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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Regular and Supplementary Examination December 2021 (2015 Scheme)

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) Distinguish between conservative and non-conservative forms of governing equations of fluid flow? (5)

b) Discuss various applications of CFD and its merits over experimental method (5)

2 Derive an expression for the lift generated by an arbitrary body in a flow field using panel method? (10)

3 a) The compressible potential flow equation, known as Prandtl-Glauert equation is given by $(1- M_{\infty}^2)\ \varphi_{xx} + \varphi_{yy} = 0$. What type of partial differential equation does this represent in subsonic, supersonic and transonic flows? (8)

b) Explain what is interpolation function and what is its use (2)

4 a) Using Taylor series expansion, derive the finite difference expressions for a first order derivative with forward, backward, and central difference approximations (6)

b) Explain how the coordinate in a compressed grid finely spaced in y direction in the physical plane is transformed to computational plane? (4)

PART B

Answer any three full questions, each carries 10 marks.

5 In a linear convection equation $\frac{\partial U}{\partial t} + a\frac{\partial U}{\partial x} = 0$ where a >0, discretize this equation and hence prove that the direct result of even order derivative indicate numerical dissipation? (10)

6 Check the consistency of the following equation's FTCS formulation, (10)

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

7 Consider an 1-D heat flow equation as given below. Write the finite difference (10)

equation in explicit form and hence prove that the numerical solution of this equation is conditionally stable

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

8 Using Von Neumann stability analysis check the stability of given equation using Crank-Nicholson implicit scheme (10)

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

PART C

Answer any four full questions, each carries 10 marks.

9 Calculate the density at one time step ahead by using Lax-Wendroff scheme applied to unsteady, incompressible inviscid flow in the absence of body forces and volumetric heating? (10)

10 a) Explain procedure for pressure correction technique for incompressible viscous flow (5)

b) Explain the necessity of staggered grids for the incompressible flow computations with suitable sketch (5)

11 Describe Jacobi and Gauss-Seidel iteration method for solution of Laplace equation (10)

12 Describe the node-centered and vertex-centered finite volume schemes with suitable sketches (10)

13 Explain Runge-Kutta and Multi stage Time stepping (10)

14 a) Explain the concept of FVM (6)

b) Compare Central difference schemes and Upwind Schemes (4)

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