Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech S7 (S) Examination Sept 2020

Course Code: AO401

Course Name: COMPUTATIONAL FLUID DYNAMICS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three full questions, each carries 10 marks. Marks

1 a) Can we use CFD as research tool? Justify your answer with example. (2)

b) Derive the differential Governing equation for fluid motion according to Newton's second law in conservation form. (8)

2 a) Discuss on source panel method, list its merits and de-merits. (5)

b) Derive an expression for shape function 3 noded bar element (5)

3 a) Show that the second order wave equation is hyperbolic. (2)

$$\frac{\partial^2 u}{\partial t^2} = c\frac{\partial^2 u}{\partial x^2}$$

b) Classify the following system of PDE's according to eigen value method (5)

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

$$\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} = 0$$

where, u and v are the two dependent variables

c) Write a short note on well-posed problems. (3)

4 a) Consider a viscous flow of air over a flat plate. At a given station in the flow direction the variation of the flow direction u in the direction perpendicular to the plate is given by an expression $u=1582\ (1-e^{-y/L})$ where L is the characteristic length 1m. The viscosity coefficient of air is (1.775×10^7 N/m-s). Assume u at discrete grid points equally spaced in the y direction with $\Delta y=0.1$m. Calculate the wall shear stress first, second and third order accuracy. (10)

PART B

Answer any three full questions, each carries 10 marks.

5 a) Consider 1-D wave equation $U_t + a\ U_x = 0$. Discretize the equation and hence deduce dissipative term and dispersive term. (10)

6 a) What are the differences between explicit and implicit methods? (5)

b) Distinguish between truncation error , round-off error and discretization error. (5)

7 a) Derive an expression for truncation error in the Implicit scheme for 1-D conduction equation $\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2}$ if α=1. (7)

b) What is the significant of 'Courant number' and CFL condition in stability analysis? (3)

8 a) Derive the expressions for explicit FTCS and CTCS for a parabolic PDE. (5)

b) Check the consistency of the following model equation using CTCS method. (5)

$$\frac{\partial u}{\partial t} = -a \frac{\partial u}{\partial x}$$

PART C

Answer any four full questions, each carries 10 marks.

9 Discretize and estimate the density in a unsteady, inviscid 2-D flow field one forward time step ahead with the help of conservative equation by using McCormack technique. (10)

10 a) Differentiate Jacobi and gauss – seidel iterative methods. (7)

b) Define staggered grid and explain the need for Staggered grid. (3)

11 a) Define upwind type discretization. (5)

b) Describe point Gauss-Seidel method. (5)

12 Solve the equation by using Runge kutta method in steps of time 'Δt' (10)

$$\frac{\partial u}{\partial t} = -\frac{\partial E}{\partial x}$$

13 Describe the node-centred and vertex-centred finite volume schemes with suitable sketches. (10)

14 a) Differentiate lax Wendroff time stepping with Runge- kutta time stepping . (4)

b) Describe the important features of Finite Volume method. (6)

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