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GREE END SEMESTER EXAMINATIONS, APRIL / MAY 2013

MECHANICAL ENGINEERING BRANCH

Fifth Semester

ME 9032 COMPUTATIONAL FLUID DYNAMICS
(Regulation 2008)

Time: 3 Hours | Answer ALL Questions | Max. Marks 100

PART-A (10 x 2 = 20 Marks)

1. Give examples for Initial and Boundary value problems?
2. What are the various sources of Errors in Finite difference numerical scheme
3. What is the type of coefficient matrix you get when one dimensional conduction problem is discretised by FDM method. What is the special method available to solve this system of equation.
4. Why time averaged equation is required for turbulent flow modeling.
5. What is Reynolds stress ?
6. What are the basic rules to be followed in the finite volume formulation.
7. Define Peclet number and explain its significane?
8. Explain how does stream function – vorticity method circumvent the difficulties in solving Navier – Stokes Equations.?
9. What is the stability criteria in the explicit scheme?
10. What are the advantages of staggered grid in control volume method.

Part – B (5 x 16 = 80 marks)

11 A property ϕ is transported by means of convection and diffusion through one-dimensional domain. The governing equation is

$$\frac{d}{dx}(\rho u \phi) = \frac{d}{dx}\left(\Gamma \frac{d\phi}{dx}\right)$$

The boundary conditions are $\phi_o = 1$ at x=0 $\phi_L = 0$ at x = L. Using five equally spaced cells and the upwind difference scheme, calculate the distribution of ϕ as a function of for u = 2 m/s. Use finite volume method. The following data apply L = 1.0 m $\rho = 1.0$ kg/m^3; $\Gamma = 0.1$ kg/m/s.

12 (a) (i) Among the difference schemes (forward, backward and central difference schemes), which one is the most accurate and how? Then what is the necessity of other methods. (6)

(ii) What are the physical behaviour of elliptic and parabolic PDE? (5)

(iii) What are sufficient and necessary conditions for the convergence of iterative Scheme ? (5)

(OR)

(b) A spherical fuel element of radius b=1 cm and thermal conductivity k = 25 W/(m- °C) generates energy at a constant rate of g = 7.5 x 10^8 W/m^3. The boundary surface at r = b is maintained at 100°C. By dividing the region into 5 equal parts, calculate the radial steady state temperature distribution in the sphere by using finite difference scheme.

13 (a) An iron rod L = 5 cm long of diameter D = 2 cm with thermal conductivity k = 50 W / (m. °C) protrudes from a wall and is exposed to an ambient at T_∞ = 20 °C and h = 100 W / (m^2. °C). The base of the rod is at T_o = 320 °C, and its tip is insulated. Assuming one - dimensional steady - state heat flow, calculate the temperature distribution along the rod and the rate of heat loss into the ambient by using finite differences method.

(OR)

(b) (i) What are the advantages and disadvantages of stream function – vorticity method. (8)

(ii) Explain the general algorithm for the solution of two dimensional, laminar, incompressible flow with constant viscosity by stream function – vorticity method. (8)

14 (a) A thin plate is initially at a uniform temperature of 200 °C. At a certain time t = 0 the temperature of the east side of the plate is suddenly reduced to 0 °C. The other surface is insulated. Use the explicit finite difference method in conjunction with a suitable time step size to calculate the transient temperature distribution of the slab at time (i) t = 40 s, (ii) t = 80 s and The data are : plate thickness L = 2 cm, thermal conductivity k = 10 W / m K and ρc = 10^6 J / m^3 / K.

(OR)

(b) Explain the sequence of operations in the calculation of flow field using SIMPLE algorithm.

15 (a) Explain the two equation model by discussing its assessment of performance in various flow situations and also discuss its advantages and disadvantages.

(OR)

15 (b) (i)What are the commercially available codes for the analysis of fluid flow and heat transfer. Discuss its salient features. *(8)*

(ii) Explain the advantages and disadvantages of Prandtl mixing length model. (***8***)