Exam. Code: 0944
Sub. Code: 6753

2054

B.E. (Mechanical Engineering)

Eighth Semester

MEC-803: Computational Fluid Dynamics

Time allowed: 3 Hours **Max. Marks: 50**

NOTE: ***Attempt <u>five</u> questions in all, including Question No. I which is compulsory and selecting two questions from each Unit. All questions carry equal marks.***

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1. Attempt the following: -

(a) Discuss the merits of CFD compared to experimental method.

(b) Classify boundary conditions and give an example of each boundary condition.

(c) Show that the second order wave equation $\frac{\partial^2 u}{\partial t^2} = c\frac{\partial^2 u}{\partial x^2}$ is hyperbolic.

(d) What is the need for Upwind scheme? Explain.

(e) State the disadvantages of SIMPLE algorithm.

UNIT-I

2. (a) How can CFD be applied and used to improve cost-effective design procedures in the automotive industry?

(b) Derive the conservative and non-conservative forms of the continuity equation.

3. (a) Write the various governing equations used in CFD in conservation form, with a suitable example.

(b) Classify the following partial differential equations:

$a_1\frac{\partial u}{\partial x} + b_1\frac{\partial u}{\partial y} + c_1\frac{\partial v}{\partial x} + d_1\frac{\partial v}{\partial y} = f_1,\ a_2\frac{\partial u}{\partial x} + b_2\frac{\partial u}{\partial y} + c_2\frac{\partial v}{\partial x} + d_2\frac{\partial v}{\partial y} = f_2,$

where $u = u(x, y), v = v(x, y)$.

4. (a) Explain forward, backward and central difference formulation by taking a suitable partial differential equations.

(b) What are the sources of errors in finite differences technique? What is meant by stability of an explicit scheme and how it is analyzed?

UNIT-II

5. Provide examples of real-world applications where the finite volume method is commonly used for solving diffusion and convection-diffusion problems, and explain why it is preferred in those areas.

P.T.O.

6. (a) Compare and contrast the Upwind differencing scheme with the central differencing scheme in terms of stability and accuracy.

(b) Introduce the quadratic Upwind differencing scheme as an extension of linear Upwind scheme. Apply quadratic upwind differencing scheme to discretize any convection or diffusion problem along with its implementation.

7. (a) Provide an example of a tridiagonal matrix system of equations and demonstrate how the Thomas algorithm can be applied to solve it numerically.

(b) Explain the concept of the SIMPLE algorithm with pressure correction and velocity correction equations. What is the difference between SIMPLE and SIMPLER algorithms?

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