Total No. of Questions : 10]

SEAT No. :

P2223

[Total No. of Pages : 3

[5254]-556
B.E. (Mechanical Sandwich)
COMPUTATIONAL FLUID DYNAMICS (Elective -I)
(2012 Pattern)

Time :2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) *Neat diagram must be drawn wherever necessary.*
2) *Figures to the right indicate full marks.*
3) *Use of logarithmic tables slide rule, Mollier charts, Electronic pocket calculator, Steam tables and p -h chart is allowed.*
4) *Assume suitable data, if necessary.*

Q1) a) Describe the physical meaning of substantial derivative with a practical example. **[7]**

b) Consider a laminar boundary layer that can be approximated as having a velocity profile u(x) = $U_\infty y / \delta$ where δ = $Cx^{1/2}$, C is a constant is free stream velocity, is the boundary layer thickness. Considering 2 dimensional flows, determine vertical component of velocity v inside the boundary layer. (Make use of differential form of continuity equation). **[7]**

δ

OR

Q2) a) Describe the various flow models used to investigate a fluid flow. State what are conservation and non conservation form of the governing equations? **[7]**

b) Discuss about the Governing equations in CFD. **[7]**

Q3) a) What is discretization? Comment further on it in relation with consistency and stability of governing equations. **[7]**

b) Derive the following finite difference approximation for applications in

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two dimensional fluid flow at point (i,j) **[7]**

OR

Q4) a) Explain what you mean by an implicit solution method and an explicit solution method. Also discuss merits and demerits of these two methods. **[7]**

b) Why relaxation techniques are needed in numerical calculations, explain how under relaxation and over relaxation works in numerical calculations. **[7]**

Q5) a) Solve following Tridigonal Matrix system using Thomas algorithm **[7]**

$$\begin{bmatrix} 2.25 & -1 & 0 & 0 \\ -1 & 2.25 & -1 & 0 \\ 0 & -1 & 2.25 & -1 \\ 0 & 0 & -2 & 2.25 \end{bmatrix} = \begin{bmatrix} T1 \\ T2 \\ T3 \\ T4 \end{bmatrix} \equiv \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\frac{\partial^4 y}{\partial x^2} \equiv \frac{y_{i-2,j} - 4y_{i-1,j} + 6y_{i,j} - 4y_{i+1,j} + y_{i+2j}}{(\Delta x)^4} + O(\Delta x)^2$$

b) What do you mean by Dirichlet, Neumann and Mixed boundary conditions give an example of each. **[7]**

OR

Q6) a) For one dimensional Transient heat conduction, formulate the finite difference expression **[7]**

i) Explicit form

ii) Crank Nicholson (semi implicit) form

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b) Explain the solution algorithm for Tridiagonal Matrix encountered in CFD calculations. **[7]**

Q7) a) Explain what is Stability and stability criteria? **[7]**

b) Explain Mac Cormac Scheme with a suitable equation. **[7]**

OR

Q8) 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. Write all the steps in the algorithm. **[14]**

Q9) What is Turbulence modeling? Explain k ε-model in detail. **[14]**

OR

Q10) Write short note on any two of the following: **[14]**

a) Use of CFD simulation in automobile industry

b) Types of Grids used in CFD simulations

c) Examples of X-Y plots and contour plots and vector plots in post processing.

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