cycle with Inter cooling and reheat

Text Books:

1 Advanced Thermodynamics, S.S. Thipse, Narosa Publishing Home Pvt. Ltd., ISBN 978-8184872446

2 Advanced Thermodynamics Engineering, K.Annamalai, I.K.Puri, M.A.Jog, CRC Press,Second Edition. ISBN 0-8493-2553-6

Reference Books:

1 Thermodynamics, Yunus A. Cengel and Michael A. Boles, McGraw-Hill Inc. ISBN-10, 0070119279

2 Advanced Thermodynamics for Engineers, Kenneth Wark., J.R, McGraw-Hill Inc. ISBN-10. 0070682925

Web Links:

1 https://archive.nptel.ac.in/courses/112/103/112103016

2 http://www.rmki.kfki.hu/~vpet/AdvThd/adv_thermo_lnp1.pdf

3 https://www.cdeep.iitb.ac.in/slides/A15/ME661/ME661-L1.pdf

ADVANCED HEAT AND MASS TRANSFER

Course Code: 242ME002	L	T	P	C
	4	0	1	5

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Apply Fourier's law to solve problems on conductive heat transfer in different materials and geometries.
- **CO2:** Apply methods to solve transient and steady-state heat conduction problems.
- **CO3:** Analyze convective heat transfer in forced and free convection
- **CO4:** Analyse the various types of Boiling and Condensation principle.
- **CO5:** Apply the radiation heat transfer priciple for enclosure analysis

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	-	-	-	-
CO2:	3	2	-	-	-	-
CO3:	3	2	-	-	-	-
CO4:	3	2	-	-	-	-
CO5:	3	2	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Conductive Heat Transfer: Fourier's law, thermal conductivity of matter, heat diffusion equation for isotropic and anisotropic media, boundary and initial conditions; One-dimensional steady-state conduction through plane wall, cylinder and sphere, conduction with thermal energy generation, heat transfer from extended surfaces, radial fins and fin optimization.

Practice:

1. Composite Slab Apparatus: Determination of theoretical end experimental values of equivalent thermal resistance of a composites lab.

UNIT – II

Transient Heat Conduction: Lumped heat capacity system, Infinite plate of finite thickness and Semi-infinite Solid, Heisler and Grober charts for Transient Conduction.

Steady- State Two-Dimensional Heat Conduction: Governing equations and solutions, Use of Bessel's functions. numerical solution of conduction problems: FDM and FEM methods.

Practice:

1. Heat Pipe Demonstrator: Demonstration of near isothermal characteristic exhibited by a heat pipe in comparison to stainless steel and copper pipes

UNIT – III

Convective Heat Transfer:

Forced Convection: Conservation equations, Integral and analytical solutions, Boundary layer analogies, Internal and external flows, Laminar and turbulent flows, Empirical relations, cooling of electronic equipment.

Free Convection: Governing equations, Laminar and turbulent flows, Analytical and empirical solutions. Combined free and forced convection, Combined convection and radiation.

Practices:

1. Natural Convection Apparatus: Determination of experimental and empirical values of convection heat transfer coefficient from a Vertical Heated Cylinder losing heat to quiescent air.
2. Forced Convection Apparatus: Determination of theoretical, experimental and empirical values of convection heat transfer coefficient for internal forced convection through a circular GIpipe.

UNIT – IV

Heat Transfer with Phase Change:

Boiling: Boiling mode, Pool boiling and flow boiling. Condensation**:** Film condensation and dropwise condensation.

Radiation heat transfer: Blackbody radiation, laws of thermal radiations, gray surface; Radiation intensity and its relation to emission, View factors and Radiation exchange between gray and non-gray surfaces. Gas Radiation: Radiation transfer in enclosures containing absorbing and emitting media-interaction of radiation with conduction and convection.

Practice:

1. Performance evaluation of Shell and Tube heat exchanger.
2. Emissivity Apparatus: Determination of surface emissivity of a given aluminium test plate at a given absolute temperature

UNIT – V

Mass Transfer: Fick's law of diffusion, Analogy between heat transfer and mass transfer - Conceptual similarities and differences, Dimensionless numbers: Prandtl number, Schmidt number. Mass diffusion - Mechanisms and types of diffusion, Estimation and measurement of diffusion coefficients, Practical examples in porous media and membrane processes and mass convection.

Textbooks:

1 Heat and Mass Transfer: Fundamentals and Applications, Yunus A. Çengel and Afshin Jahanshahi Ghajar, McGraw-Hill Education, 2020, 6th Edition ISBN, 0073398195

2 Fundamentals of Heat and Mass Transfer, Incropera, F. P. and De Witt, D. P., 5th Edition, Wiley, Indian Edition, 2018. ISBN-10. 0471386502

Reference Books:

1 Convective Heat and Mass Transfer, Ghiaasiaan, S.M., Cambridge, ISBN 10: 0815361416

2 Convective Heat and Mass Transfer, Kays, W. M. and Crawford, M. E., Tata McGraw Hill, 4th Edition. ISBN-13. 978-1259025624

Web Links:

1 https://nptel.ac.in/courses/103101137

2 https://www.edx.org/learn/engineering/delft-university-of-technology-the-basics-of-transport-phenomena

ADVANCED FLUID MECHANICS

Course Code: 242ME003	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Apply fundamental fluid mechanics concepts and equations to analyze fluid motion and behavior.
- **CO2:** Apply Navier-Stokes equations to analyze and solve problems in different types of incompressible viscous flow.
- **CO3:** Evaluate boundary layer characteristics and related parameters in fluid flow
- **CO4:** Analyze turbulent flow and its effects on drag and lift
- **CO5:** Apply concepts of compressible flow to solve problems involving shock waves, expansion waves, and nozzle flows.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	3	1	-	-	-
CO2:	2	3	-	-	-	-
CO3:	2	3	-	-	-	-
CO4:	2	3	2	-	-	-
CO5:	2	3	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Introduction:

Concept of continuum and definition of fluid, Body and surface forces, Scalar and vector field, Eulerian and Lagrangian description of fluid motion, Motion of fluid element-translation, rotation and deformation, Types of fluid flows, Differential forms of the basic laws conservation of mass, Reynolds transport equation, Condition for in actionality, circulation & vorticity, Continuity equation, Cauchy's equations of motion, Bernoulli's equation, Derivation of Navier-Stokes equations for compressible flow.

UNIT – II

General incompressible viscous flow, Navier-Stokes equation for incompressible flow, Parallel steady laminar flow problems – flow between infinite parallel plates, flow in pipes, Plane Poiseuille flow and Couette flow, Couette flow with and without pressure gradient, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Blasius solution. Stokes first and second problems, flow near a rotating disk, Flow in convergent-divergent channels.

UNIT – III

Boundary Layer Concepts: Boundary layer analysis, Derivation of boundary layer equations, Displacement thickness, Momentum thickness, Boundary layer thickness, Von Karman momentum integral equation for laminar boundary layer expressions for local and mean drag coefficients.

UNIT – IV

Turbulent Flow: Fundamental concept of turbulence time averaged equation, Turbulent flat plate boundary layer, Boundary layers with pressure gradients, Prandtl mixing length model, Universal velocity distribution law, Van Driest model approximate solutions for drag coefficients, More refined turbulence models k-Epsilon model, Boundary layer separation, Drag and lift, Drag coefficients of common geometries. Parallel flow over flat plates, Flow over cylinders and spheres, Lift on circular cylinders.

UNIT – V

Compressible Flows: Speed of sound and Mach number, Stagnation properties, Basic equations for one dimensional flows, Isentropic relations, Isentropic flow through nozzles, Normal-shock wave, Rankine-Hugoniot relations, Fanno and Rayleigh curve, Mach waves, Oblique shock wave, Prandtl-Meyer expansion waves, Quasi-one dimensional flows, Compressible viscous flows, Compressible boundary layers.

Text Books:

1. Fluid Mechanics, Fox and McDonald, John Wiley, 8th edition. ISBN-10. 9780470547557
2. Fluid Mechanics, F M White, McGraw Hill Education India Private Limited; 8th edition. ISBN-10. 9385965492

Reference Books:

1. Fluid Mechanics: Fundamentals and Applications, Cengel Y. A. and Cimbala J. M John, McGraw-Hill; 4th edition, 2019. ISBN-10. 9353166217
2. Hydraulics and Fluid Mechanics Including Hydraulics Machines, Dr. P.N. MODI & S.M. SETH, Standard Book House, 22nd edition, 2019 ISBN-13: 9788189401269
3. Incompressible Flow, Panton R. L, Wiley India, 4th Edition. ISBN-13: 978-1118013434

Web Links:

1. https://archive.nptel.ac.in/courses/112/105/112105182/
2. https://nptel.ac.in/courses/112/105/112105183/
3. https://ocw.mit.edu/courses/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/resources/learningobjectives

COMPUTATIONAL FLUID DYNAMICS

Course Code: 242ME004	L	T	P	C
	3	0	2	5

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Analyse the basics of computational fluid dynamics (CFD).
CO2: Analyse the concepts of PDEs, their application to CFD problems and fundamentals of discretization.
CO3: Analyse the concept of Finite Difference Method.
CO4: Solve the problem related to Finite Different Method.
CO5: Solve the problem related to Finite Volume Method.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	2	-	-	-
CO2:	3	2	2	-	-	-
CO3:	3	2	1	-	-	-
CO4:	3	2	1	-	-	-
CO5:	3	2	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Introduction: Role of CFD and its applications, future of CFD. Introduction to heat transfer, Compressible flows, Incompressible flows.

Governing equations (GE's) of Fluid dynamics: Modelling of flow, control volume concept, substantial derivative, physical meaning of the divergence of velocity. Continuity equation, momentum equation, energy equation and its conservation form. Energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions.

Practices

1. Introduction to CFD Drafting: Development of part drawings for various components in theorem of orthographic and isometric. Representation of dimensioning and tolerances.
2. Part Modelling: Generation of various 3D Models through Protrusion, revolve, sweep. Creation of various features. Study of parent child relation. Feature based and Boolean based modelling and Assembly modelling.

UNIT – II

Mathematical behaviour of partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behaviour of Hyperbolic, Parabolic and Elliptic equations.

Finite Difference Method: formulae for first order and second order terms, Solution of physical problems with Elliptic, type of Governing Equations for different boundary conditions.

Practices:

1. Heat conduction through a slab
2. Lumped heat capacity model.

UNIT – III

Potential flow – Mathematical considerations, Stokes' theorem, Circulation in irrotational flows, Velocity potential, Stream function and its relation with velocity field, Stream lines, Two dimensional sources and sinks, Simple vortex, Doublet, Superposition of 2D flows – sink plus vortex, flow about a cylinder without circulation, Rotating cylinder.

Practices:

1. Flow over a flat plate.
2. Flow through pipe.

UNIT – IV

Finite Difference Applications in Fluid flow problems: Fundamentals of fluid Flow modelling using Burger's Equation, Discretization using FTCS method with respect to Upwind Scheme and Transport Property, Upwind Scheme and Artificial Viscosity.

Solutions of Navier Stokes Equations for Incompressible Fluid Flows: Staggered Grid, Marker and Cell (MAC) Formulation, Numerical Stability Considerations, Pressure correction method, SIMPLE Algorithm

Practices:

1. Natural convection in a cavity (steady state)
2. Natural convection in a cavity (Unsteady)

UNIT – V

FVM: 2D steady state diffusion, 3D steady state diffusion.

Standard Variation Methods: Linear fluid flow problems, steady state problems.

Practices:

1. Numerical solution of potential flow problem.
2. Heat transfer in porous media

Text Books:

1 Introduction to Computational Fluid Dynamics, an: The Finite Volume Method, H. Versteeg, W. Malalasekera, Pearson Education Limited, 2nd Edition ISBN-10. 0131274988

2 Introduction to Computational Fluid Dynamics Development, Application and Analysis, Atul Sharma, Wiley Publication. ISBN-10. 9781119002994

Reference Books:

1. Numerical Heat Transfer and Fluid Flow, Suhas V Patankar, Mc Graw Hill Publication ISBN 0-07-048740-5
2. Computational Fluid Dynamics, John D. Anderson, McGraw-Hill Book Company. ISBN-10. 1259025969

Web Links:

1. https://nptel.ac.in/courses/112105045
2. https://archive.nptel.ac.in/courses/112/105/112105254/

DESIGN AND OPTIMIZATION OF THERMAL SYSTEMS

Course Code: 242ME005	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Apply design principles and market analysis to create workable and optimal systems.
- **CO2:** Formulate and model thermal systems using various design methodologies and mathematical modelling
- **CO3:** Design and analyse heat exchangers by considering fluid flow, heat transfer characteristics, and material requirements
- **CO4:** Apply calculus and programming methods to solve complex design problems using optimization techniques.
- **CO5:** Analyse the System Simulation models.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	3	-	1	-	-
CO2:	2	3	-	1	-	-
CO3:	2	3	-	-	-	-
CO4:	2	3	-	-	-	-
CO5:	2	3	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Introduction: Introduction to design and specifically system design. Morphology of design with a flow chart. Very brief discussion on market analysis, profit, time value of money, an example of discounted cash flow technique. Concept of workable design, practical example on workable system and optimal design.

UNIT – II

Thermal Systems-Characteristics- formulation of design problem-Steps in the design process- Modelling of thermal systems-importance- Types of models-Mathematical Modelling

UNIT – III

Design of Heat Exchanger: Study of design aspects, fluid flow and heat transfer characteristics, Material requirement of heat exchange equipment, Liquid - to - liquid and Liquid - to - gas heat exchange systems, Familiarity with use of design related industrial standards and codes, Design of Heat exchanger.

UNIT – IV

Optimization: Introduction. Formulation of optimization problems, calculus technique, search methods, method of steepest ascent/ steepest descent, conjugate gradient method, geometric programming, dynamic programming, linear programming, new generation optimization techniques – genetic algorithm and simulated annealing.

UNIT – V

Simulation: Definition- Types of Simulation models - Steps involved in simulation models- Application of simulation - Advantages and disadvantages – Introduction to Genetic algorithm – Genetic operators.

Text Books:

1 Essentials of Thermal System Design and Optimization, C. Balaji, Ane Books, New Delhi in India and CRC Press in the rest of the world. ISBN : 9781439891544

2 Design and optimization of thermal systems, Y. Jaluria, McGraw Hill. ISBN 9780429195808

Reference Books:

1 Elements of thermal fluid system design, L.C. Burmeister, Prentice Hall. ISBN-10. 0136602185

2 Design of thermal systems, W.F. Stoecker, McGraw Hill. ISBN-10. 0070616205

Web Links:

1 https://archive.nptel.ac.in/courses/112/106/112106064/

2 https://upgreengrade.ir/admin_panel/assets/images/books/1652205613.pdf

3 https://www.academia.edu/30746917/Design_and_Optimization_of_Thermal_Systems_Second_Edition

ENERGY SYSTEMS AND MANAGEMENT

Course Code: 242ME006	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Apply energy management and auditing techniques to optimize energy use
- **CO2:** Apply methods of direct energy conversion and energy storage systems.
- **CO3:** Analysis the energy efficiency in thermal utilities
- **CO4:** Evaluate heat recovery and cogeneration systems for optimizing energy efficiency.
- **CO5:** Apply financial metrics and energy management principles to evaluate and manage energy projects

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	2	-	-	-	-
CO2:	2	2	2	-	-	-
CO3:	2	3	-	-	-	-
CO4:	2	3	2	-	-	-
CO5:	2	2	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Introduction: Energy scenario, various forms of energy, Need for energy storage, Grid balancing: Supply and demand concept for energy management. recent trends in energy conservation Importance of energy management. Heat transfer equipment- Heat exchangers, Steam plant.

Energy auditing: methodology, analysis of past trends plant data, closing the energy balance, laws of thermodynamics, measurements, portable and online instruments.

UNIT – II

Direct Energy Conversion methods: Magneto-hydrodynamic (MHO) power generation, Thermionic power generation, Thermoelectric power generation, Fuel cells, Hydrogen energy system

Energy storage Methods and systems: Thermal, Electrical and Mechanical energy storage methods and systems, Energy saving in IC engines and Gas turbines.

UNIT – III

Energy Efficiency in Thermal Utilities: Boilers, steam system, furnaces insulation and refractories, FBC boilers, cogeneration, waste heat recovery. Energy Efficiency in electrical Utilities: Electrical systems, electric motors, compressed air system, HVAC and refrigeration systems, fans and blowers, pumps and pumping systems, cooling towers, lighting system, diesel generating system.

UNIT – IV

Heat recovery systems: Incinerators, regenerators and boilers. Waste heat recovery: recuperators, heat wheels, heat pipes, heat pumps. Cogeneration - concept, options (steam/gas turbines/diesel engine based), selection criteria, control strategy.

UNIT – V

Energy Economics: Discount rate, payback period, internal rate of return, life cycle costing. **Energy Management:** Principles of Energy Management, Energy demand estimation, Organizing and Managing Energy Management Programs, Energy pricing.

Text Books:

1. Energy Management audit & Conservation, De, B. K., Vrinda Publication, 2nd Edition ISBN: 9788182813434
2. Energy Management, Murphy, W. R., Elsevier, 1st Edition ISBN-13. 978-8131207383

Reference Books:

1. Guide to Energy Management, Capehart, B.L., Turner, W.C., Kennedy, W.J., 7th Edition, Fairmont Press. ISBN 978-1439883488
2. Energy: Management, Supply and Conservation, Clive Beggs, Routledge. ISBN-13: 978-0750686709

Web Links:

1. https://www.iea.org/
2. https://archive.nptel.ac.in/courses/108/106/108106022/

FUELS COMBUSTION AND EMISSION CONTROL

Course Code: 242ME007	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the chemical composition, kinematic reaction, and types of order reaction
- **CO2:** Analyse combustion parameters, including enthalpy, heating value, and flame temperature
- **CO3:** Explain the structure and flame propagation of Laminar and Turbulent Flow
- **CO4:** Analyse the processes of pollution formation, methods of measurement, and control strategies to minimize environmental impact.
- **CO5:** Explain the effects of environment and human effects in environmental consideration

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	-	-	-	-
CO2:	2	3	-	-	-	-
CO3:	2	3	-	-	-	-
CO4:	2	3	-	-	-	-
CO5:	3	2	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Principles of Combustion: Chemical composition, Flue gas analysis, dew point of products, Combustion stoichiometry, Chemical kinetics, Rate of reaction, Reaction order, Molecularity, Zeroth, first, second and third order reactions, complex reactions, chain reactions, Theories of reaction Kinetics, General oxidation behaviour of HCs.

UNIT – II

Thermodynamics of Combustion: Enthalpy of formation, Heating value of fuel, Adiabatic flame Temperature, Equilibrium composition of gaseous mixtures.

UNIT – III

Laminar and Turbulent Flames Propagation and Structure: Flame stability, burning velocity of fuels, Measurement of burning velocity, factors affecting the Burning velocity. Combustion of fuel droplets and sprays, Combustion systems, Pulverized fuel furnaces-fixed, entrained and fluidized bed systems.

UNIT – IV

Formation, Measurement, and Control of Pollution: Causes for Formation of NOx, SOx, COx, Smoke and UBHC. Different methods of measurement of pollutants. methods of controlling the formation of pollutants, BHARAT, and EURO standards of emissions

UNIT – V

Environmental Considerations: Air pollution, effects on environment, human health etc. Principal pollutants, Legislative measures, methods of emission control.

Text Books:

1 Combustion Fundamentals, Roger A strehlow, Mc Graw Hill, 2nd Edition. ISBN-13. 978-0070665996

2 Fuels and combustion, Sharma and Chander Mohan, Tata Mc Graw Hill, 3rd Edition ISBN-13. 978-0070966277

Reference Books:

1 Principles of Combustion, Kanneth K.Kuo, Wiley and Sons, 2nd edition. ISBN: 978-0-471-04689-9

2 IC Engines Combustion and Emissions, B. P. Pundir, Alpha Science International Ltd, 1st Edition. ISBN-13. 978-1842656457

Web Links:

1 https://archive.nptel.ac.in/courses/103/105/103105110/

2 https://www.coursesidekick.com/geography/4050066

ADVANCED POWER PLANT ENGINEERING

Course Code: 242ME008

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Apply the principles of thermodynamics to analyse the performance of steam power plants
- **CO2:** Apply the principles of thermodynamics to analyse the performance of Gas and Hydro Electric Power Plants
- **CO3:** Explain nuclear power plant components and environmental impacts, including carbon capture and negative emission technologies.
- **CO4:** Explain various non-conventional energy generation technologies
- **CO5:** Analyze power plant economics, including cost, load forecasting, and optimal scheduling.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	-	-	-	-
CO2:	2	2	-	-	-	-
CO3:	3	2	-	-	-	-
CO4:	3	3	-	-	-	-
CO5:	3	3	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Introduction: Energy resources and their availability, Overview of the Indian power sector, Thermodynamic analysis of Conventional Power Plants. Advanced Power Cycles, Kalina (Cheng) Cycle, IGCC, AFBC/PFBC.

Steam Power Plants: Plant layout, working of different circuits, fuel handling equipment, types of coals, coal handling, choice of handling equipment, coal storage, ash handling systems.

Combustion: Properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, dust collectors, cooling towers and heat rejection. corrosion and feed water treatment.

UNIT – II

Gas turbine plants: Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plant.

Hydroelectric Power Plants: Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, comparison with other types of powerplants.

UNIT – III

Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear cross-section, different components of nuclear power station, PWR, BWR, CANDU, liquid metal cooled, gas cooled, fast breeder, nuclear waste disposal.

Environmental aspects of power generation: sustainability and future scenarios. Negative emission power plants: Introduction, thermodynamics, carbon capture and utilization, techno-economic aspects.

UNIT – IV

Non-conventional energy generation: Geothermal power plant, Tidal and wave power plant, solar power plant, wind power generation, direct to electricity method - Magneto-hydrodynamic (MHO) power generation

UNIT – V

Power Plant Economics: load curve, different terms and definitions, base load and peak load plants, energy storage, cost of electrical energy, Analysis of Power Purchase Agreements (PPA), Debt/Equity Ratio and effect on Return on Investment, Environmental Legislations/Government Policies Optimal Dispatch Scheduling of Hydro-Thermal plants. Load Forecasting Time series, Econometric, end use techniques. Least Cost Power Planning - Integration of DSM, Renewables into supply.

Text Books:

1. A course in Power Plant Engineering, Arora and Domkundwar, Dhanpatrai &Co, 8 th edition, ISBN-10. 8177001957
2. Power Plant engineering, P. C. Sharma, S.K. Kataria & Sons, New Delhi, ISBN-10, 9350143844.

Reference Books:

1. Power Plant Engineering, P. K. Nag, McGraw Hill Education; 4th Edition ISBN-10. 9339204042
2. An Introduction to Power Plant Technology, G.D. Rai, Khanna Publishers ISBN-13: 978-9387394094

Web Links:

1. https://archive.nptel.ac.in/courses/112/107/112107291/
2. https://www.udemy.com/course/basics-of-power-plant-engineering/

MEASUREMENTS IN THERMAL ENGINEERING

Course Code: 242ME009	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Apply concepts of measurement systems, including errors, calibration, and transducer types and models
- **CO2:** Apply principles and methods to measure and analyze various types of pressure.
- **CO3:** Apply flow measurement and visualization methods to analyze fluid flow.
- **CO4:** Evaluate temperature measurement techniques and analyze errors and uncertainties.
- **CO5:** Apply different types of controllers to model and analyze control systems

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	3	1	-	-	-
CO2:	2	3	1	-	-	-
CO3:	2	3	1	-	-	-
CO4:	2	3	1	-	-	-
CO5:	2	3	1	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Concept of Generalized Measurement System: System configurations - Errors Problem analyses - Basic characteristics of measuring devices – Calibration. The transducer and its environment; an overview; sensing process and physical laws. Types of measurement problems. Transducer classification and their modeling; information, energy and incremental models

UNIT – II

Measurement of Pressure: principles of pressure measurement, static and dynamic pressure, vacuum and high-pressure measurement – Measurement of low pressure, Manometers, Calibration methods, Dynamic characteristics, design principles. pressure Variable reluctance & LVDT Type pressure sensors – Knudsen gauge Thermal conductivity ionization gauge High pressure measurement – Piezo-electric and vibrating elements pressure sensors

UNIT – III

Flow measurement and Flow Visualization methods: Positive displacement methods, Flow-obstruction methods, sonic nozzle, Flow measurement by drag effect, Hot-wire and hot-film anemometers, Magnetic flow meters, Flow-visualization methods, The shadowgraph. The schlieren, The interferometer, The Laser Doppler Anemometer (LDA), Smoke method, Pressure probes and impact pressure in supersonic flow

UNIT – IV

Measurement of Temperature: Thermo-electric sensors – Thermocouple & electrical resistance- Radiation & optical thermometers – Quartz crystal Thermometers – High speed Temperature probe

Errors in Measurement and its Analysis: Causes and types of experimental errors; systematic and random errors. Uncertainty analysis; tion of overall uncertainty; estimation for design and selection for alternative test methods.

UNIT – V

Process Control: Types of controllers - on/off, P, PI, PID controllers. Modeling of mechanical translation, rotary and simple hydraulic and pneumatic systems. Block diagrams, transfer functions and steady state behavior of systems. Dynamic behavior, stability criterion. Analog computer simulation of control systems. Discrete state process control. Introduction to digital control.

Text Books:

1. Experimental methods for engineers, J. P. Holman, McGraw Hill Education, 7th Edition, ISBN 978-0070647763
2. Experimentation, validation, and uncertainty analysis for engineers, H.W. Coleman and W.G. Steele Jr, Wiley, 3d Edition ISBN-10, 0470168889

Reference Books:

1. Modern Control Engineering, M. Ogata, 4th Edition, Prentice-Hall, ISBN-13. 978-8178085791
2. Control Systems - Principles & Design, M. Gopal, TMH, 2nd Edition. ISBN-13. 978-0071333269

Web Links:

1. https://nptel.ac.in/courses/112103261
2. https://nptel.ac.in/courses/103105064

GAS TURBINES AND JET PROPULSION

Course Code: 242ME010	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyze thermodynamic cycles and performance characteristics of gas turbines and jet engines.
- **CO2:** Explain the features of compressible flows.
- **CO3:** Analyse normal shock, oblique shock and expansion waves in high-speed flows
- **CO4:** Explain various types of propulsion engines used in aircraft and rocket vehicles and understand the engine performance.
- **CO5:** Analyze the operation and components of turbojet, turbofan, ramjet, and turboramjet engines.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	1
CO2:	2	1
CO3:	2	1
CO4:	2	1
CO5:	2	1

UNIT – I

Thermodynamic cycle analysis of gas turbines; open and closed cycles. Axial flow turbines; blade diagrams and design of blading, performance characteristics. The Gas Turbine Engine development for jet Propulsion; Jet engine performance parameters: Thrust, SFC, Efficiencies.

UNIT – II

Introduction to compressible fluid flow and control volume analysis Coefficient of Compressibility - Stagnation state – Critical state - Various regions of flow Physical significance of Mach number - Mach cone - Differences between Incompressible and Compressible flows. Properties of atmosphere - Effect of Mach number on compressibility, Conservation laws for mass - Momentum and energy in steady flow.

UNIT – III

Shocks and Expansion waves in compressible flows, Flow with normal shock waves - Governing equations - Prandtl–Meyer equation - Impossibility of rarefaction shock - Mach number downstream of shock – Property variation across shock -Strength of shock wave - entropy change, Oblique shock-Property relations, Relation between Mx and My, θ-β-M relation, Maximum Value of Oblique shock, Detached shock, Prandtl-Meyer Expansion fans.

UNIT – IV

Aircraft Propulsion: Air craft propulsion – Types of jet engines - Energy flow through jet engines - Thrust - Thrust power and Propulsive efficiency - Turbojet components - Diffuser compressor Combustion chamber - Turbines - Exhaust system - Performance of jet engines.
Rocket propulsion: Rocket propulsion – Rocket engines - Basic theory of equation - Thrust effective jet velocity -Specific impulse - Rocket engine performance - Solid and Liquid propellant rockets – Comparison of various propulsion systems.

UNIT – V

Turbojet engine Operation of a turbojet and afterburning turbojet engine Component analysis – intake and compressor combustor, turbine and nozzle. Turbofan engine-Turbofan engine - Component analysis – Fan Turbofan engine Emerging trends.
Ramjet and turboramjet engines Operation of a Ramjet Engine and a Turboramjet Engine Ramjet and turboramjet engines Component analysis – Supersonic Intake.

Text Books:

1. Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, Yahya.S.M, New Age International (P) Ltd, New Delhi, 3rd edition, ISBN-13. 978-9386649911
2. Gas Dynamics, Radhakrishnan.E, PHI Learning Pvt. Ltd, 4th edition, ISBN-13. 978-8120346055

Reference Books:

1. Elements of Propulsion: Gas turbines and Rockets, Mattingly.J.D, McGraw Hill. ISBN-13. 978-1624103711
2. Fundamentals of compressible fluid dynamics, Balachandran.P, PHI Learning. ISBN-13: 978-8120328570

Web Links:

1. https://archive.nptel.ac.in/courses/101/101/101101002/
2. https://soaneemrana.org/onewebmedia/GAS%20TURBINE%20AND%20JET%20&%20ROCKET%20PROPULSION1.pdf
3. https://www3.nd.edu/~powers/ame.40431/notes.pdf

ENERGY CONSERVATION AND WASTE HEAT RECOVERY

Course Code: 242ME011	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyse the importance of waste heat recovery and evaluate power plant cycles using thermodynamic principles.
- **CO2:** Apply thermodynamic principles to enhance efficiency in energy systems through various cycle modifications.
- **CO3:** Analyse co-generation, tri-generation systems, and various types of boilers for performance and operational efficiency.
- **CO4:** Evaluate the performance of heat recovery system for industrial applications
- **CO5:** Evaluate various energy storage techniques, including pumped hydro, batteries, and fuel cells, and their economic implications.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	3	-
CO2:	3	-
CO3:	3	-
CO4:	3	-
CO5:	3	-

UNIT – I

Introduction to Waste Heat: Importance of Waste Heat Recovery, Review of Thermodynamics – Introduction to First and Second Laws – Entropy, Entropy Generation, First and Second Law efficiency Power Plant Cycles - Energy Cascading, Rankine Cycle, modification of Rankine cycle, examples.

UNIT – II

Energy Conservation: Introduction: Principles of thermodynamics: Rankine and Brayton cycles; enhancement of efficiency by reheat, regenerative, intercooling; topping, bottoming and combined cycles;

UNIT – III

Co-generation, Tri-generation & Boilers: Definition, concept of tri generation; Cogenerations, Boilers: Types, Performance evaluation of boilers, Boiler Water Treatment and blow down, Introduction to FBC Boilers, Mechanism and Operational Features of FBC, Retrofitting FBC system to conventional boilers.

UNIT – IV

Waste Heat Recovery: Classification, Advantages and applications, Selection criteria for waste heat recovery technologies, waste heat recovery devices: recuperators, regenerators, economizers, plate heat exchangers, thermic fluid heaters, Waste heat boilers-design aspects.

UNIT – V

Energy Storage Techniques – Pumped hydro, Compressed Air, Flywheel, Superconducting Magnetic storage Thermal storage (Sensible & Latent), Battery, Chemical Energy Storage, Fuel cells, Energy Economics.

Text Books:

1. Energy Storage, J Jensen, Elsevier ISBN: 9780408012256.
2. Advance Energy Systems, Nikolai V. Khartchenko, Taylor and Francis Publishing, 2nd Edition ISBN-13: 978-1439886588

Reference Books:

1. Powerplant Technology, M.M.El-Wakil, Tata McGraw Hill, Indian Edition. ISBN-10. 9780070702448
2. Waste Heat Utilization and Management, Lee SS EDS, Seagate Subrata, Hemisphere, Washington, ISBN-13. 978-0891161189

Web Links:

1. https://archive.nptel.ac.in/courses/112/105/112105221/
2. https://beeindia.gov.in/sites/default/files/2Ch8.pdf
3. https://www.slideshare.net/slideshow/waste-heat-recovery-and-sustainable-energy-785c/266274018

HEATING, VENTILATION AND AIR-CONDITIONING

Course Code: 242ME012	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Demonstrate air distribution system for HVAC.
- **CO2:** Explain about requirement and types of ventilation.
- **CO3:** Explain psychrometry of air conditioning processes.
- **CO4:** Apply air conditioning systems for different areas.
- **CO5:** Calculate heating and cooling loads and evaluate air conditioning systems for different climate zones.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	2
CO2:	-	2
CO3:	-	2
CO4:	-	2
CO5:	-	2

UNIT – I

Introduction: Brief history of air conditioning and its impact, HVAC systems and classifications, Heat pumps, Devices used in supply systems: Air inlet system, Filters heating & cooling equipment, Fans, Duct, Grills, Diffusers, Exhaust Systems: General exhaust systems, Local exhaust system, Removal of pollutants and contaminated air, Air cleaning devices.

UNIT – II

Ventilation system: Indoor air quality, Need for ventilation, Effects of R.H. in building ventilation, Types of ventilation system-Exhaust Ventilation Systems, Supply Ventilation Systems, Balanced Ventilation Systems, and Energy Recovery Systems. Ventilation in Kitchen, Ventilation of Commercial Buildings: Design of commercial, Residential ventilation system.

UNIT – III

Psychrometry of Air Conditioning Processes: Thermodynamic properties of moist air, Important Psychrometry properties, Psychometric chart; Psychrometric process in air conditioning equipment, applied Psychrometry, Psychrometric processes in air conditioning equipment, Bypass factor, air washers, Mixing, Heating and dehumidifying coils, Cooling by dry and wet coils, Use of hygroscopic solution in air washers, Adiabatic dehumidifiers. Humidifiers, Water injection, Steam injection.

UNIT – IV

Air Conditioning Systems: Commercial, Residential and Industrial Air-Conditioning; Summer, Winter and Year round Air-Conditioning system, Comfort Air Conditioning: Thermodynamics of human body, metabolic rate, energy balance and models, thermoregulatory mechanism, Comfort & Comfort chart, Effective temperature, Factors governing optimum effective temperature, Design consideration, Selection of outside and inside design conditions.

UNIT – V

Heating and Cooling load calculations: Sensible and latent heat loads, Sensible heat factor. Relationship between ESHF, ADP and BF, Recirculated air, Bypassed air and high latent heat load systems on Psychrometric chart, Cooling and heating load calculations, Selection of suitable air conditioning/ventilation system for different climate zones.

Text Books:

1. Refrigeration & Air Conditioning, Arora & Domkundwar, Dhanpat Rai & Co, 2018. ISBN: 9788177000009
2. HVAC Simplified, S. P., Kavanaugh, American Society of Heating, Refrigerating and Air-Conditioning Engineers; Pap/Cdr edition. ISBN-13. 978-1931862974

Reference Books:

1. Refrigeration & Air Conditioning, C.P. Arora, TMH, 3rd Edition, ISBN-13. 978-9351340164
2. Refrigeration and Air Conditioning, Er. V. K. Jain, Laxmi Publications Pvt. Ltd, 1st edition, 2019. ISBN: 9789352745081
3. Ventilation Systems: Design and Performance, Hazim B. Awbi., Routledge, 1st edition. ISBN-13, 978-0419217008

Web Links:

1. https://archive.nptel.ac.in/courses/112/107/112107208/
2. https://archive.nptel.ac.in/courses/112/105/112105129/

CONVECTIVE HEAT TRANSFER

Course Code: 242ME013	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the principles of convection.
- **CO2:** Analyze external forced convection by applying related empirical correlation
- **CO3:** Analyze internal forced convection by applying related empirical correlation
- **CO4:** Evaluate Nusselt No. for natural convection cases and assess the relative importance of combined natural and forced convection.
- **CO5:** Determine LMTD and effectiveness – NTU method for cross – flow, multi pass and compact heat exchangers.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	2
CO2:	-	2
CO3:	-	2
CO4:	-	2
CO5:	-	2

UNIT – I

Principles Of Convection: Convection boundary layers, velocity boundary layers, thermal boundary layers, significance of boundary layers, laminar and turbulent flow, significance of dimensionless parameters, Reynold-Colburn analogy, drag & heat transfer.

UNIT – II

External Forced Convection. Parallel flow over flat plate, flow errors Cylinders and spheres, flow across tube banks (aligned and staggered), correlations for all the mentioned cases.

UNIT – III

Internal Flow: Hydrodynamic considerations, flow conditions, velocity profiles in fully developed regions, laminar flow inside tubes, turbulent flow in tubes, bulk temperature flow through tube annulus, correlations related to mentioned cases, convection correlations for Non circular tubes, heat transfer enhancement.

UNIT – IV

Natural Convection: Equations of motions, Grashof's number, natural convection over surfaces, Plates, Cylinders, Spheres (all cases), natural convection inside enclosures, combined free and forced convection, correlations related to mentioned cases.

UNIT – V

Heat Exchangers: Design of Parallel flow, Counter flow, Cross flow, Multipass-cross flow, Heat exchangers, LMTD, method design, effectiveness-NTU method, compact heat exchangers, heat exchanger optimization.

Text Books:

1. Heat transfer, J.P. Holman, McGraw Hill Education, 10th edition, ISBN-13. 978-0073529363
2. Fundamentals of heat transfer, Dewitt Incopera, John Wiley & Sons, 6th edition ISBN-13. 978-0470055540

Reference Books:

1. Fundamentals of Engineering Heat and Mass Transfer, R.C Sachdeva, New Age International Private Limited, 6th edition 2022 ISBN-13. 978-9395161022
2. Convective Heat Transfer, Kays & Crawford, McGraw-Hill Education, 3rd edition, ISBN-13. 978-0070337213

Web Links:

1. https://onlinecourses.nptel.ac.in/noc24_me07/preview
2. https://www.engineeringtoolbox.com/convective-heat-transfer-d_430.html

RENEWABLE SOURCES OF ENERGY

Course Code: 242ME014	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Demonstrate the various components of solar thermal energy systems.
CO2: Describe the working of Wind turbines.
CO3: Explain the principle and working of Biomass and Geothermal Energy systems
CO4: Explain the Ocean, Tidal, Wave and hydro energy conversion systems.
CO5: Analyse hydrogen fuel production and applications, and assess hybrid energy systems.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	1
CO2:	-	1
CO3:	-	1
CO4:	-	1
CO5:	-	1

UNIT – I

Introduction to Renewable energy sources: Energy demand and availability, energy crisis, renewable and non-renewable energy resources, environmental impact of conventional energy usage.

Solar Energy: Overview of the fundamental physics of solar radiation, radiation measurement. Solar energy collectors., Solar thermal power plant, Classification of solar thermal plant, Central receiver power plant, solar pond etc, basic principle of SPV conversion, Types of PV system and solar cells. Solar Applications- Solar heating and cooling technique, Solar distillation and drying, Photovoltaic energy conversion

UNIT – II

Wind Energy: Wind, Beaufort number, Characteristics, Wind energy conversion systems, Types, Betz model. Interference factor. Power coefficient, Torque coefficient and Thrust coefficient, lift machines, and Drag machines. Matching, Electricity generation.

UNIT – III

Biomass: Bio resources, Conversion process, Biomass gasifier - Types of biomass gasifiers, Biodiesel production – Ethanol production -Applications.

Geothermal Energy: Origin and types of geothermal energy and utilisation, Power generation from Geothermal energy, Environmental impact.

UNIT – IV

Ocean, Wave & Tidal Energy: Introduction - Resource Assessment - Power generation through OTEC systems. Wave and Tidal energy Fundamentals, Availability, and energy conversion systems.

Direct Energy Conversion: Nuclear Fusion, Fusion, Fusion reaction, P, P cycle, Carbon cycle, Deuterium cycle, Condition for controlled fusion, Fuel cells and photovoltaic. Thermionic & thermoelectric generation, MHD generator.

UNIT – V

Hydrogen Gas as Fuel: Production methods, Properties, I.C. Engine applications, Utilization strategy, Performance.

Hybrid Energy Systems: Systems for processes and power applications – solar – wind – Biomass hybrid technologies.

Text Books:

1. Non-Conventional Energy Resources, B H Khan, TMH Publishers, 3rd Edition, ISBN-13. 978-9352601882
2. Renewable Energy: Power for a Sustainable Future, Boyle, G, Oxford University Press, 3rd Edition, ISBN-13. 978-0199545339

Reference Books:

1. Non-Conventional Energy Sources, G.D.Rai, Khanna Publishers, 6th edition ISBN-13 978-8174090737
2. Renewable Energy Resources, John Twidell, Tony Weir, and Anthony D. Weir, Taylor & Francis, ISBN-13. 978-0415584388

Web Links:

1. https://onlinecourses.nptel.ac.in/noc22_ch27/preview
2. https://www.energy.gov/eere/renewable-energy

DESIGN OF HEAT EXCHANGERS

Course Code: 242ME015	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyse heat exchanger performance and design using LMTD, NTU methods, and selection criteria.
- **CO2:** Analysis the effect and stress of the heat exchanger.
- **CO3:** Evaluate the design concepts of double pipe, finned tube, shell and tube heat exchangers
- **CO4:** Explain the compact heat exchanger, plate heat Exchangers, Condensers and Cooling Towers
- **CO5:** Explain the feasible and optimum design of heat exchanger.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	3
CO2:	-	3
CO3:	-	3
CO4:	-	3
CO5:	-	3

UNIT – I

Introduction

Classification of Heat Exchangers - Heat Transfer Mechanisms - Flow Arrangements - Applications - Selection of Heat Exchangers. LMTD and NTU Method for heat exchanger analysis - Heat exchanger design methodology

UNIT – II

Stress Analysis

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

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

Condensers and Cooling Towers: Design of surface and evaporative condensers–cooling tower –performance characteristics

UNIT – V

Optimum Design: Criteria for optimisation of heat exchangers, constraints, feasible and optimum design, optimization based on volume, weight, cost, entropy generation and thermos economics; Brief introduction to some traditional and non-traditional optimisation techniques.

Text Books:

1. Heat transfer: A Practical Approach, Yonous A. Cengel,McGraw Hill, ISBN-13. 978-0072458930
2. Heat Exchangers: Selection, Rating, and Thermal Design, Sadik Kakaç, Hongtan Liu, Anchasa Pramuanjaroenkij, CRC Press, 4th Edition, 2020, ISBN-13. 978-1138601864

Reference Books:

1. Handbook of Heat Transfer, Warren Rohsenow, James Hartnett, Young Cho, McGraw Hill, 3d Edition. ISBN-13. 978-0070535558
2. Fundamentals of Heat Exchanger Design, RH. Shah, John Wiley & Sons Inc, 1st Edition ISBN-13, 978-0471321712

Web Links:

1. https://archive.nptel.ac.in/content/storage2/courses/103103027/pdf/mod1.pdf
2. https://inldigitallibrary.inl.gov/sites/sti/sti/5901289.pdf
3. https://onlinecourses.nptel.ac.in/noc20_me52/preview

COMBUSTION, EMISSIONS AND ENVIRONMENT

Course Code: 242ME016	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyse combustion principles, including chemical composition, stoichiometry, and reaction kinetics.
- **CO2:** Calculate and analyse the thermodynamic properties of combustion, including enthalpy, heating value, and adiabatic flame temperature.
- **CO3:** Analyse flame propagation and structure, including burning velocity, and evaluate combustion in various fuel and furnace systems.
- **CO4:** Analyse pollution formation, measurement, and control methods, including emission standards.
- **CO5:** Evaluate the Environmental Considerations

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		3
CO2:		3
CO3:		3
CO4:		3
CO5:		3

UNIT – I

Principles of Combustion: Chemical composition, Flue gas analysis, dew point of products, Combustion stoichiometry, Chemical kinetics, Rate of reaction, Reaction order, Molecularity, Zeroth, first, second and third order reactions, complex reactions, chain reactions, Theories of reaction Kinetics, General oxidation behavior of HCs.

UNIT – II

Thermodynamics of Combustion: Enthalpy of formation, Heating value of fuel, Adiabatic flame Temperature, Equilibrium composition of gaseous mixtures.

UNIT – III

Laminar and Turbulent Flames Propagation and Structure: Flame stability, burning velocity of fuels, Measurement of burning velocity, factors affecting the Burning velocity. Combustion of fuel droplets and sprays, Combustion systems, Pulverized fuel furnaces-fixed, entrained and fluidized bed systems.

UNIT – IV

Pollution Formation Measurement and Control: Causes for Formation of NOx, SOx, COx, Smoke and UBHC. Different methods of measurement of pollutants. methods of controlling the formation of pollutants, BHARAT and EURO standards of emissions**.**

UNIT – V

Environmental Considerations: Air pollution, effects on environment, human health etc. Principal pollutants, Legislative measures, methods of emission control..

Text Books:

1. Fuels and combustion, Sharma and Chandra Mohan, Tata McGraw Hill ISBN-13. 978-0070966277
2. Combustion Engineering and Fuel Technology, Shaha A.K., Oxford and IBH

Reference Books:

1. Principles of Combustion, Kanneth K.Kuo, Wiley and Sons. ISBN-978-0471046899
2. An Introduction to Combustion, Stephen R. Turns, Mc. Graw Hill International 4th Edition, 2020. ISBN-13, 978-1260575521

Web Links:

1. http://nptel.ac.in/courses/107106080/
2. http://www.engineering108.com/Data/Engineering/Automobile/advance-vehicle echnology.pdf
3. http://nptel.ac.in/112999903

ALTERNATIVE FUELS

Course Code: 242ME017	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Demonstrate various liquid alternative fuels for IC engines and their significance.
- **CO2:** Evaluate the performance and of SI & CI engines using gaseous alternative fuels.
- **CO3:** Explain the formation of emissions from SI engine and its control strategies.
- **CO4:** Analyse emission formation and control strategies in CI engines, including the effects of operating variables and various control technologies
- **CO5:** Apply different techniques and test procedures to measure emissions.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	2
CO2:	-	2
CO3:	-	2
CO4:	-	2
CO5:	-	2

UNIT – I

Liquid Fuels, Alcohols: Properties, production, advantages and disadvantages of Methanol and Ethanol and their blends as fuel for SI and CI engine.

Biodiesels: Background of Diesel/Biodiesel fuels-Oil feed stocks-Transesterification-Biodiesel production from Vegetable oils. Properties of biodiesel and their importance in the context of performance and emissions of IC Engines.

Recycled Fuels: Pyrolysis- plastic, tyre and cooking oils.

UNIT – II

Gaseous Fuels, Hydrogen: Introduction, properties and production of hydrogen. Storage, Advantages and disadvantages of hydrogen as fuel for SI and CI engines. Hazards and safety systems for hydrogen, hydrogen combustion. Performance and emission of from hydrogen.

Other Gaseous Fuels: Properties, production, advantages and disadvantages of LPG, CNG, Bio gas as fuel for SI and CI engines.

UNIT – III

SI Engine Emissions and its Control: Emission formation in SI Engines- Carbon monoxide & Carbon dioxide - Unburned hydrocarbon, NOx, Smoke-Effects of design and operating variables on emission formation- controlling of pollutants - Catalytic converters, Charcoal Canister, Positive Crank case ventilation system, Secondary air injection.

UNIT – IV

CI Engine Emission and its Control

Emission formation in CI Engines- Carbon monoxide & Carbon dioxide - Unburned hydrocarbon, NOx, soot, particulate matter and Intermediate Compounds - Physical and Chemical delay- Significance Effect of operating variables on Emission formation- Fumigation, Split injection, Catalytic Coating, EGR, HCCI, Particulate Traps, SCR.

UNIT – V

Test Procedures and Emission Measurements

Emission test cycles, constant volume sampling method, non-dispersive infrared (NDIR) analyzer, flame ionization detectors (FID), chemiluminescence analyzer, smoke meters, gas chromatograph.

Text Books:

1. Alternate Fuels, S. S. Thipse, Jaico Publications ISBN 13 978-8184950786
2. IC Engine Combustion & Emissions by B.P. Pundir, 4th Edition, Narosa Publications, 2020. ISBN-13. 978-1842656457

Reference Books:

1. Alternative Fuels Guidebook, Richard L.Bechtold, Society of Automotive Engineers (SAE), ISBN 978-0-7680-0052-8
2. Internal Combustion Engines Fundamentals, John B. Heywood, , Mc Graw Hill Publications, 2nd Edition, 2018. ISBN 9781260116106

Web Links:

1. https://archive.nptel.ac.in/content/storage2/courses/112104033/lecture39
2. https://nptel.ac.in/courses/112104033
3. https://www.udemy.com/course/automotive-engineering-automobile-fundamentals-and-advanced/?couponCode=LEADERSALE24A

CRYOGENIC ENGINEERING

Course Code: 242ME018	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the principles of cryogenic systems.
- **CO2:** Demonstrate the air and helium liquefaction processes.
- **CO3:** Explain about rectification and cryogenic storage.
- **CO4:** Explain Cryogenic Refrigeration System.
- **CO5:** Describe vacuum technology components and operations, including vacuum pumps, gauges, and system conductance.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	2
CO2:	-	2
CO3:	-	2
CO4:	-	2
CO5:	-	2

UNIT – I

Introduction: Historical background, Insight on Cryogenics, Definition and Engineering applications of Cryogenics, Properties of solids for cryogenic systems, Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures, Mechanical properties, Thermal properties, Electrical and Magnetic Properties, Present area involving cryogenics.

UNIT – II

Gas-Liquefaction System: Carnot liquefaction cycle, F.O.M, and Yield of liquefaction Cycles, Joule-Thomson effect, Adiabatic expansion, Simple Linde-Hampson system, Precooled Linde- Hampson system, Linde dual-pressure system, Cascade system, Claude system, Kapitza system, Collins helium liquefaction system, Ortho-Para hydrogen conversion, Critical components in liquefaction systems.

UNIT – III

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

Cryogenic Storage and transfer Systems: Cryogenic fluid storage vessels, insulations, cryogenic transfer systems.

UNIT – IV

Cryogenic Refrigeration System: Philips refrigerator, Importance of regenerator effectiveness for Philips refrigerator, Gifford-McMohan refrigerator, J. T. Cryocoolers, Stirling Cycle Refrigerators, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators.

UNIT – V

Vacuum Technology: Introduction and importance of vacuum technology in cryogenics, Flow regimes in vacuum systems, Conductance in vacuum systems, Operation of vacuum pumps, Calculation of pump-down time for a vacuum systems, Components of a vacuum systems, Mechanical vacuum pumps, Diffusion pumps, Ion pumps, Cryopumping. Vacuum gauges and valves.

Text Books:

1. Fundamentals of Cryogenic Engineering, Mamata Mukhopadhyay, PHI Learning, ISBN-13. 978-8120330573
2. Cryogenic Engineering, Thomas Flynn, CRC Press, 2nd edition, 2020. ISBN-13, 978-0367578169.

Reference Books:

1. Cryogenic Technology and Applications, A. R. Jha, Butterworth-Heinemann, 1st edition, ISBN-13. 978-0750678872
2. Cryogenic Mixed Refrigerant Processes, Gadhiraju Venkatarathnam, Springer-Verlag New York Inc., ISBN-13. 978-0387785134
3. Cryogenic Engineering: Fifty Years of Progress, Timmerhaus et. al., Springer, 2020. ISBN-13. 978-0387333243

Web Links:

1. https://nptel.ac.in/courses/112101004
2. https://www.slac.stanford.edu/econf/C0605091/present/CERN.PDF

SOLAR ENERGY TECHNOLOGIES

Course Code: 242ME019	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the concept of solar radiation and its measurement
- **CO2:** Describe the working principle of solar water heating system
- **CO3:** Explain the various solar thermal energy technologies and their applications
- **CO4:** Analyse the various solar PV cell materials and conversion techniques.
- **CO5:** Apply economic analysis principles to evaluate life cycle costs and optimize solar and water heating systems.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	1
CO2:	-	1
CO3:	-	1
CO4:	-	1
CO5:	-	1

UNIT – I

Introduction: Solar energy option, specialty, and potential, Solar radiation, beam and diffuse – measurement, estimation of average solar radiation on horizontal and tilted surfaces, problems, applications.

Capturing solar radiation – physical principles of collection, types – liquid flat plate collectors – construction details performance analysis – concentrating collection, flat plate collectors with plane reflectors, cylindrical parabolic collectors, Orientation and tracking Performance Analysis

UNIT – II

Design of Solar Water Heating System and Layout: Power generation –solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio.

UNIT – III

Thermal Energy Storage: Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations. Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration, active and passive heating systems.

UNIT – IV

Direct Energy Conversion: Solid state principles, semiconductors, solar cells performance, modular construction – applications. conversion efficiencies calculations

UNIT – V

Economics: Principles of Economic Analysis – Discounted cash flow – Solar system, life cycle costs – cost benefit analysis and optimization – cost-based analysis of water heating and photo voltaic applications.

Text Books:

1. Solar Energy-Principles of Thermal Collection and Storage, S P Sukhatme & J K Nayak, McGraw Hill Education, 3rd Edition ISBN-13: 978-0070142961
2. Principles of Solar Engineering, D.Yogi Goswami, Frank Krieth and Jan F. Kreider Taylor and Francis, USA. 2nd Edition, ISBN-13. 978-1560327141

Reference Books:

1. Solar Energy- Fundamentals, Design, Modelling and Applications, G.N.Tiwari, Narosa publishing house. 6— edition ISBN: 0849324092
2. Solar Energy and Non-conventional Energy Sources, Domkundwar, Dhanpat Rai & Co, (P) Ltd., Revised 2nd edition

Web Links:

1. https://archive.nptel.ac.in/courses/115/103/115103123/
2. https://www.nrel.gov/research/re-solar.html

ADVANCED FUEL CELL TECHNOLOGIES

Course Code: 242ME020	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Describe hydrogen properties and production methods.
- **CO2:** Explain hydrogen storage methods and safety.
- **CO3:** Describe the operation, types, applications, and history of fuel cells.
- **CO4:** Explain the different types of fuel cells and their functions
- **CO5:** Evaluate fuel cell applications and future trends.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	2
CO2:	-	2
CO3:	-	2
CO4:	-	2
CO5:	-	2

UNIT – I

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

UNIT – II

Hydrogen storage options – Compressed gas – Liquid hydrogen – Chemical Storage – comparisons. Safety and Management of Hydrogen. Applications of Hydrogen.

UNIT – III

Fuel Cells as Electrochemical Engines, Generic Fuel Cell and Stack, Classification of Fuel Cells, Potential Applications, History of Fuel Cell Development.

UNIT – IV

Alkaline Fuel Cells, Molten Carbonate Fuel Cells, PEM Fuel Cells, Solid Oxide Fuel Cells, Phosphoric acid Fuel Cells, Microbial Fuel Cells, Regenerative Fuel Cells.

UNIT – V

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.

Text Books:

1. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn Well Corporation, Oklahoma, ISBN-13: 978-1593700430
2. Engines and Hydrogen, Barclay F.J., Fuel Cells, Wiley ISBN-13. 978-0470019047

Reference Books:

1. Fuel Cells – Principles and Applications, Viswanathan B. and Aulice Scibioh.M, Universities Press, ISBN-13. 978-8173715570
2. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn Well Corporation, Oklahoma, ISBN-13: 978-1593700430

Web Links:

1. https://archive.nptel.ac.in/courses/103/102/103102015/
2. https://archive.nptel.ac.in/content/storage2/courses/112104033/lecture40/40_5.htm

ADVANCED I.C. ENGINES

Course Code: 242ME021	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain the gas exchange processes in the four-stroke engine cycle.
- **CO2:** Describe charge motion within the cylinder, including intake jet flow and swirl.
- **CO3:** Explain combustion in SI and CI engines, including normal and abnormal types.
- **CO4:** Explain the wiring and lighting systems of automobile.
- **CO5:** Describe the working of fuel cell and the applications.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	2
CO2:	-	2
CO3:	-	2
CO4:	-	2
CO5:	-	2

UNIT – I

Gas Exchange Processes: Inlet and exhaust processes in the four-stroke cycle volumetric efficiency quasi static effects combined quasi static and dynamic effects variation with speed and valve area and timing-flow through valves poppet valve geometry and timing flow rate and discharge efficient, residual gas fraction exhaust gas flow rate and temperature variation, scavenging in wnike eyelid engines.

UNIT – II

Charge Motion Within the Cylinder: Intake Jet Flow, Mean velocity and turbulence characteristics definitions application to engine velocity data swirl swirl measurement, swirl generation during induction swit modification within the cylinder

UNIT – III

Combustion In S.I And C.I Engines: Review of normal and abnormal combustion in SI and Ci engine cyclic variation in combustion of St engine analysis of cylindrical pressure data in SI and CI engine.

UNIT – IV

Electric Vehicles: Introduction Limitations of IC Engines as prime mover. History of EV, EVem. components of V. and AC electric machines: Introduction and basic structure, Batteries: Battery lead acid battery, cell discharge and charge operation, construction advantages of lead, acid battery.

UNIT – V

Fuel Cell Vehicles: Introduction, Fuel cell characteristics, Thermodynamics of Fuel cells, Fuell cell types; emphasis on PEM fuel cell.

Text Books:

1. Internal Combustion Engine Fundamentals, J.B. Heywood, Mc Graw Hill Co ISBN-13. 978-1259002076
2. Build your own electric vehicle, Seth Leitman and Bob Bran, McGraw Hill, Co, 3rd edition, ISBN-13. 978-0071770569

Reference Books:

1. Engineering Fundamentals of IC Engine, H.N. Gupta, 2nd edition PHI Pvt. Ltd ISBN-13: 978-8120346802
2. PEM Fuel Cells-Theory and Practice, F. Barbir, Academic Press, ISBN-13. 978-0123877109

Web Links:

1. http://nptel.ac.in/courses/112101097/
2. www.thermopedia.com/content/786

OPTMIZATION TECHNIQUES AND APPLICATIONS

Course Code: 242ME022	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Apply methods to find the optimal value of a single-variable non-linear function.

CO2: Apply direct search, pattern search, and gradient-based methods to find optimal solutions for multi-variable non-linear functions.

CO3: Analyse linear programming models, including the effects of changes in constraints, coefficients, and duality.

CO4: Compare genetic algorithms and simulated annealing with traditional optimization methods.

CO5: Design optimal thermal systems for heat exchangers, condensers, evaporators, and IC engines.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:		2
CO2:		2
CO3:		2
CO4:		2
CO5:		2

UNIT – I

Single Variable Non-Linear Unconstrained Optimization:

One dimensional Optimization methods:, Uni, modal function, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic & cubic interpolation methods.

UNIT – II

Multi Variable Non-Linear Unconstrained Optimization:

Direct search method, Univariant method, pattern search methods, Powell's, Hook, Jeeves, Rosen brock search methods, gradient methods, gradient of function, steepest decent method, Fletcher Reeves method, variable metric method.

UNIT – III

Linear Programming:

Formulation, Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. Duality, importance of duality, solution of primal from dual.

UNIT – IV

Non-Traditional Optimization Algorithms:

Genetics Algorithm, Working Principles, Similarities and Differences between Genetic Algorithm & Traditional Methods. Simulated Annealing, Working Principle, Simple Problems.

UNIT – V

Applications To Thermal Systems:

Optimal design of heat exchangers, condensers, evaporator and IC Engines.

Text Books:

1. Optimization theory & Applications, S.S. Rao, New Age International, 4th edition, ISBN-13. 978-9395161800
2. Optimization for Engineering Design, Kalyanmoy Deb, PHI, ISBN-13. 978-8120346789

Reference Books:

1. Operations Research S.D. Sharma, Kedarnath Publishers, ISBN 13 978-9380803388
2. Optimization Techniques, Benugundu & Chandraputla, Pearson Asia, ISBN 13 978-1108424882
3. Design of Thermal Systems, W.F Stoecker, Mc Graw Hill Education, 3rd edition ISBN-13. 978-1259002397

Web Links:

1. http://nptel.ac.in/downloads/112101004/
2. https://home.cern/about/engineering/cryogenics-low-temperatures-highperformance

FINITE ELEMENT METHOD IN HEAT TRANSFER ANALYSIS

Course Code: 242ME023	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyse finite element models for trusses and beams, including shape functions, stiffness matrices, and boundary conditions.
- **CO2:** Analyse higher-order and isoparametric elements for heat transfer problems.
- **CO3:** Apply finite element analysis to 1-D problems for various engineering applications.
- **CO4:** Apply 2-D finite element models to problems in heat transfer and fluid mechanics.
- **CO5:** Apply finite element analysis to 2-D plane stress, plane strain problems, and bending of plates.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	2	-
CO2:	2	-
CO3:	2	-
CO4:	2	-
CO5:	2	-

UNIT – I

Finite element modelling coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

Analysis of Trusses: Introduction, analysis of plane trusses, local and global stiffness matrix, treatment of boundary conditions, solutions, temperature effects.

Analysis of Beams: Formulation, load vector, boundary conditions, shear force and bending moment, solutions.

UNIT – II

Higher order and Isoparametric elements: One dimensional quadratic and cubic elements in natural coordinates, two dimensional four noded isoparametric elements and numerical integration.

Steady State Heat Transfer Analysis: One dimensional analysis of conduction, convection problems.

UNIT – III

Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin), Derivation of elemental equations and their assembly. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame.

UNIT – IV

Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements, Applications in heat transfer, fluid mechanics.

UNIT – V

2D problem for Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems; Discussion about pre-processors, postprocessors and finite element package ANSYS.

Text Books:

1. Introduction to Finite Elements in Engineering, T.R. Chandrupatla and A.D. Belegundu, PHI publications, 4th Edition, ISBN-13. 978-9332551824
2. A First Course in the Finite Element Method, Daryl L. Logan, Cengage Learning India Private Limited, 6th edition, ISBN-13: 978-1305635111

Reference Books:

1. An Introduction to the Finite Element Method, J.N. Reddy, McGraw Hill Education, 4th Edition, 2020. ISBN-13. 978-9390385270
2. Concepts and Applications of Finite Element Analysis, Cook et al, Wiley Publications, 4th edition, ISBN-13. 978-0471356059

Web Links:

1. https://nptel.ac.in/courses/112/104/112104193/
2. https://nptel.ac.in/courses/112/104/112104205/

BASIC CONCRETE TECHNOLOGY

Course Code: 242CE030	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Understand the chemical composition, hydration, and physical properties of Portland cement.
- **CO2:** Evaluate the effects of mineral and chemical admixtures on concrete performance.
- **CO3:** Classify and assess aggregates based on mechanical properties, grading, and thermal behavior.
- **CO4:** Analyze workability and setting characteristics of fresh concrete, including relevant testing methods.
- **CO5:** Design and proportion concrete mixes using BIS and ACI methods, ensuring quality control.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	3	1	-	-	-
CO2:	2	1	3	-	-	-
CO3:	2	1	3	-	-	-
CO4:	2	1	3	-	-	-
CO5:	2	2	3	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

UNIT – I

Cement: Portland cement – chemical composition – Hydration, Setting of cement – Structure of hydrate cement – Test on physical properties – Different grades of cement. Admixtures: Types of admixtures – mineral and chemical admixtures.

UNIT – II

Aggregates: Classification of aggregate – Particle shape & texture –, strength & other mechanical properties of aggregate – Specific gravity, Bulk density, porosity, adsorption &moisture content of aggregate – Bulking of sand – Deleterious substance in aggregate – Soundness of aggregate – Alkali aggregate reaction – Thermal properties – Sieve analysis – Fineness modulus – Grading curves – Grading of fine & coarse Aggregates – Gap graded aggregate – Maximum aggregate size.

UNIT – III

Fresh Concrete: Workability – Factors affecting workability – Measurement of workability by different tests – Setting times of concrete – Effect of time and temperature on workability – Segregation & bleeding – Mixing and vibration of concrete – Steps in manufacture of concrete – Quality of mixing water.

UNIT – IV

Hardened Concrete : Water / Cement ratio – Abram's Law – Gelspaoe ratio – Nature of strength of concrete – Maturity concept – Strength in tension & compression – Factors affecting strength – Relation between compressive & tensile strength - Curing. Testing Of Hardened Concrete: Compression tests – Tension tests– Flexure tests – Splitting tests – Pull-out test, Non-destructive testing methods – codal provisions for NDT. Elasticity, Creep & Shrinkage – Modulus of elasticity – Dynamic modulus of elasticity – Poisson's ratio – Creep of concrete – Factors influencing creep.

UNIT – V

Mix Design: Factors in the choice of mix proportions – Durability of concrete – Quality Control of concrete – Statistical methods – Acceptance criteria – Proportioning of concrete mixes by IS codes mix design. Special Concretes: Introduction to light weight concrete – Cellular concrete

Text Books:

1. Properties of Concrete by A. M. Neville Pearson 5th edition Education ltd. (ISBN: 9780273755807)
2. Concrete Technology by M. S. Shetty. – S. Chand & Co. (ISBN: 9788121900034)
3. Concrete Technology by Job Thomas -Cengage learning India Pvt Ltd.(ISBN: 9788131521099)

Reference Books:

1. Concrete Technology by M.L. Gambhir. – Tata Mc. Graw Hill Publishers, New Delhi. (ISBN: 9780070141100)
2. Concrete: Microstructure, Properties and Materials – P. K. Mehta and J. M. Monteiro, McGraw Hill Publishers. (ISBN: 9780071797870)

Web Links:

1. http://nptel.ac.in/courses/105102012/
2. www.archive.nptel.ac.in/noc/courses/noc15/SEM1/noc15-ce01
3. https://archive.nptel.ac.in/courses/105/102/105102012/

REPAIR AND REHABILITATION OF STRUCTURES

Course Code: 242CE031	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Identify the causes of deterioration of concrete structures.
- **CO2:** Illustrate the various materials for repair and rehabilitation techniques
- **CO3:** Construct the various strengthening and stabilization techniques.
- **CO4:** Determine various repair techniques of damaged structures.
- **CO5:** Evaluate the usage of different types of concretes and durability aspects
- **CO6:** Classify the usage of high-performance concretes for repairing works

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	2	2	2	2	-
CO2:	3	2	2	2	2	-
CO3:	3	2	2	2	2	-
CO4:	3	2	2	2	2	-
CO5:	2	2	1	2	1	-
CO6:	2	2	1	2	1	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-
C06:	-	-

UNIT – I

Materials for Repair and Rehabilitation: Admixtures- types of admixtures- purposes of using admixtures- chemical composition- Natural admixtures- Fibers- wraps- Glass and Carbon fiber wraps- Steel Plates-Nondestructive evaluation: Importance- Concrete behavior under corrosion, disintegrated mechanisms- moisture effects and thermal effects – Visual investigation- Acoustical emission methods-Corrosion activity measurement-chloridecontent– Depth of carbonation- Impact echo methods- Ultrasound pulse velocity methods- Pull out tests.

UNIT – II

Strengthening and Stabilization: Techniques- design considerations-Beam shear capacity strengthening- Shear Transfer strengthening-stress reduction techniques- Column strengthening-flexural strengthening Connection stabilization and strengthening, Crack stabilization.

UNIT – III

Bonded Installation Techniques: Externally bonded FRP- Wet layup sheet, bolted plate, near surface mounted FRP, fundamental debonding mechanisms-intermediate crack debonding-CDC debonding- plate end debonding- strengthening of floor of structures.

UNIT – IV

Fiber Reinforced Concrete: Properties of constituent materials- Mix proportions, mixing and casting methods-Mechanical properties of fiber reinforced concrete- applications of fibre reinforced concretes-Lightweight concrete- properties of light weightconcrete-Nofinesconcrete-designoflightweightconcreteFlyashconcrete- Introduction- classification of fly ash- properties and reaction mechanism of fly ash- Properties of fly ash concrete in fresh state and hardened state- Durability of fly ash concretes.

UNIT – V

High Performance Concrete: Introduction- Development of high performance concretes-Materials of high performance concretes-Properties of high performance concretes - Self Consolidating concrete-properties qualifications.

Text Books:

1. Concrete repair and maintenance illustrated-Peter Emmons, published by Brandon W. Emmons.(ISBN: 9780876291916)
2. Experimental Techniques and Instrumentation, Dr.M.Sreenivasa Reddy, Dr.S.Govindarajan and Dr.S.Pachaiappan, Charulatha Publications, 2022.

Reference Books:

1. Rehabilitation of Concrete Structures, Dr. B. Vidivelli, Standard Publishers Distributors. (ISBN: 978-8180140276)
2. Concrete technology, M S Shetty, S. Chand Publications.(ISBN: 9788121900034)
3. Concrete technology, Neville & Brooks, pearson education ltd.(ISBN: 9788131708384)

Web Links:

1. http://nptel.ac.in/courses/112101095/38
2. http://www.nptel.ac.in/courses/105105041/module%206.pdf
3. https://www.youtube.com/watch?v=N4KrZ_DczrE

NEURAL NETWORKS AND FUZZY LOGIC

Course Code: 242EE028	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Explain artificial neuron models.
- **CO2:** Explain various learning methods of ANN
- **CO3:** Apply different algorithms of ANN..
- **CO4:** Distinguish between Classical and Fuzzy Sets.
- **CO5:** Apply application of fuzzy logic control to real time systems.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	3	-	1	1	-	-
CO2:	3	-	1	1	-	-
CO3:	3	-	1	1	-	-
CO4:	3	-	1	1	-	-
CO5:	3	-	1	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

UNIT – I

Introduction to Neural Networks Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Applications of ANN.

UNIT – II

Essentials of Artificial Neural Networks Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN, Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application

UNIT – III

Multilayer feed forward Neural Networks Credit Assignment Problem, Generalized Delta Rule, Derivation of Back propagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements, Radial Basis Function (RBF) Neural Network – Kohonen Self Organizing feature Map (KSOM).

UNIT – IV

Classical & Fuzzy Sets Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions**.**

UNIT – V

Fuzzy Logic Modules Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods**.**

Text Books:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication. (ISBN: 9788120353343)
2. Introduction to Neural Networks using MATLAB 6.0 - S.N.Sivanandam, S.Sumathi, S.N.Deepa, TMH. (ISBN: 9780070591127)

Reference Books:

1. Neural Networks, James A Freeman and Davis Skapura, Pearson Education. (ISBN: 9780201513769)
2. Fuzzy sets University and information, J.Klin and T.A.Folger, Prentice Hall. (ISBN: 9789353065782)
3. Introduction to artificial neural systems, J.M.Zurada, Jaico Publication house.(ISBN: 9780314933911)

Web Links:

1. http://nptel.ac.in/courses/108104049/16
2. www.archive.nptel.ac.in/courses/127/105/127105006/
3. www.geeksforgeeks.org/fuzzy-logic-introduction/

HYBRID ELECTRIC VEHICLES

Course Code: 242EE029	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Analyze the architectures of HEVs with various components
- **CO2:** Illustrate the concept of Electric Vehicle and Hybrid Electric Vehicles
- **CO3:** Explain the Plan concept of Plug-in Electrical Vehicles
- **CO4:** Analyze the power electronics converters for HEVs
- **CO5:** Apply various energy storage technologies in Hybrid Vehicles.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	-	3	2	-	-
CO2:	1	-	3	2	-	-
CO3:	1	-	3	2	-	-
CO4:	1	-	3	2	-	-
CO5:	1	-	3	2	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

UNIT – I

Introduction to Electric Vehicles: History of electric vehicles, social and environmental importance of electric vehicles, impact of modern drive-trains on energy suppliesChallenges and Key Technologies of EVs – Challenges for EV Industry in India

UNIT – II

Hybridization of Automobile: Fundamentals of vehicle, components of conventional vehicle and propulsion load, Drive cycles and drive terrain, Concept of electric vehicle and hybrid electric vehicle, Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell vehicles and its constituents.

UNIT – III

Plug-in Hybrid Electric Vehicle PHEVs and EREVs, PHEV Architectures, equivalent electric range of blended PHEVs, Fuel economy and power management of PHEVs, end-of-life battery for electric power grid support, vehicle to grid technology, battery charging.

UNIT – IV

Power Electronics in HEVs Rectifiers and Buck converter used in HEVs, isolated and non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter, current source inverter, PWM rectifier in HEVs, EV and PHEV battery chargers.

UNIT – V

Battery and Storage Systems: Energy Storage Parameters; Lead–Acid Batteries; Ultra capacitors; Flywheels - Superconducting Magnetic Storage System; Pumped Hydroelectric Energy Storage; Compressed Air Energy Storage - Storage Heat; Energy Storage as an Economic Resource.

Text Books:

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press.(ISBN: 9781138072855)
2. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press. (ISBN: 9780367693930)

Reference Books:

1. Introduction to Hybrid Vehicle System Modeling and Control, Wei Liu, Wiley.(ISBN: 9788126556205)
2. Electric and Hybrid Vehicles Technologies, Modelling and Control: A Mechatronic Approach", Amir Khajepour, Saber Fallahand Avesta Goodarzi, John Wiley & Sons Ltd. (ISBN: 9781118341513)

Web Links:

1. https://archive.nptel.ac.in/courses/108/103/108103009/
2. https://ndl.iitkgp.ac.in/he_document/nptel/nptel/IN__N__1_E_E__12391_I_t_H_a_E_V__1402_4_D_o_H_E_v__14030_14031

GREEN ENGINEERING SYSTEMS
(Expect TE)

Course Code: 242ME029	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Distinguish the various solar energy collection methods and measuring instruments.
- **CO2:** Explain the different methods of solar energy storage and their applications.
- **CO3:** Illustrate the various types of wind mills and performance characteristics.
- **CO4:** Explain the principle of Biomass production, Geothermal energy sources and Ocean thermal energy conversion
- **CO5:** Illustrate the various types of electrical systems and mechanical systems.
- **CO6:** Compare the various energy efficient process.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-
CO6:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	**PSO2**
CO1:	-	3
CO2:	-	3
CO3:	-	3
CO4:	-	3
CO5:	-	3
CO6:	-	3

UNIT – I

Introduction: Solar Radiation: Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power, structure of the sun, the solar constant, sun-earth relationships, coordinate systems of the sun, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data, numerical problems. Photo voltaic energy conversion – types of PV cells, I-V characteristics

Solar Energy Collection: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT – II

Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney.

Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, betz criteria, types of winds, wind data measurement.

UNIT – III

Bio-Mass: Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, bio fuels, I.C. engine operation and economic aspects.

Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India.

Ocean Energy: OTEC, Principles of utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

UNIT – IV

Electrical Systems: Energy efficient motors, energy efficient lighting and control, selection of luminaire, variable voltage variable frequency drives (adjustable speed drives), controls for HVAC (heating, ventilation and air conditioning), demand site management.

Mechanical Systems: Fuel cells- principle, thermodynamic aspects, selection of fuels & working of various types of fuel cells, Environmentally friendly and Energy efficient compressors and pumps.

UNIT – V

Energy Efficient Processes: Environmental impact of the current manufacturing practices and systems, benefits of green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of efficient and sustainable green production systems with examples like environmentally friendly machining, vegetable based cutting fluids, alternate casting and joining techniques, zero waste manufacturing.

Green Buildings: Definition, features and benefits. Sustainable site selection and planning of building for maximum comfort. Environmentally friendly building materials like bamboo, timber, rammed earth, hollow blocks, lime & lime pozzolana cement, agro materials and industrial waste.

Text Books:

1. Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K. Nayak/ TMH.
2. Non-Conventional Energy Resources/ Khan B.H/ Tata McGraw Hill, New Delhi,

Reference Books:

1. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
2. Renewable Energy Resources-2 Edition/ J. Twidell and T. Weir/ BSP Books Pvt. Ltd.

Web Links:

1. https://onlinecourses.nptel.ac.in/noc17_me33
2. https://nptel.ac.in/courses/105107176/20

I.C.ENGINES
(Expect TE)

Course Code: 242ME030	**L**	**T**	**P**	**C**
	3	**0**	**0**	**3**

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Summarize the finite element methods
- **CO2:** Analyse one-dimensional problems in trusses and beams
- **CO3:** Solve structural problems using CST and axis - symmetric formulation
- **CO4:** Apply finite elements to higher order, Iso-parametric elements, and one-dimensional heat transfer analysis.
- **CO5:** Apply finite element methods to dynamic analysis.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1:	2	1	1	1	-	-
CO2:	2	2	1	1	-	-
CO3:	2	2	2	1	-	-
CO4:	2	1	-	1	-	-
CO5:	2	1	-	1	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	**PSO2**
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

UNIT – I

Gas Exchange Processes: Inlet and exhaust processes in the four-stroke cycle volumetric efficiency quasi static effects combined quasi static and dynamic effects variation with speed and valve area and timing-flow through valves poppet valve geometry and timing flow rate and discharge efficient, residual gas fraction exhaust gas flow rate and temperature variation, scavenging in wnike eyelid engines, scavenging parameters and mdeluctual scavenging processes. Flow through parts supercharging and turbo changing methods of power buying abusive relationships compressors, turbines wave compression devices.

UNIT – II

Charge Motion Within The Cylinder: Intake Jet Flow, Mean velocity and turbulence characteristics definitions application to engine velocity data swirl swirl measurement, swirl generation during induction swit modification within the cylinder squish pre chamber engine flow crevice flows and blowby News nerated by piston-cylinder wall interaction

UNIT – III

Combustion In S.I And C.I Engines: Review of normal and abnormal combustion in SI and Ci engine cyclic variation in combustion of St engine analysis of cylindrical pressure data in SI and CI engine. EMP Flix SI engines common rail fuel injection system in Ci engines fuel spray behavior in CI engine

UNIT – IV

Electric Vehicles: Introduction Limitations of IC Engines as prime mover. History of EV, components of EV and AC electric machines: Introduction and basic structure, Electric vehicle drive train, advantages and limitations Permanent magnet and switched reluctance motors.

UNIT – V

Hybrid Vehicles: Configurations of hybrid, Series and parallel, advantages and limitations, Hybrid drive trains, sizing of components Initial acceleration, rated vehicle velocity, Maximum velocity and maximum gradeability, Hydrogen: Production, Hydrogen storage systems, reforms.

Fuel Cell Vehicles: Introduction, Fuel cell characteristics, Thermodynamics of Fuel cells, Fuell cell types; emphasis on PEM fuel cell.

Text Books:

1. Internal Combustion Engine Fundamentals, J.B. Heywood, Mc Graw Hill Co,, ISBN-13. 978-1259002076
2. Build your own electric vehicle, Seth Leitman and Bob Brant. McGraw Hill, Co, 3 rd edition, ISBN-13. 978-0071770569

Reference Books:

1. Engineering Fundamentals of IC Engine, H.N. Gupta, 2nd edition PHI Pvt. Ltd. ISBN-13: 978-8120346802
2. PEM Fuel Cells-Theory and Practice, F. Barbir Elsevier Academic Press, ISBN: 9780128102398

Web Links:

1. http://nptel.ac.in/courses/112101097/
2. www.thermopedia.com/content/786

CAD TOOLS FOR VLSI DESIGN

Course Code: 242EC028	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Comprehend the insight of CAD Tools in modern design
- **CO2:** Develop combinational logic circuits by using CAD tools
- **CO3:** Build sequential logic circuits using Verilog HDL operators
- **CO4:** Analyze the performance of logic schematics using CAD simulation tools.
- **CO5:** Infer the performance of logic circuits in terms of DRC, LVS and PEX.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	3	1	2	2	1
CO2:	2	3	1	2	1	2
CO3:	2	2	3	2	2	1
CO4:	2	3	1	2	2	1
CO5:	2	3	2	2	2	1

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

UNIT – I

Understanding the working platform with Xilinx Vivado and its device, family and package Selection. Design and Implementation of Combinational Circuits Priority Encoder and Comparator using data flow & structural style

UNIT – II

Design and Implementation of Sequential Circuits to detect a given sequence using with and without overlapping (mealy & Moore machines). Design and Implementation of a traffic light controller in three road & four road junctions.

UNIT – III

Exercise on Concatenation, Replication operators, Reduction and Conditional operators in Verilog HDL. Performance characteristics of an n-channel and p-channel MOSFET.

UNIT – IV

Working with Schematic for Ring Oscillator with variable amounts of Pull up to pull down ratios. Design a full adder by instantiating the logic gates. Make a comment on design style on its performance.

UNIT – V

Design a NAND gate by using NMOS, PMOS and CMOS technologies and make a comment on its performance. Design a Schematic, stick and layout for given logic.

Text Books:

1. S. M. Kang and Y. Leblebici, CMOS Digital Integrated Circuits : Analysis and Design, Third Edition, MH, (ISBN Number-0072460539)
2. Plummer, Deal , Griffin “Silicon VLSI Technology: Fundamentals, Practice &Modeling”PH, (ISBN Number-0130850373)

Reference Books:

1. P. VanZant , “Microchip Fabrication”, 5th Edition, MH, (ISBN Number-6053901308)
2. R. J. Baker, H. W. Li and D. E. Boyce, CMOS Circuit Design, Layout and Simulation, PH, (ISBN Number-1119481511)

Web Links:

1. https://themosisservice.com/university-support
2. https://youtu.be/OF3Zwfu6Ngc
3. https://newsroom.ibm.com/2021-05-06-IBM-Unveils-Worlds-First-2-

FPGA DESIGN FOR EMBEDDED SYSTEMS

Course Code: 242EC029	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Outline the concepts of Embedded System and Hardware Description Languages
- **CO2:** Develop an embedded system using FPGA
- **CO3:** Explain FPGA platforms and cross development tools.
- **CO4:** Illustrate Parallelism and scheduling concepts
- **CO5:** Interpret the parallelism with in FPGA hardware core.

Mapping of Course Outcomes with Program Outcomes:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	1	1	3	1	-	-
CO2:	3	-	2	-	-	-
CO3:	1	-	2	-	-	-
CO4:	1	-	2	-	-	-
CO5:	1	-	2	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

UNIT – I: Embedded System Overview & Hardware Description Languages
H/W-FPGA-Embedded SoC and use of VLSI circuit technology-platform FPGA's-Altera, Cyclone, Hardware Description Languages - VHDL , Verilog , Other High-Level HDLs, From HDL to Configuration Bit-stream

UNIT – II: System Design using FPGA:
Principles of system design-Design quality, Modules and interfaces, Abstraction and state, Cohesion and coupling, Designing and Reuse, Control flow graph, Design-Origins of platform FPGA designs.

UNIT – III: FPGA Platform
Components, adding to platform FPGA systems, assembling custom compute cores. Software Design-System Software Options, Root File system, Cross-Development Tools, Monitors and Boot-loader.

UNIT – IV: Partitioning, Scheduling & Communication

Overview of Partitioning Problem, Analytical Solution to Partitioning-Basic definitions, expected performance gain, resource considerations, Analytical Approach, Communication-Invocation/Coordination, Transfer of State, Practical Issues- Profiling Issues, Data Structures Manipulate Feature Size.

UNIT – V: Spatial Design

Principles of Parallelism-Identifying Parallelism - Spatial Parallelism with Platform FPGAs Parallelism within FPGA Hardware Cores, Parallelism within FPGA Designs

Text Books:

1. Embedded Systems Design with Platform FPGAs, Ron Sass, Andrew G Schmidt Principles and Practices, First Edition, Tata McGraw Hill, India, ISBN Number-0123743338
2. Digital Systems design using VHDL, Charles H Roth. Jr, Re-Print, PWS publishing company (Thomson Books), USA, ISBN Number-9788131518304

Reference Books:

1. Design with VHDL,V A. Padroni Circuit First Edition, MIT Press Cambridge, England, ISBN Number-0262162245
2. FPGA Based System Design, Wayne Wolf, First Edition, Prentices Hall Modern Semiconductor Design Series, USA, ISBN Number-0131424610

Web Links:

1. https://www.coursera.org/learn/intro-fpga-design-embedded-systems
2. https://www.colorado.edu/ali/fpga-design-embedded-systems-specialization

ARTIFICIAL INTELLIGENCE

Course Code: 242CS030	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Describe fundamentals of Artificial Intelligence and its applications
- **CO2:** Solve basic AI based problems and construct logical building blocks for problem Formulation
- **CO3:** Apply various logical systems inferencing different logical problems.
- **CO4:** Illustrate knowledge representation using predicate logic and predicate rules.
- **CO5:** Design expert systems that leverage domain knowledge effectively

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	-	-	1	-
CO2:	2	1	2	-	1	-
CO3:	2	1	2	2	1	2
CO4:	2	1	2	-	1	-
CO5:	2	1	-	-	1	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

UNIT – I

Introduction to Artificial Intelligence: Introduction, History, Intelligent Systems, Foundations of AI, Applications, Tic-Tac-Toe Game playing, Development of AI Languages, Current trends in AI

UNIT – II

Problem Solving: State-Space Search And Control Strategies: Introduction, General Problem Solving, Characteristics of problem, Exhaustive Searches, Heuristic Search Techniques, Iterative- Deepening A*, Constraint Satisfaction

Problem Reduction and Game Playing: Problem Reduction, Game Playing, Minimax algorithm, Alpha- Beta Pruning, Two-player perfect information games

UNIT – III

Logic Concepts Introduction, Propositional calculus, Proportional logic, Representing facts in logic, functions and predicates, Axiomatic System, Semantic Tableau System in Proportional logic, Resolution Refutation in proportional logic, predicate logic.

UNIT – IV

Knowledge Representation Knowledge Representation Using Predicate logic, Knowledge Representation using Semantic Network, Knowledge Representation using Frames. **Representing Knowledge Using Rules:** Procedural Versus Declarative knowledge, Logic Programming, Forward versus Backward Reasoning

UNIT – V

Expert System Representing and using Domain Knowledge, Reasoning with knowledge, Expert System Shells, Support for explanation examples, Knowledge acquisition-examples.

Text Books:

1. Artificial Intelligence- Saroj Kaushik, 1st edition CENGAGE Learning, (ISBN: 9789355730428).
2. Artificial intelligence, A modern Approach, Stuart Russel, Peter Norvig, Pearson Education Ltd, 2 nd ed, (ISBN: 97881203238)
3. Artificial Intelligence- Elaine Rich, Kevin Knight, Shivashankar B Nair, 3rd ed, McGraw Hill Education, (ISBN-13. 9780070087705)

Reference Books:

1. Artificial intelligence structures and strategies for complex problem solving, George F Lugar, 5th Edition, Addison Wesley. ISBN-13: 978-0321263186

Web Links:

1. https://www.tutorialspoint.com/artificial_intelligence/index.htm/
2. https://www.slideshare.net/slideshow/logic-in-ai/5005940//
3. https://www.slideshare.net/slideshow/artificial-intelligence-3638681/3638681/

MACHINE LEARNING TECHNIQUES

Course Code: 242CS031	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Describe the need for AI and ML, and the types ofML algorithms..
- **CO2:** Apply regression techniques and dimensionality reduction methods.
- **CO3:** Implement and evaluate various classification techniques.
- **CO4:** Describe and implement Artificial NeuralNetworks.
- **CO5:** Utilize unsupervised learning methods for clustering and dimensionality reduction

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	-	-	-	-
CO2:	2	1	2	-	-	-
CO3:	2	1	2	2	-	2
CO4:	2	1	2	-	-	-
CO5:	2	1	-	-	-	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-
CO5:	-	-

UNIT – I

Introduction: Understanding the need for AI and Machine Learning (ML), AI & Data, Types of ML Algorithms: Supervised, Unsupervised Learning and semi supervised learning, reinforcement learning, evolutionary computation ML Model development life cycle Deep Learning for Human Like Learning

UNIT – II

Regression Techniques: Regression for prediction, Gradient Descent and Ascent, Learning with Momentum, Loss Functions, Over fitting and under fitting, Model evaluation techniques Types of Regression: Linear Regression,

UNIT – III

Classification Techniques: Naïve Bayes Classification: Bayesian Learning, Naïve Bayes Classification, MAP, Bayesian Belief Networks, Decision Tree, K-Nearest Neighbors Support Vector Machines: Hard Margin and Soft Margin, Kernels and Kernel Trick, Evaluation Measures for Classification Techniques

UNIT – IV

Classification Techniques: Naïve Bayes Classification: Bayesian Learning, Naïve Bayes Classification, MAP, Bayesian Belief Networks Decision Tree K-Nearest Neighbors Support Vector Machines: Hard Margin and Soft Margin, Kernels and Kernel Trick, Evaluation Measures for Classification Techniques

UNIT – V

Unsupervised Learning: Uses in Clustering, associations and dimensionality reduction Clustering, Hierarchical Agglomerative Clustering, k-means Algorithm

Text Books:

1. Machine Learning, Tom Mitchell, McGraw-Hill international editions, TMH, (ISBN: 0071154671)
2. Pattern Recognition and Machine Learning C. Bishop, Springer, (ISBN: 9781493938438)
3. Elements of Artificial Neural Networks , Kishan Mehrotra, Chilukuri Mohan and Sanjay Ranka, Penram International, (ISBN: 9780262133289).

Reference Books:

1. Pattern Recognition, Techniques and Applications , Rajjan Shinghal, OXFORD Higher Education , (ISBN:9780195676853)
2. Andrew Kelleher, Adam Kelleher, Applied Machine Learning for Data Scientist and Software engineers, Addison-Wesley Professional, (ISBN:9780134116549)

Web Links:

1. https://onlinecourses.nptel.ac.in/noc21_cs24/preview/
2. https://www.udemy.com/course/machinelearning/

VALUE EDUCATION

Course Code: 242AC001	L	T	P	C
	3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

- **CO1:** Understand value of education and self- development.
- **CO2:** Explain the need of good values in students
- **CO3:** Developing the overall personality
- **CO4:** Explain the need of character in a student.

Mapping of Course Outcomes with Program Outcomes:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1:	2	1	-	-	2	-
CO2:	3	2	1	1	3	-
CO3:	3	3	2	2	2	-
CO4:	2	1	1	1	2	-

Mapping of Course Outcomes with Program Specific Outcomes:

	PSO1	PSO2
CO1:	-	-
CO2:	-	-
CO3:	-	-
CO4:	-	-

UNIT – I

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

UNIT – II

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

UNIT – III

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship.

UNIT – IV

Happiness Vs suffering, love for truth, Aware of self- destructive habits, Association and Cooperation, Doing best for saving nature.

UNIT – V

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

Text Books:

1 Chak ro borty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi. (ISBN: 9780195643077)

Reference Books:

1. Value Education and Professional Ethics by R.P. Shukla ISBN: 978-8183560995
2. Value Education: A Textbook for Schools by Dr. N. Venkataiah ISBN: 978-8120731965
3. Value Education: Theory and Practice by G. Rajagopal ISBN: 978-8182475191

Web Links:

1. https://nptel.ac.in/courses/109/104/109104068/
2. https://nptel.ac.in/courses/109/105/109105116/
3. https://nptel.ac.in/courses/109/104/109104107/

RESEARCH METHODOLOGY

Course Code: 242AC002

L	T	P	C
3	0	0	3

Course Outcomes: At the end of the Course, Student will be able to:

CO1: Explain the characteristics and process of research.
CO2: Choose the research problem by applying problem identification techniques.
CO3: Develop and execute research design process.
CO4: Show the results of research process adhering to professional ethics..
CO5: Analyze the results of research using statistical measures of central tendency & coefficient of variation, correlation and regression

Mapping of course outcomes with program outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1			2	
CO2	3	2	1	1	3	
CO3	3	3	2	2	2	
CO4	2	1	1	1	2	
CO5	3	2	2	2	2	

Mapping of Course Outcomes with Program Specific Outcomes:

CO/PSO	PSO1	PSO2
CO1	-	-
CO2	-	-
CO3	-	-
CO4	-	-
CO5	-	-

UNIT – I:
Meaning of Research: Function of Research - Characteristics of Research – Steps involved in Research – Research in Pure and Applied Sciences - Inter Disciplinary Research. Factors which hinder Research – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature review.

UNIT – II:
Identification of Research Problem: Selecting the Research problem – Necessity of defining the problem – Goals and Criteria for identifying problems for research. Perception of Research problem – Techniques involved in defining the problem.

UNIT – III:
Research Design: Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design.

UNIT – IV:
Interpretation and Report Writing: Meaning and Technique of interpretation – Precautions in interpretation, Significance of report writing – Different steps in writing a report – Layout of a Research report.

UNIT – V:
Statistical Techniques and Tools: Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete serious and continuous serious) – Correlation – Regression.

Text Books:
1. Research Methodology Methods & Techniques, C.R. Kothari – New Age international Publishers ISBN: 9789386649225
2. A Hand Book of Methodology of Research, Rajammall, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press.ISBN: 9780367135720

Reference Books:
1. Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd.ISBN: 9780471339274
2. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi. ISBN: 9788120343818
3. Fundamentals of Mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi.ISBN: 9788180545283

Web Links:
1. https://nptel.ac.in/courses/127106227
2. https://www.coursera.org/learn/research-methodologies

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