I Year M.Tech. Machine Design, II Semester	L	T	P	TO	C
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(ME 510) COMPUTATIONAL FLUID DYNAMICS
(ELECTIVE - III)

Objective of the Course :
Computational fluid dynamics (CFD) *is one of the branches of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the millions of calculations required to simulate the interaction of fluids and gases with the complex surfaces used in engineering.*

UNIT - I
Governing Equations And Boundary Conditions : Basics of computational fluid dynamics – Definition and overview of CFD, need, advantages, problem areas, Governing equations of fluid dynamics – Continuity, Momentum and Energy equations — Physical boundary conditions – Time-averaged equations for Turbulent flow - Turbulence -Kinetic -Energy Equations – mathematical behavior of PDEs on CFD: Elliptic, Parabolic and Hyperbolic equations.

UNIT - II
Discretization And Solution Methodologies :
Discretization : Methods of Deriving the Discretization Equations - Taylor Series formulation – Finite difference method – Control volume Formulation – Detailed treatment of Finite Difference method, explicit and implicit methods, errors and stability analysis.
Solution methodologies: The Lax-Wendroff Technique, MacCormack's Technique, Space marching, Direct and iterative methods, Thomas algorithm, Relaxation method, Alternating Direction Implicit method.

UNIT - III
Heat Conduction : Finite difference and finite volume formulation of steady/transient one-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulations for two and three dimensional conduction problems.
UNIT - IV
Convection And Diffusion : Finite volume formulation of steady one-dimensional convection and Diffusion problems, Central, upwind, hybrid and power-law schemes - Discretization equations for two dimensional convection and diffusion.

UNIT - V
Calculation Of Flow Field : Representation of the pressure - Gradient term and continuity equation - Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure - Correction equation, SIMPLE algorithm and its variants.

TEXT BOOKS:

1. John D. Anderson Jr, "Computational Fluid Dynamics-The Basics withApplications", 6th Edition, Mcgraw Hill, 2009.
2. Versteeg, H.K, and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Longman Publication, 2004.
3. Anderson, D.A.,Tannehill, I.I., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, 2nd Edition, Hemishphere Publishing Corporation, 1997.

REFERENCE BOOKS:

1. C. Hirsch, "Numerical Computation of Internal and External Flows", Volumes I and II, 2nd Edition, John Wiley & Sons, 2007.
2. Subas, V.Patankar "Numerical heat transfer fluid flow", 2nd Edition, Hemisphere Publishing Corporation, 2004.
3. Ghoshdasdidar, P.S.,"Computer Simulation of flow and heat transfer" Tata McGraw-Hill PublishingCompany Ltd., 1998.
4. Muralidhar, K.,and Sundararajan,T., "Computational Fluid Flow and Heat Transfer", 2nd Edition, Narosa Publishing House New Delhi, 2011.