R19

Code No: 5621AF

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech I Semester Examinations, January - 2020

COMPUTATIONAL FLUID DYNAMICS

(Thermal Engineering)

Time: 3hrs **Max.Marks:75**

Note: This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A.Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART - A

5 × 5 Marks = 25

1.a) How many boundary conditions are required for 3D conduction governing equation? Assume without heat generation. Does this equation require any initial condition? If so, mention it. [5]

b) Consider a typical 2 D elliptic equation in cartesian system and approximate it by using 5-point formula. [5]

c) Write short note on treatment of source term. What is its significance? [5]

d) Write down the governing equations that are applicable for 1-D convection- diffusion problem. Assume no source term. [5]

e) Summarize the advantages and disadvantages of stream function and vorticity methods.[5]

PART - B

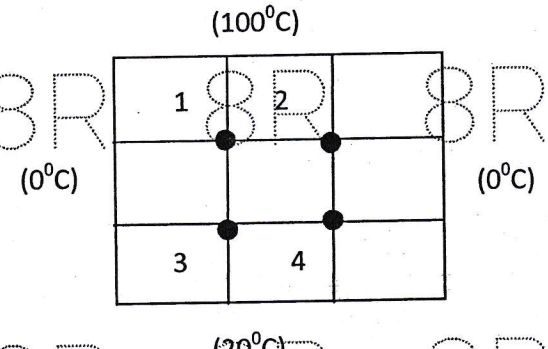
5 × 10 Marks = 50

2. Derive the finite difference expressions for the first order derivative with forward, backward and central difference approximations using Taylor series expansion. [10]

OR

3. Give the classification of linear PDEs. What are the different discretization schemes that are used to solve parabolic equations? Compare them. [10]

4. Consider steady state heat conduction in a square region, subjected to a boundary condition as shown in figure. Use mesh size $\Delta x = \Delta y$, and determine the node temperatures indicated below. [10]



OR

5. Do Von-Neumann stability analysis on the CTCS (Center Time Center Space) scheme for the 1-D heat conduction equation and find its stability condition.

$$\frac{T_i^{n+1} - T_i^{n-1}}{2\Delta t} = \alpha \frac{T_{i+1}^n - 2T_i^n + T_{i-1}^n}{\Delta x^2}$$

Assume that the amplification factor, 'a' is the same for two sequential steps: i.e. [10]

$$\frac{T_i^{n+1}}{T_i^n} = \frac{T_i^n}{T_i^{n-1}} = a$$

6. A rectangular fin of length 2.5 cm, thickness, 3 mm and breadth 24 cm is attached to a plane wall. The wall temperature $T_w = 210^0$ C and ambient temperature $T_\infty = 30^0$ C. For the fin material k = 50 W/ m-K, and the operating h = 10 W/m^2-K. Determine the steady state temperature distribution in the fin using finite volume method by taking five equal control volumes. Assume the fin tip is insulated. [10]

OR

7. What is Nonlinearity? Why linearization is required? Explain finite volume method (FVM) for two-dimensional diffusion problems. [10]

8. What are the basic parameters used to assess interpolation schemes in finite volume formulation of Convection – Diffusion problems? [10]

OR

9. Write the Burger's equation. What types of problems are governed by Burger's equation? [10]

10. Derive the equation for convective mass flux (F) and the diffusive conductance at v-control volume using staggered grid. [10]

OR

11. Discuss in detail about how to discretize the momentum equation by using guessed pressure field in SIMPLE method. [10]

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