COMPUTATIONAL FLUID DYNAMICS

CourseCode		Year		Semester	
Course Category	HONORS	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: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understanding for the major theories, approaches and methodologies used in CFD	Understand, Communication	L2	1,2,3,4,5
CO2	Understand physical behaviour of partial difference equations	Understand, Communication	L2	1
CO3	Apply numerical math to convert PDE's into Finite Difference equations	Apply, Communication	L3	2,3
CO4	Apply the skills in Grid generation techniques	Apply, Communication	L3	4
CO5	Analyze different solution schemes of FVM.	Analyze	L4	5

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					3	3			2		2	3	2
CO2	3	2				3	3			2		2	3	2
CO3	3					3	3			2		2	3	2
CO4	3					3	3			2		2	3	2
CO5	3					3	3			2		2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction to Computational Fluid Dynamics and Principles of Conservation:** Introduction and history of Computational Fluid Dynamics: CFD Applications, difference between Numerical, Analytical and Experimental analysis, Differentiation between Modeling vs Experimentation. Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy	CO1 CO2
II	**Classification of Partial Differential Equations and Physical Behavior:** Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and hyperbolic equations Physical applications of elliptic, parabolic and hyperbolic partial differential equations.	CO1 CO3
III	**Fundamentals of Discretization:**	CO1

	Discretization principles: Preprocessing, Solution, Postprocessing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness.	**CO3**
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.	**CO1** **CO4**
V	**Finite Volume Method** Introduction to Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term, 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.	**CO1** **CO5**

Learning Resource
Text books:
1. Computational Fluid Dynamics - Basics with Applications - John. D. Anderson, JR. McGraw Hill Education (India) Edition 2012. 2. Computational Fluid Dynamics - T. J. Chung, Cambridge University Press, 2nd Edition, 2014.
1. Introduction to computational fluid mechanics - Niyogi, Chakravarty, Laha, Pearson pub. 1st ed. 2009. 2. Numerical heat transfer and fluid flow - S.V. Patankar, Hemisphere Pub. 1st ed. 3. Computational Fluid flow and Heat transfer - K. Muralidhar and T. Sundararajan, Narosa Pub. 2nd ed. 2003.
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) 6. http://www.cfd-online.com/