HEAT TRANSFER

VI Semester: ME								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AMEB21	Core	L	T	P	C	CIA	SEE	Total
		3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil				Total Classes: 60		

OBJECTIVES

The students will try to learn

I. The governing equations and performance relations of various modes of heat transfer using the three types of coordinate systems.

II. The concepts for validating heat transfer parameters during internal and external flows based on non-dimensional numbers and convective mode heat transfer.

III. The performance and analysis of heat exchangers for real-time applications using various methods and indicators (such as LMTD and NTU etc).

IV. The design methodologies for enhancing heat transfer among a wide variety of practical engineering problems.

COURSE OUTCOMES

At the end of the course students are able to

CO1 **Recall the basic concepts of heat transfer fundamentals, mechanisms, temperature field and temperature gradient for various measures of heat transfer rate.**

CO2 **Classify the general differential equation of heat conduction in Cartesian, Cylindrical and Spherical Coordinate System (Steady and Unsteady) to calculate temperature and heat flux.**

CO3 **Explain different types of boundary conditions applied to heat conduction problems.**

CO4 **Solve one-dimensional problems with different surfaces and geometries (fins) for which the temperature distribution and heat flow rates are calculated from Fourier's Law.**

CO5 **Explain the concepts associated with transient heat conduction equation linked with time and temperature applied to environment sudden changes (various geographical location temperatures).**

CO6 **Utilize the principles associated with convective heat transfer to formulate and calculate the dynamics of temperature field in fluid flow.**

CO7 **Apply the forced convection equation for solving heat transfer rate on cylinders and spheres.**

CO8 **Make use of the concept of Boundary layer theory for the derivation of empirical relations related to the characteristics of Boundary layer.**

CO9 **Examine the phenomena of boiling and condensation to give various correlations applied to heat exchangers, boilers, heat engines, etc.**

CO10 **Explain the physical mechanisms involved in radiation heat transfer and analyze the radiative heat exchange between black body and grey body surfaces.**

CO11 **Develop an expression for overall heat transfer coefficient and Identify the appropriate type of heat exchangers such as parallel and counter flow.**

CO12 **Analyze LMTD and NTU techniques for tackling real time problems with thermal analysis, simulation (mathematical model) and cost optimization of heat exchangers.**

MODULE-I	INTRODUCTION TO HEAT TRANSFER	Classes: 10

Modes and mechanisms of heat transfer, basic laws of heat transfer, applications of heat transfer; conduction heat transfer: Fourier rate equation, general three dimensional heat conduction equations in cartesian, cylindrical and spherical coordinates; Simplification and forms of the field equation, steady and unsteady and periodic heat transfer, initial and boundary conditions.

MODULE-II	CONDUCTION HEAT TRANSFER	Classes: 14

One dimensional steady state conduction heat transfer: Homogeneous slabs, hollow cylinders and spheres, overall heat transfer coefficient, electrical analogy, Critical radius of insulation; one dimensional steady state conduction; heat transfer: with variable thermal conductivity, extended surfaces (Fins) long, short and insulated tips; significance of Biot and Fourier numbers, chart solutions of transient conduction systems.

MODULE-III	CONVECTIVE HEAT TRANSFER	Classes: 11

Buckingham Pi Theorem and method, application for developing semi, empirical non-dimensional correlation for convection heat transfer, significance of non-dimension numbers, concepts of continuity, momentum and energy equations; free convection: Development of hydrodynamic and thermal boundary layer along a vertical plate, use of empirical relations for vertical plates and pipes.

Forced convection: external flows: Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer, flat plates and cylinders; Internal flows, Concepts about Hydrodynamic and thermal entry lengths, division of internal flows based on this, use of empirical correlations for horizontal pipe flow and annulus flow

MODULE-IV	RADIATION HEAT TRANSFER	Classes: 11

Emission characteristics, laws of black-body radiation, Irradiation, total and Monochromatic quantities, laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann, heat exchange between two black bodies, concepts of shape factor, emissivity, heat exchange between grey bodies, radiation shields, electrical analogy for radiation networks.

MODULE-V	HEAT EXCHANGERS AND PHASE CHANGE	Classes: 10

Classification of heat exchangers, overall heat transfer Coefficient and fouling factor, Concepts of LMTD and NTU methods, Problems using LMTD and NTU methods. Boiling: Pool boiling-regimes Calculations on Nucleate boiling, Critical heat flux, Film boiling; Condensation: Film wise and drop wise condensation, Nusselts theory of condensation on a vertical plate Film condensation on vertical and horizontal cylinders using empirical correlations.

Text Books:

1. Yunus A. Cengel, “Heat Transfer A Practical Approach”, Tata McGraw hill Education (P) Ltd, New Delhi, India. 4th Edition, 2012.
2. R. C. Sachdeva, “Fundamentals of Engineering, Heat and Mass Transfer”, New Age, New Delhi, India, 3rd Edition, 2012.

Reference Books:

1. Holman, ―Heat Transfer, Tata McGraw-Hill education, 10th Edition, 2011.
2. P. S. Ghoshdastidar, ―Heat Transfer, Oxford University Press, 2nd Edition, 2012.
3. D. S. Kumar, ―Heat and Mass Transfer, S.K. Kataria & sons, 9th Edition 2015.

Web References:

1. https: //nptel.ac.in/courses/112108149/
2. https://www.wisc-online.com/learn/natural-science/earth-science/sce304/heat-transfer-conduction-convection-radiation