Roll No. | | | | | | | | | | | | | Total No. of Pages : 02

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

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. $k\frac{\partial^2 T}{\partial x^2} = 0$ 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)

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)