Total No. of Questions : 12]

SEAT No. :

P1531

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[4759] - 43

B.E. (Mechanical/Sandwich)

COMPUTATIONAL FLUID DYNAMICS

(Semester - II) (2008 Pattern) (402049)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) *Answer any three questions from each section.*
2) *Answers to the two sections should be written in separate answer books.*
3) *Figures to the right indicate full marks.*
4) *Neat diagrams must be drawn wherever necessary.*
5) *Use of logarithmic tables, Mollier charts, electronic calculator is allowed.*
6) *Your answer will be valued as a whole.*
7) *Assume Suitable data, if necessary.*

SECTION - I

Q1) a) Derive mass conservation equation using any flow model. **[12]**

b) Explain how numbers of equations (of the flow field variables) to the no. of unknowns to solve Navier-Stokes equations are not sufficient. Justify your approach to resolve this. **[4]**

OR

Q2) a) Give examples of industrial manufacturing and gas turbine industry analyses using CFD concepts for application development. **[8]**

b) Mention the significance of two types of forces to derive the momentum equation. **[8]**

Q3) a) Derive finite difference quotient for $\frac{\partial u}{\partial x}$ and $\frac{\partial u}{\partial y}$ over a grid having running index i, j in X and Y direction respectively. **[10]**

b) Given the function $f(x) = 0.25\ X^2$; find the first derivative of f at $x = 2$; using forward and backward differencing of order (Δx). Use a step size of $\Delta x = 0.1$ **[8]**

OR

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Q4) a) Derive the first derivative and second derivative of the temperature by finite difference representation of a heat transfer considering general internal node. **[10]**

b) Differentiate two properties of partial differential equations: elliptic, hyperbolic, parabolic. **[8]**

Q5) a) Differentiate grid: **[6]**

i) Structured vs Unstructured

ii) C and H type grid

b) A large plate of thickness L = 4cm and thermal conductivity k = 28 W/m °C in which heat is generated uniformly at a constant rate of 5000 kW/cu.m. One side of the plate is maintained at zero degree centigrade by iced water while other side is subjected to convection to an environment at T = 30 °C with a heat transfer co-efficient of h = 45 W/sq.m. °C. as shown in the figure 1. Consider 3 equally spaced nodes, two at boundaries and one in the middle. Calculate the nodal steady state temperature of the plate by finite difference method. **[10]**

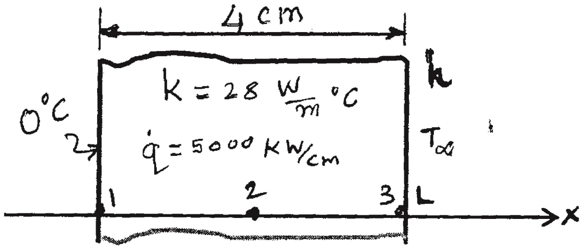

Figure : 1 Q.5(b)

OR

Q6) a) Classify & Derive differential equation of the 1D heat transfer by conduction. **[6]**

b) Calculate the temperature at points 1, 2, 3 and 4 using numerical method.

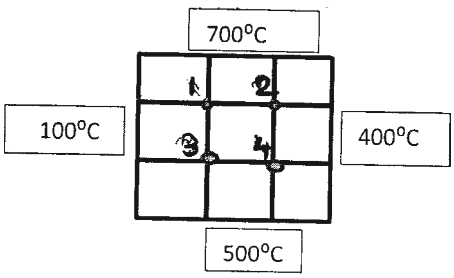

Figure Q.6(b)

Consider the square plate having thermal constants h = 10 W/sq.m. C and k = 10 W/m. The left face is maintained at 100°C and the top face at 700°C, while the right face at 400°C and the bottom face at 500°C. **[10]**

SECTION - II

Q7) For a long thin aluminium rod, 10 cm long having values k' = 0.49 cal/sec. cm. °C. Take equal node distance of 2 cm and time step of 0.1 sec. At time instant zero, the temperature of the rod is zero, and boundary conditions are fixed for all times at T(0) = 100°C and T(10) = 50°C. Note that the material properties are C = 0.2174 cal/g. °C and density ρ = 2.7g/cc., Note k = k' $/(\rho(\Delta t)C)$;

and $\lambda = k[\Delta(t)]/(\Delta x)^2$ find nodal temperatures for two time steps 0.1 sec and 0.2 sec using explicit finite difference method. **[18]**

OR

Q8) a) Distinguish the explicit and implicit finite difference approach. **[10]**

b) How does time step affect stability, explain with suitable example. **[8]**

Q9) Describe the following types of grids: **[16]**

a) Structured and unstructured.

b) Staggered and unstaggered grid.

c) Boundary fitted grid.

d) C type and H type.

OR

Q10) a) List all the steps of SIMPLE algorithm. **[8]**

b) State the boundary conditions applied in the pressure correction method. **[8]**

Q11) a) List various computer graphic techniques used in CFD and describe two in detail. **[8]**

b) Justify the need of Pressure correction method. **[8]**

OR

Q12) Write short notes on any two: **[16]**

a) Lax wendroff method.

b) MacCormack method.

c) Crank Nicholson technique.

d) Grid independence truncation error.

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