HEAT AND MASS TRANSFER

V Semester: AE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
AAEC17	Elective	L	T	P	C	CIA	SEE	Total
		3	-	-	3	30	70	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			
Prerequisite: Knowledge of Engineering Thermodynamics and Fluid dynamics								

I. COURSE OVERVIEW:

Heat transfer is the flow of thermal energy due to temperature difference and the subsequent temperature distribution changes commonly measured as heat flux. This course focuses on heat transfer modes such as conduction, convection and radiation, boundary conditions, one dimensional steady and unsteady state condition, heat exchangers and mass transfer mechanisms applied to modern aero-thermal systems for designing higher thermal efficient systems. Thus there is great relevance for this course in modeling heat exchangers, heat treatment of fins and complex mechanical systems and creates a scope for further graduate studies.

II. COURSE OBJECTIVES:

The student 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 and mass transfer among a wide variety of practical engineering problems.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Solve** problems involving steady state heat conduction with andwithout heat generation in simple geometries.	Apply
CO 2	**Make use of** the concept of Boundary layer theory for the derivation of empirical relations related to the characteristics of Boundary layer.	Apply
CO 3	**Utilize** the principles associated with convective heat transfer to formulate and solve the heat transfer coefficients for various cross section areas	Apply
CO 4	**Identify** the physical mechanisms involved in radiation heat transfer, boiling and condensation to give various correlations applied to heat exchangers, boilers, heat engines, etc.	Apply
CO 5	**Analyze** LMTD and NTU techniques for tackling real time problems with thermal analysis, simulation (mathematical model) and cost optimization of heat exchangers.	Analyze
CO 6	**Analyze** various mass transfer correlations for comparing themomentum, heat and mass transfer analogies.	Analyze

IV. SYLLABUS:

MODULE-I: INTRODUCTION TO HEAT TRANSFER, CONDUCTION (10)

Modes and mechanisms of heat transfer, Basic laws of heat transfer. Conduction heat transfer: Fourier rate equation, Steady, unsteady and periodic heat transfer -Initial and boundary conditions, Overall heat transfer coefficient, Electrical analogy, Critical radius of insulation, Extended surfaces (Fins) Long, Short and insulated tips. Application to error measurement of temperature. Significance of Biot and Fourier numbers, Chart solutions of transient conduction systems –concept of Functional Body.

MODULE –II: FREE AND FORCED CONVECTION (08)

Free and Forced Convection – Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.

MODULE –III: PHASE CHANGE HEAT TRANSFER, HEAT EXCHANGERS (10)

Film boiling, Regimes of pool boiling and flow boiling. Film wise and drop wise condensation, Nusselt’s theory of condensation on a vertical plate.

Classification of heat exchangers, overall heat transfer Coefficient and fouling factor, Concepts of LMTD and NTU methods, Problems using LMTD and NTU Methods, Application in Aero engines.

MODULE –IV: RADIATION HEAT TRANSFER (08)
Emission characteristics, Laws of black-body radiation, Irradiation, Total and Monochromatic quantities, 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: MASS TRANSFER (09)
Basic Concepts, Diffusion Mass Transfer, Fick's Law of Diffusion, Steady state Molecular Diffusion, Convective Mass Transfer, Momentum, Heat and Mass Transfer Analogy, Convective Mass Transfer Correlations.

V. 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.

VI. REFERENCE BOOKS:

1. Holman, "Heat Transfer" Tata McGraw Hill education (P) Ltd, New Delhi, India. 10th Edition, 2012.
2. C. P. Kothandaraman, "Heat and Mass Transfer Data Book", New Age International Publishers, New Delhi, India, 9th Edition 2018.
3. P. S. Ghoshdastidar, "Heat Transfer", Oxford University Press, 2nd Edition, 2012.
4. D. S. Kumar, "Heat and Mass Transfer", S.K. Kataria& sons, 9th Edition 2015.

VII. WEB REFERENCES:

1. https://nptel.ac.in/courses/112101097/
2. https://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatra.html

VIII. E-TEXT BOOKS:

1. https://bookzz.org/book/2556672/5ef6f5
2. https://bookzz.org/book/533930/66495a
3. https://bookzz.org/book/495953/61bfa5