## **B.Tech IV Year I Semester**

# JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS) PULIVENDULA 19AME76d- COMPUTATIONAL FLUID DYNAMICS

(Professional Elective-IV)

L T P C 3 0 0 3

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

<ul> <li>Compare FDM, FEM, FVM methods</li> </ul>	L2
<ul> <li>List the various solution methods of elliptical equations</li> </ul>	L1
<ul> <li>Identify the types of parabolic equations</li> </ul>	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

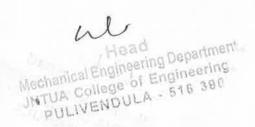
•	Describe explicit and implicit schemes	L2
•	List second order one-dimensional wave equations	L1
•	Explain the Runge-Kutta method	L2
•	Explain Von Neumann stability analyses	L2

### **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.



## **Learning Outcomes:**

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

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

### **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
 Solve the fluid flow problems using finite volume method

## **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.
 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.
 Formulate finite volume method for two and three dimensional fluid flow problems.
 apply numerical models to fluid flow and heat transfer calculations
 L3