COURSE CONTENT

COMPUTATIONAL HEAT TRANSFER								
II Semester: AE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
BAEE19	Elective	L	T	P	C	CIA	SEE	Total
		3	-	-	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		
Prerequisite: Computational Aerodynamics								

I. COURSE OVERVIEW:

Computational Heat Transfer focuses on the numerical methods and techniques used to simulate and analyze heat transfer phenomena in various engineering applications. It Introduces the governing equations for heat transfer, including the heat conduction equation, Navier-Stokes equations for fluid flow, and the energy equation. This course equips students with the computational skills and knowledge necessary to tackle heat transfer problems in diverse engineering fields, allowing them to contribute to the design and optimization of thermal systems and processes.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Understand the fundamental principles of heat transfer and its mathematical modeling.
II. Apply computational tools to solve complex heat transfer problems in engineering applications.
III. The types of PDE's and its boundary conditions to arrive at its solution
IV. To developing numerical codes for solving heat transfer Problems

III. COURSE OUTCOMES:

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

CO 1	Choose appropriate discretization methodologies for solving heat transfer problems
CO 2	Apply appropriate boundary condition for solving 2D and 3D conductive heat transfer problems
CO 3	Make use of implicit, explicit and crank-Nicolson schemes for solving unsteady heat conduction problems
CO 4	Develop numerical solutions for transient heat conduction in simple geometries.
CO 5	Make use of numerical treatment of steady and unsteady 1-D and 2-d heat convection for solving thermal and Velocity boundary layer flows
CO 6	Develop numerical code using radiosity and- absorption Method for radiative heat transfer problem

IV. COURSE CONTENT:

MODULE-I: OVERVIEW AND INTRODUCTION (09)

Finite Difference Method-Introduction-Taylor's series expansion-Discretization Methods Forward, backward and central differencing scheme for first order and second order Derivatives - Types of partial differential equations-Types of errors-Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition-FDM - FEM - FVM.

MODULE-II: CONDUCTIVE HEAT TRANSFER (09)

General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One -dimensional steady state heat conduction -with Heat generation without Heat generation-2D-heat conduction problem with different boundary conditions Numerical treatment for extended surfaces- Numerical treatment for 3D- Heat conduction Numerical treatment to 1D-steady heat conduction using FEM.

MODULE-III: TRANSIENT HEAT CONDUCTION (09)

Introduction to Implicit, explicit Schemes and crank-Nicolson Schemes Computation (FDM) of One-dimensional un-steady heat conduction -with heat Generation-without Heat generation.

2D-transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes-Importance of Courant number- Analysis for I-D,2-D transient heat Conduction problems.

MODULE-IV: CONVECTIVE HEAT TRANSFER (09)

Convection- Numerical treatment (FDM) of steady and unsteady 1-D and 2-d heat convection diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme-Stream function-vorticity approach-Creeping flow.

MODULE-V: **RADIATIVE HEAT TRANSFER (09)**

Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method -Monte Carlo Method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method. Developing a numerical code for 1D, 2D heat transfer problems

V. TEXT BOOKS:

1. Holman, JP, "Heat Transfer", McGraw-Hill Book Co, Inc., McGraw-Hill College; 10th edition, 2017.
2. Richard H. Pletcher, John C. Tannehill & Dale Anderson, "Computational Fluid Mechanics and Heat Transfer", 4th edition, CRC Press, 2021.
3. Frank J. Regan "Dynamics of Atmospheric Re-Entry" American Institute of Astronautics and Aeronautics Publications, 1st edition, 1993.

VI. REFERENCE BOOKS:

1. Chung, TJ, "Computational Fluid Dynamics", Cambridge University Press, 2002.
2. Sachdeva, SC, "Fundamentals of Engineering Heat & Mass Transfer", New age publisher, 4th edition Internationals, 2017.

VII. ELECTRONICS RESOURCES:

1. http://spacecraft.ssl.umd.edu/academics/791S04/791S04.040302.text.pdf

VIII. MATERIALS ONLINE

1. Course template.
2. Assignments.
3. Tutorial question bank.
4. Model question paper – I.
5. Model question paper – II.
6. Lecture notes.
7. Power point presentations.