B.Tech IV Year I Semester

JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA

19AME76d- COMPUTATIONAL FLUID DYNAMICS

(Professional Elective-IV)

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Course Objectives: The objectives of the course are to make the students learn about

- Teach the basics of the major theories, approaches and methodologies used in CFD.
- Familiar with the differential equations for flow phenomena and numerical methods for their solutions.
- Introduce explicit and implicit schemes in hyperbolic equations.
- Expose the students to solve the problems through finite volume method.
- Understand the concepts of linear fluid flow problems, steady state problems and transient problems.

UNIT – 1: Introduction & Solution methods **12 Hrs**

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

Learning Outcomes:

At the end of this unit, the student will be able to

- Compare FDM, FEM, FVM methods **L2**
- List the various solution methods of elliptical equations **L1**
- Identify the types of parabolic equations **L3**

UNIT – II: Hyperbolic equations: **10Hrs**

Explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

Learning Outcomes:

At the end of this unit, the student will be able to

- Describe explicit and implicit schemes **L2**
- List second order one-dimensional wave equations **L1**
- Explain the Runge-Kutta method **L2**
- Explain Von Neumann stability analyses **L2**

UNIT – III: Formulations Of Incompressible Viscous Flows: **10Hrs**

Formulations Of Incompressible Viscous Flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Treatment of compressible flows: potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

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Learning Outcomes:
At the end of this unit, the student will be able to

- Apply numerical models to fluid flow and heat transfer calculations **L3**
- Determine incompressible viscous flows by FDM, PCM and Vortex methods **L3**
- Formulate potential equation and Euler equations **L6**

UNIT – IV: Finite Volume Method: **8 Hrs**
Finite volume method via finite difference method, formulations for two and three-dimensional problems.

Learning Outcomes:
At the end of this unit, the student will be able to

- Formulate finite volume method for two and three dimensional fluid flow problems **L3**
- Solve the fluid flow problems using finite volume method **L6**

UNIT – V: Standard Variational Methods: **8Hrs**
Linear fluid flow problems, steady state problems, Transient problems.

Learning Outcomes:
At the end of this unit, the student will be able to

- Model equations for linear fluid flow, steady state and transient flow problems. **L3**
- Apply standard variational methods to solve fluid flow problems **L3**

Text Books:

1. Computational fluid dynamics/ T. J. C'hung/ Cambridge University press,2002.
2. Computational Fluid Dynamics: Basics with applications/John D. Anderson/ Mc Graw Hill.

Reference Books:

1. Text book of fluid dynamics/ Frank Choriton/ CBS Publishers & distributors, 1985.
2. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hema shava Publishers corporation & Mc Graw Hill.
3. Computational Fluid Flow and Heat Transfer/ Muralidaran/ Narosa Publications.
4. Fundamentals of Computational Fluid Dynamics/Tapan K. Sengupta / Universities Press.
5. Introduction to Theoretical and Computational Fluid Dynamics/C. Pozrikidis /Oxford

Course Outcomes:
At the end of this Course the student will be able to

- Summarize the major theories, approaches and methodologies used in CFD. **L2**
- Formulate finite volume method for two and three dimensional fluid flow problems. **L3**
- apply numerical models to fluid flow and heat transfer calculations **L3**

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