OP Jindal University

Raigarh-Chhattisgarh

Scheme and Syllabus

of

M.Tech

School of Engineering

Session- 2017-19

M.Tech (Power Plant Engineering & Energy Management)

Program Outcomes for Engineering Post Graduate Program

PO1: Disciplinary knowledge: Accomplish vertical expertise in chosen discipline and enhance ability to function in multidisciplinary domains.

PO2: Research aptitude: Ability and aptitude to exercise research intelligence in investigations/ innovations and to communicate the findings in a clear, concise manner.

PO3: Project management: Develop and apply knowledge of engineering and management principles to manage a project in a multidisciplinary environment.

PO4: Ethics: Gain knowledge of ethical principles and commit to professional ethics

PO5: Self-directed lifelong learning: Ability to identify appropriate resources and learn independently for projects, research etc. using online resources.

Programme Specific Outcomes for M.Tech in Power Plant Engineering & Energy Management

PSO 1: Use engineering knowledge to design and analyse energy systems for different energy sources; suggest measures for energy conservation and management in industry and research organization.

PSO 2: Apply the knowledge of science and engineering to develop efficient, clean and sustainable ways to supply energy for social and industrial need.

PSO 3: Practice as professionals by applying the state of the art research tools & techniques to analyse real-life industry problems.

MTech in Power Plant Engineering & Energy Management
Semester I

SN	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical		Total Marks	Credit L+(T+P)/2
			L	T	P	ESE	TA		
1	SOE-M-PPE101	Advances in Numerical Method and Scientific Computing	4	0	0	50	50	100	4
2	SOE-M-PPE102	Advanced Power Plant Engineering	4	0	0	50	50	100	4
3	SOE-M-PPE103	Power Plant Machines	4	0	0	50	50	100	4
4	SOE-M-PPE104	Advanced Thermodynamics and Combustion	4	0	0	50	50	100	4
5	SOE-M-PPE105 **(1-4)**	Program Elective I **(Annexure -I)**	4	0	0	50	50	100	4
6	SOE-M-PPE106	Advanced Power Plant Engineering Lab-I	0	0	4	50	50	100	2
7	SOE-M-PPE107	Numerical Method and Scientific Computing Lab	0	0	4	50	50	100	2
8	SOE-M-PPE108	Scientific paper writing & Seminar	1	0	1	25	25	50	2
		Total	**21**	**0**	**10**	**375**	**375**	**750**	**26**

Program Elective I (Annexure - I)

Sr. No.	Subject Code	Name of the Courses
1	SOE-M-PPE105 (1)	Design and Analysis of Thermal Power Plant Equipment's
2	SOE-M-PPE105 (2)	Advanced Heat Transfer
3	SOE-M-PPE105 (3)	Sustainable and Renewable Energy Technology
4	SOE-M-PPE105 (4)	Energy Storage Systems
5	SOE-M-PPE105 (5)	Industrial Automation and Control

Programme:	M.Tech	**Semester :**	I Sem
Name of the Course:	Advances in Numerical Method and Scientific Computing	**Course Code:**	SOE-M-PPE101
Credits :	4	**No of Hours :**	4 hours/week
Max Marks:	100		

Course Description:

Scientific computing has become an indispensable tool in many branches of research, and is vitally important for studying a wide range of physical and social phenomena. In this course we will examine the mathematical foundations of well-established numerical algorithms and explore their use through practical examples drawn from a range of scientific and engineering disciplines.

Course Outcomes:

After completion of the course, students will be able to

CO Number	Course Outcomes
CO1	Apply the transform methods for the solution of differential equations arising in the modeling of real world problems.
CO2	Implement the algorithms for the computation of inverse of Discrete Fourier and Wavelet Transforms.
CO3	Solve the system of algebraic equations arising in solution of PDEs by Finite Difference and Finite Element Methods, by matrix methods and by iterative methods.
CO4	Apply and analyze the finite difference schemes for the numerical solution of parabolic, hyperbolic and elliptic partial differential equations in one and two dimensions.
CO5	Implement the finite element technique for the solution of one and two dimensional equations, particularly arising in the study of heat transfer and fluid mechanics.

Syllabus:

Unit-1

Fourier Transform, Elementary properties of Fourier Transform, Sine and Cosine Fourier Transform, Discrete Fourier Transform, Wavelet Transform.

Unit-2

Solution of Tri-diagonal Systems, Solution of Simultaneous Algebraic and transcendental equations, classification of partial Differential Equations, Finite different approximations. Solution of parabolic equations in one and two dimensions by finite difference approximations methods.

Unit-3

Numerical Solution of elliptic and hyperbolic partial differential equations by finite difference approximation methods.

Unit-4

Variation principles, Euler's equation, functional and differential equation forms, Principal of stationary total potential, Rayleigh-Ritz method, Galerkin's method, one dimensional bar finite element, one dimensional heat transfer element.

Unit-5

Piece-wise continuous trial function-finite element method, Quadratic bar element-determination of shape function, element matrices, two dimensional finite analysis-three nodded triangular element.

Text Book:

1. I.N Sneddon: Fourier Transform
2. E. Kreszing: Advance Engineering Mathematics
3. S.C. Chapra: Applied Numerical Methods with MATLAB

References Books

1. S.S. Sastry: Introductory method of Numerical Analysis:
2. Buchanan, Finite Element Analysis (Schaum's Outline Series)
3. Krishnamurthy: Finite Element Analysis
4. J.N. Reddy: An Introduction to Finite Element Method
5. B.V. Ramana: Higher Engineering Mathematics

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	2	2	2	1	2	1	2	3
CO2	2	2	1	-	2	1	1	2
CO3	1	2	2	1	2	2	1	3
CO4	3	2	1	3	1	-	2	3
CO5	2	2	3	1	3	2	1	3

Note: 1: Low 2: Moderate 3: High

Programme :	M.Tech.	**Semester :**	I Sem
Name of the Course:	Advanced Power Plant Engineering	**Course Code:**	SOE-M-PPE102
Credits :	4	**No of Hours :**	4 hours/week
Max Marks:	100		

Course Description:

This course offers lecture and laboratory classes to impart teaching and learning. The course is designed to provide a detailed knowledge of advanced power plant technologies to the learners. This course covers the concepts, numerical problems, and working principles of the various power plant technologies. The subject is dealing with conventional as well as non-conventional energy resources of power generation.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Describe and classify the various source of power generation such as conventional, Non-conventional, Renewable, Non-renewable etc.
CO2	Identify elements of steam, hydro, diesel, nuclear, wind and solar and their functions.
CO3	Illustrate the general & modern layout of the Diesel & Nuclear Power Generation.
CO4	Explain the working of gas turbine cycle and analyze the various parameters effect on cycle performance.
CO5	Explain and Classify the various energy storage schemes for renewable and nonrenewable power generation.

Syllabus:

Unit-I: Introduction: Conventional & Non-Conventional Sources of Energy and their availability in India, Different Types of Power Plants, Choice of Type of Power Generation, Power Plants in India. Thermal Power Generation: Operating Principle, Site selection, Coal to Electricity, General Layout of Thermal Power Plant, Brief description of different parts/systems and their functions, Advantages and Limitations.

Unit-2: Hydro Power Generation: Hydrology – Hydrographs, Flow Duration Curve, Mass Curve; Principle of working, Classification, Site selection; Different components & their functions; Types of Dams; Types, Characteristics & Selection of Hydro-Turbines;

Specific Speed of Hydro Turbines; Power Output Equation; Turbine Governing; Draft Tube; Bearings; Water Hammer & Surge Tank, Cavitation's, General arrangement and Operation of Hydro-electric Power Plant, Mini & Micro Hydro Power Plants, Pumped Storage Power Plants; Advantages of Hydro-electric Power Plants; Hydro Power in India & future trends.

Unit-3: Diesel & Nuclear Power Generation: Applications of Diesel Engine, Advantages & disadvantages, Types of Diesel Plants, General Layout, Combustion in CI Engines, Performance Characteristics, Supercharging, Layout of a Diesel Engine Power plant, Principle of Nuclear Energy, Nuclear Power Plant Components & their Functions; Nuclear Fuels, Radioactivity, Nuclear Reaction & Classification.

Unit-4: Gas Power Generation: Operating Principle; Classification – Open Cycle, Closed Cycle, Combined Cycle; Fuels for Gas Turbine Power Plants; Different Components and their functions; Gas Turbine Characteristics, Cycle Efficiency, Operational Aspects, Advantages and Limitations.

Unit-5: Energy Storage: Pumped hydro, Compressed Air Energy Storage (CAES), Flywheel energy storage, Electrochemical Energy Storage, Thermal Energy Storage, Magnetic Energy Storage, Chemical Energy Storage, Hydrogen Energy storage.

Text Books:

1. P.C. Sharma, Power Plant Engineering, S.K.Kataria Pub.
2. Arora and S. Domkundwar, A Course in Power Plant Engineering.
3. Rajput, A Text Book of Power Plant Engineering, Laxmi Publications.

References Books:

1. P.K.Nag, Power Plant Engineering, II Edition, TMH.
2. G.D. Rai, An Introduction to Power Plant Technology, Khanna Publishers.
3. Elanchezhian, Power plant Engg, I.K. International Pub.
4. Power plant Engineering, Ramalingam, Scietech Publishers.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	2	2	-	-	1	2	-	-
CO2	-	1	-	-	1	1	1	-
CO3	2	-	2	2	-	1	-	2
CO4	2	2	2	-	1	2	2	-
CO5	3	2	-	-	2	1	-	3

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**I Sem**
Name of the Course:	**Power Plant Machines**	**Course Code:**	**SOE-M-PPE103**
Credits :	**4**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description:

The course will cover in detail all the components of power plants such as: generator, electric motor, transformer, industrial fan, pump and its auxiliary parts.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcomes
CO1	Aware of typical electrical energy powered machinery and equipment of organizations, specially the industrial units.
CO2	Understand the performance characteristics of generators and transformer and their cooling.
CO3	Analyze the performance of pumps and fans. Also develop the ability to size and select for a specific application.
CO4	Acquiring the techniques and skills of electrical energy analysis and identification of opportunities and options for electrical energy conservation and management.

Syllabus:

Unit -1

Generator and auxiliaries: Constructional aspects of synchronous generators, principle of operation and Performance management of generator, classification, factors affecting the operation, ratings, optimization of excitation systems, voltage regulation of generator, sealing and cooling systems for large size machines (Turbo-generators), E.M.F. equation, elimination of harmonics from emf waveforms, real and reactive power management, power factor control. Constructional aspects of asynchronous generators and their applications for power generation, Real and reactive power management Issues.

Unit-2

Electric motors: Classification, Basic concepts of motors, Physical concepts of torque production, Losses in electrical motors, Concept of constant power and constant torque drive, Motor efficiency, Factors affecting motor performance, Selection of motors, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient motors.

Unit-3

Transformers and Switchyard equipments: Construction and principal of operation, performance characteristics, Vector groups, Protection of transformers, Cooling arrangements, Transformer oil testing. Studies of Relays, Circuit breakers, Isolators, lightening arrestors, C.T. & P.T., Earthing system.

Unit-4

Power Plant Fans: Types, Principle, constructional aspects, operation of fans used in power plant. Performance evaluation, efficient system operation, Flow control strategies and energy conservation opportunities.

Unit-5

Pumps and Pumping System: Types, pumps used in power plants, Performance evaluation, efficient system operation, Flow control strategies and energy conservation opportunities.

Text Books:

1. Walter Herman James, Myron Wilkinson Dole, Power Plant Machinery, John Wiley & Sons, INC 1923, 2nd edition.
2. M.G. Say, Performance and design A.C Machines, CBS Publisher.
3. A.K. Sawhney, Electrical Machine Design, Dhanpatrai and Sons, Delhi.
4. Black & Veatch, Springer, Power Plant Engineering, Technology and Engineering-1996.
5. Frank Bleier, Fan Handbook: Selection, Application, and Design, Mc Graw Hill.
6. Igor J. Karassik and Joseph, Pump Handbook, P. Messina – Hippo.

Reference Books

1. Philip Kiameh, Power Plant Equipment Operation and Maintenance Guide, McGraw-Hill Professional, 1st edition.
2. Heinz P Bloch, Process Plant Machinery, Claire Soares – Elsevier
3. Myer Kutz, Pumps, Fans, Blowers, and Compressors, Keith Marchildon and David Mody – Wiley.
4. A. E. FitzgeraldElectric Machinery, and Charles Kingsley Jr.
5. Igor Karassik, Pump Handbook, Joseph Messina, Paul Cooper, Charles Heald, 4th Edition

Online Resources:

1. beeindia.in/energy_managers_auditors/documents/guide.../3Ch6.pdfhttp://www.cdeep.iitb.ac.in
2. www.youtube.com/watch?v=Tt_NtTOJEE8 (Pumped Storage Hydro Power Plant)
3. www.youtube.com/watch?v=G3pN4FgbefU (Pump Storage Hydro Power Plant)
4. dguha1952.blogspot.com/.../idfdpa-fans-for-boiler-in-thermal-power.ht...
5. https://thermalpowerplant.wordpress.com/fans/
6. www.skf.com/in/...power-generation/...power-plant/...fans/index.html

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	2	-	-	-	-	1	2	-
CO2	1	1	-	-	1	-	1	3
CO3	1	2	2	2	2	1	2	3
CO4	1	2	2	1	3	1	3	2

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**I Sem**
Name of the Course:	**Advanced Thermodynamics & Combustion**	**Course Code:**	**SOE-M-PPE104**
Credits:	**4**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description:

In these courses, the basic thermodynamic fundamentals are studied in details and the thermochemistry concepts are applied to combustion phenomena occurring in internal combustion (IC) engines, gas turbine (GT) engines, rocket propulsion etc.

Course Outcomes: at the end of the course the students will be able to

CO Number	Course Outcomes
CO1	Learn analytical methods for determination of the direction of processes from first and second laws of thermodynamics and carry out the thermodynamic analysis.
CO2	Apply 2nd law of thermodynamics to engineering systems and understand the Maxwell relations
CO3	Develop equations of state and thermodynamic property relations and carry out multi-component and multiphase system analysis
CO4	Apply the knowledge of Direct Energy Conversion of Fuel Cells, Thermo electric energy, Thermionic power generation, Thermodynamic devices and MHD.
CO5	Apply the enthalpy of formation to find the adiabatic flame temperature and applications of Van't Hoff's and Gibbs equation.

Syllabus:

Unit-I:

Review of Thermodynamic Laws and Corollaries, Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation. Evaluation of thermodynamic properties of working substance.

Unit-II:

P.V.T Surface, Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapors pressure, Clausius-Clapeyron equation. Throttling, Joule. Thompson coefficient. Non-reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air conditioning processes, cooling towers. Real gas mixture.

Unit-III:
Power Cycles, Review binary vapor cycle, co-generation and combined cycles, second law analysis of cycles. Refrigeration cycles. Thermodynamics of irreversible processes. Introduction, Phenomenological laws, Onsager Reciprocity relation, Applicability of the Phenomenon logical relations, Heat flux and entropy production, Thermodynamic phenomena, Thermo electric circuits.

Unit-IV:
Direct Energy Conversion Introduction, Fuel cells, Thermo electric energy, Thermionic power generation, Thermodynamic devices magneto hydrodynamic generations, Photovoltaic cells.

Unit-V:
Combustion, Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gas, Effect of non-reacting gases equilibrium in multiple reactions, The Van't Hoff's equation. The chemical potential and phase equilibrium. The Gibbs phase rule.

Text books:
1. P.K. Nag, Basic and Applied Thermodynamics, Tata McGraw Hill, New Delhi.
2. J. P Holman, Thermodynamics, Tata McGraw Hill, New Delhi.
3. P.L Dhar, Engineering Thermodynamics, Elsevier

References Books:
1. Sonnatag & Van Wylen, Thermodynamics, John Wiley & Sons
2. Doolittle Messe, Thermodynamics for Engineers, John Wiley & Sons
3. K. Soman, Thermal Engineering, PHI
4. Rathore, Thermal Engineering, Tata McGraw Hill, New Delhi

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	3	3	2	1	2	3	2	2
CO2	3	3	2	1	2	3	2	2
CO3	3	3	1	1	2	2	3	1
CO4	3	2	2	2	2	3	3	2
CO5	3	3	1	1	2	2	1	2

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**I Sem**
Name of the Course:	**Design & Analysis of Thermal Power Plant Equipment's**	**Course Code:**	**SOE-M-PPE105 (1)**
Credits :	**4**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description:

A primary objective is to develop an additional perspective of engineering areas important to power plant thermal equipment's design which interplay with one another. Emphasis is given to turbo machines, combustion system, Centrifugal and Axial Flow Compressors, Gas Turbines, heat exchanger.

Course Outcomes: at the end of the course the students will be able to

CO Number	Course Outcomes
CO1	Understand the basics of Energy transfer in Turbo-Machines and Flow dynamics.
CO2	Design the blading, and estimate the performance of centrifugal Compressor and axial flow compressor.
CO3	Understand the basics of combustion chambers of Gas Turbine Plant.
CO4	Understand the blade design of axial and radial flow turbines and performance estimation.
CO5	Design power plant heat exchanger parts

Syllabus:

Unit-I:

Turbo-Machines and Gas Dynamics, Introduction, Types of Turbo machines, applications of Turbo machines, Performance Characteristics, Methods of Analysis, Dimensional Analysis, Dimensions and Dimensional Homogeneity, Buckingham Pi Theorem, Other Non-Dimensional Parameters for Turbo Machines, Energy Transfer in Turbo Machines, efficiency, static and stagnant conditions, Mach Number, Area Velocity relations, Dynamic pressures, normal shock relations for perfect gas.

Unit-II:

Combustion System, Introduction, Types of Combustion System, Factors affecting combustor design, fuels, combustion chamber performance, Existing combustion technologies, Flameless oxidation, Continuous air staging, pressure loss in combustion chamber, combustion efficiency and its effect on Gas turbine cycle, Gas turbine Emissions.

Unit-III:

Centrifugal and Axial Flow Compressors, Classification, Performance Parameters and Characteristics, Change of Performance, Polytrophic Efficiency, Preliminary Design of Centrifugal Compressors. Axial Flow Compressors, Introduction. Basic Theory, Preliminary Design of Compressor Stage, Determination of Stage Efficiency, Axial Flow Compressor Performance, Surge and Stall in Compressor and the Remedies.

Unit-IV:

Gas Turbines, Introduction, Thermodynamics of Axial Flow Turbine, Degree of Reaction, Preliminary Design Procedure for Turbine Stage, Determination of Turbine Stage Efficiency, Axial Flow Turbine Performance, Compressor, Turbine Matching, Radial Inflow Gas Turbine, Thermodynamic Processes in Radial Inflow Gas Turbine.

Unit-V:

Power Plant Heat Exchangers, Shell and tube heat exchanger, Shell side film coefficients, Shell side equivalent diameter, Air pre-heaters, Economizer — Super heater and condensers, Heat exchanger optimization.

Text books:

1. William W Perg, Fundamentals of Turbo machinery, John Wiley & Sons, Inc.
2. D. G. Shepherd, Principles of Turbo Machinery, The Macmillan Company.
3. S.M.Yahya, Turbines, Compressors and Fans, Tata McGraw-Hill.
4. Cohen and Rogers, Theory of Gas Turbines, Longman, 1974.
5. Sarvanamuttoo, Gas Turbine Theory, H.I.H., Rogers, G. F. C. and Cohen, H., 6th Edition, Pearson Prentice Hall, 2008.
6. D.Q.Kern, Process Heat Transfer, TMH.
7. R.K.Shah and D.P.Sekulic, Fundamentals of Heat Exchanger Design, John Wiely & sons, New York.

References Books:

1. Philip Hill and Carl Peterson, Mechanics and thermodynamics of Propulsion, Prentice Hall.
2. Stepanoff A.J., Centrifugal and axial flow pumps, John Wiley, 1962.
3. Horlack, Axial flow turbines, H.H., Butter worth, London, 1973.
4. Ganesan, Gas Turbines, V., 3rd Edition, Tata McGraw Hill, 2010.
5. A.P.Fraas and M.N.Ozisicj, Heat Exchanger Design, John Wiely & sons, New York.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	3	2	1	1	2	3	1	1
CO2	3	3	2	1	3	3	2	3
CO3	3	2	1	1	2	2	2	1
CO4	3	3	2	1	2	3	2	3
CO5	3	3	3	1	2	3	2	3

Note: 1: Low 2: Moderate 3: High

Programme : M.Tech.		**Semester :**	**I Sem**
Name of the Course:	**Advanced Heat Transfer**	**Course Code:**	**SOE-M-PPE105 (2)**
Credits :	**4**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description:

The course will deepen the fundamentals of heat transfer. Particular focus will be put on radiative and convective heat transfer, and computational approaches to solve complex, coupled heat transfer problems.

Course Outcomes: at the end of the course the students will be able to

CO Number	Course Outcomes
CO1	Understand both the physics and the mathematical treatment of the advanced topics pertaining to the modes of heat transfer.
CO2	Apply the principles of heat transfer to develop mathematical models for uniform and non-uniform fins.
CO3	Employ mathematical functions and heat conduction charts in tackling two-Dimensional and three-dimensional heat conduction problems.
CO4	Analyze free and forced convection problems involving complex geometries with proper boundary conditions.
CO5	Apply the concepts of radiation heat transfer for enclosure analysis.

Syllabus:

Unit-I:

Review of conduction heat transfer, multi-dimensional conduction, and unsteady conduction heat transfer.

Unit-II:

A review of viscous flow, the continuity and Navier-Stokes equation, boundary layer equation, laminar boundary layer over a flat plate, Energy equation, derivation of energy equation, energy equation in non-dimensional form, derivation of thermal boundary layer equation, heat transfer in a parallel flow over a flat surface, analogy between momentum and heat transfer in turbulent flow.

Unit-III:

Forced convection in internal flows, concept of entrance length and fully developed flow, heat transfer in high speed flow; Governing equation, scaling laws, free convection in laminar flow over a vertical plate, empirical co-relation in external free convection flows, inclined plates, long horizontal cylinder, spheres, free convection in enclosures, and cavities, concentric cylinders, concentric spheres, combined free and forced convection.

Unit-IV:

Basic design methodologies - LMTD and effectiveness-NTU methods. Overall heat transfer coefficient, fouling, Correlations for heat transfer coefficient and friction factor, Heat transfer in boiling, forced convection boiling, Condensation heat transfer, theory of film condensation, drop wise condensation, heat pipes, heat transfer in freezing and melting.

Unit-V:

Radiation exchange between black surfaces, shape factor, radiation exchange between gray surfaces, Radiosity- Irradiation method, parallel plate, enclosures (non-participating gases), gas radiation.

Text books:

1. Incropera & Dewitt, Fundamentals of Heat and Mass Transfer- Wiley
2. Cengel & Ghajar, Heat and Mass Transfer, McGraw Hill.
3. M. N. Ozisik, Heat Transfer, A Basic Approach, McGraw Hill.

Reference Books:

1. Mills & Ganeshan, Mechanics Heat Transfer, Pearson.
2. J. P. Holman, Heat Transfer, McGraw Hill.
3. A. Bejan, Convective Heat Transfer, Wiley.
4. S. V. Patankar, Computation of Conduction and Duct Flow Heat Transfer, CRC Press.
5. D. Q. Kern, Process Heat Transfer, McGraw Hill.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	3	2	1	2	2	3	1	2
CO2	3	2	2	1	2	3	2	2
CO3	3	3	2	1	2	2	2	2
CO4	3	3	2	1	2	2	2	2
CO5	3	2	2	1	2	2	1	2

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**I Sem**
Name of the Course:	**Sustainable and Renewable Energy Technology**	**Course Code:**	**SOE-M-PPE105 (3)**
Credits :	**4**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description:

This course aims to provide an introduction to the engineering principles and designs underpinning key sustainable / renewable energy technologies. It is structured to familiarize students with an analytical toolkit to allow them to independently appraise such technologies and their role in the energy system.

Course Outcomes:

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

CO Number	Course Outcomes
CO1	List and generally explain the main sources of energy and their primary applications.
CO2	Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.
CO3	List and describe the primary renewable energy resources and technologies.
CO4	Access the performance of various solar and wind energy technologies.
CO5	Identify issues and challenges associated with the current development of renewable energy technologies including technical, financial and environmental risks and mitigation measures.

Syllabus:

Unit-I:

Challenges of Energy Sustainability, Future Energy Systems: Clean/Green Energy Technologies. International agreements/conventions on Energy and Sustainability: United Nations Framework Convention on Climate Change (UNFCC) sustainable development.

Unit-II:

Renewable Energy Technologies: Renewable energy utilization in ancient times, Solar energy: Solar radiation measurements, Effects of changes in tilt angle, Sun Tracking, PV cell: Principle, types, PV Module and Array, Modelling of PV cell, Effects of shaded and faulty cell, Maximum power tracking, Charge Controllers, MPPT Algorithms, Stand Alone PV System, Grid Connected PV System, Hybrid Systems.

Unit-III:
Wind energy: Atmospheric circulations, Wind monitoring and resource assessment, modeling, Types and characteristics of wind turbines, thrust and torque, power coefficient, thrust coefficient, axial interference factor, Pitch and stall regulation, power curve, energy calculation, Principle of operation, types, configurations: WT-IG, WT-DWIG, WTDOIG, WT-PMG and WTVSIG. Small WEGs - standalone/grid connected applications.

Unit-IV:
Biomass Energy: Classification of biomass. Physicochemical characteristics of biomass as fuel. Biomass conversion routes, Biomass-Gasifiers.
Ocean energy resources-ocean energy routes - Principles of ocean thermal energy conversion systems- ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion.

Unit-V:
Other Sources: Hydropower, Nuclear fission and Fusion-Geothermal energy: Origin, types of geothermal energy sites, site selection, geothermal power plants; Magneto-hydro-dynamic (MHD) energy conversion.

Text books:

1. G N Tiwari, M K Ghosal, Fundamentals of Renewable Energy Sources, Narosa Publishing House.
2. J W Twidell and A D Weir, Renewable Energy Resources, ELBS.
3. N K Bansal, M Kleemann and M Mellis, Renewable Energy Resources and conversion Technology, Tata McGraw Hill, 1990.

References Books:

1. Kastha D, Banerji S and Bhdra S N, Wind Electrical Systems, Oxford University Press, New Delhi.
2. Tony Burton, David Sharpe, Nick Jemkins and Ervin Bossanyi, Wind Energy Hand Book John Wiley & Sons.
3. Chetan S. Solanki, Fundamentals, Technologies and Applications, Solar Photovoltaics, PHI publications.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	2	2	1	1	2	3	2	1
CO2	3	2	2	2	2	3	3	1
CO3	2	2	1	1	2	2	2	1
CO4	3	3	2	1	3	3	3	3
CO5	3	3	2	2	3	3	3	3

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**I Sem**
Name of the Course:	**Energy Storage Systems**	**Course Code:**	**SOE-M-PPE105 (4)**
Credits :	**4**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description:

This course introduces students to energy storage systems and provides a broad understanding and appreciation of the scientific principles that underpin the operation of such systems. The emphasis is on grid-scale (or utility-scale) energy storage as a means of addressing the intermittency of renewable energy components (e.g. solar or wind power systems) of modern electricity networks. Smaller energy storage systems are also discussed for benchmarking and comparisons.

Course Outcomes:

After completion of the course, students will be able to

CO Number	Course Outcomes
CO1	Understand the working principle of different energy storage devices.
CO2	Analyze and compare different energy storage technologies.
CO3	Handle the forthcoming technologies in the energy storage systems.
CO4	Estimate the storage capacity of different storage technologies
CO5	Demonstrate problem solving skills in energy storage engineering as a means of resolving the intermittency of renewable energy sources such and solar and wind.

Syllabus:

Unit-I:

Challenges of Energy Sustainability, Future Energy Systems: Clean/Green Energy Technologies. International agreements/conventions on Energy and Sustainability: United Nations Framework Convention on Climate Change (UNFCC) sustainable development.

Unit-II:

Renewable Energy Technologies: Renewable energy utilization in ancient times, Solar energy: Solar radiation measurements, Effects of changes in tilt angle, Sun Tracking, PV cell: Principle, types, PV Module and Array, Modelling of PV cell, Effects of shaded and faulty cell, Maximum power tracking, Charge Controllers, MPPT Algorithms, Stand Alone PV System, Grid Connected PV System, Hybrid Systems.

Unit-III:

Centrifugal and Axial Flow Compressors, Classification, Performance Parameters and Characteristics, Change of Performance, Polytrophic Efficiency, Preliminary Design of Centrifugal Compressors. Axial Flow Compressors, Introduction. Basic Theory, Preliminary Design of Compressor Stage, Determination of Stage Efficiency, Axial Flow Compressor Performance, Surge and Stall in Compressor and the Remedies.

Unit-IV:

Gas Turbines, Introduction, Thermodynamics of Axial Flow Turbine, Degree of Reaction, Preliminary Design Procedure for Turbine Stage, Determination of Turbine Stage Efficiency, Axial Flow Turbine Performance, Compressor, Turbine Matching, Radial Inflow Gas Turbine, Thermodynamic Processes in Radial Inflow Gas Turbine.

Unit-V:

Power Plant Heat Exchangers, Shell and tube heat exchanger, Shell side film coefficients, Shell side equivalent diameter, Air pre-heaters, Economizer — Super heater and condensers, Heat exchanger optimization.

Text books:

1. Dincer 1., and Rosen M., Thermal Energy Storage: Systems and Applications, Wiley.
2. Huggins R. A., Energy Storage: Fundamentals, Materials and Applications, Springer.

Reference Books:

1. O'Hayre R., Cha S., Colella and Prinz B,Fuel Cell Fundamentals, Second Edition, Wiley.
2. Narayan R. and Viswanathan B, Chemical and Electrochemical Energy System, Universities Press.
3. Rahn C. D. and Wang C., Battery Systems Engineering, First Edition, Wiley.
4. Moseley P. T., and Garche J., Electrochemical Energy Storage for Renewable Sources and Grid Balancing, Elsevier Science.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	3	2	2	1	2	2	2	1
CO2	3	2	2	1	2	3	3	1
CO3	2	3	2	-	2	2	2	2
CO4	3	3	2	1	3	3	3	2
CO5	3	3	2	1	3	3	3	2

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**I Sem**
Name of the Course:	**Advanced Power Plant Engineering Lab-I**	**Course Code:**	**SOE-M-PPEI06**
Credits :	**2**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description:

This Lab course offers experimentations to impart teaching and learning. In this course learners will study and perform the experiments on power plant major and minor components such as condenser, cooling tower, solar panels, and axial flow compressor. In the study part learners will get the insight of various boilers and their accessories & mountings. This course covers the study of important thermal power plant components and experimentation on some of them.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Experiment with surface and Jet steam condenser and examine the performance.
CO2	Experiment with axial and reciprocating air compressor and examine the performance.
CO3	Classify and explain the boilers, accessories, & mountings and can experiment with bomb calorimeter for determination of calorific value of fuel.
CO4	Experiment with cooling tower and examine the performance.
CO5	Experiment with solar power plant and examine the performance characteristics.

List of Experiments (minimum nine experiments):

1. To obtain performance characteristics of an Axial Flow air compressor.
2. To obtain overall heat transfer coefficient in a computerized shell and tube surface condenser set up.
3. To obtain heat transfer coefficient in case of film and drop wise condensation by using condensation apparatus.

4. To perform testing on double pipe heat exchanger and simulation by using CFD Software
5. Performance test on Lab cooling tower set up and on site cooling tower.
6. To determine the calorific value of the given sample fuel by Bomb Calorimeter.
7. To obtain Flash point and Fire point of an oil.
8. To test the performance of onsite boiler and to calculate the boiler efficiency by direct and indirect method.
9. To Perform testing on Plate Type Heat Exchanger.
10. To perform testing on Solar PV training kit and research system.
11. Study of solar tracking and to measure global short wave radiation by using Solar Pyranometer.
12. Study and experimentation on Muffle furnace.
13. To determine calorific value of gaseous fuel by using Junker's gas Calorimeter
14. To obtain hands on experience in Boiler Feed Pump and air Heaters of Power Plants.
15. To perform Maintenance Planning, Practice and inspection of Generator and electrical auxiliaries.

Equipment/Machines/Instruments/Tools/Software Required:

1. Axial Flow Compressor
2. Drop wise and Film wise condensation apparatus
3. Surface condenser set up
4. Flash and fire point apparatus
5. Solar Radiation Meters
6. Heat Exchangers (plate, pipe-in-pipe, shell and tube)
7. Solar P-V Training Kit
8. Junker's Gas Calorimeter Cooling tower set up.
9. Model of La Mont boiler

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	2	-	1	-	1	2	-	1
CO2	-	1	1	3	-	1	-	2
CO3	2	-	-	-	2	-	3	1
CO4	2	2	-	2	1	2	-	-
CO5	2	2	1	-	2	1	-	3

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**I Sem**
Name of the Course:	**Numerical Method and Scientific Computing Lab**	**Course Code:**	**SOE-M-PPE107**
Credits :	**2**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description:

The objective of the lab work is to familiarize you with implementation of numerical methods using Matlab. Knowledge of Matlab is not a prerequesite of the course, and all the relevant features of Matlab will be explained in the text of the labs. Because of the focus on numerical methods, neither the toolboxes nor many capabilities of Matlab will be covered. Instead, numerical methods will be implemented and tested using Matlab functions and scripts.

Course Outcomes:

After completion of the course, students will be able to

CO Number	Course Outcomes
CO1	Apply the transform methods for the solution of differential equations arising in the modeling of real world problems.
CO2	Implement the algorithms for the computation of inverse of Discrete Fourier and Wavelet Transforms.
CO3	Solve the system of algebraic equations arising in solution of PDEs by Finite Difference and Finite Element Methods, by matrix methods and by iterative methods.
CO4	Apply and analyze the finite difference schemes for the numerical solution of parabolic, hyperbolic and elliptic partial differential equations in one and two dimensions.
CO5	Implement the finite element technique for the solution of one and two dimensional equations, particularly arising in the study of heat transfer and fluid mechanics.

Syllabus:

Unit-1

Fourier Transform, Elementary properties of Fourier Transform, Sine and Cosine Fourier Transform, Discrete Fourier Transform, Wavelet Transform.

Unit-2

Solution of Tri-diagonal Systems, Solution of Simultaneous Algebraic and transcendental equations, classification of partial Differential Equations, Finite different approximations. Solution of parabolic equations in one and two dimensions by finite difference approximations methods.

Unit-3

Numerical Solution of elliptic and hyperbolic partial differential equations by finite difference approximation methods.

Unit-4

Variation principles, Euler's equation, functional and differential equation forms, Principal of stationary total potential, Rayleigh-Ritz method, Galerkin's method, one dimensional bar finite element, one dimensional heat transfer element.

Unit-5

Piece-wise continuous trial function-finite element method, Quadratic bar element-determination of shape function, element matrices, two dimensional finite analysis-three nodded triangular element.

Text Book:

1. I.N Sneddon, Fourier Transform
2. E. Kreszing, Advance Engineering Mathematics
3. S.C. Chapra Applied Numerical Methods with MATLAB

References Books

1. S.S. Sastry, Introductory method of Numerical Analysis
2. Buchanan, Finite Element Analysis (Schaum's Outline Series)
3. Krishnamurthy, Finite Element Analysis
4. J.N. Reddy, An Introduction to Finite Element Method
5. B.V. Ramana, Higher Engineering Mathematics

Recommended Text Books

1. Erwin Kreyszig, Advanced Engineering Mathematics (8th edition) – John Wiley & Sons.
2. B. V. Rammana, Higher Engineering Mathematics -Tata Mc Graw Hill.
3. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics– Narosa Publishing House.
4. R. R. Greenberg, Advance Engineering Mathematics - Pearson Publication.
5. S.C. Chapra, Applied Numerical Methods with MATLAB - Tata Mc Graw Hill.
6. J.N. Reddy, An Introduction to Finite Element Method -Tata Mc Graw Hill.
7. Krishnamurthy, Finite Element Analysis:
8. Jichun Li & Yi-Tung, Computational Partial Differential Equations Using MATLAB, Chen – CRC Press.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	2	2	2	1	2	1	2	3
CO2	2	2	1	-	2	1	1	2
CO3	1	2	2	1	2	2	1	3
CO4	3	2	1	3	1	-	2	3
CO5	2	2	3	1	3	2	1	3

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**I Sem**
Name of the Course:	**Scientific paper writing & Seminar**	**Course Code:**	**SOE-M-PPE108**
Credits :	**2**	**No of Hours :**	**4 hours/week**
Max Marks:	**50**		

Course Description

This subject is related the techniques of scientific study and understanding related research mobility and how to express in a scientific framework. The area of the subject may be particular topic/subject/area/live project/case study and identifies the key areas and express in a paper mode for the scientific audiences.

Course Outcomes

After completion of the course, students will be able to

CO Number	Course Outcomes
CO1	Understanding the research methods
CO2	Acquire the perfection in journal reading
CO3	Perform skills for research publication/write up.
CO4	Effective presentation and improve soft skills.
CO5	Make use of new and recent technology (e.g. Latex) for creating technical reports

Syllabus:

In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas.

The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic

2. Stating an objective.

3. Collecting the relevant bibliography (at least 15 journal papers)

4. Preparing a working outline.

5. Studying the papers and understanding the authors contributions and critically analyzing each paper.

6. Preparing a working outline

7. Linking the papers and preparing a draft of the paper.

8. Preparing conclusions based on the reading of all the papers.

9. Writing the Final Paper and giving final Presentation

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	1	3	1	1	-	2	1	3
CO2	2	2	-	1	2	2	1	-
CO3	-	2	2	-	1	2	1	1
CO4	-	-	2	1	2	2	1	2
CO5	-	-	2	1	2	-	-	3

Note: 1: Low 2: Moderate 3: High

MTech in Power Plant Engineering & Energy Management

Semester II

SN	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical		Total Marks	Credit L+(T+P)/2
			L	T	P	ESE	TA		
1	SOE-M-PPE201	Power Plant Instrumentation and Control Engineering	4	0	0	50	50	100	4
2	SOE-M-PPE202	Advanced Steam & Gas Turbine Engineering	4	0	0	50	50	100	4
3	SOE-M-PPE203	Design of Heat Exchangers	4	0	0	50	50	100	4
4	SOE-M-PPE204	Computational Fluid Dynamics	4	0	0	50	50	100	4
5	SOE-M-PPE205 **(1-4)**	Program Elective II **(Annexure -II)**	4	0	0	50	50	100	4
6	SOE-M-PPE206	Advanced Power Plant Engineering Lab-II	0	0	4	50	50	100	2
7	SOE-M-PPE207	Computational Fluid Dynamics Lab	0	0	4	50	50	100	2
8	SOE-M-PPE208	Project report writing & Seminar	1	0	2	25	25	50	2
		Total	**21**	**0**	**10**	**375**	**375**	**750**	**26**

Program Elective -II (Annexure - II)

S.N	Subject Code	Name of the Courses
1	SOE-M-PPE205 (1)	Energy Management & Audit
2	SOE-M-PPE205 (2)	Advanced Solar Thermal Energy.
3	SOE-M-PPE205 (3)	Artificial Intelligence in Power Systems.
4	SOE-M-PPE205 (4)	Energy Conservation by Waste Heat Recovery.
5	SOE-M-PPE205 (5)	Modeling and Analysis of Solar Systems

Programme:	**M.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Power Plant Instrumentation and Control Engineering**	**Course Code:**	**SOE-M-PPE201**
Credits :	**4**	**No of Hours :**	**4 hours/week**
Max Marks:	**100**		

Course Description

The course is designed to familiarize the student with the functions and instrumentation available in a modern power generation plant.

Course Outcomes

After completion of the course, students will be able to

CO Number	Course Outcomes
CO1	Understand about different instruments that are used for measurement purpose.
CO2	Analyze the Performance characteristics of each instrument, analyses the data and generate report.
CO3	Understand how waveforms can be analyzed using wave analyzers, MATLAB and Simulink
CO4	Able to determine transfer function models of electrical, mechanical and electromechanical systems.
CO5	Able to determine stability/relative stability from characteristic equation.

Syllabus:

Unit-1

Basics of Measurement Systems: Static and dynamic characteristics of measurement systems. Measurement errors: Gross error, systematic error, absolute error and relative error, accuracy, precision, resolution and significant figures, Measurement error combination, basics of statistical analysis. Statistical analysis of data and curve fitting.

Unit-2

Electrical and Electronic Measurements: Bridges and potentiometers, measurement of R, L and C. Measurements of voltage, current, power, power factor and energy. AC & DC current probes. Extension of instrument ranges. Q-meter and waveform analyzer. Digital voltmeter and multi-meter. Time, phase and frequency measurements. Cathode ray oscilloscope. Serial and parallel communication. Shielding and groundings.

Unit-3

Transducers, Mechanical Measurement and Industrial Instrumentation: Resistive, Capacitive, Inductive and piezoelectric transducers and their signal conditioning. Measurement of displacement, velocity and acceleration (translational and rotational), force, torque, vibration and shock. Measurement of pressure, flow, temperature and liquid level. Measurement of pH, conductivity, viscosity and humidity.

Unit-4

Control Systems and Process Control: Open loop and closed loop control systems, Feedback characteristics of control systems, Mathematical representation of physical systems, electrical, mechanical, hydraulic, thermal systems, Block diagram, algebra and signal flow graphs, Mason's gain formula. Time Domain Analysis, standard test signals, time response of first, second and higher order systems, performance indices. Error analysis, static and dynamic error coefficients. Stability, concept of stability, asymptotic and conditional stability, Routh Hurwitz criterion, Root locus technique (Concept and construction) Frequency Response Analysis Correlation between time and frequency response, Polar and inverse polar plots, NY Quist stability criterion, Bode plots, Time delay systems. Phase and gain margin. Mechanical, hydraulic and pneumatic system components. Synchro pair, servo and step motors. On-off, cascade, P, P-I, P-I-D, feed forward and derivative controller, Fuzzy controller.

Unit-5

State-Variable Analysis: Introduction, Vector matrix representation of State equation, State Transition Matrix, State-Transition Equation, Relationship between State Equations and High-order Differential Equations, Relationship between State Equations and Transfer Functions.

Text Books

1. Benjamin C Kuo-Automatic Control System
2. U A Bakshi and A V Bakshi- Automatic Control System
3. Ogata- Modern Control System

Reference Books:

1. W Bolton- Instrumentation and control systems
2. A K Ghosh -Introduction to instrumentation and control
3. A Bakshi and A V Bakshi- Electrical Measurement and measuring instruments

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	3	-	-	-	-	2	2	1
CO2	2	2	2	-	1	1	1	3
CO3	3	1	2	1	2	1	2	3
CO4	3	-	1	1	1	2	1	1
CO5	2	2	3	2	2	1	2	2

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Advanced Steam & Gas Turbine Engineering**	**Course Code:**	**SOE-M-PPE202**
Credits :	**4**	**No of Hours :**	**4**
Max Marks:	**100**		

Course Description:

This course offers lecture and laboratory classes to impart teaching and learning. The course is designed to provide a detailed knowledge of advanced steam and gas turbine systems to the learners. This course covers the working principle of elements, numerical problems, design, and development of components of the various power plant technologies.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Identify the principle elements of steam turbine as well as can classify the steam turbines.
CO2	Understand about the working of nozzles, diffusers, flow of steam in steam turbine.
CO3	Understand the working principle and operations of different auxiliary units.
CO4	Explain the working of gas turbine cycle and analyze the various elements of it and its effect on gas turbine performance.
CO5	Explain gas turbine auxiliary units and its maintenance.

Syllabus:

Unit-I: Brief historical note on steam turbine development, Principle element and design of steam turbine Heat Cycle of Turbine Plant Heat Cycle of modern steam turbine plants Heat cycle of turbine plants for nuclear power stations Classification of steam turbine Improvement in Plant efficiency.

Unit-2: Determination of dimensions' steam nozzles and moving blades for single and two row turbine stages. Internal relative efficiency of a turbine stage. Flow of steam through impulse turbine blades and impulse & reaction turbines blades. Energy losses in steam turbines, governing and performance of steam turbines.

Unit-3: Steam turbine auxiliary systems: Turbine protective devices, tripping devices, unloading gears, lubricating systems, glands and sealing systems Construction, Operation and Maintenance of Steam Turbines.

Unit-4: Gas Turbine shaft power cycles, velocity diagram and work done by gas turbine, turbine blade cooling, blade materials, blade manufacture, matching of turbine components, Combustion chambers, requirements, types, factor affecting performance of Combustion Chambers, performance of turbines.

Unit-5: Gas Turbine auxiliary systems, operation and maintenance, starting and ignition systems, lubrication systems, Fuel system and controls, operation, maintenance and trouble shooting.

Text Books:

1. Cohen & Rogers Longman, Gas turbine theory.
2. P. Shlyakhan, Steam Turbine: Theory and Design.
3. Heck, Robert Culbertson, The steam engine and turbine.
4. Lee J.E., Steam & Gas Turbine, McGraw Hill, 1962.

References Books:

1. William Johnston Kearton, Steam turbine theory and practice.
2. Gerogeous lucaus and Murari singh, Blade Design and analysis for steam turbines, Mc GrawHill.
3. Design Alexndar Leyzerovich, Large Power steam turbines, Pennwell books.

CO, PO & PSO Correlation

	Program Outcomes					**PSOs**		
CO Number	**1**	**2**	**3**	**4**	**5 6**	**1**	**2**	**3**
CO1	2	2	-	2	1	2	-	3
CO2	-	1	-	-	2	1	2	-
CO3	2	-	-	2	2	1	-	-
CO4	2	3	2	-	1	2	-	3
CO5	2	3	1	-	2	1	2	-

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Design of Heat Exchangers**	**Course Code:**	**SOE-M-PPE203**
Credits :	**4**	**No of Hours :**	**4**
Max Marks:	**100**		

Course Description:

Thermal design and application of different heat-exchanger types, including surface selection, economics, performance calculations and design optimization.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Differentiate between the different type of heat exchangers.
CO2	Do heat transfer analysis using LMTD or NTU method depending on the nature of problem and available data.
CO3	Identify the important heat-exchanger design parameters
CO4	Perform thermal design of heat exchanger (Including heat exchangers with phase change).
CO5	Extend the knowledge of heat exchanger analysis in practical applications.

Syllabus:

Unit-I:

Introduction, classification of heat exchangers, Arithmetic mean temperature difference (AMTD), Heat transfer with phase change — condensation and boiling heat transfer-Heat transfer in condensation, Effect of non-condensable gases in condensing equipment's. Flow boiling correlations.

Unit-II:

Extended surfaces - Steady State analysis and Optimization-Radial fins of rectangular and hyperbolic profiles- longitudinal fin of rectangular profile radiating to free space,

Unit-III:

Thermal Design of Recuperates and Regenerators, Plate and spiral plate heat exchanger — Plate heat exchanger for High-capacity power plant — Heat Pipes.

Unit-IV:

Radiative exchange in Furnaces-Radiation characteristics of particle systems, Thermal radiation of a luminous fuel oil and gas- Soot flame- overall heat transfer in furnaces.

Unit-V:

Selection of compact Heat exchangers, Heat exchangers Analysis- Heat transfer and flow friction and design of the cooling towers.

Text books:

1. Applied Heat Transfer, Ganapathy, V., Pennwell Books.
2. Compact Heat Exchangers, Kays, W.M. and London, A.L., McGraw-Hill.

References Books:

1. Heat Pipes, Dunn, P. and Reay, D.A., Pergamon.
2. Heat Exchangers, Kakac, S. and Liu, H., CRC Press.
3. Fundamentals of Heat Exchanger design, R.K. Shah and D.P. SSekulic.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	3	2	1	-	2	2	1	1
CO2	3	2	2	1	2	3	2	2
CO3	3	2	2	-	2	2	2	2
CO4	3	3	2	1	3	3	3	3
CO5	3	3	2	1	2	3	3	2

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Computational Fluid Dynamics**	**Course Code:**	**SOE-M-PPE204**
Credits :	**4**	**No of Hours :**	**4**
Max Marks:	**100**		

Course Description:

Computational fluid dynamics is an important tool to investigate fluid flow problems in industry and academia. This course can be taken without prior background in computational techniques. A background of fundamental fluid dynamics, partial differential equations, linear algebra and a programming language is desirable. The primary focus of this course is to gain a solid foundation of numerical methods for convection-diffusion problems.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Appreciate the importance, advantages, and disadvantages of CFD in solving transport phenomenon problems.
CO2	Understand the stepwise procedure to completely solve a fluid dynamics problem using computational methods
CO3	Derive the governing equations and understand the behavior of the equations.
CO4	Analyze the consistency, stability and convergence of various discretization schemes for parabolic, elliptic and hyperbolic partial differential equations
CO5	Analyze various methods of grid generation techniques and application of finite difference, finite volume methods and finite element methods to various fluid flow and heat transfer problems.

Syllabus:

Unit-I:

Basic concepts Euleraian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, Vorticity. Laws governing fluid motion, continuity, Navier — stokes & energy equations. Boundary layer equation, Euler equations, potential flow equations, Bernoulli's equation and vorticity transport equation, Initial boundary conditions, Classification of equations — hyperbolic, parabolic, elliptic.

Unit-II:

Solution of simultaneous equations: system of direct and iterative methods; Jacobi and various Gauss-Seidel methods (PSOR, LSOR and ADD, Gauss-elimination, TDMA (Thomas), Gauss Jordan, other direct and indirect methods.

Unit-III:

Finite Difference Discretization, Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis. Stability of elliptic and hyperbolic equations. Fundamentals of fluid flow modeling-conservative property, upwind scheme, transporting property, higher order up winding. Finite difference applications in heat transfer — conduction, convection.

Unit-IV:

Finite Volume Method, Introduction, Application of F VM in diffusion and convection problems, NS equations — staggered grid, collocated grid, SIMPLE algorithm. Solution of discretized equations using TDMA. Finite volume method for unsteady problems — explicit schemes, implicit schemes and Crank-Nicholson Scheme.

Unit-V:

Finite Element Method, Introduction, Weighted residual and variational formulations, Interpolation in one-dimensional and two-dimensional cases, application of FEM to ID and problems in fluid flow and heat transfer.

Text books:

1. Computational Fluid Flow and Heat Transfer, K. Muralidhar, Sundararajan, Narosa.
2. Computational Methods for fluid Dynamics, Ferziger J. Fl., Springer P.M, Verlag Berlin
3. Computational fluid Dynamics, Anderson J. D. JR, Mc Graw Hill Inc
4. Computational Fluid Dynamics, Chung T. J., Cambridge University Press

References Books:

1. Numerical Heat Transfer and Fluid Flow, S. V. Patankar, Hemisphere Publishing company
2. An Introduction of Computational Fluid Dynamics, H.K Versteeg and V. Malalashekhara, Pearson

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	3	3	2	1	3	3	1	2
CO2	3	3	2	1	3	3	3	3
CO3	3	3	2	1	2	1	2	2
CO4	3	2	2	1	2	3	2	3
CO5	3	3	3	1	2	3	3	3

Note: 1: Low 2: Moderate 3: High

Programme :	M.Tech.	**Semester :**	**II Sem**
Name of the Course:	Energy Management & Audit	**Course Code:**	**SOE-M-PPE205 (1)**
Credits :	4	**No of Hours :**	**4**
Max Marks:	100		

Course Description:

The course is designed to enable the students to understand the concept of energy management and energy management opportunities. It covers different methods used to control peak demand and demonstrate the energy auditing procedure. It is also emphases on the different methods used for the economic analysis of energy projects.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Acquaintance with conservation of energy and its management
CO2	Knowledge of energy efficient systems, energy losses and their management.
CO3	Competency in energy analysis techniques and energy conversion planning.
CO4	Develop a proposal for energy efficiency improvements to a company.
CO5	Knowledge about energy forecasting, energy economics, pricing and incentives for energy conservation.

Syllabus:

Unit -01

Energy management:

General Aspects General Philosophy and need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy.

Unit -02

Procedures and Techniques:

Data gathering: Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering. Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation. Evaluation of saving opportunities: Determining the savings in Rs, Noneconomic factors, Conservation opportunities, estimating cost of implementation. Energy Audit Reporting: The plant energy study report-Importance, contents, effective organization, report writing and presentation.

Unit -03

Energy Policy Planning and Implementation:

Key Elements: Force Field Analysis, Energy Policy Purpose, Perspective, Contents and Formulation. Format and Ratification, Organizing: Location of Energy Manager, Top Management Support, Managerial functions, Role and responsibilities of Energy Manager, Accountability. Motivating – Motivation of employees, Requirements for Energy Action Planning. Information Systems: Designing, Barriers, Strategies, Marketing and Communicating Training and Planning.

Unit -04

Energy Balance & MIS:

First law of efficiency and Second law of efficiency, Facility as an Energy system, Methods for preparing process flow, Materials and Energy Balance diagram, Identification.

Unit –05

Heat Exchangers and Heat Recovery Systems:

Heat Exchangers Classification Over all heat transfer coefficient, Fouling factor, Design of heat exchangers by L.M.T.D. and N.T.U. methods. Liquid to Liquid heat exchangers Shell and tube Heat exchanger. Sources of waste heat, Guidelines to identify waste heat, Grading of waste heat, Feasibility study of waste heat recovery, Gas to Gas and Liquid to liquid heat recovery, waste heat boilers.

Text Books

1. W.R. Murphy, Energy Management: G. Mckay (Butterworths).
2. C.B. Smith, Energy Management Principles: (Pergamon Press).
3. I.G.C. Dryden, Efficient Use of Energy: (Butterworth Scientific)
2. A.V. Desai, Energy Economics - (Wieley Eastern)

Reference Books:

1. D.A. Reay, Industrial Energy Conservation: (Pergammon Press)
2. E.G. Shinskey – Energy Conservation through Control –Academic Press.
3. W.C. Turner (John Wiley and Sons, Energy Management Handbook –A Wiley Interscience Publication)

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	3	2	2	1	3	1	1	2
CO2	2	3	-	2	1	2	2	3
CO3	2	2	3	1	2	1	1	3
CO4	3	2	2	3	1	3	2	2
CO5	2	3	3	1	2	1	-	3

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Advanced Solar Thermal Energy**	**Course Code:**	**SOE-M-PPE205 (2)**
Credits :	**4**	**No of Hours :**	**4**
Max Marks:	**100**		

Course Description:

The course content is designed to provide comprehensive knowledge on solar radiation, analysis of solar radiation data, fundamentals of the solar thermal and photovoltaic system along with storage of energy required for effective design of efficient solar energy conversion devices.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the working principle of different solar thermal energy systems
CO2	Understand different aspects and parameters of solar energy to design solar thermal system.
CO3	able to design different solar thermal systems
CO4	Demonstrate the learner for tackling different issues and challenges of various solar thermal collectors.
CO5	understand the power generation aspects from solar thermal systems

Syllabus:

Unit-I

Flat plate collector: Theory and basic design aspects; Thermal analysis and effective heat loss; Performance analysis methods; Thermal analysis and effective energy loss of evacuated tube collector; Flat plate solar dryer: Issues and challenges.

Unit-2

Concentrating collector: Classification of concentrating collector; concentrating collector configurations; concentration ratio: optical, geometrical; Thermal performance of concentrating collector; Optical and thermal performance of different concentrating collector designs; Parabolic trough concentrators; Compound parabolic concentrator; Concentrators with point focus.

Unit-3

Solar thermal power plant: Central receiver systems; Heliostats; Comparison of various designs: Parabolic trough systems, Rankine cycle, Parabolic Dish - Sterling System, Combined cycle.

Unit-4

Solar industrial process heat: Integration of solar thermal system with industrial processes; Mechanical design considerations; Economics of industrial process heat

Unit-5

Solar thermal energy storage: Sensible storage; Latent heat storage; Thermochemical storage; High temperature storage; Designing thermal storage systems

Text books:

1. Solar Engineering of Thermal Processes, Duffie J.A. and Beckman W. A., John Wiley, 2013.
2. Solar Energy: Fundamental and Application, Garg H. P. and Prakash S., Tata McGraw Hill, 2000.

References Books

1. Renewable Energy Resources, Twidell J, Weir T, Routledge, 2015.
2. Principles of Solar Engineering, Goswami D. Y, Taylor and Francis, 2015.
3. Solar Energy: Fundamentals, Design, Modeling, and, Applications, Tiwari G. N., Narosa.
4. Solar Energy: Principles of Thermal Collection and Storage, Nayak J. K. and Sukhatme S. P. Tata McGraw Hill, 2006.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	2	-	-	-	-	-	-	-
CO2	3	2	-	1	2	2	2	-
CO3	2	3	3	1	3	3	2	3
CO4	1	2	2	2	2	2	1	2
CO5	2	2	1	-	-	-	-	-

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Artificial Intelligence in Power Systems**	**Course Code:**	**SOE-M-PPE205 (3)**
Credits :	**4**	**No of Hours :**	**4**
Max Marks:	**100**		

Course Description:

Artificial Intelligence (AI) is becoming more and more popular and it has made its way also in power sector Industry. Artificial Intelligence (AI) techniques, discuss various kinds of Artificial Intelligence.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the basic concepts of expert systems and their applications
CO2	Understand the concepts of artificial intelligence systems and their applications.
CO3	Master the programming in Artificial Neural Networks
CO4	Able to use and analyze Artificial intelligence concepts for Power System problems
CO5	Able to program, trouble shoot the neural network based problems

Syllabus:

Unit-I

Artificial Intelligence: Definition, problem solving methods, searching techniques, knowledge representation, reasoning methods, predicate logic, predicate calculus, multivalue logic.

Unit-2

Fuzzy Logic: Concepts, fuzzy relations, membership functions, matrix representation, defuzzification methods.

Unit-3

Artificial Neural Network: Introduction, multi-layer feed forward networks, back propagation algorithms, radial basis function and recurrent networks.

Unit-4

Evolutionary Techniques: Introduction and concepts of genetic algorithms and evolutionary programming.

Unit-5

Hybrid Systems: Introduction and Algorithms for Neuro-Fuzzy, Neuro-Genetic, Genetic-Fuzzy Systems Application of Al Techniques: Load forcasting, load flow studies, economic load dispatch, load frequency control, reactive power control, speed control of DC and AC motors.

Text books:

1. NP Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press.
2. Rajasekaran S. and Pai G.A.V., Neural Networks, Fuzzy Logic and Genetic Algorithm Synthesis and applications, PHI New Delhi.
3. Lin C. and Lee G., Neural Fuzzy Systems, Prentice Hall International Inc.

References Books

1. Genetic Algorithms in Search Optimization & Machine Learning, Goldberg D.E., Addition Wesley Co., New York.
2. Neural Networks & Fuzzy Systems A dynamical systems approach to machine intelligence, Kosko 13., Prentice Hall of India.
3. Power System stability, Taylor C.W., Mc-Graw Hill, New York.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	2	1	-	-	1	2	1	3
CO2	2	1	-	-	1	2	1	3
CO3	-	2	2	-	2	1	-	3
CO4	1	2	3	-	2	2	2	3
CO5	1	1	1	-	3	1	1	3

Note: 1: Low 2: Moderate 3: High

OP JINDAL UNIVERSITY

OP Jindal Knowledge Park, Punjipatra, Raigarh-496109

Department of Mechanical Engineering

Programme :	M.Tech.	**Semester :**	II Sem
Name of the Course:	Energy Conservation by Waste-Heat Recovery	**Course Code:**	SOE-M-PPE205 (4)
Credits :	4	**No of Hours :**	4
Max Marks:	100		

Course Description:

The proposed course introduces us to various methods of Waste Heat Recovery that has been employed by the industry to harness the energy stored in waste heat and use it for generation of additional electric power.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand the principles and methods of application of low temperature heat.
CO2	Understand the basic principles and available technologies for waste heat recovery.
CO3	Understand the design of waste heat recovery systems, efficient power cycles and power generation system
CO4	Demonstrate the knowledge of waste heat recovery in different industrial applications.
CO5	Able to identify sources of energy loss and power saving.

Syllabus:

Unit-I

Introduction: heat losses, its quality and quantity, potential for energy conservation. Waste heat sources: steam, compressed air, refrigeration, flue gases, furnace/air stream exhaust, high grade heat, low grade heat. Optimal utilization of fossil fuels, Total energy approach; Coupled cycles and combined plants; Cogeneration systems.

Unit-2

Exergy analysis: Utilization of industrial waste heat; Properties of exhaust gas; Gas-to- gas, gas-to liquid heat recovery systems, Recuperates and regenerators; Shell and tube heat exchangers; Spiral tube and plate heat exchangers.

Unit-3

Waste heat boilers: various types and design aspects. Heat pipes: theory and applications in waste heat recovery. Prime movers: sources and uses of waste heat; Fluidized bed heat recovery systems.

Unit-4

Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems; Thermoelectric system to recover waste heat; Heat pump for energy recovery; Heat recovery from incineration plants

Unit-5

Waste Heat Recovery calculations: Quantifying available heat (kWh), Pinch analysis, typical energy costs/construction costs, pay back analysis, thermo-economic viability.

Text books:

1. Hewitt, G. F., Shires, G. L., and Bott, Process Heat Transfer, T. R., CRC Press, Florida, 1993.
2. D. A. Reay, Heat Recovery System, E & F. N. Span, London.
3. C. C. S. Reddy and S. V. Naidu, Waste Heat Recovery Methods and Technologies, National University of Singapore.

References Books

1. Goswami, D. Y., and Kreith, F., Energy Conversion, CRC Press, 2007.
2. Harlock J. H., Combined Heat and Power, Pergaman Press, 1987.
3. Kreith F. and West R. E., Handbook of Energy Efficiency, CRC Press, 1999.
4. Kays W. M. and London A. Ia., Compact Heat Exchangers, Third Edition, McGraw Hill, 1984
5. Ennio Macchi Marco Astolf, Organic Rankine Cycle Power Systems 1st Edition Technologies and Applications, Woodhead Publishing.
6. Ramesh K. Sash and Dusan P. Sekulic, Fundamental of Heat Exchanger Design, Wiley.
7. D. M. Rowe, Thermoelectric Handbook, CRC Press. Department of Mechanical Engineering

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	3	-	-	-	1	2	-	-
CO2	2	1	-	-	-	2	-	-
CO3	3	3	3	1	2	3	3	1
CO4	2	2	2	2	3	3	3	3
CO5	2	3	1	2	2	2	1	-

Programme :	**M.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Advanced Power Plant Engineering Lab-II**	**Course Code:**	**SOE-M-PPE206**
Credits :	**2**	**No of Hours :**	**4**
Max Marks:	**100**		

Course Description:

This Lab course offers experimentations to impart teaching and learning. In this course learners will study and perform the experiments on power plant major and minor components as well as will perform the experiments on combustion devices. The course will make students familiar with different terminologies of power plant operations such as audit, energy management etc.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Experiment with solar panels for various usage of solar power such as water heating, space heating etc.
CO2	Experiment with wind energy training system and PCM based thermal storage system.
CO3	Explain the working of fuel cell and boiler feed pump.
CO4	Experiment with turbidity kit for determination of water quality.
CO5	Experiment with combustion gas analyzer and can classify the various exhaust from power plant.

List of Experiments (minimum eight experiments):

1. Performance on solar water heating system with flat plate collector.
2. To perform testing on Wind Energy Training system.
3. To perform testing on PCM Based thermal storage system.
4. Study of different types of Boiler feed pump and onsite visit of Feed Pump.
5. Study and simulation of fuel cell.
6. To perform testing on combustion Laboratory Unit.
7. To perform the exhaust gas analysis of power plants.
8. To determine fault in transmission line by using simulator.

9. To determine puncture voltage using pin/disc type insulator.
10. Turbidity analysis of feed water of steam power plants.
11. Analysis of feed water using the Hydrometer.
12. To perform energy audit of a production unit
13. To perform simulation on power plant equipment through CFD/FEM Software.

Equipment/Machines/Instruments/Tools/Software Required:

1. Solar thermal training unit.
2. Flash and fire point apparatus.
3. 3. Proximate analyzer (Muffle furnace and micro weigh balance).
4. Fuel cell- Educational Kit.
5. PCM based energy storage system.
6. Combustion Laboratory Unit.
7. Turbidity meter.
8. Hydrometer.

CO, PO & PSO Correlation

CO Number	Program Outcomes					PSOs		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	2	-	1	3	1	2	2	-
CO2	-	1	-	-	1	1	-	2
CO3	2	2	-	1	2	1	-	3
CO4	2	2	2	-	1	2	-	-
CO5	2	-	1	-	2	1	2	-

Note: 1: Low 2: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**II Sem**
Name of the Course:	**Computational Fluid Dynamics Lab**	**Course Code:**	**SOE-M-PPE207**
Credits :	**2**	**No of Hours :**	**4**
Max Marks:	**100**		

Course Description:

This Lab course offers computer simulations of real world problems to impart teaching and learning. In this course learners will study and do the hands on practice on simulation software's. The course will make students familiar with different CAD/CAM design as well as analysis software, which will help the students for research work.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Demonstrate flow system modeling and analysis in ANSYS Design Modeler and fluent.
CO2	Solve problems of heat transfer in a composite slab and unsteady state heat conduction in a rectangular slab.
CO3	Analyze heat transfer from 1D and 2D walls in steady state condition.
CO4	Solve problems of laminar and turbulent and flow past cylinder & Sphere.
CO5	Analyze the laminar flow of air in convergent divergent nozzle for velocity and pressure distribution.

List of Experiments (minimum eight experiments):

1. To obtain solution for the 1-D heat conduction equation using explicit method using finite difference method (Code Development).
2. To perform simulation of 1-D laminar flow in pipe using commercial software package.
3. To perform simulation of 1-D steady state heat transfer in a composite wall using commercial software package.
4. To perform simulation of 2-D steady state heat transfer in a composite wall with radiation effect using commercial software package.

5. To perform numerical simulation of flow over a sphere using commercial software package.
6. To perform numerical simulation of laminar flow of air in convergent divergent nozzle using commercial software package.
7. To perform numerical simulation of flat plate boundary layer using commercial software package.
8. To perform numerical simulation of unsteady heat, transfer in a cylinder using commercial software package.
9. To perform numerical simulation of flow past cylinder using commercial software package.
10. Generation of the algebraic grid (Code Development).
11. Generation of the elliptic grid (Code Development).

Equipment/Machines/Instruments/Tools/Software Required:

1) Ansys Software.
2) High end computers for smooth working.

CO, PO & PSO Correlation

Course Number	Program Outcomes					PSOs		
	1	2	3	4	5	1	2	3
CO1	2	-	2	-	1	2	-	2
CO2	-	1	-	2	1	1	-	3
CO3	2	2	-	-	2	1	2	-
CO4	2	2	2	-	1	2	-	2
CO5	2	-	1	2	2	1	2	-

Note: 1: Low 2: Moderate 3: High

Programme :	M.Tech.	**Semester :**	II Sem
Name of the Course:	Project Report Writing and Seminar	**Course Code:**	SOE-M-PPE208
Credits :	2	**No of Hours :**	2 hours/week
Max Marks:	50		

Course Description:

This subject is related the techniques of scientific study and understanding related research mobility and how to express in a scientific framework. Seminar has its own importance in a career of a student to improve the logical communicative skills and confidences.

Objectives:

1. To set out the chosen research methods, including their theoretical basis, and the literature survey.
2. The experimental methods to be performed to reach a logical conceptual conclusion.
3. Aim to test the research methods opted and find the conceptual understanding.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Know and understand skills and qualities needed to prepare a high-quality Master thesis (dissertation).
CO2	Understand and justify the relevance, soundness and research scope of the project's topic.
CO3	Know key aspects regarding complete and qualitative presentation of the work done.
CO4	Understand the importance of critical thinking in reading sources and writing text.
CO5	Understand the specifics of the language and style of presentation used in writing.

Course Contents

- What 'Master's thesis' really means? The difference between Master's, Specialist's and Bachelor's degree theses. Why are we talking about a research? Choosing a topic and developing a work plan for the thesis activity. How to get a proper mentoring – a point that requires special attention and time
- Why it is important for master's level students to be critical in reading literature (sources) and writing text; working with references. The language and style of master's thesis (dissertation). Specific aspects of writing individual parts of the work (introduction, specification of models (methodology), results)
- Project (work) planning: from the subject of interest to understanding the topic, from the topic "in the broad sense" to the narrowed topic. Raising questions and awareness of the importance of the chosen topic. Initiating major discussion with the project's supervisor (mentor), motivation for the research. Is the chosen topic suitable for the research? What does it mean a "good topic"?
- The initial part of the thesis (topic's relevance, research problem, state of the topic's coverage, the object of the dissertation, the subject of the study, purpose of the study, formulation of the hypothesis, etc.). What is presented? What is important for a complete and qualitative presentation of the work done. Disclosure of the main content of the work
- Project's focus – practical (product-oriented) and research; from questioning to problem solving. General structure of problems. Project (research) proposal. The purpose and the structure of the project (research) proposal.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	2	1	3	1	1	2	2	
CO2	2	2	1	-	-	3	1	
CO3	-	2	3	-	2	2	-	
CO4	-	2	2	-	1	1	2	
CO5	-	1	2	2	-	-	-	

Note: 1: Low 2: Moderate 3: High

M.Tech in Power Plant Engineering & Energy Management

Semester III

S.N	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical		Total Marks	Credit L+(T+P)/2
			L	T	P	ESE	TA		
1	SOE-M-PPE301	Power Plant Maintenance and Safety	4	0	0	50	50	100	4
2	SOE-M-PPE302	Industrial Training*	0	0	8	100	100	200	4
3	SOE-M-PPE303	Research Seminar	0	0	4	25	25	50	2
4	SOE-M-PPE303	Dissertation-Phase I	0	0	24	125	125	250	10
Total			**4**	**0**	**36**	**300**	**300**	**600**	**20**

Programme :	M.Tech.	**Semester :**	III Sem
Name of the Course:	Power Plant Maintenance and Safety	**Course Code:**	SOE-M-PPE301
Credits :	4	**No of Hours :**	4 hours/week
Max Marks:	100		

Course Description:

Basic mechanical skills and repair techniques common to most fields of industrial maintenance. Topics include precision measuring instruments and general safety rules common in industry, including lock-out/tag-out, motorized equipment operation and basic industrial safety knowledge competency testing.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Understand about fundamental of maintenance and Carry out plant maintenance using tribology, corrosion and preventive maintenance
CO2	Develop decision tree for fault tracing in mechanical and electrical components.
CO3	Carry out plant periodic maintenance and preventive maintenance
CO4	Get aware about industrial safety norms as per act 1948
CO5	Select appropriate recovery method for machine elements and Plan foundation and erection of equipment's in plant.

Syllabus:

Unit-I: Fundamentals of maintenance engineering

Definition and aim of maintenance engineering. Primary and secondary functions and responsibility of maintenance department. Types of maintenance. Types and applications of tools used for maintenance. Maintenance cost & its relation with replacement economy. Service life of equipment.

Wear and Corrosion and their prevention

Wear- types, causes, effects, Wear reduction methods. Lubricants-types and applications. Lubrication methods –General sketch, working and applications. Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication. Wick feed lubrication; Side feed lubrication, Ring lubrication. Definition, principle and factors affecting the corrosion, Types of corrosion. Corrosion prevention methods.

Unit-II: Fault tracing

Fault tracing-concept and importance. Decision tree-concept, need and applications. Sequence of fault finding activities, show as decision tree. Draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipments like: Any one machine tool. Pump, Air compressor. Internal Combustion engine. Boiler, Electrical motors. Types of faults in machine tools and their general causes.

Unit-III: Periodic and preventive maintenance

Periodic inspection-concept and need. Degreasing, cleaning and repairing schemes. Overhauling of mechanical components. Overhauling of electrical motor. Common troubles and remedies of Electric motor. Repair complexities and its use. Definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: Machine tools, Pumps, Air compressors, Diesel generating (DG) sets. Program and schedule of preventive maintenance of mechanical and electrical equipments. Advantages of Preventive maintenance. Repair cycle-concept and importance.

Unit-IV: Industrial safety

Accident - causes, types, results and control. Mechanical and electrical hazards-types, causes and preventive steps/procedure. Describe salient points of Factories act 1948. for health and safety-, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc. Safety colour codes. Fire prevention and firefighting, equipment and methods.

Unit-V: Recovery, reconditioning and retrofitting

Definition of recovery, reconditioning and retrofitting. Methods of recovery and their applications. Selection criteria of recovery methods. Reconditioning - process, features and advantages. Retrofitting - concept, need and applications.

Installation, erection and commissioning of equipments

Design and planning of foundation. Erection and commissioning of equipment. Alignment and testing of equipment.

Text books:

1. H.P.Garg, Maintenance Engineering, S. Chand and Company.
2. Higgins & Morrow, Maintenance Engineering Handbook, DA Information Services
3. R.P.Blake, “Industrial Safety”, Prentice Hall of India, New Delhi

References Books

1. Gilbirg & Morrow, Maintenance of Machine Tools.
2. Audels, Pump-hydraulic Compressors, McGrew Hill Publication.
3. Winterkorn, Hans., Foundation Engineering Handbook, Chapman & Hall London.
4. Heinrich H.W, “Industrial accident prevention‟, McGraw Hill Company, New York, 1980.

CO, PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	2	2	3	1	2	1	2	3
CO2	3	2	2	-	2	1	1	2
CO3	3	2	2	1	2	2	1	3
CO4	2	2	1	3	1	3	2	3
CO5	3	3	3	1	3	-	1	3

Note: 1: Low 2: Moderate 3: High

Programme: MTech **Semester: III**

Name of the Course: Industrial Training **Course Code: SOE-M-PPE302**

Credits: 4 **No of Hours:8** **Max Marks: 200**

Course Description:

Many companies that offer internships in core branch profiles require an internship having a semester-long duration. This course is proposed to tap these opportunities. This course is offered to the M.Tech. students to enable them to do a semester-long internship in industry and gain industrial experience. This course opens up opportunities for students to work intensely with the industry to pursue University's goals of education and research, leading to the development of cutting edge and commercially-viable technologies and is thereby aligned with the vision of OPJU.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Participate in the projects in industries during his or her industrial training.
CO2	Describe use of advanced tools and techniques encountered during industrial training and visit.
CO3	Interact with industrial personnel and follow engineering practices and discipline prescribed in industry.
CO4	Develop awareness about general workplace behavior and build interpersonal and team skills.
CO5	Prepare professional work reports and presentations.

Evaluation

The student must intimate the name and contact details of a mentor from the organization where the internship is to be carried out, within 2 weeks of starting the internship to their Faculty Coordinator. A report (ideally 50 pages, in standard format) on the work done during internship should be submitted by the student to their Faculty Advisor. The student needs to include a duly signed certificate of internship completion from the mentor in the report submitted to the FA. A presentation on the work done during the semester internship shall also be given to the FA. Any further requirement for evaluation if deemed necessary by the Faculty Advisor may be included in the evaluation pattern. The evaluation outcomes can be either Satisfactory or Unsatisfactory. The details are given in guideline for internship for MTech students.

CO-PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	2	2	3	1	2	1	2	3
CO2	3	2	2	-	2	1	1	2
CO3	3	2	2	1	2	2	1	3
CO4	2	2	1	3	1	3	2	3
CO5	3	3	3	1	3	-	1	3

Note: 1: Low 2.: Moderate 3: High

Programme :	**M.Tech.**	**Semester :**	**III Sem**
Name of the Course:	**Research Seminar**	**Course Code:**	**SOE-M-PPE303**
Credits :	**2**	**No of Hours :**	**4**
Max Marks:	**50**		

Course Description: Research Seminar have its own importance in a career of a student who is pursuing a professional degree. It is considered as a part of PG curriculum.

Objectives:

1. To set out the chosen research methods, including their theoretical basis, and the literature survey.
2. The experimental methods to be performed to reach a logical conceptual conclusion.
3. Aim to test the research methods opted and find the conceptual understanding.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Acquired the basic skills for performing literature survey and paper presentation
CO2	Demonstrating effective communication and problem-solving skills
CO3	Describe the emerging topics in renewable energy sources, automation, Artificial Intelligence in power plant and related areas based on current publications.
CO4	Work collaboratively with other students and prepare the report
CO5	Demonstrate leadership and professional skills requisite for future academic and professional pursuits.

CO-PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	2	2	2	1	2	3	1	3
CO2	-	2	-	-	2	2	2	2
CO3	2	2	-	-	1	1	2	2
CO4	-	1	2	-	1	-	2	2
CO5	-	1	2	-	3	-	-	3

Note: 1: Low 2: Moderate 3: High

Programme : M.Tech. **Semester :** III Sem

Name of the Course: Dissertation-Phase I **Course Code:** SOE-M-PPE303

Credits : 10 **No of Hours :** 25

Max Marks: 250

Course Description: Research Seminar have its own importance in a career of a student who is pursuing a professional degree. It is considered as a part of PG curriculum.

Course Outcomes:

After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	gain in-depth knowledge and use adequate methods in the major subject/field of study.
CO2	create, analyze and critically evaluate different technical/research solutions
CO3	clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings
CO4	identify the issues that must be addressed within the framework of the specific dissertation in order to take into consideration
CO5	able to apply principles of ethics and standards, skill of presentation and communication techniques.

Objectives:

1. To set out the chosen research methods, including their theoretical basis, and the literature supporting.
2. The method is more experimental, and what kind of reliance could place on the results and reaches a discussion section.
3. Aim to test the research methods, to see if the work is in certain circumstances or not.

CO-PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
CO1	3	-	2	-	1	3	3	3
CO2	1	-	2	-	3	3	3	2
CO3	2	2	2	1	2	2	2	3
CO4	-	2	1	2	1	1	2	3
CO5	-	3	2	3	-	1	3	1

Note: 1: Low 2: Moderate 3: High

MTech in Power Plant Engineering & Energy Management

Semester IV

SN	Board of Study	Subject Code	Subject	Periods per Week			Scheme of Examination Theory / Practical		Total Marks	Credit L+(T+P)/2
				L	T	P	ESE	TA		
1	**Mechanical**	SOE-M-PPE401	Dissertation-Phase II	0	0	28	200	200	400	14
Total				**0**	**0**	**28**	**200**	**200**	**400**	**14**

L- Lecture **ESE-** End Semester Exam **P-** Practical **T.A-** Teacher's Assessment

Programme :	M.Tech.	**Semester :**	III Sem
Name of the Course:	Dissertation Phase-II	**Course Code:**	SOE-M-PPE401
Credits :	14	**No of Hours :**	28
Max Marks:	400		

Course Description:
The course shall be pursued for a minimum of 16 weeks during the final semester, following the preliminary work carried out in Phase-1 during the previous semester. The student is expected to enhance the knowledge base in the chosen field of research in power sector. The student demonstrates the ability to design effective and novel solutions to the defined problem in Phase 1 and through rigorous experimental and theoretical analysis demonstrate the effectiveness of the proposed solution. The student is also expected to effectively communicate the scholarly outcomes as presentations and report and publish the same in reputed conference or journal.

Course Outcomes:
After Completion of the course Students will be able to:

CO Number	Course Outcome
CO1	Plan an independent and sustained critical investigation and evaluation of a chosen research topic relevant to environment and society.
CO2	systematically identify relevant theory and concepts, relate these to appropriate methodologies and evidence, apply appropriate techniques and draw appropriate conclusions.
CO3	engage in systematic discovery and critical review of appropriate and relevant information sources.
CO4	understand and apply ethical standards of conduct in the collection and evaluation of data and other resources.
CO5	communicate research concepts and contexts clearly and effectively both in writing and orally.

CO-PO & PSO Correlation

Course Outcome	Program Outcome					PSO		
	1	2	3	4	5	1	2	3
CO1	3	3	2	1	1	2	3	1
CO2	2	2	3	1	2	2	1	1
CO3	1	2	2	-	2	2	2	2
CO4	-	2	2	3	-	-	2	2
CO5	1	2	3	1	2	-	-	2

Note: 1: Low 2: Moderate 3: High