B E MECHANICAL ENGG.
THIRD YEAR FIRST SEMESTER 2024- SUPPLEMENTARY EXAMINATION
Subj: NUMERICAL HEAT TRANSFER

Time: Three hours **Full Marks: 100**

Answer Q. 1 and any four (4) questions from the rest
All parts of a question must be answered together- marks shall be deducted for scattering answers in different places. First five answers will be evaluated – so do not attempt more than five questions.

1 (a) Starting with the governing equations of fluid flow and thermal trasnport, discuss the complexities of solving equations of fluid Flow.

(b Discuss the role of cell Peclet number in solving fluid flow.

(c) Calculate the allowable time step size for calculation of duct flow with inlet velocity of 100 m/s. The duct has been meshed with 100 meshes per meter length.

(d) Derive an expression fore obtaining first derivative with second order accuracy using one sided (forward difference). Hence calculate the gradient if nodal values are 10, 20 and 40 with a distance of 1 unit between successive points.

(e) What do you mean by transportive property of a numerical scheme?

5+3+2+(5+1)+4

2 Discretize the equation with grid spacings of Δx and Δy, respectivey in x and y –direction

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0$$

(b) Derive the stability criterion for the following equation

$$\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$$

10+10

3 Consider the equation $\frac{\partial T}{\partial t} = \alpha \frac{\partial^2 T}{\partial x^2}$. Show the implicit and explicit forms of the disccretized equation considering Forward in Time Central in Space (FTCS) formulation. State the merits and demerits of these schemes .

12+8

[Turn over

4 Using **first order upwind scheme**, derive the finite volume coefficients for a 1-D problem, for the equation

$$\rho u \frac{\partial \phi}{\partial x} = \Gamma \frac{\partial^2 \phi}{\partial x^2}$$

5 (b) Sketch the function Q(Pe) and state the limiting values. Show the approximations for central difference, upwinding and hybrid scheme (write the expressions separately). Use Graph paper.

12+8

5. Briefly describe the SIMPLE Scheme explaining how momentum equation is solved using staggered mesh. 20

6 Write short notes on any four (4) topic

(a) Errors in CFD (b) selection of time step size in CFD, (c) Grid independence and validation (d) Numerical experiments (e) QUICK scheme

5 x 4