BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE - PILANI
Department of Chemical Engineering, Pilani Campus, Rajasthan
II Semester 2022-2023
CHE G554 Computational Fluid Dynamics
Comprehensive Examination (Closed Book + Open Book)

Duration: 180 Mins **Date: 12.05.2023** **Max Marks: 40**

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Part – A Closed Book (120 minutes)

Q 1 **[3 x 4 = 12]**

(a) Explain the adaptive grid generation with an appropriate example.

(b) An analytical transformation which can accomplish the grid stretching is $\xi = \ln(x+1)$ and $\eta = y$.
Convert the steady flow continuity equation of the physical plane to the computational plane considering the above analytical transformation.

(c) Using Von Neumann stability analysis, discuss the stability criteria for pure convection in 1 D unsteady state system with implicit FTBS finite difference method.

(d) Explain the concepts of conservativeness, boundedness and transportiveness with relevant examples.

Q 2 **[2 + 3 = 5]**

(a) Write the four basic rules of the Finite volume method.

(b) For a one-dimensional cylindrical coordinate system, the governing equation is given below. Employ the Finite volume method and develop the algebraic equation for internal control volume considering the source term linearly varying with temperature.

$$\frac{1}{r}\frac{d}{dr}\left(rk\frac{dT}{dr}\right) + S = 0$$

Q 3 **[10]**

An aluminium (thermal diffusivity = 100 mm^2/s) circular plate (80 mm diameter) is initially at 25 ˚C. The periphery of the circular plate is suddenly exposed to condensing steam at 100˚C. Apply the finite volume method with weight function $f = 0.5$ and find a circular plate's dynamic temperature profile (for consecutive two-time intervals) considering the $\Delta t = 0.25$ seconds and $\Delta r = 10$ mm.

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Part – B Open Book (60 minutes)

Q 1 **[13]**

A copper wire of constant density ρ moves downward with uniform speed v (0.01 m/s) into a liquid metal bath at temperature T_0 = 1360 K. It is desired to find the temperature profile $T(z)$. Assume that T = 500 K at z = 1 m and that resistance to radial heat conduction is negligible. Considering the Δz = 0.25 m, find the steady-state temperature variation using the appropriate scheme of the finite volume method to get the physically realizable results.

Consider the following properties of copper.

Density = 8954 kg/m^3; Specific Heat = 0.3831 kJ/kg K; thermal conductivity = 350 W/m K