HEAT TRANSFER

VI Semester: ME								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
AME016	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	1	-	4	30	70	100
Contact Classes: 45	**Tutorial Classes: 15**	**Practical Classes: Nil**				**Total Classes: 60**		

OBJECTIVES:

The course should enable the students to:

I. Understand the basic modes of heat transfer like conduction, convection and radiation with and without phase change in solid liquids and gases.
II. Design and analyze thermal fluidic components in engineering systems to energy mechanisms (in the form of heat transfer) for steady and unsteady state.
III. Conduct experiments in laboratories and analyze the results with theoretical ones to evolve research oriented projects in the field of heat transfer as well as propulsion.
IV. Apply the concepts of heat transfer with convective mode in internal and external flows involved in engineering components and work in real time problems in Industry.

COURSE OUTCOMES (COs):

1. Describe the basic concept of the mechanism of heat transfer and understand the law of energy exchange in heat transfer mechanisms.
2. Derive and formulate the mathematical models for steady state heat transfer phenomenon and comprehend the applicability to different surfaces and geometries.
3. Understand the concept heat convection and its forms like free and forced convection.
4. Explore the concept of Boundary layer and derivation of empirical relations; also understand the concept of condensation & boiling and Radiation Heat transfer.
5. Understand the concept of Heat Exchangers. Introduction to the methods of solving real time problems

COURSE LEARNING OUTCOMES (CLOs):

1. Understand basic concepts of heat transfer modes, Fourier Law and First law of thermodynamics.
2. Remember the basic laws of energy involved in the heat transfer mechanisms.
3. Understand the physical system to convert into mathematical model depending upon the mode of Heat Transfer.
4. Understand the thermal response of engineering systems for application of Heat Transfer mechanism in both steady and unsteady state problems.
5. Understand heat transfer process and systems by applying conservation of mass and energy into a system.
6. Understand the steady state condition and mathematically correlate different forms of heat transfer
7. Analyse finned surfaces, and assess how fins can enhance heat transfer
8. Remember dimensionless numbers which are used for forced and free convection phenomena.
9. Understand the applications of Buckingham Pi Theorem in deriving various non dimensional numbers and their applications in heat transfer
10. Remember and use the methodology presented in tutorial to solve a convective heat transfer problems
11. Understand the various forms of free and forced convection and the application of the same in day to day problems

12. Calculate local and global convective heat fluxes using Nusselt's Theory.
13. Understand the method to evolve hydrodynamic and thermal boundary layers applied mathematically to vertical plates and Tubes
14. Understand the physical mechanisms of phase change involving pool, nucleate and film boiling processes
15. Understand Nusselt's theory of condensation for the application in film and dropwise condensation
16. Correlate the empirical relations in terms of vertical and horizontal cylinders during film condensation
17. Understand the concepts of black and gray body radiation heat transfer.
18. Understand the concept of shape factor and evolve a mechanism for conducive radiation shields
19. Understand the various classifications of heat exchangers based on arrangement and correlate the effects of fouling
20. Understand the LMTD and NTU methods and apply the same for solving real time problems in heat exchangers

UNIT-I	BASIC CONCEPTS	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.

UNIT -II	ONE DIMENSIONAL STEADY STATE AND TRANSIENT 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 and systems with internal heat generation, extended surfaces (Fins) long, short and insulated tips; one dimensional transient heat conduction: Systems with negligible internal resistance, significance of Biot and Fourier numbers, chart solutions of transient conduction systems.

UNIT -III	CONVECTIVE HEAT TRANSFER	Classes: 11

Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow, dimensional analysis as a tool for experimental investigation, 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;

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; free convection: Development of hydrodynamic and thermal boundary layer along a vertical plate, use of empirical relations for vertical plates and pipes

UNIT -IV	HEAT TRANSFER WITH PHASE CHANGE	Classes: 11

Boiling: Pool boiling- regimes Calculations on Nucleate boiling, Critical heat flux, Film boiling; Condensation: Film wise and drop wise condensation, Nusselt's theory of condensation on a vertical plate Film condensation on vertical and horizontal cylinders using empirical correlations;
Radiation heat transfer: 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.

UNIT -V	HEAT EXCHANGERS	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.

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

E-Text Books:

1. https://www.e-booksdirectory.com/details.php?ebook=8139
2. https:// bookboon.com/en/engineering-ebooks