2106

Code No: 5221AP **R15**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech II Semester Examinations, August - 2017

COMPUTATIONAL FLUID DYNAMICS

(Thermal Engineering)

Time: 3hrs **Max.Marks:75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

5 × 5 Marks = 25

1.a) Distinguish between finite difference, finite volume and finite element discretizations. [5]

b) Write the CFD methodology to solve hyperbolic equations with an example. [5]

c) Write a short note on the need of pressure correction method for incompressible viscous flows. [5]

d) What are the conditions on the selection of finite volumes for conservative discretization? [5]

e) Explain the meaning of the term 'residual' in variational methods. [5]

PART - B

5 × 10 Marks = 50

2. Derive finite difference equations for the following partial differential equations and indicate their order of accuracy: [10]
a) $(\partial u/\partial t) + a\,(\partial u / \partial x) = 0$.
b) $(\partial u/\partial t) = a\,(\partial^2 u / \partial x^2)$.
c) $(\partial^2 u / \partial x^2) + (\partial^2 u / \partial y^2) = 0$.

OR

3. Given the function $f(x) = x^3-5x$, calculate $\partial f/\partial x$, $\partial^2 f/\partial x^2$, at x=0.5 and 1.5 by using second order central, forward and backward differencing. Using step sizes 0.00001, 0.0001, 0.01, 0.2, 0.3 determine numerical error for each computation. [10]

4. Derive the stability condition for CTCS discretization of second order wave equation using von Neumann stability analysis. [10]

OR

5.a) Write the Burger's equation. What types of problems are governed by Burger's equation?

b) Discretize Burger's equation using any finite difference scheme of your choice. Give the name of the scheme you have selected and comment on its order of accuracy. [5+5]

6. Describe SIMPLER pressure correction technique for an incompressible viscous flow and compare it with SIMPLE technique. [10]

OR

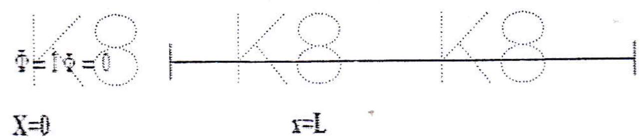
7. Explain the method of solving an incompressible flow problem using stream function – Vorticity formulation. [10]

8. Explain the two-dimensional finite volume method and describe evaluation of fluxes through cell surfaces using central discretization schemes and how to evaluate areas of volumes with neat sketches. [10]

OR

9. A property Φ is transported by means of convection and diffusion through the one dimensional Domain the governing equation is $\frac{d}{dx}(\rho u \phi) = \frac{d}{dx}\left[\Gamma \frac{d\phi}{dx}\right]$ with boundary conditions are $\Phi_0 = 1$ at x=0 and $\Phi_L = 0$ at x=L. using five equally spaced cells and the central differencing scheme for convection and diffusion calculate the distribution of Φ as a function of x for u=0.1 m/s [10]

$\rho = 1.0\, kg/m^3$, $\Gamma = 0.1\, kg/m\,s$, Length L=1.0 m,



10. Explain generalized Galerkin method for formulating finite element equations for unsteady heat conduction flow problems. [10]

OR

11. Write short notes on the following time integration methods for space-discretized equations occurring in numerical simulation of fluid flows: (a) Multistep methods. (b) Predictor-Corrector Methods. (c) Runge-Kutta Methods. [10]

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