

ED5093 COMPUTATIONAL FLUID DYNAMICS

DETAILED SYLLABUS

OBJECTIVES

- This course aims to introduce numerical modeling and its role in the field of heat, fluid flow and combustion it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.
- To develop finite volume discretized forms of the CFD equations.
- To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations.

UNIT I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer– Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor’s Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II DIFFUSION PROCESSES: FINITE VOLUME METHOD

Steady one-dimensional diffusion, Two and three dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank- Nicholson’s schemes, Stability of schemes.

UNIT III CONVECTION - DIFFUSION PROCESSES: FINITE VOLUME METHOD

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme– Hybrid and power law discretization techniques – QUICK scheme.

UNIT IV FLOW PROCESSES: FINITE VOLUME METHOD

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

UNIT V MODELING OF COMBUSTION AND TURBULENCE

Mechanisms of combustion and Chemical Kinetics, Overall reactions and intermediate reactions, Reaction rate, Governing equations for combusting flows. Simple Chemical

Reacting System (SCRS), Turbulence - Algebraic Models, One equation model & $k - \epsilon$, $k - \omega$ models – Standard and High and Low Reynolds number models.

REFERENCES

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2. Jiyuan Tu, Guan Heng Yeoh, Chaogun Liu, "Computational Fluid Dynamics A Practical Approach" Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008
3. John D. Anderson . JR. "Computational Fluid Dynamics The Basics with Applications" McGraw- Hill International Editions, 1995.
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.
5. Subas and V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
6. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014