Total No. of Questions : 10] SEAT No. :

P4836

[Total No. of Pages : 4

[5154]-557
B.E. (Mechanical Engg.) (Semester - II)
COMPUTATIONAL FLUID DYNAMICS
(2012 Pattern) (Elective - IV)

Time : 2.30 Hours] *[Max. Marks : 70*

Instructions to the candidates:-

1) ***Answer Q1 or Q2, Q3or Q4, Q5 or Q6, Q7or Q8, Q9 or Q10.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate side full marks.***
4) ***Use of electronic pocket calculator is allowed.***
5) ***Assume suitable data, if necessary.***

Q1) a) What is control volume analogy in CFD? What are the different flow models used in CFD analysis? Comment on the resultant equations. **[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) Explain divergence of velocity. Explain the physical significance of it with suitable example. **[3]**

b) Consider One Dimensional steady-state heat conduction in varying cross section horizontal fin as shown in Fig.l The fin is subjected to the boundary conditions shown in Fig.l.

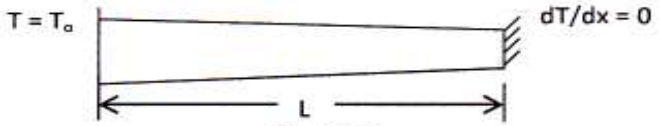

Fig.1 Fin

Above system results into following set of equations.

$$\begin{bmatrix} 1 & 2 & 0 & 0 \\ -1 & 1 & 2 & 0 \\ 0 & 1 & 3 & 1 \\ 0 & 0 & 2 & 2 \end{bmatrix} \begin{bmatrix} T1 \\ T2 \\ T3 \\ T4 \end{bmatrix} = \begin{bmatrix} 4 \\ 1 \\ 7 \\ 8 \end{bmatrix}$$

P.T.O.

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]**

Q3) a) Discretize the second order partial differential term with suitable discretization method and show that **[5]**

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

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

OR

Q4) a) In any commercial software, consider numerical analysis of any cooling application. Assign the Dirichlet and Neumann boundary conditions. Draw neat schematic and explain the boundary conditions for the same. **[6]**

b) Consider steady two-dimensional heat transfer in a long solid body whose cross section is given in the figure. The measured temperatures at selected points of the outer surfaces are as shown. The thermal conductivity of the body is k 45 W/m °C, and there is no heat generation. Discuss the solution methodology to determine the temperatures at the indicated points in the medium. Consider the finite difference method and formulate the problem. Take mesh size of & $\Delta x = \Delta y = 2.0$ cm. **[4]**

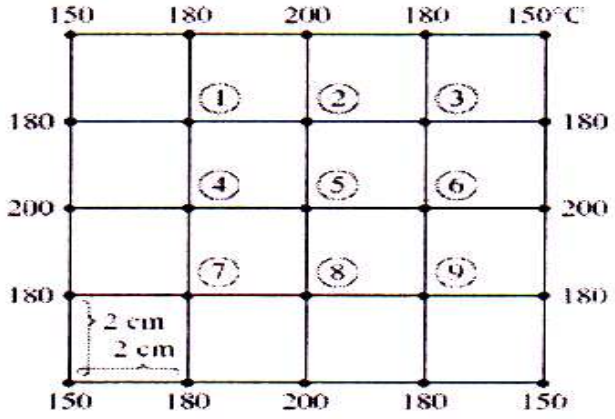

Fig.2 Computational domain

Q5) a) Discretize the Convective - Diffusion equation using upwind difference approach. Comment on the accuracy of the method. **[8]**

b) 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]**

OR

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

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

using Lax-Wendroff scheme. The initial condition and boundary conditions are given below. **[10]**

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

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

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

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

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

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 over come in SIMPLER algorithm. **[6]**

Q9) a) What is turbulence modeling? Explain **k - ω** model in detail. **[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) A schematic of a computational domain with boundary conditions is shown in Figure 3. Write a CFD simulation process in detail using any suitable commercial software. Draw neat sketches wherever necessary. Discuss **[10]**

i) The flow physics for given flow over circular cylinder.

ii) The flow parameters for analyzing the flow.

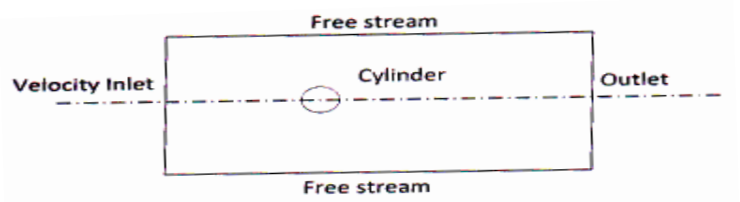

Fig.3 Computational Domain

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

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