Master of Science Examination, 2023

(2nd Year, 1st Semester)

MATHEMATICS

UNIT - DSE 04 A18

[Computational Fluid Dynamics - I (Theory)]

Time : 1.30 Hours | Full Marks : 24

Symbols/Notations have their usual meaning.

Answer any ***two*** questions.

1. Write the Navier-Stokes equations system in primitive variables for two-dimensional incompressible viscous in non-dimensional form. Sketch the control volume for x-momentum equation and discretize only x-momentum equation using staggered grid concept for SIMPLE formulation. 3+2+7

2. Compute the steady state temperature distribution from the governing equation

$$\frac{d}{dx}\left(\kappa\frac{dT}{dx}\right)+q=0$$

in a large plate of thickness L=2 cm with constant thermal conductivity $\kappa = 0{\cdot}5$ W/m.K and uniform heat generation

$q = 10^6$ kW/m^3. The faces A and B are at temperatures of 100^0C and 200^0C respectively. 12

3. (a) Derive the computational scheme of finite volume method for solving two-dimensional steady state diffusion equation

$$\frac{\partial}{\partial x}\left(k\frac{\partial\phi}{\partial x}\right)+\frac{\partial}{\partial y}\left(k\frac{\partial\phi}{\partial y}\right)+S_\phi=0,$$ where S_ϕ denotes the source term.

   (b) What are the advantages of Upwind differencing scheme in deriving the finite volume methods? 9+3