COMPUTATIONAL FLUID DYNAMICS

Course Code	23ME4701B	Year	IV	Semester	I
Course Category	Professional Elective-IV	Branch	Mechanical	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	NIL
Continuous Internal Evaluation:	30	Semester End Evaluation:	70	Total Marks:	100

Course Outcomes		
Upon successful completion of the course, the student will be able to		Blooms Level
CO1	Derive governing equations of fluid flow and apply numerical methods like TDMA for solving linear systems.	L3
CO2	Analyze steady/transient heat conduction and convective problems using finite difference techniques.	L3
CO3	Apply finite difference methods and assess consistency and stability of numerical schemes.	L3
CO4	Analyze stability and implement interpolation schemes using finite volume methods for fluid flow problems.	L3
CO5	Solve fluid flow and heat transfer problems using FEM with appropriate interpolation and error control techniques.	L3

Strength of Correlation between CO – PO , CO- PSO in scale of 1-3- Course Articulation Matrix

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	-	-	-	-	-	2	3	3
CO2	3	3	2	3	3	-	-	-	-	-	2	3	3
CO3	3	3	1	3	3	-	-	-	-	-	2	3	2
CO4	3	3	2	3	3	-	-	-	-	-	2	3	3
CO5	3	3	3	3	3	-	-	-	-	-	2	3	3

SYLLABUS		
Unit No.	**Contents**	**Mapped CO**
I	**CONSERVATION PRINCIPLES:** Introduction, conservation of mass, Newton's second law of motion, expanded forms of Navier-stokes equations (Derivation), conservation of energy principle, special forms of the Navier-stokes equations. **APPLIED NUMERICAL METHODS:** Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices, TDMA – Algorithms.	**CO1**
II	**CONDUCTION AND CONVENTION:** Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function - vorticity formulation. Finite difference applications in heat conduction and convention –heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure.	**CO2**
III	**EXPLICIT AND IMPLICIT METHODS:** Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modelling: introduction, elementary finite difference quotients, implementation aspects of finite difference equations, consistency, explicit and implicit methods.	**CO3**
IV	**INTRODUCTION TO FIRST ORDER WAVE EQUATION:** Stability of hyperbolic and elliptic equations, fundamentals of fluid flow modelling, conservative property, the upwind scheme. FINITE VOLUME METHOD: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.	**CO4**
V	**FINITE ELEMENT METHOD:** Introduction – Weighted Residual and Variational Formulations – Rayleigh-Ritz Method – Interpolation – One dimensional and Two dimensional regions – Error Control – Applications of FEM to One dimensional Problems (Steady and Transient) – Two dimensional problems	**CO5**

Learning Resourses

Text Books:

1. Numerical heat transfer and fluid flow/Suhas V. Patankar/Butter-worth Publishers
2. Computational fluid dynamics-Basics with applications/John.D.Anderson/McGrawHill.

References:

1. Computational Fluid Flow and Heat Transfer/ Niyogi/Pearson Publications
2. Introduction to CFD: Finite Volume Method – H. Versteeg and W. Malalasekahara
3. Fundamentals of Computational Fluid Dynamics /TapanK.Sengupta/Universities Press.
4. Computational fluid dynamics: An introduction, 3rd edition/John.F Wendt/Springer publishers