Roll No.

Total No. of Questions : 08

M.Tech. (ME) (Sem.–2) COMPUTATIONAL FLUID DYNAMICS Subject Code : MME-504 Paper ID : [E0429]

Time: 3 Hrs.

Max. Marks: 100

Total No. of Pages : 02

INSTRUCTION TO CANDIDATES :

- 1. Attempt any FIVE questions out of EIGHT questions.
- 2. Each question carries TWENTY marks.
- Q1. a) How is CFD being used as a research tool, a design tool, and an educational tool in academic fields, such as Thermal-Fluids? (10)
 - b) What are the main elements involved in a complete CFD analysis? (10)
- Q2. A simplified one-dimensional inviscid, incompressible, laminar flow is defined by the following momentum equation in the x direction : (20)

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} = -\frac{1}{\rho} \frac{\partial p}{\partial x}$$

Name each term and discuss their contribution to the flow.

Q3. a) Consider the following finite-difference formulation in the x-coordinate. (10)

$$\frac{\varphi_{i-1} - 2\varphi_i + \varphi_{i+1}}{\Delta x^2} = 0$$

What is the finite-differencing type? Is it first order or second order? Write the same formulation with respect to the y-coordinate?

- b) Using finite difference, show that the steady one-dimensional heat conduction equation. $k \frac{\partial^2 T}{\partial x^2} = 0 \text{ can be expressed as } \frac{T_{i-1} - 2T_i + T_{i+1}}{\Delta x^2} = 0$ (10)
- Q4. a) What are the main advantages and disadvantages of discretization of the governing equations through the finite-volume method? (10)

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- b) Is the finite-volume method more suited for structured or unstructured mesh geometries? Why? (10)
- Q5. a) In a finite-difference scheme, data is resolved at nodal points, how is this different to the finite-volume scheme? (10)
 - b) What do you mean by upwind scheme and why are upwind schemes important for strongly convective flow? (10)
- Q6. What is the purpose of the SIMPLE scheme? Does it give us a direct solution or depend on the iterative concept? (20)
- Q7. Consider the conservation of mass. Determine the discretized form of the two- dimensional continuity equation : $\frac{\partial u}{\partial x} + \frac{\partial v}{\partial x} = 0$ by the finite-volume method in a structured uniform grid arrangement. (20)
- Q8. Why do the results obtained through numerical methods differ from the exact solutions that are solved analytically? What are some of the causes for this difference? (20)