

**SYLLABUS**

**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>I/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Advanced Thermodynamics</b>				
<b>Subject Code</b>	<b>MMEHE20S101</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To understand various laws of thermodynamics
2. To understand combustion mechanics
3. To learn about pollutants and their estimation

**Course Outcomes:**

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

- CO1:** Learn the concept of energy availability and analysis of thermodynamic systems.
- CO2:** Apply basic laws of thermodynamics in analysis and design of thermodynamic cycles including vapor and gas power cycles, refrigeration cycles, and heat-pump.
- CO3:** Develop understanding how thermodynamic relations are used in evaluation of thermodynamic properties.
- CO4:** Learn how to apply the fundamentals of conservation of mass and energy, and properties of ideal gas mixtures in design and analysis of psychrometric systems.
- CO5:** Learn the thermodynamic analysis of reacting mixtures and the applications in analysis of combustion processes.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<b>Pure Substance:</b> Introduction, properties and application of thermodynamics to pure substance. Equation of States: Ideal gas equation and its limitations for real	<b>8</b>

	gases, other equations of state like Vander walls, Berthelot, Dieterici, Redlich-kwong equations, Bose-Einstein statistic. Fermi-Dirac statistics.	
<b>UNIT-II</b>	<b>Thermodynamic Relations</b> Mathematical theorems, Helmholtz and Gibb's function, T- ds equations, Maxwell's relations, energy equations, variation in heat capacities, Clapeyron relation	<b>9</b>
<b>UNIT-III</b>	<b>Entropy:</b> The essence of entropy, a law of quantum state, quantum state probability, entropy definition, decrease of exergy principal, exergy analysis of thermal systems (Case study), thermal energy reservoir, mechanical energy reservoir, constituent reservoir.	<b>11</b>
<b>UNIT-IV</b>	<b>Composition of gas mixture:</b> mass and molar fraction, P-v-T behavior of gas mixture. Dalton'slaw of partial pressure, Amagat's law, properties of gas mixture. <b>Irreversible thermodynamics:</b> Reversible and irreversible process, the flux postulate, entropy production; heat flux, thermoelectric phenomenon; thermodynamic analysis of the thermocouple, Onseger's reciprocal relation.	<b>15</b>
<b>UNIT-V</b>	<b>Thermodynamic Equilibrium and stability;</b> condition for chemical equilibrium; equilibrium and third law; phase equilibrium; chemical reaction, equation of reaction equilibrium; phase rule; chemical potential of ideal gases and fugacity .	<b>12</b>

**Text Books:**

1. W.C. Reynolds and H.C. Perkins, Engineering Thermodynamics, McGraw-Hill.
2. P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill, 2005 Ed.

**Reference Books:**

1. Michel SAAD, Engineering Thermodynamics, Mc Graw Hill.
2. Jones and Hawkins, Engineering Thermodynamics, Prentice Hall India.
3. J. P. Holman, Engineering Thermodynamics, McGraw-Hill.
4. Y. A, Cengel and M. A. Boles, Thermodynamics: an engineering approach, Tata McGraw-Hill.
5. S .R. Turns, Thermodynamics Concepts and Applications.
6. P. L. Dhar , Engineering Thermodynamics, Elsevier Publication.

**SYLLABUS**  
**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>I/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Advanced Heat Transfer</b>				
<b>Subject Code</b>	<b>MMEHE20S102</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. Analyse multi dimensional transient & steady state heat transfer through solids.
2. Predict heat transfer coefficient on different surfaces/ tube banks and design of heat exchanging equipments..
3. Estimate radiative heat transfer in enclosures with/ without participating media.
4. Analyse one dimensional steady state mass transfer rate for different situations.

**Course Outcomes:**

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

- CO1.** Analyse multi dimensional transient & steady state heat transfer through solids.
- CO2.** Predict heat transfer coefficient on different surfaces/ tube banks and design of heat exchanging equipments
- CO3.** Estimate radiative heat transfer in enclosures with/ without participating media.
- CO4.** Analyse one dimensional steady state mass transfer rate for different situations.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
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<p><b>UNIT-I</b></p>	<p><b>Brief introduction to different modes of heat transfer:</b> conduction: general heat conduction equation-initial and boundary conditions.</p> <p><b>Finite difference methods for conduction:</b> 1d &amp; 2d steady state and simple transient heat conduction problems-implicit and explicit methods.</p> <p><b>Transient heat conduction:</b> lumped system analysis, Heisler charts, semi-infinite solid, use of shape factors in conduction, 2d transient heat conduction, product solutions.</p>	<p><b>8</b></p>
<p><b>UNIT-II</b></p>	<p><b>Forced Convection:</b> Equations of fluid flow-concepts of continuity, momentum equations, derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method, integral analysis</p>	<p><b>12</b></p>
<p><b>UNIT-III</b></p>	<p><b>External flows:</b> Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to various geometries for laminar and turbulent flows.</p> <p><b>Internal flows:</b> Fully developed flow: integral analysis for laminar heat transfer coefficient-types of flow-constant wall temperature and constant heat flux boundary conditions hydrodynamic &amp; thermal entry lengths; use of empirical correlations.</p>	<p><b>11</b></p>
<p><b>UNIT-IV</b></p>	<p><b>Free convection:</b> Approximate analysis on laminar free convective heat transfer, Boussinesque approximation, different geometries, combined free and forced convection.</p> <p><b>Boiling and condensation:</b> Boiling curve, correlations, Nusselts theory of film condensation on a vertical plate, assumptions &amp; correlations of film condensation for different geometries.</p>	<p><b>12</b></p>
<p><b>UNIT-V</b></p>	<p><b>Radiation heat transfer:</b> Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames. Radiative heat transfer through participating medium.</p>	<p><b>10</b></p>

**Text Books:**

1. Yunus A. Cengel, Heat and Mass Transfer – A practical Approach, 3<sup>rd</sup> edition, Tata Mc Graw - Hill, 2007.
2. Holman J.P, Heat Transfer, Tata Mc Graw Hill, 2002.

**Reference Books:**

1. S. P. Sukhatme, A Textbook on Heat Transfer.
2. Ozisik M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985.
3. Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons, 2002.
4. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004.
5. M.M. Modest, Radiative Heat Transfer, Tata-McGraw-Hill.



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**HEAT AND POWER ENGINEERING**

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<b>Semester/Year</b>	<b>I/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Combustion Engineering</b>				
<b>Subject Code</b>	<b>MMEHE20S103</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To get the knowledge of IC, CI engines and testing and characterization of engines.

**Course Outcomes:**

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

- CO1.** Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle.
- CO2.** Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine's performance.
- CO3.** To Demonstrate the delay period and fuel injection system.
- CO4.** Demonstrate an understanding of the Engine.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	Review of energy sources and fossil fuels, role of combustion in energy conservation, comprehensive treatment of combustion principles and their applications.	<b>8</b>
<b>UNIT-II</b>	<b>Thermo chemistry:</b> Stoichiometry and combustion reactions, Enthalpy of formation, Calculation of excess air, Adiabatic flame temperature, Chemical thermodynamics and chemical kinetics, Conservation equations for multi-component systems, System Conservation Laws, Reynolds Transport	<b>9</b>

	Theorem, Governing 3D Partial Differential Equations, Shvab-Zeldovich Coupling Functions and Mixture Fraction.	
<b>UNIT-III</b>	<p><b>Premixed systems detonation and deflagration</b>, laminar flames, 1D propagating flame and flame speed Quenching, flammability, ignition and blow off, effects of different variables on burning velocity, methods for measuring burning velocity, flammability limits, ignition and quenching, detonations, their propagation and structure, flame stability.</p> <p><b>Laminar Non-premixed (Diffusion) Flames</b>, laminar diffusion flame jet, Jet flames and the Burke Schumann Solution, Soot Formation, Counter-flow Flames.</p>	<b>12</b>
<b>UNIT-IV</b>	<p><b>Turbulent pre-mixed flames</b>, turbulent flames, turbulent combustion, chemical effects on turbulence, transition from laminar to turbulent diffusion flames.</p> <p><b>Non-premixed systems:</b> Flame let Modelling Approaches, General probability Density Function (PDF) Formulations.</p>	<b>13</b>
<b>UNIT-V</b>	<p><b>Droplet Combustion</b>, Droplet Evaporation, Droplet Combustion, Simple 1-D Analysis for Multiphase Flows.</p> <p><b>Combustion of solids:</b> drying, devolatilization and char combustion, Practical aspects of coal combustion. Pollution and environment. Formation and control of pollution in flames, engineering applications; Combustion processes in SI Engines and C.I. Engines, Gas turbine combustors, fluidized bed combustors, Design of burners and Combustion chambers.</p>	<b>13</b>

**Text Books:**

1. N.A.Chigier, Energy, Combustion and Environment, McGraw-Hill Co, New York, 1981.
2. Glassman, Combustion, Academic Press, New York, 1977
3. A.MurthyKanury, Introduction to Combustion Phenomena, Gordon and Breach, New York, 1975.

**Reference Books:**

1. S. P. Sharma and Chander Mohan, Fuels and Combustion, Tata McGraw-Hill, 1984.
2. K. K. Kuo, Principles of Combustion.
3. Combustion – Physical and Chemical Fundamentals, Modeling and Simulation, Experiments.
4. J. Warnatz, U. Mass and R. W. Dibble, Pollutant Formation.
5. F. Williams, Combustion Theory 6.S.R. Turns , Introduction to combustion, Tata McGraw-Hill.
7. N. Peters ,Turbulent.



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<b>Semester/Year</b>	<b>I/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Utilization of Solar Energy</b>				
<b>Subject Code</b>	<b>MMEHE20S104</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. Fundamentals of solar radiation.
2. Estimation of solar energy available.
3. Design and fabrication of solar thermal systems.
4. Analyze the solar thermal system.
5. Design a solar PV system.

**Course Outcomes:**

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

**CO1:** Implement fundamentals of solar radiation to real time systems

**CO2:** Do estimation of solar energy available.

**CO3:** Design and fabrication of solar thermal systems

**CO4:** Analyze the solar thermal system

**CO5:** Design a solar PV system.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<b>Solar Radiation Analysis:</b> Solar constant, Basic earth sun angles, Beam and diffuse radiations, Radiation on tilted surfaces (estimation), Measurement of solar radiation (calibration of equipment)	<b>9</b>
<b>UNIT-II</b>	<b>Heat Transfer for Solar Energy Utilization:</b> Basic models of heat transfer, Radiation characteristics of opaque materials and partially transparent media, Heat transfer analysis for flat plate collectors.	<b>9</b>

	<b>Flat Plate Collectors:</b> Physical principles of conversion of solar radiation into heat, Thermal losses and efficiency of FPC, Practical considerations for flat plate collectors, Applications of FPC – Water heating and Drying	
<b>UNIT-III</b>	<b>Focusing Type Collectors:</b> Orientation and sun tracking systems, Types of concentrating collectors – Cylindrical parabolic collector, Compound parabolic collector, Thermal performance of focusing collectors, Testing of solar collectors.	<b>11</b>
<b>UNIT-IV</b>	Solar cooking, Solar desalination, Solar ponds and Solar space heating Solar Industrial process heating and Solar power generation.	<b>10</b>
<b>UNIT-V</b>	Solar Green Houses, Solar thermo mechanical power, Solar refrigeration & air conditioning and Solar High Temperature Applications Energy Storage for Solar Energy Utilization: Importance of storage systems, Different types of thermal storage systems, Alternate storage methods	<b>14</b>

**Text Books:**

1. G D Rai , “Solar Energy Utilization” – Khanna publishers
2. John A Duffie & William A Beckman : “Solar Energy Thermal processes

**Reference Books:**

1. John A Duffie& William A Beckman : “Solar Energy Thermal processes” – Wiley Inter science publication.
2. S P Sukhatme“Solar Energy – Principles of thermal Collection & Storage” – Tata McGraw Hill Publisher., New Delhi.

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<b>Semester/Year</b>	<b>I/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Analysis of Thermal Systems</b>				
<b>Subject Code</b>	<b>MMEHE20S105</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To understand various principle of exergy.
2. To understand gas dynamics.
3. To learn about pollutants and their estimation.

**Course Outcomes:**

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

1. Learn the concept of energy availability and analysis of thermodynamic systems.
2. Apply basic laws of thermodynamics in analysis and design of thermodynamic cycles including vapour and gas power cycles, refrigeration cycles, and heat-pump.
3. Develop understanding how thermodynamic relations are used in evaluation of thermodynamic properties.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<b>Exergy Destruction:</b> Lost available work referred to heat engine cycle, refrigeration cycle, heatpump cycle, non-flow and steady flow processes, Mechanism of exergy destruction, modified Gay Stadola theorem, concept of effective temperature	<b>8</b>
<b>UNIT-II</b>	<b>Exergy Analysis of Simple Processes:</b> Mixing and separation process of fluids of different temperature, heat transfer across a temperature difference, expansion and compression process, combustion process.	<b>9</b>

<b>UNIT-III</b>	<b>Exergy Analysis of Power Plant Cycles:</b> Maximum power subject to size constraint with fixed heat input and its application to Brayton cycle Steam turbine power plants: External and internal irreversibility, superheater, reheater, vacuum condenser, regenerative feed water heating, combined feed water heating and reheating.	<b>11</b>
<b>UNIT-IV</b>	<b>Gas turbine power plant:</b> External and internal irreversibility, regeneration, reheater, an intercooler, combined steam and gas turbine power plant. <b>Exergy-economic Analysis:</b> Fundamental of exergy-economics, exergy costing of different thermal components: steam or gas turbine, boiler, cogeneration system.	<b>13</b>
<b>UNIT-V</b>	<b>Exergy analysis of Refrigeration cycle:</b> Joule-Thomson Expansion, Work-Producing Expansion, Brayton Cycle, Optimal Intermediate Cooling, Exergy analysis of Air-conditioning applications: Mixtures of air and water vapour, total flow exergy of humid air & liquid water, Evaporative cooling process and other aspects, Cryogenic systems and small capacity units.	<b>12</b>

**Text Books:**

1. Advanced Engineering Thermodynamics by Adrian Bejan, John Wiley & Sons, Inc.
2. The Exergy Method of Thermal Plant Analysis by T J Kotas, Krieger Publishing Company.

**Reference Books:**

1. Thermal Design and Optimization by Adrian Bejan, George Tsatsaronis, Michael Moran, John Wiley & Sons, Inc.
2. Advance Thermodynamics for Engineers by Winterbore D E, Arnold Publication.
3. Advanced Thermodynamics for Engineers by Kenneth Wark, McGraw Hill Publishing Co. Ltd.
4. Fundamentals of Engineering Thermodynamics by Michel J Moran, Howard N Shapiro, Daisie D Boettner, Margaret B Bailey, John Wiley & Sons, Inc.

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<b>Semester/Year</b>	<b>I/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Energy Conservation &amp; Management</b>				
<b>Subject Code</b>	<b>MMEHE20S106</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To provide the sufficient knowledge of concept, applications, importance of Energy Conservation and management.
2. To familiarize the students about the Energy audit and its applications in real life situations.
3. To carry out a energy audit on the existed thermal system.

**Course Outcomes:**

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

- CO1:** Understanding of energy conservation and identification of energy conservation opportunities in various industrial processes.
- CO2:** Knowledge of various tools and components energy auditing.
- CO3:** Ability to evaluate the performance of industrial boilers, furnaces etc. by direct and indirect methods.
- CO4:** Understanding of cogeneration in industry and waste heat recovery techniques and Devices.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	Energy scenario and its various forms, General energy problem, Energy use patterns, Energy balance. <b>Energy Management Principles:</b> Need, Organizing, Initiating and managing an energy management program. <b>Energy Auditing:</b> Elements and concepts, Types of energy audits, Instruments	<b>8</b>

	used in energy auditing.	
<b>UNIT-II</b>	<p><b>Economic Analysis:</b> Cash flows, Time value of money, Formulae relating present and future cash flows - single amount, uniform series.</p> <p><b>Financial appraisal methods:</b> Payback period, Net present value, Benefit-cost ratio, Internal-rate of return &amp; Life cycle costs/benefits. Thermodynamics of energy conservation, Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system.</p>	<b>14</b>
<b>UNIT-III</b>	<p><b>Cogeneration:</b> Concepts, Types of cogeneration systems, Performance evaluation of a cogeneration system.</p> <p><b>Waste Heat Recovery:</b> Potential, benefits, waste heat recovery Equipments. Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conservation methods.</p>	<b>11</b>
<b>UNIT-IV</b>	<p><b>Industrial Insulation:</b> Insulation materials, Insulation selection, Economical thickness of insulation. Industrial Heating: Heating by indirect resistance, direct resistance heating (salt bath furnace), and Heat treatment by induction heating in the electric arc furnace industry.</p>	<b>10</b>
<b>UNIT-V</b>	<p><b>Energy Conservation in Electric Utility and Industry:</b> Energy costs and two – part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems, Importance of Power factor in energy conservation - Power factor improvement methods, Energy conservation in industries</p>	<b>10</b>

**Text Books:**

1. Industrial Energy Conservation Manuals: MIT Press by Elias P. Gyftopoulos.
2. Energy Conservation Handbook by W. C. Turner

**Reference Books:**

1. S. C. Tripathy: “Electric Energy Utilization and Conservation”, TMG Delhi, 1991.
2. Wayne C. Turner: “Energy Management Handbook”, Wiley Inter science Publication, NY, 1982.
3. D. A. Reay: “Industrial Energy Conservation”, Pergamon Press. 1980.
4. T. L. Boten: “Thermal Energy Recovery”, Wiley, 1980.

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>I/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Design of Heat Exchangers</b>				
<b>Subject Code</b>	<b>MMEHE20S107</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. Analyse multi dimensional transient & steady state heat transfer through solids.
2. Predict heat transfer coefficient on different surfaces/ tube banks and design of heat exchanging equipments.
3. Estimate radiative with/ without participating media.
4. Analyse one dimensional steady state heat transfer in enclosures mass transfer rate for different situations.

**Course Outcomes:**

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

- CO1.** Analyse multi dimensional transient & steady state heat transfer through solids.
- CO2.** Predict heat transfer coefficient on different surfaces/ tube banks and design of heat exchanging equipments.
- CO3.** Estimate radiative heat transfer in enclosures with/ without participating media.
- CO4.** Analyse one dimensional steady state mass transfer rate for different situations.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<b>Introduction:</b> Classification, overview of heat exchanger design methodology, Design specifications, thermo hydraulic design, and other	<b>8</b>

	considerations. <b>Basic design theory:</b> LMTD method, $\epsilon$ -NTU method, P-NTU method, $\psi$ -P method and P1-P2method.	
<b>UNIT-II</b>	<b>Heat exchanger design procedures:</b> Design of double pipe, shell and tube, tube fin, plate type and plate-fin heat exchanger, Design of cryogenic heat exchangers.	<b>9</b>
<b>UNIT-III</b>	<b>Selection of heat exchangers:</b> selection criteria, general selection guidelines of shell and tube heat exchanger, plate type heat exchanger.	<b>10</b>
<b>UNIT-IV</b>	<b>Thermodynamic modelling and analysis:</b> modelling of heat exchanger based on I-law and Irreversibility.	<b>8</b>
<b>UNIT-V</b>	<b>Header design:</b> Flow distribution, fouling and corrosion, advances in heat exchangers.	<b>9</b>

**Text Books:**

1. D. Q. Kern, Process Heat Transfer, McGraw-Hill.
2. W. M. Kays and A. C. London, Compact Heat Exchangers, McGraw-Hill.

**Reference Books:**

1. R. K. Shah and Deusan P. Sekulic, Fundamentals of heat exchanger design, 2003, John Willey and Sons.
2. S. Kakac, Heat Exchangers – Thermal Hydraulic Fundamentals and Design, Hemisphere, Mc Graw Hill.
3. D. Q. Kern and A. D. Kraus; Extended Surface Heat transfer, McGraw-Hill.

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<b>Semester/Year</b>	<b>I/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Design of Air Conditioning System</b>				
<b>Subject Code</b>	<b>MMEHE20S108</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To impart knowledge about principles of producing low temperatures by using multi-pressure systems and cascade systems.
2. To provide concepts about designing, installation and servicing of air conditioning systems in residential, commercial and industrial buildings.
3. To educate about various system components and accessories of refrigeration and air-conditioning systems.

**Course Outcomes:**

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

- CO1:** Learn the concept of energy availability and analysis of thermodynamic systems.
- CO2:** Apply basic laws of thermodynamics in analysis and design of thermodynamic cycles including vapour and gas power cycles, refrigeration cycles, and heat-pump.
- CO3:** Develop understanding how thermodynamic relations are used in evaluation of thermodynamic properties.
- CO4:** Learn how to apply the fundamentals of conservation of mass and energy, and properties of ideal gas mixtures in design and analysis of psychrometric systems.
- CO5:** Learn the thermodynamic analysis of reacting mixtures and the applications in analysis of combustion processes.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	Psychometric, Air-conditioning processes, Advanced psychrometry, ERSHF, winter air-conditioning, Preparation of psychometric charts.	<b>8</b>
<b>UNIT-II</b>	Ventilation, Necessity, Natural Ventilation, wind effect, stack effect, flow around building, Thermal Comfort, Thermal human model, Measurement of thermal comfort indices.	<b>9</b>
<b>UNIT-III</b>	Solar geometry, Building Heat Transfer, Cooling Load Calculation, CLTD Method Cooling Load and Heat Loss calculations, Concept of energy days, Heating load calculation.	<b>9</b>
<b>UNIT-IV</b>	Room Air Diffusion, Filtration, Duct Design for real life applications such as hospitals, hotels, shopping malls etc., Air Distribution Design. Noise control, Sound propagation, SPL, PWL, Sound Intensity, room acoustics, sound control in ducts.	<b>13</b>
<b>UNIT-V</b>	HVAC Equipment, Packaged and Split HVAC Equipment, Heat pump Design and selection, Equipment Selection, Auxiliaries.	<b>9</b>

**Text Books:**

1. Thermal Environmental Engineering, James L. Threlkeld, Prentice Hall.
2. Air conditioning engineering, W. P. Jones, ELBS.

**Reference Books:**

1. Handbook of Air Conditioning System Design, Carrier Air Conditioning, 1965.
2. ASHRAE Handbooks and ISHRAE Handbooks.

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<b>Semester/Year</b>	<b>I/I</b>	0	-	4	2
<b>Subject Name</b>	<b>Thermal Engineering Lab</b>				
<b>Subject Code</b>	<b>MMEHE20S109</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>50</b>				
<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. To apply the theoretical concepts and enhance understanding of the engineering concepts.</li> <li>2. To familiarize the students about the measurements and error calculations during experiments.</li> <li>3. To understand the design of experiments and report writing.</li> </ol>					
<p><b>Course Outcomes:</b></p> <p>Upon completion of the course, the students will be able to:</p> <p><b>CO1:</b> To Conduct test on heat transfer enhancement set-up, single-cylinder diesel engine.</p> <p><b>CO2:</b> To set air conditioning set-up, centrifugal pump etc.</p> <p><b>CO2:</b> To study Their performance and analyze the results.</p> <p><b>CO4:</b> Draw and analyze performance curves of these machines/systems.</p>					

## **Thermal Engineering Lab**

### **List of Experiments:**

1. Heat Transfer Enhancement Set-up.
2. Computerised Single-Cylinder Diesel Engine Set-up with Alternative Fuel.
3. Set-up for Extraction of Vegetable Oil and its Trans esterification.
4. Air-Conditioning Test-rig.
5. Variable speed Centrifugal/Gear Pump Setups.
6. Unsteady State Heat Transfer Set-up.
7. Blower Test-rig.

### **Text Books:**

1. Lab Manual.

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>I/I</b>	0	-	4	2
<b>Subject Name</b>	<b>Numerical Methods &amp; Computational Techniques</b>				
<b>Subject Code</b>	<b>MMEHE20S110</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>50</b>				

**Course Objectives:**

1. To inculcate subject knowledge of numerical methods applied to thermal engineering applications.
2. To learnt the numerical techniques useful to apply in the areas such as CFD etc.
3. To extent the learning of Numerical method applying the computer programming.

**Course Outcomes:**

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

- CO1:** Understand and be able to numerically solve the governing equations for fluid flow.
- CO2:** Understand and apply finite difference, finite volume and finite element methods to fluid flow problems.
- CO3:** Understand how grids are generated.
- CO4:** Understand how to assess stability and conduct a grid-convergence assessment.
- CO5:** Understand and apply turbulence models to engineering fluid flow problems.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<b>Introduction to Numerical Analysis:</b> Objectives, Mathematical Modelling, Programming Concepts, MATLAB,FORTAN etc., Computational Accuracy, Precision, Truncation Errors, Taylor Series, Curve fitting and Regression,	<b>8</b>

	Interpolation, Fourier Series concepts.	
<b>UNIT-II</b>	<b>Roots of equations:</b> Bisection, False position, Fixed Point Iteration, Newton-Raphson, Secant methods, Roots of polynomials Linear Algebraic Equations, Gauss Elimination.	<b>9</b>
<b>UNIT-III</b>	<b>Non-linear Systems of Equations,</b> Gauss-Jordan, LU Decomposition and Matrix Inversion, Gauss-Seidel.	<b>10</b>
<b>UNIT-IV</b>	<b>Numerical Integration:</b> Trapezoidal and Simpson's Rules, Gaussian Quadrature. Numerical Differentiation and finite-difference approximations .	<b>13</b>
<b>UNIT-V</b>	<b>Ordinary Differential Equations:</b> Euler's and Runge-Kutta Methods, Boundary-Value, Eigen value and Eigen vector Problems. <b>Partial Differential Equations:</b> Elliptic Equations, Laplace Equation and Boundary Conditions, Control Volume Approach, Parabolic Equations, Explicit and Implicit Methods, Crank-Nicolson, Introduction to Finite Element Methods.	<b>10</b>

**Text Books:**

1. S.K. Gupta, Numerical Methods for Engineers, New Age International, 2009
2. Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge, 2007

**Reference Books:**

1. Steven C. Chapra and Raymond P. Canale, Numerical Method for Engineers, 6th Edition, McGraw-Hill, 2010.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, 5th Edition, PHI Learning, 2012
3. S. P. Venkateshan, Computational Methods in Engineering, 1st Edition, Academic Press, 2013

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**HEAT POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>I/I</b>		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>Subject Name</b>	<b>Research Methodology and IPR</b>					
<b>Subject Code</b>	<b>MMAT20S111</b>					
<b>Paper</b>	<b>English</b>	<b>English</b>				
	<b>Hindi</b>					
<b>Max. Marks</b>	<b>100</b>					

**Course objectives:**

1. To explain the functions of the literature review in research and writing a review.
2. To explain various research designs and their characteristics. Methods of data collections.

**Course Outcomes:**

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

**CO1:** Understand research problem formulation.

**CO2:** Analyze research related information.

**CO3:** Follow research ethics.

**CO4:** Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

**CO5:** Understanding that when IPR would take such important place in growth of individuals & Nation, it is needless to emphasis the need of information about Intellectual Property Right to be Promoted among students in general & engineering in particular.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	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.	<b>8</b>

<b>UNIT-II</b>	Effective literature studies approaches, analysis plagiarism, Research ethics.	<b>9</b>
<b>UNIT-III</b>	Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	<b>11</b>
<b>UNIT-IV</b>	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	<b>13</b>
<b>UNIT-V</b>	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	<b>14</b>

**Text books:**

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
3. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

**References books:**

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.

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**HEAT POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>I/I</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Subject Name</b>	<b>English for Research Paper Writing</b>				
<b>Subject Code</b>	<b>MMEHE20S112</b>				
<b>Paper</b>	<b>English</b>	<b>English</b>			
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>00</b>				

**Course objectives:**

Students will be able to:

1. Understand that how to improve your writing skills and level of readability.
2. Learn about what to write in each section.
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first time submission.

**Course Outcomes:**

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

**CO1:** Understand that how to improve your writing skills and level of readability.

**CO2:** Learn about what to write in each section Understand the skills needed when writing a Title.

**CO3:** Ensure the good quality of paper at very first-time submission.

**CO4:** Being Concise and Removing Redundancy, Avoiding Ambiguity.

**CO5:** Apply the discussion, skills are needed when writing the Conclusions.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>Unit-I</b>	Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.	<b>8</b>
<b>Unit-II</b>	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism.	

<b>Unit-III</b>	Sections of a Paper, Abstracts. Introduction. Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.	
<b>Unit-IV</b>	Key skills needed when writing a Title, key skills needed when writing an Abstract, key skills needed when writing an Introduction, skills needed when writing a Review of the Literature, skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills are needed when writing the Conclusions,	
<b>Unit-V</b>	Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.	

**Text books:**

1. Gold bort R (2006) Writing for Science, Yale University Press (available on Google Books).
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.

**References books:**

1. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book publication.
2. Adrian Wall work, English for Writing Research Papers, Dordrecht Heidelberg London, 2011.

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Modelling and Analysis in Thermal Engineering</b>				
<b>Subject Code</b>	<b>MMEHE20S201</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To provide the sufficient knowledge to learn the thermal modelling of real engineering problems.
2. To familiarize the students about the applications of fundamental laws and mathematics principles for thermal modelling.
3. To understand the concept of optimization applied to engineering applications.

**Course Outcomes:**

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

- CO1: Attempt modeling real life systems of interest in order to predict its dynamic behaviour.
- CO2: Use simulation tools to determine dynamic response of system following external inputs.
- CO3: Optimization of thermal systems, formulation, optimization methods.
- CO4: Deep understanding on the governing equations for convection heat transfer; knowing the dimensionless parameter.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<b>Introduction:</b> Engineering Design, design and analysis, Workable and optimum system, formulation Thermal systems, basic characteristics and analysis.	<b>8</b>
<b>UNIT-II</b>	<b>Modelling of Thermal systems:</b> Procedure of mathematical modelling, basic features of modelling, System and types of Model, characteristic of models,	<b>9</b>

	Curve fitting, exact fit, best fit.	
<b>UNIT-III</b>	Modelling and analysis of thermal systems, including - thermodynamics, fluid mechanics, heat and mass transfer, refrigeration and air-conditioning, system components (heat exchangers, expansion devices, pumps, compressors, turbines, boilers).	<b>9</b>
<b>UNIT-IV</b>	Thermal system simulation: Sequential simulation, simultaneous simulation, successive substitution, Newton-Raphson method. Optimization of thermal systems, formulation, optimization methods; Lagrange Multipliers, Search Methods, Linear programming, Dynamic programming and geometric programming.	<b>13</b>
<b>UNIT-V</b>	Develop methodologies for the design and optimization of thermal systems. A non-linear equation solver, Engineering Equation Solver (EES), Pinch technology: basic concepts, T-h, h-s diagrams, design of recovery system using pinch technology.	<b>10</b>

**Text Books:**

1. W.C. Reynolds and H.C. Perkins, Engineering Thermodynamics, McGraw-Hill.
2. P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill, 2005.

**Reference Books:**

1. Michel SAAD, Engineering Thermodynamics, McGraw Hill.
2. Jones and Hawkins, Engineering Thermodynamics, Prentice Hall India.
3. J. P. Holman, Engineering Thermodynamics, McGraw-Hill.
4. Y. A. Cengel and M. A. Boles, Thermodynamics: an engineering approach, Tata McGraw-Hill.
5. S. R. Turns, Thermodynamics Concepts and Applications.
6. P. L. Dhar , Engineering Thermodynamics, Elsevier Publication.

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### HEAT AND POWER ENGINEERING

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>III/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Fluid Dynamics</b>				
<b>Subject Code</b>	<b>MMEHE20S202</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

#### Course Objectives:

1. Explain the physical properties of a fluid and the consequence of such properties on fluid flow.
2. Identify the fundamental kinematics of a fluid element.
3. State the conservation principles of mass, linear momentum, and energy for fluid flow.
4. Apply the basic applied-mathematical tools that support fluid dynamics.

#### Course Outcomes:

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

**CO1:** Classify and exploit fluids based on the physical properties of a fluid.

**CO2:** Compute correctly the kinematical properties of a fluid element.

**CO3:** Apply correctly the conservation principles of mass, linear momentum, and energy to fluid flow systems.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, Scalar and vector fields, Eulerian and Lagrangian approach. Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential. Transport theorems, constitutive equations.	
<b>UNIT-II</b>	Derivation of Navier Stokes equations for compressible flow. Exact solutions of Navier Stokes equations : plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow over a flat plate, cylinders and spherical bodies, Stoke's	<b>9</b>

	first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent- divergent channels. Slow viscous flow: Stokes and Oseen's approximation, theory of hydrodynamic lubrication.	
<b>UNIT-III</b>	Boundary layer: derivation, exact solutions, Non dimensionalization of Boundary layer equation, Blasius (similarity solution) , Falkner Skan, Von-karmon integral equation series solution and numerical solutions. Approximate methods. Momentum integral method.	<b>10</b>
<b>UNIT-IV</b>	Turbulent flow: algebraic models, hydrodynamic stability, velocity correlations, Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution, Plane and axi-symmetric jets, Two equation model(k-epsilon), large eddy simulation.	<b>13</b>
<b>UNIT-V</b>	Compressible flow: 1D flow, speed of sound, variable c/s flow, converging-diverging nozzle, normal shock relation, past slender bodies, compressible boundary layer. Computational fluid dynamics: Introduction, fundamentals of numerical analysis of partial differential equations (PDE).	<b>12</b>

**Text Books:**

1. Fox and McDonald, Introduction to Fluid Mechanics, J.H. Wiley and Sons.
2. S. M. Yahya, Fundamentals of Compressible Flow, Wiley Eastern Ltd.
3. H. Schlichting, Boundary Layers Theory, McGraw - Hill

**Reference Books:**

1. J. M. Robertson, Hydrodynamics in Theory and Application, Prentice Hall.
2. A. H. Shapiro, The Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald.
3. F. M. White ,Fluid Mechanics, McGraw-Hill.
4. K. Muralidhar and Bishwas, Advance Engineering fluid mechanics.

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Cryogenic Engineering</b>				
<b>Subject Code</b>	<b>MMEHE20S203</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To cover the basic principles of cryogenic engineering.
2. To develop an intuitive understanding of cryogenics for the student who are interested
3. To study the science technology of low temperatures.

**Course Outcomes:**

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

**CO1:** Demonstrate and identify role of cryogenics in the industrial applications.

**CO2:** Describe mechanical, thermal, thermo-electric properties of cryogenic fluids.

**CO3:** Study and describe Insulation and storage systems in cryogenic engineering

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<p><b>Introduction:</b> Industrial applications, research and development, properties of cryogenic fluids- oxygen, nitrogen, air, hydrogen and helium.</p> <p><b>Behaviour of Structural Materials at Cryogenic temperature:</b> Mechanical properties, thermal properties, thermoelectric properties.</p>	<b>9</b>
<b>UNIT-II</b>	<p><b>Liquefaction of Cryogenic Gases:</b> Inversion Temperature, Liquefaction Performance Parameters, Ideal cycle, liquefaction of air, Hydrogen and helium, critical components of liquefiers, efficiency, Cryogenic heat exchangers. <b>Separation of Gases:</b> Ideal separation,</p>	<b>9</b>

	properties of mixtures, Rectifiers column, separation of air, purification.	
<b>UNIT-III</b>	<b>Cryogenic Refrigeration Systems:</b> Ideal refrigeration systems, J-T Refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvey refrigerator, G-M regrogerator.	<b>11</b>
<b>UNIT-IV</b>	Vacuum insulation, fibrous materials, Solid foams, Gas filled power, comparison, critical thickness.	<b>10</b>
<b>UNIT-V</b>	Size and shape of vessel, portable commercial containers, large stationary container, power, transport, storage system, Liquid level indicators. <b>Transfer of Liquefied Gases:</b> Two phase flow transfer through insulated and uninsulated lines, cryogenic pumps and valves.	<b>11</b>
<b>Text Books:</b>		
<ol style="list-style-type: none"> <li>1. R. F. Barron, Cryogenic Systems, Oxford University Press, 1985.</li> <li>2. P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill, 2005.</li> </ol>		
<b>Reference Books:</b>		
<ol style="list-style-type: none"> <li>1. Advanced Cryogenic Engineering, Proceedings of Cryogenic Engineering Conference, Vol1-145, Plenum press, New York, 1968.</li> </ol>		

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Steam and Gas Turbines</b>				
<b>Subject Code</b>	<b>MMEHE20S204</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To provide the sufficient knowledge of working, construction and control of ST and GT
2. To familiarize the students about the industrial applications of ST and GT
3. To understand the analysis of GT and ST employing real life data

**Course Outcomes:**

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

- CO1:** Demonstrate and analyze vortex flow, energy lines and reheat factors of steam turbines. Solve problems of finding performance steam turbine power.
- CO2:** Design and suggest and analyze cooling accessories and protective material for steam turbine.
- CO3:** Visit thermal power plant and enumerate performance and maintenance and troubleshooting criteria for steam turbine.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	Introduction, properties of steam, steam quality, Theoretical steam turbine cycle. The flow of steam through Impulse and Impulse–Reaction turbine blades, compounding of steam turbine.	<b>8</b>
<b>UNIT-II</b>	Vortex flow in steam turbines, Energy lines, State point locus, Reheat factor and Design procedure. Governing and performance of steam turbine, Effect of operating variables on thermal efficiency.	<b>9</b>

<b>UNIT-III</b>	Steam nozzles, Turbine Blade-Design, Selection of blade profile, blade cooling techniques, material, protective coating. Gas turbine Introduction, simple open cycle gas turbine, Actual Brayton cycle, Means of Improving the efficiency and the specific output of simple cycle, Regeneration, Reheat, Inter cooling.	<b>11</b>
<b>UNIT-IV</b>	Closed-cycle gas turbine, turbine velocity diagram and work done, Performance improvement, Effect of operating variables on thermal efficiency.	<b>10</b>
<b>UNIT-V</b>	Fuel supply techniques and control, Combuster design, Lubrication, Maintenance and trouble shooting.	<b>10</b>

**Text Books:**

1. W.J.Kearton, Steam Turbine Theory and Practice, ELBS.
2. R.Yadav, Steam and Gas Turbine, Central Publishing Home, Allahabad.

**Reference Books:**

1. Jack D. Mattingly., Elements of Gas Turbine propulsion, McGraw – Hill Pub.
2. Cohen Rogers, Gas Turbine Theory, Longman Publishing.
3. V Ganesan: “Gas Turbines”, 2002.

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>		3	-	-	3
<b>Subject Name</b>	<b>Biomass Energy</b>					
<b>Subject Code</b>	<b>MMEHE20S205</b>					
<b>Paper</b>	<b>English</b>					
	<b>Hindi</b>					
<b>Max. Marks</b>	<b>100</b>					

**Course Objectives:**

1. To Understand the concept of Biomass its importance, availability, and energy conversion process
2. To familiarize the students about the biomass systems design
3. To understand the industrial applications of Biomass systems through real life problems

**Course Outcomes:**

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

- CO1:** Illustrate relevance of biomass as energy source, enumerate advantages and disadvantages of biomass resources.
- CO2:** Survey and identify wasteland in India, suggest suitable biomass resource management.
- CO3:** Design and construct down draft gasifier, its Cooling–cleaning systems and Performance evaluation of a Down draft gasifier
- CO4:** Conduct an experiment and calculate load capacity, efficiency and identify maintenance, troubleshooting and exhaust emission problems.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<b>Introduction:</b> Relevance of biomass as an energy source, Biomass Resources, Cultivated biomass resources, Water-to-biomass resources, Advantages associated with biomass resources, Availability of biomass for energy generation.	<b>8</b>

<b>UNIT-II</b>	<b>Energy plantation:</b> Concept, Objectives and advantages. <b>Wasteland development:</b> Extent of water lands in India, Nature of waste lands.	<b>9</b>
<b>UNIT-III</b>	<b>Biomass Conversion Processes:</b> Combustion, Biochemical and Thermo chemical. <b>Gasification:</b> Fuels for gasification, Properties of biomass - size, size distribution, bulk density, volatile matter, ash and ultimate analysis. Air gasification in a down draft gasifier, Types of gasifiers, Gasifier engine system, Use of producer gas in SI & CI engines, Reasons for decorating, Problems associated with gasifier engine system and its efficiency.	<b>10</b>
<b>UNIT-IV</b>	<b>Design of a Down draft gasifier</b> Cooling–cleaning systems, Performance evaluation of a Down draft gasifier. <b>Performance of Dual Fuel Engine:</b> Power capacity, Diesel substitution, Thermal efficiency, Smoothness of operation, Load following capability, Maintenance and durability, Exhaust emissions.	<b>10</b>
<b>UNIT-V</b>	<b>Bio-conversion Process:</b> The process, Types of biogas plants, Design of biogas plants, Factors affecting gas generation rate, Biogas engine for water pumping and electric power generation applications, Government programmes. <b>Wood fuelled Cooks stoves,</b> Effects of various stove parameters, Effects of various stove components, Current versions of improved stoves, Efficiency of stoves, Utilization of biomass based fuels for thermal and shaft power applications.	<b>12</b>

**Text Books:**

1. T.B.Reed: “Biomass Gasification Principles and Technology”, Noyes Data Corporation, Energy Technology Review, No.67, U.S.A., 1981.
2. P Vimal& M S Bhatt: “Wood Energy Systems”, K L Publications, New Delhi , 1989.

**Reference Books:**

1. S Rao& B BParulkar: “Energy Technology” Khanna Publishers Delhi , 1999.
2. A.Kaupp and J.R.Goss: “State of Art Report for small scale Gas Producer Engine Systems”, FriedrVieweg & Sohn Verlags, Gmbh, Braunschweig, 1984.

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>	<b>3</b>	<b>-</b>	<b>-</b>	<b>3</b>
<b>Subject Name</b>	<b>Advanced Optimization Techniques</b>				
<b>Subject Code</b>	<b>MMEHE20S206</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To Understand the concept of optimization and its importance in the back ground of real life engineering systems.
2. To familiarize the students about the optimization techniques and their implementations.
3. To carry out the case study using optimization technique.

**Course Outcomes:**

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

- CO1:** Enables to acquire mathematical methods and apply in engineering disciplines.
- CO2:** Apply methods of optimization to solve a linear,non-linear programming problem by various methods.
- CO3:** Use of dynamic programming problem in controlling in industrial managements.
- CO4:** Simulate Thermal engineering system problem. Understand integer programming and stochastic programming to evaluate advanced optimization techniques.

Unit	Syllabus	Periods
UNIT-I	<p>Engineering application of optimization, terminology, design variables, constraints, objective functions, variable bounds, problem formulation.</p> <p><b>Single Variable Non-Linear Unconstrained Optimizing:</b> One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic &amp; cubic interpolation methods.</p>	8
UNIT-II	<p><b>Multi Variable Non-Linear Unconstrained Optimization:</b> Direct search method, Uni variant Method – pattern search methods , Powell’s – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeve’s method. <b>Variable</b> metric method.</p>	9
UNIT-III	<p><b>Geometric Programming:</b> Polynomials – arithmetic – geometric inequality – unconstrained G.P– Constrained G.P.</p> <p><b>Dynamic Programming:</b> Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.</p>	11
UNIT-IV	<p><b>Linear Programming:</b> Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. <b>Simulation:</b> Introduction – Types – Steps – application – inventory – queuing – thermal system.</p>	12
UNIT-V	<p><b>Integer Programming:</b> Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.</p> <p><b>Stochastic Programming:</b> Basic concepts of probability theory, random variables –distributions – mean, variance, Correlation, co variance, joint probability distribution stochasticlinear, dynamic programming.</p>	10

**Text Books:**

1. Operation Research/H.A. Taha/TMH.
2. Optimization in operations research/R.L Rardin.
3. Optimization Techniques/Benugundu & Chandraputla/Person Asia.

**Reference Books:**

1. Michel SAAD, Engineering Thermodynamics, McGraw Hill.
2. Jones and Hawkins, Engineering Thermodynamics, Prentice Hall India.
3. J. P. Holman, Engineering Thermodynamics, McGraw-Hill.
4. Y. A, Cengel and M. A. Boles, Thermodynamics: an engineering approach, Tata McGraw-Hill.
5. S.R. Turns, Thermodynamics Concepts and Applications.
6. P.L. Dhar , Engineering Thermodynamics, Elsevier Publication.



**SYLLABUS**

**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>	3	-	-	3
<b>Subject Name</b>	<b>JET &amp; ROCKET PROPULSION</b>				
<b>Subject Code</b>	<b>MMEHE20S207</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To Understand the concept of gas dynamics.
2. To familiarize the students about the Jet and rocket propulsion and its whole thermodynamics analysis.
3. To understand the applications of Jet propulsion.

**Course Outcomes:**

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

- CO1:** Apply knowledge of features and capabilities of chemical and non-chemical rocket propulsion systems.
- CO2:** Calculate the design thrust and overall efficiency of turbojet and turbofan engines, with and without afterburners, from given component performance..
- CO3:** Estimate the specific impulse and mass flow for a rocket engine accounting for chemical reaction and non-constant specific heats.
- CO4:** Design simple rocket propulsive system.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	Velocity triangles; compressor performance maps, Compressor blading; design; multi-staging, Turbines; stage characteristics; degree of reaction, mass flow limits; blade temperature. Turbine cooling; general trends and systems; internal	<b>10</b>

	cooling, Film cooling; thermal stresses; impingement cooling; how to do cooling design, Compressor-turbine matching; gas generators, Engine structures; centrifugal stresses; engine arrangements, Critical speeds and vibration, Combustors; afterburners.	
<b>UNIT-II</b>	Jet climb & acceleration, calculation of drag and thrust, optimum exhaust velocity, Air breathing and non-air breathing engines, aircraft gas turbine engine, cycles analysis of ideal and real engines, components performance-intake, combustor, nozzle, turbomachinery, etc. limitations of jet engines, Rocket equation; optimum acceleration, Rocket staging.	<b>9</b>
<b>UNIT-III</b>	Turbojet, turboprop, turbofan engines, ramjet and pulsejet, design parameters; performance parameters like thrust, propulsive efficiency. Models for rocket engines; Inlets or diffusers, Exhaust nozzles, Compressors and fans.	<b>11</b>
<b>UNIT-IV</b>	Modelling of thermal rocket engines; fuels, fuels arrangement, Types of nozzles; connection of flow to nozzle shape, control of mass flow, Modelling of rocket nozzles; effects of nozzle area ratio. Jet engine and rocket structures, Rocket casing design; structural modelling, Heat transfer and cooling arrangement, Ablative cooling, Thrust vectoring; mass estimates.	<b>13</b>
<b>UNIT-V</b>	Chemical Rockets, types of propellants and their properties, injectors, thrust chamber, burning rate; Solid propellant gas generators; stability; grain designs; Cryogenic propellant, combustion phenomena, thrust vector control, ignition and inhibitors. Basics of Electrical and Nuclear rockets. Pollutant; motivations for control; formation; strategies for reduction, Aircraft engine noise: principles; regulations, Jet noise, turbo machinery noise, Rotor dynamics of the jet engine.	<b>14</b>

**Text Books:**

1. W.C. Reynolds and H.C. Perkins, Engineering Thermodynamics, McGraw-Hill.
2. P.K. Nag, Engineering Thermodynamics, Tata McGraw-Hill, 2005.

**Reference Books:**

1. Jack D. Mattingly., Elements of Gas Turbine propulsion, McGraw – Hill Pub.
2. Cohen Rogers, Gas Turbine Theory, Longman Publishing.
3. V Ganesan: “Gas Turbines”, 2002

**SYLLABUS**

**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>	3	-	-	3
<b>Subject Name</b>	<b>Nuclear Power Plant</b>				
<b>Subject Code</b>	<b>MMEHE20S208</b>				
<b>Paper</b>	<b>English</b>				
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>100</b>				

**Course Objectives:**

1. To provide the sufficient knowledge of concept, applications, importance of Nuclear Power plant.
2. To familiarize the students about the design of Nuclear Power plant.
3. To understand the environment impact and policies about the NPP.

**Course Outcomes:**

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

- CO1:** Identify various energy sources, Indian Power Scenario, Nuclear Power Scenario in the World, Nuclear Power Scenario in India, Scope.
- CO2:** Describe Nuclear physics, reactor, classification and types of nuclear reactor, economics of power plant.
- CO3:** Analyze heat transfer from nuclear, heat flux radiation.
- CO4:** Analyze economics of nuclear power plant, load generation.

<b>Unit</b>	<b>Syllabus</b>	<b>Periods</b>
<b>UNIT-I</b>	<b>Introduction</b> – World Energy Sources, Indian Power Scenario, Nuclear Power Scenario in the World, Nuclear Power Scenario in India, Scope of the Present Course.	<b>8</b>
<b>UNIT-II</b>	<b>Nuclear Power Plant:</b> Nuclear physics, Nuclear Reactor, Classification, Types of reactors, Site selection. Method of enriching uranium. Application of nuclear power plant. Nuclear Power Plant Safety: Bi-Product of nuclear power	<b>9</b>

	generation, Economics of nuclear power plant, Nuclear power plant in India, Future of nuclear power.	
<b>UNIT-III</b>	Basic Concepts in Neutron Reactions, Neutron Moderation and Diffusion, Nuclear Reactor Theory. Nuclear Reactor Dynamics and Control., Nuclear Reactor Thermal-Hydraulics.	<b>11</b>
<b>UNIT-IV</b>	<b>Power Plant Instrumentations:</b> Classification, Pressure measuring instrument, Temperature measurement and Flow Measurement, Analysis of combustion gases, Pollution types, Methods of control.	<b>13</b>
<b>UNIT-V</b>	Health Physics, Radiation Shielding., Nuclear Reactor Safety and licensing. <b>Economics of Power Generation:</b> Factors affecting the economics, loading factors, Utilization factor, Performance and operating characteristics of power plant, Point economic load sharing, Depreciation. Energy rate, Criteria for optimum loading. Specific economic energy problem.	<b>14</b>

**Text Books:**

1. Power Plant Engineering / P.K.Naga / TMH.
2. Power Plant Technology / El Wakil, McGraw Hill Publication.

**Reference Books:**

1. Power Plant Engineering / R. K. Rajput/ Lakshmi Publications.
2. Power Plant Engineering / P. C. Sharma/ Kotearia Publications.

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>		-	-	4	2
<b>Subject Name</b>	<b>Computational Fluid Dynamics Lab</b>					
<b>Subject Code</b>	<b>MMEHE20S209</b>					
<b>Paper</b>	<b>English</b>					
	<b>Hindi</b>					
<b>Max. Marks</b>	<b>50</b>					

**Course Objectives:**

1. To develop an understanding for the major theories, approaches and methodologies used in CFD.
2. To build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modelling etc.) in using commercial CFD codes.
3. To gain experience in the application of CFD analysis to real engineering designs.

**Course Outcomes:**

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

- CO1:** Understand and be able to numerically solve the governing equations for fluid.
- CO2:** Understand and apply finite difference, finite volume and finite element methods to fluid flow problems.
- CO3:** Understand how grids are generated.
- CO4:** Understand how to assess stability and conduct a grid-convergence assessment.
- CO5:** Understand and apply turbulence models to engineering fluid flow problems.

**List of Experiments**

1. To study fundamentals of Computational Fluid Dynamics (CFD).
2. To perform CFD analysis of lid driven cavity in Open-Foam.
3. To perform CFD analysis of square tube in Open-Foam.
4. To perform CFD analysis of a 2D-plate in Open-Foam. form CFD analysis of bifurcated blood vessel in FEM.
5. To study fundamentals of Finite element method and FEA.
6. To perform FEM analysis of deep drawing process in FEM.
7. To study fundamentals of Sci - Lab.
8. To perform matrix operations in Sci -lab.

**Text Books:**

1. Lab Manuals

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**HEAT AND POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>		-	-	4	2
<b>Subject Name</b>	<b>Fluid Dynamics Lab</b>					
<b>Subject Code</b>	<b>MMEHE20S210</b>					
<b>Paper</b>	<b>English</b>					
	<b>Hindi</b>					
<b>Max. Marks</b>	<b>50</b>					
<p><b>Course Objectives:</b></p> <ol style="list-style-type: none"> <li>1. Explain the physical properties of a fluid and the consequence of such properties on fluid flow.</li> <li>2. Identify the fundamental kinematics of a fluid element.</li> <li>3. State the conservation principles of mass, linear momentum, and energy for fluid flow.</li> <li>4. Apply the basic applied-mathematical tools that support fluid dynamics.</li> </ol>						
<p><b>Course Outcomes:</b></p> <p>Upon completion of the course, the students will be able to:</p> <p>CO1: Classify and exploit fluids based on the physical properties of a fluid.</p> <p>CO2: Compute correctly the kinematical properties of a fluid element.</p> <p>CO3: Apply correctly the conservation principles of mass, linear momentum, and energy to fluid flow systems.</p>						

**List of Experiments:**

1. Flow measurement using venturimeter.
2. Determination of pipe friction factor.
3. Performance test on Kaplan turbine.
4. Performance test on reciprocating pump.
5. Flow measurement using Orificemeter.
6. Verification of Bernoulli's theorem.
7. Performance test on Francis turbine
8. Performance test on centrifugal pump.

**Text Books:**

1. Lab Manuals

**SYLLABUS**

**HEAT POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>		<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>		<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>
<b>Subject Name</b>	<b>Mini Project</b>					
<b>Subject Code</b>	<b>MMEHE20S211</b>					
<b>Paper</b>	<b>English</b>	<b>English</b>				
	<b>Hindi</b>					
<b>Max. Marks</b>	<b>50</b>					

**Course Objective:**

1. The aim of the mini project is that the student has to understand the structural engineering problems
2. The student should gain a thorough knowledge in the problem, he/she has selected and to analyze complex structural systems.

**Course Outcomes:** At the end of the Subject, the student will be able to:

**CO1:** Identify structural engineering problems reviewing available literature.

**CO2:** Study different techniques used to analyze complex structural systems.

**CO3:** Work on the solutions given and present solution by using his/her technique applying engineering principles.

**Contents**

1. Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.
2. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals 'contribution.
3. Continuous assessment of Mini Project at Mid Sem and End-Sem will be monitored by the departmental committee.



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**HEAT POWER ENGINEERING**

<b>Class</b>	<b>M.TECH.</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>Semester/Year</b>	<b>II/I</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Subject Name</b>	<b>Stress Management by Yoga</b>				
<b>Subject Code</b>	<b>MMEHE20S212</b>				
<b>Paper</b>	<b>English</b>	<b>English</b>			
	<b>Hindi</b>				
<b>Max. Marks</b>	<b>00</b>				

**Course Objectives**

1. To achieve overall health of body and mind.
2. To overcome stress.

**Course Outcomes:** Students will be able to:

- CO1:** Develop healthy mind in a healthy body thus improving social health also.  
**CO2:** Improve efficiency

**Syllabus**

1. Definitions of Eight parts of yog. (Ashtanga).
2. Yam and Niyam. Do's and Don'ts in life.
3. Ahinsa, satya, astheya, bramhacharya and aparigraha, Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.
4. Asan and Pranayam.
5. Various yog poses and their benefits for mind & body, Regularization of breathing techniques and its effects-Types of pranayam

**Suggested reading:**

1. 'Yogic Asanas for Group Training - Part I': Janardan Swami Yogabhyasi Mandal, Nagpur.
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.