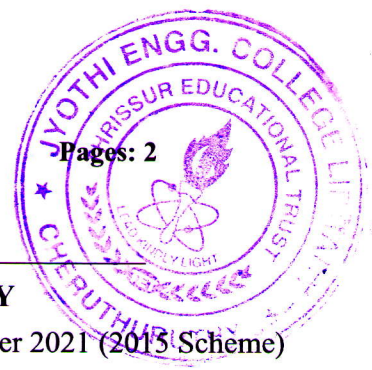


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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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  $(1 - M_\infty^2) \phi_{xx} + \phi_{yy} = 0$ . 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 (10) using Crank-Nicholson implicit scheme

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

### 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 (10) applied to unsteady, incompressible inviscid flow in the absence of body forces and volumetric heating?
- 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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