FOUNDATION OF COMPUTATIONAL FLUID DYNAMICS

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COURSE OUTLINE :

This is an introductory course in CFD. In this course, students will be exposed to basics of CFD. Students will gain knowledge on FD/ FV strategy, formulation of the problem and solution techniques. Students at the end of the course will get to experience a simple and sample working CFD code and thus develop confidence.

ABOUT INSTRUCTOR :
Prof.Vengadesan did B.E (Hons.) in Mechanical Engineering from NITT, MS (by Research) from IITM and PhD from Kobe University, Japan. He has been teaching various UG and PG courses related to Fluid Mechanics at IITM since 2003. His areas of research interests are CFD, Turbulent flows and modeling, Application of these techniques for different theoretical and industry problems, insect aerodynamics and biofluid dynamics. He has so far guided 6 PhD and 21 MS, and currently guiding 9 PhD and 5 MS. He carries out sponsored research projects from ARDB, DST, CSIR and NRB and also consultancy projects.

COURSE PLAN :

Week1 :
Module 1: Introduction
Module 2: Review of basic fluid mechanics
Module 3: Review of equations and importance of terms
Module 4: Review of equations (contd.) and non-dimensionalization
Module 5: Vorticity-Stream function equation, classification of equation and the solution nature
Module 6: Classification of equations (contd.), types of boundary conditions and description about standard test cases.

Week2:
Module 1: Steps involved in CFD, Information about Computational domain and grid with illustration
Module 2: Information about grid (contd.); Taylor's series expansion
Module 3: Taylor's series expansion, CD / FD / BD for first & second derivative;
Module 4: FD formula for non-uniform mesh; mixed derivative
Module 5: Derivation for higher derivative; FD formula by Polynomial procedure

Week3:
Module 1: Different Approximation Methods
Module 2: Properties associated with discretization
Module 3: Errors due to approximation and their analysis – consistency, convergence
Module 4: Stability analysis
Module 5: FD formulation for model equations and explanation

Week 4:
Module 1: FV formulation for diffusion equation – 1D
Module 2: Example and extension to 2D and 3D
Module 3: FV formulation for convection and diffusion equation
Module 4 & 5: Treatment of convective terms - different interpolations

Week 5:
Module 1 & 2: Illustration on the performance by different approximation for convection terms
Module 3: Time integration methods
Module 4: Arrangement of variables; Introduction to Pressure velocity coupling, MAC
Module 5: SIMPLE
Module 6: Variants of SIMPLE, Projection Method

Week 6:
Module 1: Introduction to Turbulent flows
Module 2: Deriving governing equations
Module 3: Reynolds stresses, modeling strategy
Module 4 & 5: Introduction to Standard models and explanation

Week 7:
Module 1: Matrix inversion – Direct, Iterative procedure
Module 2: Direct solver / Iterative solver
Module 3 - 5: Iterative solver

Week 8:
Module 1 - 5: Demonstration of a test case with a display of working CFD code and details