Semester	**:**	**V**		
Course No.	**:**	**PFE-353**	**Credit Hrs.**	**: 3(3+0)**
Course Title	**:**	**Thermodynamics and Heat Transfer**		

SYLLABUS

Objectives : (i) To make the students acquainted with principles of Thermodynamics and Heat transfer,

(ii) To make them understand the mathematical and practical aspects of heat exchangers.

THEORY

Basic concepts and definitions of Thermodynamics, Statistical and Classical Thermodynamics, Microscopic and macroscopic point of view; Thermodynamic systems- Thermodynamic equilibrium, Properties of systems; State, path, process, cycle; Point function, path function; Temperature and Zeroth Law of Thermodynamics; Pressure, specific volume, density, energy, work and heat.

First Law of Thermodynamics: Internal energy, Law of conservation of energy, First Law of Thermodynamics, Application of First Law to a process; Energy- a property of system, perpetual motion machine of the first kind- PMM1; Characteristic equation of state, specific heats; Application of First Law of Thermodynamics to non-flow or closed system; Free expansion and throttling process; Second Law of Thermodynamics: Limitations of First Law of Thermodynamics and introduction to Second Law, Statements of Second Law of Thermodynamics; Clausius statement, Kelvin-Planck statement; Perpetual motion machine of the second kind-PMM2; Clausius inequality; Carnot Cycle, Carnot's Theorem, Entropy, entropy changes for a closed system.

Concept, modes of Heat transfer, 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, insulation materials and fins; Free and forced convection, Newton's Law of Cooling, heat transfer coefficient in convection, non-dimensional numbers; equation of laminar boundary layer on flat plate and in a tube, laminar forced convection on a flat plate and tube, combined free and forced convection.

Thermal radiation, black body radiation, Stefan-Boltzman Law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity.

Heat transfer analysis involving conduction, convection and radiation; Types of heat exchangers; fouling, log mean temperature difference, heat exchanger performance, transfer units; Heat exchanger analysis restricted to parallel and counter flow heat exchangers.

Introduction to Mass transfer, Analogy between heat and mass transfer, Fick's Law of Diffusion.

TEACHING SCHEDULE

THEORY [PFE-353]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Basic Concepts and Thermodynamic Systems	Basic Concepts and Definitions of Thermodynamics, Statistical and Classical Thermodynamics, Microscopic and macroscopic point of view	10
3 - 4		Thermodynamic systems- Thermodynamic equilibrium, Properties of systems; State, path, process, cycle	
5 - 6		Point function, Path function; Temperature and Zeroth Law of Thermodynamics; Pressure, Specific volume, Density, Energy, Work and Heat	
7 - 9	First Law of Thermodynamics Analysis	First Law of Thermodynamics: Internal energy, Law of Conservation of Energy, First Law of Thermodynamics, Application of First aw to a process	15
10 - 13		Energy- a property of system, Perpetual motion machine of the first kind- PMM1. Characteristic equation of state, specific heats. Application of First Law of Thermodynamics to non-flow or closed system. Free expansion and throttling process	
14 - 17	Second Law of Thermodynamics and Entropy	Limitations of First Law of Thermodynamics and introduction to Second Law, statements of Second Law of Thermodynamics; Clausius statement, Kelvin-Planck statement	20
18 - 20		Perpetual motion machine of the second kind- PMM2	
21 - 23		Clausius inequality; Carnot Cycle, Carnot's Theorem, entropy. Entropy changes for a closed system.	
24 - 28	Modes of Heat Transfer, Conduction Fundamentals and Applications	Concept, Modes of heat transfer, 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; Insulation materials and fins.	20
29 - 31	Convection Fundamentals	Free and forced convection. Newton's Law of Cooling, Heat transfer coefficient in convection; Non-dimensional numbers.	

Continued…

32 - 35	Convection Applications	Equation of laminar boundary layer on flat plate and in a tube, Laminar forced convection on a flat plate and tube, combined free and forced convection	15
36 - 40	Radiation Fundamentals and Heat Transfer	Thermal radiation, Black body radiation. Stefan-Boltzmann Law, Black body emissive power. Emissivity, Absorptivity, Reflectivity & Transmissivity; Heat transfer analysis involving conduction, convection and radiation.	
41 - 45	Heat Exchanger	Types of Heat exchangers; Fouling; Log mean temperature difference, heat exchanger performance, transfer units; Heat exchanger analysis restricted to parallel and counter flow heat exchangers.	20
46 - 48	Mass Transfer	Introduction to Mass Transfer, Analogy between Heat and Mass transfers, Fick's Law of Diffusion.	
		Total =	**100**

Suggested Readings [PFE -353]:

1. Gupta, C.P. and Prakash, R. 2008. Engineering Heat Transfer. Nem Chand and Bros., Roorkee.
2. Holman, J.P. 2018. Heat Transfer. McGraw Hill Book Co., New Delhi.
3. Incropera, F.P. and DeWitt, D.P. 2016. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, New York.
4. Kumar, D.S. 2016. Engineering Thermodynamics. S.K. Kataria & Sons, Delhi.
5. Rajput, R.K. 2019. A Text Book of Heat and Mass Transfer. S. Chand & Company Ltd., New Delhi.