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Total No. of Questions : 08

M.Tech. (ME) (2017 Batch) (Sem.–2)

COMPUTATIONAL FLUID DYNAMICS

Subject Code : MTME-204

M.Code : 74980

Time : 3 Hrs. Max. Marks : 100

INSTRUCTIONS TO CANDIDATES :

1. **Attempt any FIVE questions in all.**
2. **Each question carries TWENTY marks.**

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

   b) Why is it important to correctly define the computational domain for the fluid flow problem? Give an example of this.

2. A simplified one-dimensional inviscid, incompressible, laminar flow is defined by the following momentum equation in the x direction :

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

   Name each term and discuss their contribution to the flow.

3. a) What is the second term in the central difference approximation for a first- order derivative (given below) called and what does it measure?

$$\left(\frac{\partial \varphi}{\partial x}\right)=\frac{\varphi_{i+1,j}-\varphi_{i-1,j}}{2\Delta x}+O(\Delta x^2)$$

   b) Which of the following is most accurate and why? Forward difference, backward difference, and central difference.

4. a) What are the main advantages and disadvantages of discretization of the governing equations through the finite-volume method?

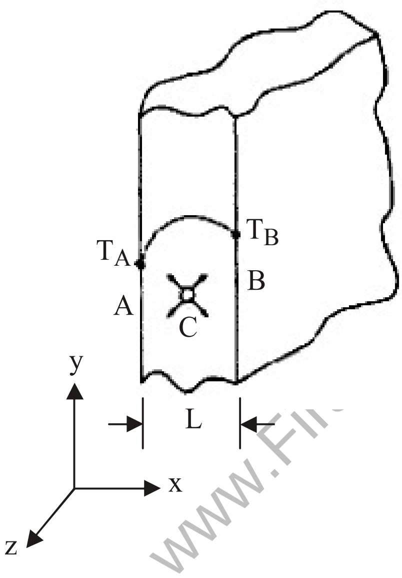
   b) Is the finite-volume method more suited for structured or unstructured mesh geometries? Why?

5. a) Write down the formulation of central difference scheme for u velocity in the *x* direction. What is its truncation error in terms of Ax? And state the order of this discretization scheme.

   b) Why are higher order upwind schemes more favorable than the first-order upwind scheme?

6. What is the purpose of the SIMPLE scheme? Does it give us a direct solution or depend on the iterative concept?

7. Consider the problem of steady-heat conduction in a large brick plate with a uniform heat generation. The faces A and B as shown in Figure 1 below are maintained at constant temperatures. Write down the generic governing equation. The diffusion coefficient Γ governing the heat conduction problem becomes the thermal conductivity k of the material. For a given thickness L = 1.5cm, with constant thermal conductivity k = 5W/mK, Temperatures at T_A and T_B are 100°C and 400°C respectively, and heat generation q is 400 kW/m^3. Determine and plot the steady-state temperature distribution in the plate.



Note: Take atleast four control volumes

FIG.1

8. 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?

NOTE : Disclosure of Identity by writing Mobile No. or Making of passing request on any page of Answer Sheet will lead to UMC against the Student.