Total No. of Questions : 10]

SEAT No. :

P2153

[Total No. of Pages : 4

[5254] - 549
B.E. (Mechanical Engg.)
COMPUTATIONAL FLUID DYNAMICS
(Semester - II) (Elective - IV) (2012 Pattern)

Time : 2½ Hours] *[Max. Marks :70*

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8, Q.9 or Q.10.***

2) ***Neat diagrams must be drawn wherever necessary.***

3) ***Figures to the right indicate full marks.***

4) ***Use of electronic pocket calculator is allowed.***

5) ***Assume suitable data if necessary.***

Q1) a) Write momentum equation in differential form. Identify the pressure gradient and diffusion terms in the momentum equation. Interpret its physical significance. **[6]**

b) In the context of CFD analysis of following engineering domains, explain the post processing **[4]**

i) Electronic cooling

ii) Brake pad heat dissipation

OR

Q2) a) Justify implicit methods are computationally costly. Comment on advantages of implicit methods over explicit methods. **[5]**

b) Discretize the second order partial differential term with suitable discretization method and show that **[5]**

$$\frac{\partial^2 u}{\partial x^2} = \frac{2u_i - 5u_{i+1} + 4u_{i+2} + u_{i+3}}{(\Delta x)^2}$$

P.T.O.

Q3) a) Consider one dimensional steady-state heat conduction in varying cross section horizontal fin as shown in Fig.1 The fin is subjected to the boundary conditions shown in Fig.1.

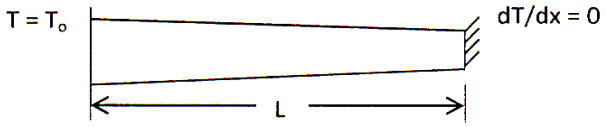

Fig.1 Fin

Above system results into following set of equations.

$$\begin{bmatrix} 1 & 2 & 0 & 0 \\ -1 & 1 & 2 & 0 \\ 0 & 1 & 3 & 1 \\ 0 & 0 & 2 & 2 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{bmatrix} = \begin{bmatrix} 4 \\ 1 \\ 7 \\ 8 \end{bmatrix}$$

i) Write an algorithm to find out numerical solution of above system of equations. **[3]**

ii) Find temperature distribution (temperatures, T_1 to T_4) in the fin using same algorithm. **[4]**

b) Explain divergence of velocity. Explain the physical significance of it with suitable example. **[3]**

OR

Q4) a) Explain any two physical boundary conditions used in CFD analysis.**[2]**

b) Two parallel plates are separated by a fluid film of 0.04 m. The fluid between the plates has a kinematic viscosity 2.17×10^{-4} m^2/s and density of 800 Kg/m^3. The lower plate is stationary and upper plate is suddenly set in motion with a constant velocity of 40 m/s. Find the velocity distribution within the fluid in y direction for one time step of 0.5 sec. Use 5 nodes for finite differencing and apply crank Nicolson's implicit method. The governing equation reduced from Navier-Stokes equation is as given below **[8]**

$$\rho \frac{\partial u}{\partial t} = \mu \frac{\partial u^2}{\partial y^2}$$

Q5) a) Derive an expression of Lax-Wendroff method used for solving an initial value problem. What is stability condition for Lax-Wendroff method? Comment on the CFL number and order of accuracy of the method. **[10]**

b) Discretize the Convective – Diffusion equation using upwind difference approach. Comment on the accuracy of the method. **[8]**

OR

Q6) a) Compute solution for the first time step of the wave equation as given below **[10]**

$$\frac{\partial u}{\partial t} + C\frac{\partial u}{\partial x} = 0, \quad \text{c = constant} > 0$$

Using Lax - Wendroff scheme. The initial condition and boundary conditions are given below.

Initial condition : $u(x,0) = \begin{cases} x - x^2, & 0 \le x \le 1 \\ 0, & x > 1 \end{cases}$

Boundary condition : $u(0,t) = 0,$ for all t.

Take $\Delta x = 0.25,\ c\dfrac{\Delta t}{\Delta x} = 0.25$

b) Write an algorithm to find the numerical solution of second order wave equation. Give any suitable example and discuss its implementation. **[8]**

Q7) a) Differentiate between Finite difference method and finite volume method. **[6]**

b) Explain SIMPLE numerical technique. Write stepwise algorithm to find out the numerical simulation of flow through convergent divergent nozzle. **[10]**

OR

Q8) a) Write a note on finite volume method. Give the nomenclature of a discretized cell in finite volume method with neat schematics. Explain advantages of finite volume method. **[10]**

b) Explain the necessity of the variation of SIMPLER algorithm from SIMPLE algorithm. Explain how the drawbacks encountered in SIMPLE algorithm are overcome in SIMPLER algorithm. **[6]**

Q9) a) Write any four characteristics of the turbulence. Explain its significance in brief. **[6]**

b) Write a grid generation method in any suitable commercial software. What are the important criteria considered for grid generation? Explain how grid quality affects the CFD solution. **[10]**

OR

Q10) a) Why do the results obtained through numerical methods differ from the exact solutions solved analytically? What are some of the causes for this difference? **[4]**

b) List any two advanced topics in CFD and discuss them briefly. **[6]**

c) What is turbulence modeling? Explain. k — ω model in detail. **[6]**

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