

**Course name:** Mechanical Engineering

**Course code:** ME/MH

**Semester:** Fourth

**Subject title:** Thermal Engineering

**Subject code:** 9053

Teaching Scheme			Examination Scheme						
TH	TU	PR	PAPER HRS	TH	TEST	PR	OR	TW	TOTAL
04	--	02	03	80	20	--	25#	25@	150

**Rationale:**

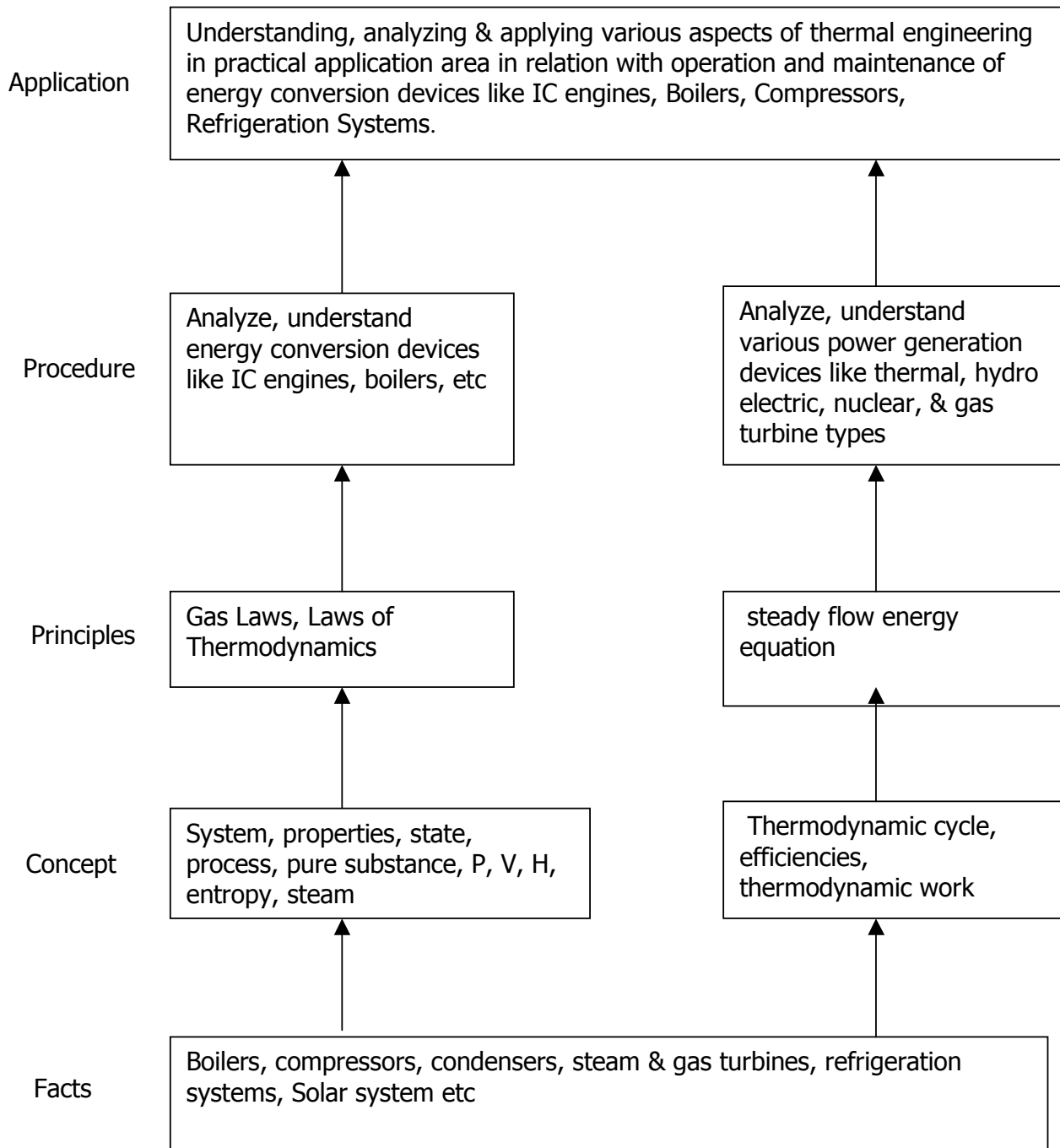
Mechanical engineers have to work with various power producing & power absorbing devices like boilers, turbines, compressors, pumps etc. In order to understand the principles, construction & working of these devices, it is essential to understand the concept of energy, work, heat & conversion between them. Hence it is important to study the subject of Thermal Engineering which is a core subject. It includes the study of various sources of energy, basic laws & concept of thermodynamics, gas laws, properties of steam & generation. Heat transfer forms the basis for different power engineering application. Boilers find application in different process industries. Steam turbines and condensers are the major component of any steam power plant. Mechanical engineer should understand working and application of these devices.

**Objectives:**

The Students should be able to:

1. Know various sources of energy & their applications.
2. Apply fundamental concepts of thermodynamics to thermodynamic systems.
3. Understand various laws of thermodynamics.
4. Apply various gas laws & ideal gas processes to various thermodynamic systems.
5. Calculate properties of two phase system by using steam tables/ mollier charts.
6. Explain construction & working of boilers, mountings & accessories.

## Learning Structure:



## Contents: Theory

Chapter	Name of the Topic	Hours	Marks
<b>1.</b>	<p><b>Sources of energy</b></p> <p>1.1 Brief description of energy sources</p> <ul style="list-style-type: none"> <li>- Classification of energy sources</li> <li>- Renewable, Non-Renewable</li> </ul> <p>1.2 Fossil fuels, including CNG, LPG.</p> <p>1.3 Solar</p> <ul style="list-style-type: none"> <li>- Flat plate and concentrating collectors &amp; its application.</li> <li>- Solar Water Heater</li> <li>- Photovoltaic Cell, Solar Distillation.</li> </ul> <p>1.4 Wind, Tidal, Geothermal</p> <p>1.5 Biogas, Biomass, Bio-diesel</p> <p>1.6 Hydraulic, Nuclear</p> <p>1.7 Fuel cell – list of fuel cells</p>	<b>08</b>	<b>08</b>
<b>2.</b>	<p><b>Fundamentals of Thermodynamics</b></p> <p>2.1 Concepts of pure substance, types of systems , properties of systems , Extensive and Intensive properties with units and conversion like P, V, <math>\rho</math> And temperature. Point function and path function.</p> <p>2.2 Work and Energy</p> <ul style="list-style-type: none"> <li>- Thermodynamic definition of work, heat, difference between heat and work, P.E., K.E, Internal Energy, Flow work, concepts of enthalpy, entropy.</li> </ul> <p>2.3 Laws of Thermodynamic</p> <ul style="list-style-type: none"> <li>- Zeroth Law, Temperature measurement, principle of energy conservation, irreversibility, Second Law of Thermodynamics, Kelvin Plank, Clausius statements and their equivalence, Concept of perpetual motion machine 1 and 2.</li> </ul> <p>2.4 Application of Thermodynamic laws</p> <ul style="list-style-type: none"> <li>- Steady Flow Energy equation and its application to open system like boiler, engine, nozzle, turbine, compressor &amp; condenser.</li> </ul> <p>2.5 Application of Second law to Heat Engine, Heat Pump and Refrigerator.</p>	<b>12</b>	<b>16</b>
<b>3.</b>	<p><b>Ideal Gases</b></p> <p>3.1 Concept of Ideal gas, Charle’s law, Boyle’s</p>	<b>08</b>	<b>16</b>

	<p>law, Avogadro's law, equation of state, Characteristic gas constant and universal gas constant.</p> <p>3.2 Ideal gas processes: -</p> <ul style="list-style-type: none"> <li>- Isobaric, Isochoric, Isothermal, Adiabatic, Polytropic, Isentropic with representation of the processes on P-V and T-S diagram (only simple numericals)</li> </ul>		
<b>4.</b>	<p><b>Steam and Steam Boiler</b></p> <p>4.1 Generation of steam at constant pressure with representation on various charts such as T-H, T-S, H-S, P-H. Properties of steam and use of steam table, Quality of steam and its determination with Separating, throttling and combined Separating and throttling calorimeter (no numerical).</p> <p>4.2 Vapour process : -</p> <ul style="list-style-type: none"> <li>- constant pressure, constant volume, constant enthalpy, constant entropy (numericals using steam table and Mollier chart), Rankine Cycle</li> </ul> <p>4.3 Steam Boilers: -</p> <ul style="list-style-type: none"> <li>- Classification of boilers.</li> <li>- Construction and working of</li> <li>- Cochran, Babcock and Wilcox, Lamont and Loeffler boiler. Boiler draught natural and Mechanical.</li> </ul> <p>4.4 Boiler mounting and accessories [to be covered in practical].</p>	<b>14</b>	<b>16</b>
<b>5.</b>	<p><b>Steam Turbines and Condensers</b></p> <p>5.1 Steam nozzle: -</p> <ul style="list-style-type: none"> <li>- Continuity equation, types of nozzles, concept of Mach number, critical pressure, application of steam nozzles.</li> </ul> <p>5.2 Steam turbine: -</p> <ul style="list-style-type: none"> <li>- Classification of turbines, Construction and working of Impulse and Reaction turbine.</li> </ul> <p>5.3 Compounding of turbines, Regenerative feed heating, bleeding of steam, nozzle control governing (no velocity diagrams and numerical).</p> <p>5.4 Steam condenser: -</p> <ul style="list-style-type: none"> <li>- Dalton's law of partial pressure, function and classification of condensers, construction and working of surface condensers.</li> </ul> <p>5.5 Sources of air leakage, concept of condenser</p>	<b>12</b>	<b>16</b>

	<p>efficiency, vacuum efficiency (no numerical).</p> <p>5.6 Cooling Towers. - Force draught, natural draught and induced draught.</p>		
<b>6.</b>	<p><b>Heat Transfer</b></p> <p>6.1 Modes of heat transfer: - - Conduction, convection and radiation.</p> <p>6.2 Conduction by heat transfer - Fourier's law, thermal conductivity, conduction through cylinder, thermal resistance, composite walls, combined conduction and convection (Simple numerical)</p> <p>6.3 Heat transfer by Radiation: - - Thermal Radiation, Absorptivity, Transmissivity, Reflectivity, Emissivity, black and gray bodies, Stefan-Boltzman law.</p> <p>6.4 Heat Exchangers: - - Shell and tube, plate type, multiphase heat exchangers. Materials Used and applications of heat exchangers.</p>	<b>10</b>	<b>08</b>
<b>Total</b>		<b>64</b>	<b>80</b>

**Practical:**

Skills to be Developed:

Intellectual Skill :

1. Understand different sources of energy and their applications.
2. Understand various concepts and fundamentals of thermodynamics.
3. Understand concepts and laws of ideal gasses.
4. Understand vapour processes, steam boilers and different mountings and accessories.
5. Understand modes of heat transfer and concept of heat exchanges.
6. Interpret steam tables , mollier chart and relationship between different thermodynamic properties.

Motor Skills :

1. Collect and write technical specifications of photovoltaic cells and identify different components on panels of photovoltaic cells.
2. Conduct trial on the setup for calculation of thermal conductivity of metal rod
3. Trace path of flue gases and water steam circuit in a boiler.
4. Conduct trial on solar water heating system.

**List of practical:**

1. Collection of technical data and specification of photovoltaic cell by referring to manufacturers' catalogues.
2. Study and Trial on solar water heating system.
3. Report on visit to wind power generation plant / biogas plant / hydraulic power plant.
4. Trace the flue gas path and water-steam circuit with the help of boiler model and write a report.
5. Report on visit to sugar factory / Dairy / steam power plant with specifications of boiler and list of mountings and accessories.
6. Calculation of thermal conductivity of a solid metallic rod.
7. Verification of Stefan-Boltzman's law
8. Study and compare various heat exchangers such as radiators, evaporators, condensers, plate heat exchangers etc.
9. Numericals on vapour processes and ideal gas processes (minimum two problems on each)

**Learning Resources:****Books:**

<b>Sr. No.</b>	<b>Author</b>	<b>Title</b>	<b>Publication</b>
<b>01</b>	Domkundwar V. M.	A Course in Thermal Engineering	Dhanpat Rai & Co.
<b>02</b>	P. L. Ballaney	A Course in Thermal Engineering	Khanna Publishers
<b>03</b>	R. S. Khurmi	A text book of Thermal Engineering.	S. Chand & co. Ltd.
<b>04</b>	R. K. Rajput	A Course in Thermal Engineering	Laxmi Publication, Delhi
<b>05</b>	Patel and Karmchandani	Heat Engine Vol. - I & II	Acharya Publication
<b>06</b>	P. K. Nag	Engineering Thermodynamics	Tata McGraw Hill
<b>07</b>	B. K. Sarkar	Thermal Engineering	Tata McGraw Hill