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Computational Fluid Dynamics
(1100 / 1102 / 1103)

P. Pages : 2

Time : Three Hours **Max. Marks : 100**

Instructions to Candidates :
1. Do not write anything on question paper except Seat No.
2. Answer sheet should be written with blue ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. Answer **any five** questions.
5. Neat diagram must be drawn wherever necessary.
6. Figures to the right indicate full marks.
7. Assume suitable data if necessary.

1. a) How does a CFD code work ? Explain pre-processor, solver, post-processor in detail. **10**

b) List three main governing equations of fluid flow and heat transfer. Explain unsteady, three-dimensional mass conservation or continuity equation for compressible and incompressible fluid. **10**

2. a) Explain momentum equation in three dimensions and explain how you will find x, y and z component of the said equation. **10**

b) How you will classify second order PDE ? Explain its classification according to **10**

i) Value or discriminant and

ii) basis of the eigen values of a matrix.

3. a) Consider the one-dimensional steady state conductive / convective heat transfer from a bar of a material having geometry as shown in fig.1. **10**

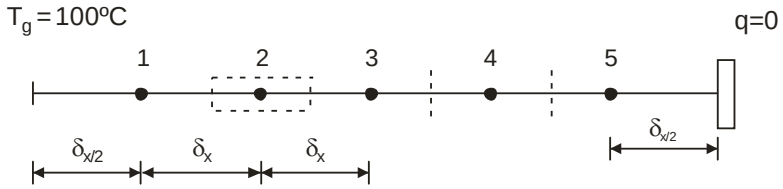

Fig 1 : Heat Transfer from a bar

The temperature on the left hand boundary is taken to be 100ºC and the right hand side boundary is insulated so the heat flux across it is zero. Heat is lost to the surroundings by convective heat transfer. Solve the matrix equation

$$\begin{bmatrix} 20 & -5 & 0 & 0 & 0 \\ -5 & 15 & -5 & 0 & 0 \\ 0 & -5 & 15 & -5 & 0 \\ 0 & 0 & -5 & 15 & -5 \\ 0 & 0 & 0 & -5 & 10 \end{bmatrix} \begin{bmatrix} \phi_1 \\ \phi 2 \\ \phi_3 \\ \phi_4 \\ \phi_5 \end{bmatrix} = \begin{bmatrix} 1100 \\ 100 \\ 100 \\ 100 \\ 100 \end{bmatrix}$$

for this problem using the TDMA

b) Explain following recognized errors in CFD **10**
i) Roundoff error,
ii) Interative convergence error and
iii) Discretisation error. Explain each error in detail.

4. a) Explain explicit and Implicit approaches of Discretization. Differentiate these approaches in detail. **10**

b) Explain implicit crank-Nicholson technique for solving incompressible couette flow numerical problem. **10**

5. a) Derive Lax-wendroff finite difference scheme. **10**

b) Explain philosophy of pressure correction method and its equation in detail. **10**

6. a) Derive step by step the procedure of SIMPLE (semi-implicit method for pressure-linked equations algorithm) **10**

b) Illustrate how staggered grid is used for central differencing of the incompressible Navier-stokes equations. **10**

7. a) Explain high order schemes used in FVM with an example. **10**

b) Explain with example Estimation of Discretization Errors. **10**

8. a) Show that for unsteady quasi-one dimensional nozzle flow **10**
$\frac{\partial p A}{\partial t} + \frac{\partial p AV}{\partial x} = 0$.

b) Explain in brief Mccormack's Technique to solve CFD problem. **10**

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