COEP Technological University, Pune

(A Unitary Public University of Govt. of Maharashtra)

NEP 2020 Compliant

Proposed Curriculum Structure

M. Tech. (Mechanical Engineering)
Specialization: Thermal Science and Energy Systems

(Effective from: A.Y. 2024-25)

PG Program [M. Tech. (Mechanical Engineering) Specialization: Thermal Science and Energy Systems]
Proposed Curriculum Structure
W. e. f. AY 2024-25

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5.9%
PSBC	Program Specific Bridge Course	1	3	4.4%
PEC	Program Specific Elective Course	3	9	13.2%
MLC	Mandatory Learning Course	2	0	0%
PCC	Program Core Course	6	22	32.4%
LC	Laboratory Course	2	2	2.9%
OE	Open Elective	1	3	4.4%
AEC	Ability Enhancement Course	1	1	1.5%
SLC	Self Learning Course	2	6	8.8%
VSEC	Vocational and Skill Enhancement Course	2	18	26.5%
Total		21	68	100

PG Program [M. Tech. (Mechanical Engineering) Specialization: Thermal Science and Energy Systems]
Proposed Curriculum Structure

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	PSMC	PSMC -MHP-24001	Applied Numerical Methods with C ++	3	1	--	4
2.	PSBC	PSBC -MHP-24001	Advanced Thermodynamics	3	0	--	3
3.	PEC	PEC-MHP-24001 PEC-MHP-24002 PEC-MHP-24003	Program Specific Elective Course –I 1. Energy Conservation and Management 2. Design of Thermal Systems 3. IC Engine Combustion and Pollution	3	--	--	3
4.	PCC	PCC -MHP-24001	Fluid Dynamics	3	--	--	3
5.	PCC	PCC -MHP-24002	Advanced Heat Transfer	3	--	--	3
6.	PCC	PCC -MHP-24003	Low Temperature Energy Systems	3	--	--	3
7.	LC	LC -MHP-24001	Thermal Engineering Lab Practice	--	--	6	3
Total				**21**	**1**	**6**	**22**

Open Elective (OE): Every department shall offer one OE course (in Engineering/Science/Technology). A student can opt for an OE course offered by a department except the one offered by his /her department.

PG Program [M. Tech. (Mechanical Engineering) Specialization: Thermal Science and Energy Systems]
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Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	OE	OE-MHP-24001	Interdisciplinary Open Course	3	--	--	3
2.	PEC	PEC-MHP-24003 PEC-MHP-24004	Program Specific Elective Course –II 1. Solar and Wind System Design 2. Renewable Energy Systems 3. Cooling of Electronic System	3	--	--	3
3.	PEC	PEC-MHP-24005 PEC-MHP-24006	Program Specific Elective Course –III 1. Micro-fluidics 2. Air Conditioning System Design 3. Energy and Environment	3	--	--	3
4.	MLC	MLC-MHP-24001	Research Methodology and Intellectual Property Rights	2	--	--	--
5.	MLC	MLC-MHP-24002	Effective Technical Communication	1	--	--	--
6.	AEC	AEC-MHP-24001	Liberal Learning Course	1	--	--	1
7.	PCC	PCC -MHP-24004	Computational Fluid Dynamics	3	--	--	3
8.	PCC	PCC -MHP-24005	Heat Exchanger Design	3	--	--	3
9.	PCC	PCC -MHP-24006	Gas turbines and Jet Propulsion	3	--	--	3
10	LC	LC -MHP-24002	Energy System Lab Practice	--	--	6	3
Total				**22**	**0**	**6**	**22**

Following OE courses are offered to other programs:
1. Mechanics of Composite Materials
2. Finite Element Method

- Exit option to qualify for **PG Diploma in Thermal Science and Energy Systems**:
  - Eight weeks domain specific industrial internship in the month of June-July after successfully completing first year of the program.

PG Program [M. Tech. (Mechanical Engineering) Specialization: Thermal Science and Energy Systems]

Proposed Curriculum Structure

Semester-III

Sr. No.	Course Type	CourseCode	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	VSEC	VSEC -MHP-24001	Dissertation Phase – I	--	--	18	9
2.	SLC	SLC-MHP-24001	Massive Open Online Course –I	3	--	--	3
Total				**3**		**18**	**12**

- **MOOC Courses:**
  - ✓ The MOOC Course must be from NPTEL of minimum 12 weeks duration.
  - ✓ Generally the selected course should be in line with specializations or project needs.

Semester-IV

Sr. No.	Course Type	CourseCode	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	VSEC	VSEC -MHP-23002	Dissertation Phase – II	--	--	18	9
2.	SLC	SLC-MHP-23002	Massive Open Online Course -II	3	--	--	3
Total				**3**		**18**	**12**

- **MOOC Courses:**
  - ✓ The MOOC Course must be from NPTEL of minimum 12 weeks duration.
  - ✓ Generally the selected course should be in line with specializations or project needs.

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(PSMC- MHP-24001) Applied Numerical Methods with C ++

Teaching Scheme

Lectures: 3 hrs/week, Tutorial:1hr/week

Examination Scheme

T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. remember basics of numerical methods.
2. understand basic concepts of numerical differentiation and integratio interpolation.
3. find numerical solutions to ordinary differential equations PDEs, algebraic ar transcendental equations.
4. compare numerical solutions obtained by analytical methods with solutio obtained by C++ and MATLAB programs.
5. write C++ and MATLAB program and run it in the laboratory for the given data.

Syllabus Contents:

Prerequisites: Concepts of programming: Revision of Coding languages such as C++ , Introduction to Mathematical Modeling

Unit I : Finding roots of equations: Numerical Solution of Algebraic and Transcendental equations: Bisection Method, Secant Method, Regula-Falsi Method, Newton-Raphson Method, Successive Approximation Method, Applications. [4L+2T]

Unit II: Interpolation and Extrapolation: Langrange's Interpolation, Newton's forward, backward and central difference method, divided difference method, Inverse Interpolation,
Curve Fitting: least square criteria- 1st and 2nd Degree, Applications. [5L+2T]

Unit III: Numerical Differentiation, Integration:
Numerical Differentiation: Forward, Backward and Central Difference Methods, Applications.
Numerical integration: Trapezoidal Rule, Simpson 1/3rd and 3/8th Rule, Weddle's Rule, Gauss Quadrature - Two and Three Point Formula, Double Integration, Applications.

[7L+4T]

Unit IV: Numerical Solution of linear equations: Solution of linear simultaneous equations: Homogeneous/Non-homogeneous systems, Gauss Elimination, Gauss Jordon, Gauss-Seidel Methods, LU- Decomposition, Cholesky Method, Applications. [4L+4T]

Unit V: Numerical Solution of ODEs and PDEs

Numerical Solution of Ordinary Differential Equation: Taylor Series Method, Euler Method, Modifie

Euler Method, Runge Kutta 2nd and 4th order method, Simultaneous Differential Equations ar Second Order Differential Equations, Applications, predictor-corrector methods and Boundary valu problems, Linear PDEs by finite differences,
Project: Programming projects based on mathematical modeling and application of appropria numerical methods [8L+6T]

Text Books:

- Numerical Methods for Engineers; Steven C. Chapra and Raymond P. Canale, 7th edition, McGraw-Hill, 2014.
- Introduction to Numerical Analysis, S.S. Sastry; Prentice Hall of India, 2012.
- Numerical Methods for Engineers, Santhosh .K. Gupta, New Age International; 2012.
- Applied Numerical Methods for Digital Computation , M.L. James, G.M. Smith & J.C. Wolford, Harper- Collins College Division; 4th edition, 1993.

Reference Books:

- Balagurusamy, E., Numerical Methods, Tata McGraw Hill Publication.
- Rajaraman, V., Computer Oriented Numerical Methods, Prentice Hall of India Ltd.
- Sastry, S. S., Introductory Methods of Numerical Analysis, Prentice Hall of India Ltd.
- Jain, M.K., Iyengar, S.R.K. and Jain, R.K., Numerical Methods for Scientific and Engineering Computations, 5th Ed., New Age International Ltd.
- Rajasekaran, S., Numerical Methods in Science and Engineering – A practical Approach, S. Chand and Co. Ltd.
- Rao, S.S., Optimization Theory and Applications, New Age International Ltd.

Note :

- To measure CO1, questions may be of the type- define, identify, state, match, list, name etc.
- To measure CO2, questions may be of the type- explain, describe, illustrate, evaluate, give examples, compute etc.
- To measure CO3, questions will be based on applications of core concepts.

- To measure CO4, questions may be of the type- true/false with justification, theoretical fill in the blanks, theoretical problems, prove implications or corollaries of theorems, etc.
- To measure CO5, some questions may be based on self-study topics and also comprehension of unseen passages.

(PSBC- MHP-24001) Advanced Thermodynamics

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, the students will be able to:

1. Apply the 1st Law for steady and transient systems.
2. Apply the 2nd Law for cyclic systems
3. Analyze multi-components systems.
4. Analyze exergy, availability, and irreversibility in closed and open thermodynamic systems
5. Apply mass, energy, entropy, and availability balance equations for closed and open thermodynamic systems
6. Derive and apply thermodynamic relations between the measurable and non-measurable properties.
7. Determine adiabatic flame temperature
8. Appreciate importance of non-equilibrium thermodynamics

Syllabus Contents:

- **Recapitulation of Fundamentals, Maxwell equations**
  Laws of Thermodynamics, First Law Analysis of Closed Systems and Open Systems, Thermodynamic behavior of real gases.
- **Second Law Analysis of Thermodynamic Systems**
  Introduction, Thermodynamic availability, Second Law Analysis of Closed Systems and Open Systems
- **Thermodynamic relationships.**
  Mathematical preliminaries, Gibbs equations and Maxwell Relations, General Equations for internal energy, enthalpy, entropy and specific heats, other thermodynamic relations
- **Thermodynamics of Chemical reactions**
  Introduction, conservation of mass, theoretical combustion process, actual combustion process, enthalpy of formation, enthalpy of combustion and heating values, adiabatic flame temperature.
- **Elements of equilibrium and non-equilibrium thermodynamics**

References:

1. William Z. Black and Jems G. Hartley, "Thermodynamics", Pearson, 3rd Edition. ISBN 9788131733165
2. Lynn D. Russell and George A. Adebiyi, "Engineering Thermodynamics", Oxford Publication, 2010, ISBN-10: 0-19-568905-4
3. Howell and Dedcius, "Fundamentals of Engineering Thermodynamics", McGraw Hill Inc., U.S.A.
4. Van Wylen & Sonntag, "Thermodynamics", John Wiley and Sons Inc., U.S.A.
5. Jones and Hawkings, "Engineering Thermodynamics", John Wiley and Sons Inc.,

U.S.A, 2004.
6. Faires V.M. and Simmag, “Thermodynamics”, Macmillan Publishing Co. Inc., U.S.A.
7. Rao Y.V.C., “Postulational and Statistical Thermodynamics”, Allied Publishers Inc, 1994.

PEC-MHP-24001 Energy Conservation and Management

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able

1. Analyze national and international energy scenarios
2. Generate scenarios of energy consumption and predict the future trend
3. Suggest and plan energy conservation solutions

Syllabus Contents:

Introduction: Global Energy Scenario and Indian Energy Scenario in various sectors and Indian economy. Concerns of Energy Security in India
Basics – Revision of basics of Electrical and Mechanical Engineering relevant to Energy conservation and Management, Definitions of units, conversions in commercial practices Sankey Diagrams, Specific Energy consumption
Economic Analysis : Simple Payback Period, Return on Investment, Dynamic value of money, Discount Rate Cash flows, Time value of money, Formulae relating present and future cash flows - single amount, uniform series; Payback period; Return on Investment (ROI); Life Cycle cost.
Costing of Utilities – specific costs of utilities like; all fuels steam, compressed air, electricity, water etc.
Energy Auditing : Elements and concepts, Types of energy audits, methodology, Instruments used in energy auditing; Portable and On-line instruments; Role of Non-Conventional Energy Sources in Energy Conservation; Need and Kyoto Protocol, Carbon Credits and Clean Development Mechanism (CDM).
Fuels – Solid, Liquid and gaseous, Combustion, Excess air requirements, Flue gas monitoring
Boilers–Performance testing, efficiencies, and energy conservation opportunities
Steam Systems– Aspects of steam distribution, Steam Traps, Condensate and Flash-steam utilization, Energy conservation opportunities, Thermal Insulation
Mechanical Systems: Energy Conservation Opportunities in compressed air systems, Refrigeration and air-conditioning system and water systems, Elementary coverage of Energy conservation in pumps and fans Cogeneration-concept, options(steam/gas, turbine/DCT-based), Selection criteria, Trigeneration
Electric System: Demand control, Demand Side Management (DSM), Power Factor Improvement, benefits and ways of improvement, Load scheduling, Electric motors, losses, efficiency, energy-efficient motors, motor speed control, variable speed drive. Lighting: Illumination levels, fixtures,

timers, energy- efficient illumination.

Text Books:

1. Energy Manager Training Manual (4 Volumes) available at a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.
2. S Rao and B BParulekar ,” Energy Technology’ Khanna Publishers, 1999
3. B.G. Desai, M.D.Parmar, R.Paraman and B.S. Vaidya, “Efficient Use of Electricity in Industries” ECQ serriesDevki R & D. Engineers, Vadodara

Reference Books

4. Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilization” Hemisphere Publication, Washington, 1988.
5. D.A. Ray: Industrial Energy conservation. Pergamon Press
6. W.C. Turner, editor: Energy Management handbook (Willey)
7. Patrick Steven R., Patric Dale R. , and Fordo Stephen : Energy conservation Guide book, The Fairmont Press Inc.7.
8. F. William Payne and Richard E. Thompson: Efficient Boiler Operation Source Book.
9. Albert Thumann: Plant Engineers and managers Guide to Energy conservation

PEC-MHP-24002 Design of Thermal Systems

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able to

1. Understand the basic principles of thermal design
2. Apply the basic modeling knowledge about subjects of applied thermodynamics and heat transfer to the devices such as heat exchangers, evaporators, condensers, boilers, condensation of binary mixtures and turbo machinery
3. Construct the simulation of thermal systems
4. Understand the basic of optimum system design

Syllabus Contents:

1. Fundamentals of engineering design. Economic analysis. Equation fitting. Solution of linear and nonlinear equation sets. Cost analysis.
2. Fundamentals of design, and selection of thermal equipment and processes such as heat exchangers, evaporators, condensers, boilers, binary mixtures and turbo machinery.
3. Mathematical modeling of thermal equipment.
4. Simulation of thermal systems.
5. Fundamentals of optimum system design. Optimization methods and optimization of thermal systems.

References:

1. Stoker W. F., Design of Thermal Systems, McGraw Hill

PEC-MHP-24003 IC Engine Combustion and Pollution

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able to

1. Understand the thermo-chemistry of Fuel-air mixtures, Thermodynamic analysis of IC engines and models used in IC engines.
2. Understand gas exchange process, combustion in SI engines.
3. Understand the combustion in diesel engines
4. Identify the nature and extent of the problem of pollutant formation and control and modern developments in IC engines.

Syllabus Contents:

Thermochemistry of Fuel-air mixtures, Properties of working fluids, chemical kinetics, First law analysis, Availability analysis of engine processes. Conceptual SI engine combustion models, features of SI engine combustion processes Thermodynamic analysis of SI engine combustion, Flame structure and speed, abnormal combustion. Features of CI engine combustion process, conceptual CI engine combustion models, combustion process characterization. Fuel injection, spray structure, atomization, penetration, drop size distribution, spray evaporation. Ignition delay, factors affecting delay. Mixing controlled combustion, heat release rates, effect of engine design variables, swirl, injection rates. Thermodynamic analysis of CI engine combustion. Supercharging of SI & CI engines and its limitations, methods of supercharging, supercharging arrangements , turbochargers , methods of turbo charging & its limitations.

Air Pollution - Sources and nature of various types of pollutants, Pollutant formation, control, Pollution monitoring instruments and techniques. Modern developments in IC Engines, EGR, MPFI, HCCI, Gasoline Direct Injection. Alternative fuels to reduce emissions: Alcohols, natural gas, biodiesel, hydrogen.

References:

1. H.B. Heywood, “Fundamentals of I.C. Engines”, McGraw Hill, 1988.
2. C.F. Taylor, “I.C.Engine Theory and Practices”, Vol.I & II, MIT Press, 1985
3. Mathur and Sharma, “I.C.Engine”, Dhanpat Rai and Sons, 2006.
4. Ganeshan, “Fundamentals of I.C.Engine”, Tata McGraw Hill, 2006.

PCC-MHP-24001 Fluid Dynamics

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the Students shall be able

1. Understand and define the fluid flow problems along with range of governing parameters
2. Take up the fluid flow problems of industrial base.
3. Devise the experiments in the field of fluid mechanics.
4. Understand the flow patterns and differentiate between the flow regimes and its effects.

Syllabus Contents:

- **Governing equations in Fluid Dynamics:** Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities
- **Exact Solutions of Navier-Stokes Equations:** Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows
- **Potential Flow:** Kelvin's theorem, Irrotational flow, Stream function-vorticity

approach,

- **Laminar Boundary layers:** Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations
- **Turbulent Flow:** Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution
- **Experimental Techniques:** Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry

References:

1. Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha Science International, 2005
2. Irwin Shames, Mechanics of Fluids, , McGraw Hill, 2003
3. Fox R.W., McDonald A.T , Introduction to Fluid Mechanics, John Wiley and Sons Inc, 1985
4. Pijush K. Kundu, Ira M Kohen and David R. Dawaling, Fluid Mechanics, Fifth Edition, 2005

PCC-MHP-24002 Advance Heat Transfer

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able to

1. Understand the fundamental governing equations of conduction, convection and radiation
2. Account for the consequence of heat transfer in thermal analyses of engineering systems
3. Evaluate heat transfer coefficients in forced convection for internal and external flows.
4. Calculate radiation heat transfer between black body surfaces and gray body surfaces.

Syllabus Contents:

- Steady and transient conduction- one and two dimensional
- Fins, conduction with heat source, unsteady state heat transfer
- Natural and forced convection, integral equation, analysis and analogies,
- Transpiration cooling, ablation heat transfer, boiling, condensation and two phase flow mass transfer, cooling, fluidized bed combustion,

- Heat pipes, Radiation, shape factor, analogy, shields,
- Radiation of gases & vapours.

References:

1. J.P. Holman, "Heat Transfer", McGraw Hill Book Company, New York, 1990.
2. Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, NewYork, 2000.
3. Frank Kreith, "Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
4. Donald Q. Kern "Process Heat Transfer", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.
5. Gupta and Prakash, "Engineering Heat Transfer", New Chand and Bros, Roorkee (U.P.) India, 1996.
6. R.C. Sachdeva "Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern Ltd., India,

PCC-MHP-24003 Low Temperature Energy System

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week, Tutorial:1hr/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will be able to:

1. Understand basics of refrigeration and cryogenics and its application areas
2. Design the refrigeration systems for domestic and industrial applications like cold storages
3. Demonstrate knowledge about ODP, GWP and related environmental issues

Syllabus Contents:

- Vapour compression refrigeration, actual cycle, second law efficiency,
- Multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems,
- Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor,
- Design, selection of evaporators, condensers, control systems, motor selection,
- Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations,
- Refrigeration applications, food preservation, transport,
- Introduction to Vapor absorption refrigeration, single effect and double effect systems,

- Gas liquefaction systems - Linde-Hampson, Linde dual pressure, Claude cycle.

References:

1. R.J.Dossat, “Principles of Refrigeration”, Pearson Education Asia, 2001.
2. C.P.Arora, “Refrigeration and Air-conditioning”, Tata McGraw-Hill, 2000.
3. Stoecker & Jones, “Refrigeration and Air-conditioning”, McGraw Hill Book Company, New York, 1982.
4. Jordan &Priester, “Refrigeration and Air-conditioning”.
5. A.R.Trott, “Refrigeration and Air-conditioning”, Butterworths, 2000.
6. J.L.Threlkeld, “Thermal Environmental Engineering”, Prentice Hall, 1970.
7. R.Barron, “Cryogenic systems”, McGraw–Hill Company, New Yourk, 1985.
8. G.G.Hasseldon. “Cryogenic Fundamentals”, Academic Press.
9. Bailey, “Advanced Cryogenics”, Plenum Press, London, 1971.
10. W.F.Stoecker, “Industrial Refrigeration Handbook”, McGraw-Hill, 1998.
11. John A.Corinchock, “Technician’s Guide to Refrigeration systems”, McGrawHill.
12. P.C.Koelet, “Industrial Refrigeration: Principles, Design and Applications”, Macmillan, 1992.
13. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.
14. Graham Walker, “Miniature Refrigerators for Cryogenic Sensors and Cold Electronics”, Clarendon Press, 1989

LC -MHP-24001 Thermal Engineering Lab Practice

Teaching Scheme
Practical: 6 hrs/week,

Examination Scheme
Internal Continuous Assessment - 50

Course Outcomes:
At the end of the course, students will be able to: 1. Apply the fundamental understanding of fluid dynamic concepts to the practical problems 2. Design the refrigeration systems for domestic and industrial applications like cold storages 3. Carry out the temperature measurements for determination of heat transfer coefficients
Syllabus Contents:
• Students are expected to carry out at least 6 practical assignments (Minimum two from courses on fluid dynamics, advanced heat transfer, and refrigeration and cryogenics

Open Elective

OE-MHP-24001 Mechanics of Composite Materials

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

The student should be able to

1. Student will be able to understand the basic concepts and difference between composite materials with conventional materials.
2. Students will be able to understand role of constituent materials in defining the average properties and response of composite materials on macroscopic level.
3. Students will be able to apply knowledge for finding failure envelopes and stress-strain plots of laminates.
4. Students will be able to develop a clear understanding to utilize subject knowledge using computer programs to solve problems at structural level.

Syllabus Contents:

Introduction

Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus

Basic Concepts and Characteristics

Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials

Elastic Behavior of Unidirectional Lamina

Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters

Strength of Unidirectional Lamina

Micromechanics of failure; failure mechanisms, Macromechanical strength parameters, Macro-mechanical failure theories, Applicability of various failure theories

Elastic Behavior of Laminate

Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates

Hygrothermal Effects

Hygrothermal effects on mechanical behavior, Hygrothermal stress-strain relations, Hygro-thermoelastic stress analysis of laminates, Residual stresses, Warpage

Stress and Failure Analysis of Laminates

Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials

References:

1. Isaac M. Daniels, Ori Ishai, "Engineering Mechaincs of Composite Materials", Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fiber composites", John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "Composite Materials: Engineering and Science", CRC Press, Boca Raton, 2003.
4. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press, 2004.
5. Mazumdar S. K., "Composaite Manufacturing – Materials, Product and Processing Engineering", CRC Press, Boca Raton, 2002.
6. Robert M. Jones, "*Mechanics* of Composite Materials", Taylor and Francis, Inc., 1999.

OE-MHP-24002 Finite Element Method

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The student will be able to classify a given problem on the basis of its dimensionality as 1-D, 2-D, or 3-D, time-dependence as Static or Dynamic, Linear or Non-linear.
2. The students will be able to develop system level matrix equations from a given mathematical model of a problem following the Galerkin weighted residual method or principle of stationary potential.
3. While demonstrating the process mentioned in 2 above, he will be able to identify the primary and secondary variables of the problem and choose correct nodal degrees of freedom and develop suitable shape functions for an element, implement Gauss-Legendre scheme of numerical integration to evaluate integrals at element level, and assemble the element level equations to get the system level matrix equations. He will also be able to substitute the essential boundary conditions correctly and obtain the solution to system level matrix equations to get the values of the field variable at the global nodes.
4. The student will be able to state three sources of errors in implementing FEM and suggest remedies to minimize the same for a given problem, viz. Modelling errors, Approximation errors, and numerical errors.
5. The student will be able to obtain consistent and lumped mass matrices for axial vibration of bars and transverse vibration of beams and obtain fundamental frequency of natural vibration using the methods mentioned in the curricula.
6. The students will be able use MATLAB for implementation of FEM to obtain elongations at nodes of a bar subjected to traction and concentrated loads and prescribed boundary conditions
7. The students will be able to use commercial software like ANSYS or ABAQUS for implementation of FEM to obtain stress concentration due to a small hole in a rectangular plate subjected to traction on edges and concentrated loads at points on the edges and prescribed boundary conditions.

Syllabus Contents:

Introduction, Classification of problems – Dimensionality, time dependence, Boundary Value problems, Initial value problems, Linear/Non-linear, etc, Differential equation as the starting point for FEM, steps in finite element method, discretization, types of elements used, Shape functions,

Linear Elements, Local and Global coordinates, Coordinate transformation and Gauss-Legendre scheme of numerical integration, Nodal degrees of freedom,

Finite element formulation, variational, weighted residual and virtual work methods, 1-D and 2-D problems from Structural Mechanics – Bar and Beam problem,

Plane stress and plane strain problems, Axi-symmetric problems – Axi-symmetric forces and geometry, computer implementation, higher order elements, iso-parametric formulation,

Eigen-value problems, Natural axial vibration of bars and transverse vibration of beams, Methods to find eigen-values and eigen-vectors.

References:

1. Chandrupatla and Belegundu "Introduction to finite elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, 2001.
2. Logan Deryl L., "A First Course in Finite Element Method", Thomson Brook/Cole, 3rd ed. 2002
3. Cook R.D. "Concepts and applications of finite element analysis" Wiley, New York, 1981.
4. Reddy J N, "Finite element Method", Tata McGraw Hill publishing Co Ltd, New Delhi, Ed. 2, 2003
5. Bathe K.J., Cliffs, N.J. "Finite Element Procedures in Engineering Analysis", Englewood. Prentice Hall, 1981.

Program Specific Elective Course –II

PEC-MHP-24004 Solar and Wind System Design

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able to

1. Demonstrate significance of analysis of solar and wind sources and design technologies of their Utilization
2. Confidently estimate the potential of solar and wind resources through numerical Assignments

3. Understand economics of Solar and Wind power plants
4. Expose themselves to conceptualize and design renewable energy appliances and equipment
5. Enable them to independently analyze, implement and asses the real life systems
6. Develop a research insight about solar and wind energy technologies so as to motivate all concerned for enhanced deployment of renewable energy option

Syllabus Contents:

Introduction: Solar radiation fundamentals, review of solar thermal applications and devices, Indian Standards for FPC, Characterization of Flat plate collectors, Design and Performance estimation of solar water and air heating systems, modern design and simulation methods, intelligence economic analysis of solar systems

Medium and high temperature applications of Solar Thermal Energy – Concentrating collectors, classification, types and suitability, tracking, Performance evaluation point of focusing, line focusing collectors, Industrial Process heating systems, Solar thermal power generation-technologies, Thermodynamic cycles, Storage issues and challenges in the commercialization.

Solar Photovoltaic Conversion- Review of Basics of Photovoltaic Technology, Fill Factor, Impact of Temperature and Shading on the performance of a PV modules, shading correction, MPPT, NOCT, Design of Standalone and grid connected Solar Photovoltaic arrays and systems, BOS

Wind power systems

History and types of wind machines, Terminology, Dimensional analysis, Principles of Aerodynamics of wind turbine blade, Maximum rotor efficiency (Betz Limit), Power output from practical wind turbine generators, Concept of Load matching.

Wind Resource analysis

.Average power in wind, Wind speed statistics, Wind speed distribution, Wind shear, Wind measurement instrumentation, Wind data analysis, tabulation, Wind resource estimation.

Wind turbine Generators, Control and hybrid systems

Generators and control systems, On-grid and off grid wind power plants, sizing of wind based off grid systems, wind-PV hybrid, wind-diesel hybrid

References:

1. KalogirouSoteris A. Solar energy Engineering Process and Systems, Academic Press Amsterdam, 9th Edition, 2009
2. Sukhtme, J. K. Nayak, Solar Energy Principles of Thermal Collection and Storage, Tata McGraw Hill
3. Duffie John A.and Beckman William A., Solar Engineering of Thermal Processes, John Wiley and Sons, Inc. Second Edition, 1991
4. Gilbert Masters, Renewable and Efficient Power Systems, Wiley Inter-science, John Wiley and Sons. Inc. ,2004
5. Tiwari G. N. and Ghosal M. K. Fundamentals of Renewable Energy Sources, by, Narosa Publishing House
6. V.V. N. Kishore, Editor, Renewable Energy Engineering and Technology, A knowledge Compendium, The Energy and Resources Institute, New Delhi, 2008
7. G. L. Johnson, Wind Energy Systems, Prentice Hall, New York, 1985.
8. S. N. Bhadra, D. Kastha, Soumitro Banerjee, Wind Electrical Systems, Oxford University Press, USA
9. S. Mathew, Wind Energy : Fundamentals, Resource Analysis and Economics, Springer-Verlag Berlin Heidelberg

PEC-MHP-24005 Renewable Energy Systems

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able to

1. Analyze the performance of solar energy conversion systems.
2. Performance analysis of various wind energy conversion systems.
3. Compare various bio-energy conversion methods
4. Explore various ocean energy resources such as tidal, wave and ocean thermal energy and geothermal energy systems.

Syllabus :

Introduction: Energy demand growth and supply: Historical Perspectives, Fossil fuels, Consumption and Reserve; Environmental Impacts of Burning of Fossil fuels. Sustainable development and role of renewable energy sources. Solar Energy: The Sun as energy source and its movement in the sky. Solar energy received on the earth; Primary and Secondary Solar energy and Utilization of Solar Energy. Solar concentrators and tracking; Dish and Parabolic trough concentrating generating systems, Central tower solar thermal power plants; Solar ponds. Photovoltaic cells. Wind Energy: Types of turbines, Coefficient of Power, Betz limit, Wind electric generators, Power curve; wind characteristics and site selection; Potential of wind electricity generation in India and its current growth rate. Biomass Energy: Biomass: Sources and Characteristics; Wet biogas plants; Biomass gasifiers: Classification and Operating characteristics; Updraft and Downdraft gasifiers; Gasifier based electricity generating systems. Ocean Energy: Tidal power plants: single basin and double basis plants, Variation in generation level; Ocean Thermal Electricity Conversion (OTEC); Power generation from Waves: Shoreline and Floating wave systems. Geothermal Energy: Conversion technologies- Steam and Binary systems; Geothermal power plants.

Textbook/References:

1. G.D Rai, “Non-Conventional Energy Source”, Khanna Publishers,2008.
2. D.O. Hall and R.P. Overend, “Biomass Regenerable Energy”, John Wiley and Sons, New York, 1987. 11
3. Freris L.L, “Wind Energy Conversion Systems”, Prentice Hall1990
4. John W. Twidell and Anthony D.Weir, “Renewable Energy Resource”, Taylor & Francis, 2006.
5. Sukhatme, S.P. and Nayak, J.K., “Solar Energy - Principles of Thermal Collection and Storage”, Tata McGraw Hill, New Delhi, 2008.
6. John A. Duffie, William A and Beckman “Solar Engineering of Thermal Processes” Fourth Edition, Wiley,2013

PEC-MHP-24006 Cooling of Electronic System

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able to

1. Understand the heat transfer mechanisms of electronic cooling systems. and assess their capability and applicability
2. Describe different cooling techniques and its applications in various domains
3. Analyse new cooling methods in the present scenario and use of commercial tools

Syllabus :

Introduction, objectives of thermal control, heat sources, heat transmission, steady and unsteady heat transfer. Electronic equipment for airplanes, missiles, satellites, spacecraft, ships, submarines, personal computers, microcomputers and microprocessors. Cooling techniques: i) air cooling-natural cooling ii) air cooling-forced convection iii) liquid cooling.Thermal contact conductance, fundamentals of heat transfer across an interface, real contact area, applications to microelectronics, enhancement of contact conductance. Extended surface arrays for air cooled systems, parameterizations, the fin input admittance, the limitations of the fin efficiency, Introduction to impinging jet theory, description of the principal flow regimes, single nozzle and multi-nozzle test rig, Taxonomy of liquid jet impingement conditions. Unconfined: free surface and submerged jets, semi confined, submerged jets. Heat transfer for unconfined free-surface and submerged jets i) circular ii) planar jets. Multiple impinging jets. Synthetic jets design and measurement approaches, enhancing heat transfer with synthetic jets (free and forced convection). Introduction to heat pipe, working principle, thermal performance, design, thermal resistance considerations, types of heat pipes, cylindrical, flat, micro and oscillating heat pipes.

Textbook/References:

1. Kakac Sadik, Yuncu Hafit, Hijikata, K. “Cooling of Electronic systems”, Springer Science+ Business Media, Dordrecht, 1994.
2. Dave S. Steinberg “Cooling Techniques for Electronic Equipment”, John Wiley and sons Inc, Canada, 1991
3. S M Sohel Murshed “Electronics Cooling”, ExLi4EvA, 2016
4. Madhusudan Iyengar, Karl J L Geisler, Bahgat Sammakia “Cooling of Microelectronic and Nanoelectronic Equipment: Advances and Emerging Research”, WSPC ltd, Singapore, 2015
5. Bahman Zohuri “Heat pipe Design and Technology”, Taylor and Francis ltd, U.S., 2011

Program Specific Elective Course–III

PEC-MHP-24007 Micro-fluidics

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course students will be able to:

1. Understand the fundamentals of the physics of flows at micro-levelin terms of Knudsen number
2. Mathematically model the micro scale flow including boundary conditions
3. Solve the flow problems in case of capillary flow
4. Explain and apply fundamentals of electro-kinetics to the flow problems

Syllabus Contents:

Introduction:
Origin, Definition, Benefits, Challenges, Commercial activities, Physics of miniaturization, Scaling laws.

Micro-scale fluid mechanics:
Intermolecular forces, States of matter, Continuum assumption, Governing equations, Constitutive relations. Gas and liquid flows, Boundary conditions, Slip theory, Transition to turbulence, Low Re flows,Entrance effects. Exact solutions, Couetteflow, Poiseuille flow, Stokes drag on a sphere, Time-dependent flows, Two-phase flows, Thermal transfer in microchannels.

Capillary flows:
Surface tension and interfacial energy,Young-Laplace equation, Contact angle, Capillary length and capillary rise, Interfacial boundary conditions, Marangoni effect.

Electrokinetics:
Electrohydrodynamics fundamentals. Electro-osmosis, Debye layer, Thin ED Llimit, Ideal electroosmotic flow, Ideal EOF with back pressure, Cascade electroosmotic micropump, EOF of power-law fluids. Electrophoresis of particles, Electrophoretic mobility, Electrophoretic velocity dependence on particle size. Dielectrophoresis, Induced polarization and DEP ,Point dipole in a dielectric fluid, DEP force on a dielectric sphere, DEP particle trapping, AC DEP force on a dielectric sphere. Electro-capillary effects, Continuous electro-wetting, Direct electro-wetting, Electro-wetting on dielectric.

Microfluidics components:
Micropumps, Check-valve pumps,Valve-less pumps,Peristaltic pumps, Rotary pumps, Centrifugal pumps, Ultrasonic pump, EHD pump, MHD pumps. Microvalves,Pneumatic valves, Thermopneumaticvalves, Thermomechanical valves, Piezoelectricvalves, Electrostaticvalves, Electromagnetic valves, Capillary force valves. Microflow sensors, Differential pressure flow sensors, Drag force flow sensors, Lift force flow sensors, Coriolis flow sensors, Thermal flow sensors. Micromixers, Physics of mixing, Pe-Re diagram of micromixers, Parallel lamination, Sequential lamination, Taylor-Aris dispersion. Droplet generators, Kinetics of a droplet, Dynamics of a droplet, In-channel dispensers, T-junction and Cross-junction, Droplet formation, breakup and transport. Microparticle separator, principles of separation and sorting of microparticles, design and applications. Microreactors, Design considerations, Liquid-phase reactors, PCR, Design consideration for PCR reactors.

Few applications of microfluidics:
Drug delivery, Diagnostics,Bio-sensing.

References:

1. Nguyen, N. T., Werely,S. T., Fundamentals and applications of Microfluidics,Artech house Inc., 2002.
2. Bruus, H., Theoretical Microfluidics, Oxford University Press Inc., 2008.
3. Madou, M. J., Fundamentals of Microfabrication, CRC press, 2002.
4. Tabeling,P., Introduction to microfluidics, Oxford University Press Inc., 2005.
5. Kirby,B.J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices, Cambridge University Press, 2010.
6. Colin,S., Microfluidics, John Wiley & Sons, 2009.

PEC-MHP-24008 Air conditioning system Design

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course students will be able to:

1. Understand construction and design features Air-conditioning system.
2. Apply psychrometry for the practical applications.
3. Design Air conditioning systems.
4. Design seasonal energy efficient systems
5. Design Air conditioning ducts.

Syllabus Contents:

- Air conditioning systems,
- Various air-conditioning processes,
- Enthalpy deviation curve, Psychrometry , SHF, dehumidified air quantity, human comfort, indoor air quality,
- Design conditions and load calculations, air distribution, pressure drop, duct design, fans &, blowers,
- Cooling load estimation for residential and industry applications, designing the AC systems, selection of components, design of ducts.
- Performance & selection, noise control.

References:

1. ASHRAE Handbook.
2. "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co., U.S.A, 1965.
3. "Refrigeration and air-conditioning", ARI, Prentice Hall, New Delhi, 1993.

4. Norman C. Harris, “Modern Air Conditioning”, New York, McGraw-Hill,1974.
5. Jones W.P., “Air Conditioning Engineering”, Edward Arnold Publishers Ltd., London, 1984.
6. Hainer R.W., “Control Systems for Heating, Ventilation and Air-Conditioning”, Van Nostrand
7. Reinhold Co., New York, 1984. 7. Arora C.P., “Refrigeration & Air Conditioning”, Tata Mc Graw Hill, 1985.
8. Manohar Prasad, “Refrigeration & Air Conditioning”, New Age Publishers.
9. Stoecker, “Refrigeration & Air Conditioning”, Mc Graw Hill, 1992.
10. Stoecker, “Design of Thermal Systems”, Mc Graw Hill, 1992.

PEC-MHP-24009 Energy and Environment

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course students will be able to:

1. Understand the types of energy resources and its utilization, Energy scenario, Energy conservation and management.
2. Understand the sources of air pollution, its measurement and control
3. Understand the sources of water, water pollution, its measurement and control and water treatment

Syllabus Contents:

Basics of energy: Types of energy and its utilization; Energy characteristics; Energy scenario - India energy scenario- Energy crisis. Energy conservation. Environment studies: Water cycle - Oxygen cycle - Carbon cycle - Nitrogen cycle - Phosphorous cycle; Bio-diversity. Environmental aspects of energy utilization. Hazards of environmental Pollution. Air Pollution: air pollutants, sources of emission; Air quality standards; Physical and chemical characteristics - Meteorological aspects; Temperature lapse rate and stability. Dispersal of air pollutant - Air pollution dispersion models: sampling and measurement, Analysis of air pollutants. Air Pollution Control methods: Particulate emission control; Gaseous emission control. Water pollution: Sources and hazards, water quality standards; Waste water sampling and analysis; Waste water treatment: Primary treatment - Secondary treatment - Advanced treatment. Feed water treatment. Pollution prevention and control acts; Methodology of Environmental impact assessment, Air and water quality impacts by project type.

References:

1.C. S. Rao, “Environmental Pollution Control Engineering”, Wiley Eastern, 1992.
2. Y. Anjaneyulu, “Air Pollution and Control Technologies”, Allied Publishers, 2002.
3. J. Rau and D.C. Wooten, “Environmental Impact Analysis Handbook”, McGraw Hill, 1980.
4. D.H.T. Liu, “Environmental Engineers Handbook”, Lewis, 1997.
5. James A. Fay and Dan S. Golomb, “Energy and the Environment”, Oxford University Press, 2002.

MLC-MHP-24001 Research Methodology and Intellectual Property Rights

Teaching Scheme	**Examination Scheme**
Lectures: 2hr / week	**Continuous evaluation Assignments/Presentation/Quiz/Test)**

Course Outcomes:

Student will be able to

1. Understand research problem formulation and approaches of investigation of solutions for research problems
2. Learn ethical practices to be followed in research and apply research methodology in case studies and acquire skills required for presentation of research outcomes
3. Discover how IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario
4. Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits

Syllabus Contents:

Unit 1: Fundamentals of Communication **[5 Hrs]**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

Unit 2: Aural-Oral Communication **[5 Hrs]**

Effective literature studies approaches, analysis

Use Design of Experiments /Taguchi Method to plan a set of experiments or simulations or build prototype

Analyze your results and draw conclusions or Build Prototype, Test and Redesign

Unit 3: Reading and Writing **[5 Hrs]**

Plagiarism, Research ethics

Effective technical writing, how to write report, Paper.

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit 4 : **[4Hrs]**

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Unit 5 : **[7Hrs]**

Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act , Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non Provisional Patent Application and Specification, Plant Patenting, Idea Patenting,

Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies

Unit 6: **[4Hrs]**

New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development,

International Scenario: WIPO, TRIPs, Patenting under PCT

References:

1. Aswani Kumar Bansal : Law of Trademarks in India
2. B L Wadehra : Law Relating to Patents, Trademarks, Copyright,
    a. Designs and Geographical Indications.
3. G.V.G Krishnamurthy : The Law of Trademarks, Copyright, Patents and
    a. Design.
4. Satyawrat Ponkse: The Management of Intellectual Property.
5. S K Roy Chaudhary & H K Saharay : The Law of Trademarks, Copyright, Patents
6. Intellectual Property Rights under WTO by T. Ramappa, S. Chand.
7. Manual of Patent Office Practice and Procedure
8. WIPO : WIPO Guide To Using Patent Information
9. Resisting Intellectual Property by Halbert ,Taylor & Francis
10. Industrial Design by Mayall, Mc Graw Hill
11. Product Design by Niebel, Mc Graw Hill

MLC-MHP-24002 Effective Technical Communication

Teaching Scheme
Lectures: 1hr / week

Examination Scheme
100Marks: 4 Assignments (25M each)

Course Outcomes:

Student will be able to

1. Produce effective dialogue for business related situations
2. Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively
3. Analyze critically different concepts / principles of communication skills
4. Demonstrate productive skills and have a knack for structured conversations
5. Appreciate, analyze, evaluate business reports and research papers

Syllabus Contents:

Unit 1: Fundamentals of Communication **[4 Hrs]**
7 Cs of communication, common errors in English, enriching vocabulary, styles and registers

Unit 2: Aural-Oral Communication **[4 Hrs]**
The art of listening, stress and intonation, group discussion, oral presentation skills

Unit 3: Reading and Writing **[4 Hrs]**
Types of reading, effective writing, business correspondence, interpretation of technical reports and research Papers

References:

1. Raman Sharma, "Technical Communication", Oxford University Press.
2. Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge University Press.
3. Mark Hancock "English Pronunciation in Use" Cambridge University Press.
4. Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentise Hall
5. Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non-native speakers of English", McGraw Hill.

AEC-MHP-24001 Liberal Learning Course

PCC -MHP-24004 Computational Fluid Dynamics

Teaching Scheme
Lectures: 3 hrs/week, Tutorial :1hr/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able to

1. Understand and modify the governing equations of fluid flow and heat transfer as per

problem statement

2. Discretize the governing equations using finite volume method
3. Apply the boundary conditions in discretized form
4. Numerically solve the conduction, convection, momentum and energy equation
5. Carry out the post processing of the results to determine engineering parameters

Syllabus Contents:

- **Introduction to CFD:** Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.
- **Governing Equations:** Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy.
- **Finite Volume Method:** Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach
- **Geometry Modeling and Grid Generation:** Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance
- **Methodology of CFDHT:** Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation
- **Solution of N-S Equations for Incompressible Flows:** Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid System and Non Staggered Grid System of N-S Equations for Incompressible Flows

References:

1. Atul Sharma, Introduction to Computational Fluid Dynamics: Development, Application and Analysis, John Wiely and Sons Ltd, 2017
2. Computational Fluid Dynamics, The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series.
3. Numerical Methods in Fluid Flow & Heat Transfer by Dr. SuhasPatankar.
4. An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W.Malalasekera, Printice Hall
5. Computational Methods for Fluid Dynamics by Ferziger and Peric, Springer Publication.
6. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow, Wiley Publication.
7. Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, Narosa Publication.

PCC -MHP-24005 Heat Exchanger Design

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course the students will be able to:

1. select the appropriate heat exchanger
2. estimate fouling rates according to design conditions
3. perform sizing and rating of heat exchangers for complicated designs
4. design, analyze and evaluate heat exchangers and use of commercial software
5. perform optimum design of heat exchangers

Syllabus Contents:

Heat Exchangers – Classification according to transfer process, flow arrangement, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators.

Heat exchanger design methodology, assumption for heat transfer analysis, problem formulation,ϵ-NTU method, P-NTU method, Mean temperature difference method.

Fouling of heat exchanger, effects of fouling, categories of fouling, fundamental processes of fouling, determination of fouling resistance and consequences of fouling on performance of heat exchangers.

Double Pipe Heat Exchangers: Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Pressure drop analysis

Compact Heat Exchangers: Thermal and Hydraulic design of compact heat exchanger

Shell and Tube heat exchangers – Tinker's, Kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchanger

Mechanical Design of Heat Exchangers – design standards and codes, key terms in heat exchanger design, and thickness calculation for major components such as tube sheet, shell, tubes etc.

Optimum design of Heat Exchanger- Heat transfer equipment cost, relative cost, optimum design and optimization procedure

References:

1. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley & sons Inc., 2003.
2. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
3. SadikKakac and Hongton Liu, "Heat Exchangers: Selection, Rating and Thermal Design" CRC Press, 1998.
4. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984
5. Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book".
6. T. Kuppan, "Hand Book of Heat Exchanger Design".
7. "T.E.M.A. Standard", New York, 1999.
8. G. Walkers, "Industrial Heat Exchangers-A Basic Guide", McGraw Hill, 1982.

PCC -MHP-24006 Gas Turbines and Jet Propulsion

Teaching Scheme
Lectures: 3hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand compressible flow through variable area ducts, concept of shock waves, and flow with friction and heat addition.
2. Understand the thermodynamic cycle for Gas Turbine – the principle of operation of compressors, and turbines.
3. Analyze the design concepts for components of Axial, Radial flow Multistage Gas Turbines, Axial flow and Centrifugal compressors for optimum performance including Surging and stalling .
4. Interpret the basic principle of Jet Propulsion –for air-breathing Aircraft Engines and have clear understanding about the performance characteristics of Jet Propulsion.

Syllabus Contents:

- Compressible Flow: One-dimensional flow, speed of sound, variable cross-section flow, converging diverging nozzle, flow with friction and heat transfer, normal and oblique shock waves. Fundamentals of turbo machines: ideal and actual cycles for shaft power and propulsion. Compressors: axial flow and centrifugal compressors, principle of operation, work done, elementary theory, performance, compressibility effects, surge and stall. Combustion Systems: types, requirements, combustion chamber performance, emissions. Axial and radial flow turbines: elementary theory, vortex theory, performance characteristics, blade cooling, design of gas turbines, off design performance, gas turbine blade materials. Thermodynamics of propulsion system, engine performance parameters. Air breathing and non-air breathing engines, aircraft gas turbine engine, cycle analysis of ideal and real engines. Turbojet, turboprop, turbofan engines, ramjet and pulsejet engines.

References:

1.Sarvanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., “Gas Turbine Theory”, Sixth Edition, Pearson Prentice Hall, 2008.

2. Ganesan, V., “Gas Turbines”, Third Edition, Tata McGraw Hill, 2010.

3. Yahya, S. M., “Turbines, Compressors and Fans”, Fourth Edition, Tata McGraw Hill, 2010.

4. Mattingly, “Elements of Gas Turbine Propulsion”, McGraw-Hill Publications, 1996.

5. N.A.Cumpsty, “Jet Propulsion”, Cambridge University Press, 2000.

LC -MHP-24002 Energy System Lab Practice

Teaching Scheme	**Examination Scheme**
Practical: 6 hrs/week,	Internal Continuous Assessment - 50

Course Outcomes:

At the end of the course, students will be able to:

1. Apply the fundamental understanding of finite volume method to develop the solver for simple fluid flow and heat transfer problems
2. Design the air conditioning systems for domestic and industrial applications
3. Design the heat exchanger with given heat loads

Syllabus Contents:

- Students are expected to carry out at least 6 practical assignments (Minimum two from courses on computational fluid dynamics, heat exchanger, and IC engine modeling

VSEC -MHP-24001 Dissertation Phase-I

Teaching Scheme	**Examination Scheme**
Lectures: 14 hr/week	In semester assessment: 40 End semester assessment 60

Course Outcomes:

At the end of the course the students will be able to

1. Students will be exposed to self learning various topics.
2. Carry out literature survey from books, national/international refereed journals andcontact resource persons for the selected topic of research.
3. Learn to write technical reports.
4. Develop oral and written communication skills to present and defend their work in front of technically qualified audience. .

Guidelines:

- The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

SLC-MHP-24001 Massive Open Online Course –I

- **MOOC Courses:**
  - ✓ The MOOC Course must be from NPTEL of minimum 12 weeks duration.
  - ✓ Generally the selected course should be in line with specializations or project needs.

VSEC -MHP-23002 Dissertation Phase- II

Teaching Scheme	Examination Scheme
Lectures: 18 hr/week	In semester assessment: 40
	End semester assessment 60

Course Outcomes:

At the end of the course students will be able to

1. Use different experimental techniques.
2. Use different software/ computational/analytical tools.
3. Design and develop an experimental set up/ equipment/test rig.
4. Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
5. Work in a research environment or in an industrial environment.
6. make themselves conversant with technical report writing.
7. Present and convince their topic of study to the engineering community.

Guidelines:

- It is a continuation of dissertation work started in semester III. He/she has to submit the report in the prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study. . The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his guide throughout the semester.

SLC-MHP-24002 Massive Open Online Course –II

- **MOOC Courses:**
  - ✓ The MOOC Course must be from NPTEL of minimum 12 weeks duration.
  - ✓ Generally the selected course should be in line with specializations or project needs.