COMPUTATIONAL FLUID DYNAMICS

Course Code	22MEMD1T5D	**Year**	I	**Semester**	I
Course Category	Programme Elective	**Branch**	ME	**Course Type**	Theory
Credits	4	**L-T-P**	4-0-0	**Prerequisites**	Fluid Mechanics
Continuous Internal Evaluation:	40	**Semester End Evaluation:**	60	**Total Marks:**	100

Course outcomes: At the end of the course, the student will be able to:

CO	Statement	BTL	Units
CO1	Describe governing flow equations for a fluid dynamics problem.	L3	1
CO2	Classify the Partial Differential Equations (PDEs) and various Discretization techniques.	L3	2
CO3	Apply the basic knowledge of Computational Fluid Dynamics (CFD) to Nozzle flow problems and Incompressible flow problems.	L3	3
CO4	Apply the basic knowledge of CFD to Heat Transfer problems.	L3	4

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO 1	3	3	3	3	3							3	3	2
CO 2	3	3	3	3	3							3	3	2
CO 3	3	3	3	3	3							3	3	2
CO 4	3	3	3	3	3							3	3	2

Syllabus		
Unit	**Contents**	**Mapped CO**
1	**INTRODUCTION** Computational Fluid Dynamics as a Research and Design Tool, Applications of Computational Fluid Dynamics,	**CO1**

	GOVERNING EQUATIONS OF FLUID DYNAMICS: Introduction, Models of the Flow, Substantial Derivative, Divergence of Velocity, Continuity Equation, Momentum Equation and Energy Equation, Conservation and Non-conservation forms of Governing Flow Equations.	
2	**PARTIAL DIFFERENTIAL EQUATIONS – ITS MATHEMATICAL BEHAVIOR** Introduction, Classification of Quasi-Linear Partial Differential Equations, Eigen Value Method, Hyperbolic Equations, Parabolic Equations, Elliptic Equations. **DISCRETIZATION** Introduction, Finite Differences, Difference Equations, Explicit and Implicit Approaches, Errors and Stability Analysis, Grid Generation. **TRANSFORMATION OF GRIDS** Transformation of Equations, Metrics and Jacobians, Transformed version of Governing Flow Equations.	**CO2**
3	**CFD TECHNIQUES** Introduction, The Lax Wendroff Technique, MacCormack's Technique, The Alternation-Direction Implicit (ADI) Technique, Pressure Correction Technique. **CFD Application to Nozzle Flow** Solution to Subsonic-Supersonic Isentropic flow using MacCormack's Technique **CFD Application to Incompressible Couette Flow** Solution by using Pressure Correction method.	**CO3**
4	**NUMERICAL METHODS IN HEAT CONDUCTION** One-Dimensional Steady Heat Conduction in a plane wall and boundary conditions; Two-Dimensional Steady Heat Conduction and boundary conditions; Transient Heat Conduction in a plane wall; Two-Dimensional Transient Heat Conduction in a rectangular coordinates.	**CO4**

Learning Resources
Text Book(s): 1. John. D. Anderson, Computational fluid dynamics - Basics with applications, McGraw Hill 2. D. A. Anderson, J. C. Tannehill, and R. H. Pletcher. Computational Fluid Mechanics and Heat Transfer. NewYork: Hemisphere, 1984.
References: 1. Suhas V. Patankar, Numerical heat transfer and fluid flow, Butter-worth Publishers. 2. T. K Sengupta, Fundamentals of Computational Fluid Dynamics, University Press