

NIRMA UNIVERSITY
School of Engineering, Institute of Technology
Disciplinary Minor B.Tech. in Chemical Engineering
Third Year /Semester VI

Institute:	Institute of Technology
Name of Programme:	BTech Chemical Engineering
Course Code:	3CH503DE24
Course Title:	Computational Fluid Dynamics
Course Type:	Elective Under Minor
Year of introduction:	2024-2025

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Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to –

1. examine aerodynamic flow solutions and compare existing CFD software (BL4)
2. analyse the flow problem, use a CAD programme to model solidly, and use a meshing tool to create grids. (BL4)
3. apply Navier-Stokes equations and use finite difference method (BL3)
4. apply CFD software to engineering flow problems. (BL3)

Contents

	Teaching hours	
Unit I	Fundamental and Basic Concept of CFD	(Total 45)
<p>Illustration of CFD approach, future, Governing equations (GE's) of Fluid dynamics: Modeling of flow, control volume concept, substantial derivative, physical meaning of the divergence of velocity. Continuity equation, momentum equation, energy equation and its conservation form. Equations for viscous flow (Navier-Stokes equations), equations for inviscid flow (Euler equation). Different forms of GE's, initial and boundary conditions.</p>	11	
Unit II	<p>Discretisation FVM for 1D steady state diffusion, 2D steady state diffusion, 3d steady state diffusion. Solution of discretised equations - TDMA scheme for 2D and 3D flows. FVM for 1D steady state convection-diffusion, Central differencing scheme, Conservativeness, Boundedness, Transportiveness, upward differencing scheme, Hybrid differencing scheme for 2D and 3D convection-diffusion, Power-law scheme, QUICK scheme.</p>	10



Unit III	Solution Methods	12
	Discretisation schemes for pressure, momentum, and energy equations – Explicit and implicit Schemes, Solution methods of discretised equations - Tridiagonal matrix algorithm (TDMA) Application of TDMA for 2D problems potential flow - Stream and vorticity function. Unsteady flows - Crank Nicholson scheme, solution of Navier-Stokes equations.	
Unit IV	CFD Solution Procedure	12
	Problem setup-creation of geometry, mesh generation, selection of physics and fluid properties, initialisation, solution control and convergence monitoring, results reports and visualisation. Case Studies: Benchmarking, validation, Simulation of CFD problems by use of general CFD software, Simulation of coupled heat, mass and momentum transfer problem.	

Self-Study:

Self-study contents will be declared at the commencement of the semester. Around 10 % of the questions will be asked from the self-study contents.

Tutorial Work:

Tutorial work will be based on the above content of course.

Suggested Readings/ References:

1. John D. Anderson, Computational Fluid Dynamics: The Basics with Applications. McGraw-Hill Education.
2. H.K. Versteeg and W. Malalasekera , An Introduction to Computational Fluid Dynamics: The Finite Volume Method, Pearson Education.
3. P.S. Ghosdastidar, Computer Simulation of Flow and Heat Transfer, Tata McGraw-Hill
4. Niyogi, P. Chakrabarty, S.K. and Laha, M.K., Introduction to computational fluid dynamics, Pearson education.
5. S.K. Gupta, Numerical Methods for Engineers, New Age Publishers.

L = Lecture, T = Tutorial, P = Practical, C = Credit