COMPUTATIONAL FLUID DYNAMICS

Course Code	19ME4701A	**Year**	IV	**Semester**	I
Course Category	Program Elective-IV	**Branch**	ME	**Course Type**	Theory
Credits	3	**L – T – P**	3 – 0 – 0	**Prerequisites**	Nil
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes		**Levels**
Upon successful completion of the course, the student will be able to		
CO1	Develop an understanding for the major theories, approaches and methodologies used in CFD	L2
CO2	Understand physical behaviour of partial difference equations	L1
CO3	Apply numerical math to convert PDE's into Finite Difference equations	L5
CO4	Build up the skills in Grid generation techniques	L3
CO5	Use finite volume technique to discretise diffusion and convection problems	L2

	Contribution of Course Outcomes towards achievement of Program Outcomes Strength of correlations (3: High, 2: Moderate, 1: Low)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	3							3	3	2
CO2	3	3	3	3	3							3	3	2
CO3	3	3	3	3	3							3	3	2
CO4	3	3	3	3	3							3	3	2
CO5	3	3	3	3	3							3	3	2

Syllabus		
Unit No	**Contents**	**Mapped CO**
I	**INTRODUCTION TO COMPUTATIONAL FLUID DYNAMICS AND PRINCIPLES OF CONSERVATION:** Computational Fluid Dynamics: What, When, and Why?, CFD Applications, Numerical vs Analytical vs Experimental, Modeling vs Experimentation. Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy	CO1
II	**CLASSIFICATION OF PARTIAL DIFFERENTIAL EQUATIONS AND PHYSICAL BEHAVIOR:** Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and hyperbolic equations Physical examples of elliptic, parabolic and hyperbolic partial differential equations.	CO 2
III	**FUNDAMENTALS OF DISCRETIZATION:** Discretization principles: Preprocessing, Solution, Postprocessing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness,	CO3

	Boundedness, Transportiveness. Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term	
IV	**GRID GENERATION:** Transformation of coordinates. General principles of grid generation – structured grids in two and three dimensions, algebraic grid generation, differential equations based grid generation; Elliptic grid generation. Grid clustering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation.	CO4
V	**FINITE VOLUME METHOD:** Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretized equations using TDMA.Finite volume methods for unsteady problems – explicit schemes, implicit schemes.	CO5

Learning Recourse(s)

Text Book(s)

1. John. D. Anderson, JR, “Computational Fluid Dynamics - Basics with Applications “, McGraw Hill Education (India) Edition 2012.
2. T. J. Chung, “Computational Fluid Dynamics”, Cambridge University Press, 2nd Edition, 2014

Reference Book(s)

1. Niyogi, Chakravarty, Laha, “Introduction to computational fluid mechanics”, Pearson pub. 1st ed. 2009.
2. S.V. Patankar, “Numerical heat transfer and fluid flow”, Hemisphere Pub. 1st ed.
3. K. Muralidhar and T. Sundararajan, “Computational Fluid flow and Heat transfer”, Narosa Pub. 2nd ed. 2003.

e-Resources & other digital material

1. http://ocw.mit.edu/courses/mechanical-engineering/2-29-numerical fluidmechanics-fall-2011/
2. http://nptel.ac.in/courses/112105045/(IIT Kharagpur)
3. http://nptel.ac.in/courses/112107080/(IIT Roorkee)
4. http://nptel.ac.in/courses/112104030/(IIT Kanpur)
5. http://www.nptelvideos.in/2012/11/computational-fluid- dynamics.html (IIT Madras)