

Branch Name:	Mechanical Engineering
Program Code:	ET101
Course Name:	Professional Elective –III: Computational Fluid Dynamics
Course Code:	2ET1010704T
Pre-requisite Course:	Applied Thermodynamics, Heat Transfer and Thermal Machines, Fluid Mechanics and Hydraulic Machines

Course Objectives:

1. To study the basic governing equations and understand the basic properties of CFD.
2. To understand discretization techniques and solving methods for improving accuracy.
3. To inculcate the knowledge required to solve real time physical problems using simulation software.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)									Total (Marks)
					Theory (Marks)				Practical (Marks)					
	L	T	P	Total	SEE		CCA		SEE		CCA			
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		
3	3	-	-	3	24	60	16	40	-	-	-	-	100	

Course Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Introduction to Computational Fluid Dynamics: Continuity Equation, Navier Stokes Equation, Energy Equation and General Structure of Conservation Equations, Classification of Partial Differential Equations and Physical Behavior, Approximate Solutions of Differential Equations: Error Minimization Principles. Fundamentals of Discretization: Finite Element Method, Finite Difference and Finite Volume Method, Consistency, Stability and Convergence. 1-D Steady State Diffusion Problems- Source term linearization, Implementation of boundary conditions.	14	35
2	1-D unsteady state diffusion problems: Implicit, fully explicit and Crank-Nicholson scheme. Finite volume discretization of convection-diffusion problem. Central difference scheme, Upwind scheme, Exponential scheme and Hybrid scheme, Power law scheme, Generalized convection-diffusion formulation, Finite volume discretization of two-dimensional convection-diffusion problem. The concept of false diffusion, QUICK scheme, TVD schemes and flux limiter functions.	14	30
3	Finite Volume Discretization of 2-D unsteady State Diffusion type Problems, Solution of Systems of Linear Algebraic Equations: Elimination Methods, Iterative Methods Discretization of Navier Stokes Equations, primitive variable approach, SIMPLE Algorithm, SIMPLER Algorithm, Unstructured Grid Formulation. Introduction to Turbulence Modeling, Important features of turbulent flow, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence: Necessity of turbulence modeling and applications.	14	35

Reference Books:

1. J. D. Anderson, & J. Wendt, "Computational fluid dynamics" McGraw-Hill
2. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation
3. H. K. Versteeg, and W. Malalasekara, "An Introduction to Computational Fluid Dynamics", The Finite Volume Method,
4. F. Moukalled, L. Mangani, & M. Darwish, "The finite volume method in computational fluid dynamics. An Advanced Introduction with OpenFOAM and Matlab"

E-Resources:

- 1 <https://nptel.ac.in/courses/103106119>

Course Learning Outcomes (CLO):

CLO	Description	Bloom's Taxonomy Level
CLO1	To understand the classification of PDEs, governing equations.	1 Remembering
CLO2	To understand the basic principles of computational methods.	2 Understanding
CLO3	To apply finite volume method to solve steady and unsteady diffusion, advection-diffusion problems.	3 Applying
CLO4	To understand Solution algorithms and various discretization schemes.	3 Applying 4 Analyze
CLO5	To solve engineering problems using CFD software.	4 Analyze 5 Evaluating
CLO6	To evaluate the different methods.	5 Evaluating 6 Creating

Mapping of CLOs with POs & PSOs:

Course Learning Outcomes	Program Outcomes (POs)												Program Specific Outcomes (PSOs)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CLO1	M	H	M			L							M	
CLO2	M	H	H	H									M	
CLO3	M	M	M	L		L				L	L		M	
CLO4			M	M	M	L	M		M			M		M
CLO5			M	M	M				L			L		M
CLO6		M	M	M								L		M

H: High, M: Medium, L: Low