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12MTP322

Third Semester M.Tech. Degree Examination, June/July 2014
Computational Methods in Heat Transfer and Fluid Flow

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Explain : (i) Neuman boundary condition (ii) Dinchlet boundary conditions. **(08 Marks)**
b. Write momentum and energy equations for fluid flow and explain each term in these two equations. **(08 Marks)**
c. What are the different types of partial differential equations. **(04 Marks)**

2 a. Explain (i) Consistency (ii) Stability and (iii) Convergence as applied to FDM. **(06 Marks)**
b. Explain the rules of discretization. **(06 Marks)**
c. Develop finite difference scheme to solve, $\frac{\partial^2\phi}{\partial x^2}+\frac{\partial^2\phi}{\partial y^2}=0$. **(08 Marks)**

3 a. Discretize the following one dimensional steady state conduction equation using finite volume method: $\frac{d}{dx}\left(k\frac{dT}{dx}\right)+S=0$ **(12 Marks)**
b. Obtain the expression for interface thermal conductivity. **(08 Marks)**

4 Discretize the following unsteady one-dimensional conduction equation using finite volume methods using temperature variation with respect to time given below:
$\rho c\frac{\partial T}{\partial t}=\frac{\partial}{\partial x}\left[k\frac{\partial T}{\partial x}\right]$, where ρc is constant and $\int_t^{t+\Delta t} T_p dt=\left[\theta T_p{}' + (1-\theta)T_p{}^{\circ}\right]\Delta t$, where θ is a weighting factor between 0 and 1. Simplify the discretized equation using explicit, Crank-Nicolson and fully implicit schemes. **(20 Marks)**

5 Discretize the one-dimensional convection and diffusion equation
$\frac{d}{dx}(\rho u\phi)=\frac{d}{dx}\left[\Gamma\frac{d\phi}{dx}\right]$, for the upwind scheme. **(20 Marks)**

6 a. What is staggered grid? What are the advantages of staggered grid? **(10 Marks)**
b. Describe the sequence of operations in the calculation of flow field using the SIMPLE algorithm. **(10 Marks)**

7 If the stream functions and vorticity equations for steady, incompressive flow over an infinite long cylinder are

$$\frac{\partial^2\psi}{\partial r^2}+\frac{1}{r}\frac{\partial^2\psi}{\partial r}+\frac{1}{r^2}\frac{\partial^2\psi}{\partial\theta}=-\omega$$

$$V_r\frac{\partial\omega}{\partial r}+\frac{V_\theta}{r}\frac{\partial\omega}{\partial\theta}=V\left\{\frac{\partial^2\omega}{\partial r^2}+\frac{1}{r}\frac{\partial\omega}{\partial r}+\frac{1}{r^2}\frac{\partial^2\omega}{\partial\theta^2}\right\}$$

where the radial and tangential velocity components are $V_r=\frac{1}{r}\frac{\partial\psi}{\partial\theta}$, $V_\theta=-\frac{\partial\psi}{\partial r}$.

Derive the boundary conditions for stream function and vorticity and also discretize $\frac{\partial\omega}{\partial r}$, $\frac{\partial^2\omega}{\partial r^2}$, $\frac{\partial\omega}{\partial\theta}$ and $\frac{\partial^2\omega}{\partial\theta^2}$ **(20 Marks)**

8 Write short notes on :

a. Riemann problem and solver **(07 Marks)**

b. Scarborough criterian **(07 Marks)**

c. Tank and tube model. **(06 Marks)**

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