Course Type	Course Code	Name of Course	L	T	P	Credit
DE	NCHD512	Computational Fluid Dynamics	3	0	0	3

Course Objective
• To provide basic theoretical understanding to the students on mathematical formulation and different approaches underlying computational techniques in fluid flow, heat and mass transfer

Learning Outcomes
• Students will have sufficient knowledge to formulate and solve various problems using CFD including CFD tools.

Unit No.	Description of Lectures	Contact Hours	Learning Outcomes
1	**Introduction to CFD:** Basics of CFD and its importance. **Basic Conservation Laws:** Reynolds transport theorem: Integral and Differential forms of Conservative equation: Continuity Equation, Navier-Stokes equation, energy equation.	6	Introduction to CFD and its applications. Theoretic laws underlying CFD
2	**PDE characteristics:** Classification of PDEs: linear, non-linear characteristics equation, parabolic, elliptic, and hyperbolic equations, examples of such equations in fluid mechanics and heat Transfer.	4	Understanding on nature of PDES
3	**Weighted residual Method:** Discretization methods, finite volume method.	6	Understanding on Weighted residual method
4	**Steady and unsteady-diffusion:** Discretization internal and boundary grid points and, Interface conductivity, source term Linearization. Explicit, implicit, discretization for unsteady-diffusion for 2D and 3D.	8	Formulation of discretization methods for steady and un-steady state.
5	**Solution methods:** Linear algebra, direct method, TDMA, line by line, iterative Gauss Seidel, point wise, diagonal dominance, concept of convergence (Graphical) and relaxation parameter.	3	Knowledge on solution methods
6	**Advection diffusion:** Upwind, Peclet number, exponential and hybrid scheme, numerical diffusion.	6	Knowledge on advection methods
7	**Flow solution:** Staggered grid solution algorithm for Pressure-Velocity coupling: SIMPLE,SIMPLER	6	Formulation of discretization methods for unsteady state
8	**Turbulence modelling:** Review of turbulence, direct numerical simulation (DNS), large eddy simulation (LES), and two-equation model.	3	Understanding of turbulent flows

	Total	42	

Textbooks:

1. Versteeg, H.K. & Malalasekera, W. (1995) *Introduction to Computational Fluid Dynamics: The Finite Volume Method* John Wiley & Sons Inc.
2. Patankar, S. (1980) *Numerical heat transfer and fluid flow*, Taylor & Francis.

Reference Books:

1. Chung, T. J. (2002) *Computational Fluid Dynamics*, Cambridge Univ. Press.
2. Ranade V, (2002) Computational Flow Modelling For Chemical Reactor Engineering, Acad Press