EXTENDED LECTURE OUTLINE

PFE6 311 **Thermodynamics and Heat Transfer** **(3+0)**

Sl. No.	Lecture outline	Week of semester
1.	Basic concepts and definitions-thermodynamics, statistical and classical thermodynamics; Major difference between microscopic and macroscopic approaches; Definitions-Thermodynamic systems-open system, closed system and isolated system, thermodynamic equilibrium-thermal equilibrium, chemical equilibrium & mechanical equilibrium, properties of systems-extrinsic and properties, state, path, process, cycle; point function and path function – key differences with examples; temperature - absolute temperature; Zeroth law of thermodynamics-statement, schematic explanation, significance of zeroth law; Definition-pressure, specific volume, density, energy, work and heat.	1-2
2.	First law of thermodynamics- statement, Joule's experiment; Definition and mathematical relationship - energy of system- internal energy, kinetic energy and potential energy; application of first law of thermodynamics to closed system- mathematical derivation; Definition- enthalpy, specific heat at constant volume, constant pressure; enthalpy of closed system at constant pressure - mathematical derivation; perpetual motion machine of the first kind-PMM 1; Limitations of First law of thermodynamics.	2-4
3.	Definition: Reversible process, Irreversible process, heat engine, heat pump; Second law of thermodynamics: statement; Clausius statement, Kelvin-Planck statement; Perpetual Motion Machine of the second kind-PMM2; Carnot Cycle, Carnot's Theorem, entropy, entropy changes for a closed system.	5
4.	Concept-modes of heat transfer; Definition-thermal conductivity of materials, measurement; general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres without heat generation, electrical analogy; Definition-Free and forced convection, Newton's law of cooling-statement; heat transfer coefficient in convection, non-dimensional numbers-mathematical relationship-Fourier number, Biot number, Grashof number, Prandtl number, Nusselt number, Reynolds number; equation of laminar boundary layer on flat plate and in a tube.	6-8
5.	Concept-Thermal radiation, black body; Stefan-Boltzman law- statement; black body, emissive power, emissivity, absorptivity, reflectivity and transmissivity.	9
6.	Classification of heat exchangers; Type of heat exchangers- parallel flow, cross flow, counter flow, shell and tube heat exchanger ; fouling-different fouling process, factors affecting fouling, fouling prevention methods; Heat Exchanger Analysis-parallel flow; log mean temperature difference – parallel flow and counter flow.	10-12
7.	Introduction to mass transfer, modes of mass transfer; Definition- mass concentration, molar concentration, mass diffusion velocity, molar diffusion velocity and diffusion flux; analogy between heat and mass transfer; Fick's law of diffusion-mathematical relationship for molecular diffusion governed by Fick's law of diffusion.	13

Suggested Readings

1. Holman J P. 2018. Heat Transfer. Mc Graw Hill Book Co., New Delhi
2. A Venkatesh. 2013. Basic Engineering Thermodynamics. Universities Press (India) Pvt. Ltd.
3. Rajput, R. K. 2015. A Text Book of Heat and Mass Transfer. S. Chand & Company Ltd., NewDelhi.