

(3 Hours)

Marks : 80

**N.B: 1) Question No.1is compulsory****2) Attempt any three questions of the remaining five questions****3) Assume suitable data wherever necessary****4) Figures to the right indicate maximum marks****Q.1 Answer any four****20**

- Write the general scalar transport equation for any property  $\Phi$  and explain the various terms and their significance
- Explain the meaning and the significance of relaxation techniques used in a CFD solution
- Explain the concept of meshing and mesh quality
- Discuss the characteristics of free turbulent flows.
- Derive the continuity equation in two dimensions

**Q. No.2**

a) A property  $\phi$  is transported by means of convection and diffusion through a one dimensional domain. The governing equation to be used is  $d/dx (\rho u \phi) = d/dx (\Gamma d\phi/dx)$ . The boundary conditions to be used are at  $x = 0$ ,  $\phi_0 = 1$  and at  $x = L$ ,  $\phi_L = 0$ . Assume that the property is transported from  $x= 0$  to  $x = L$ . Using five equally spaced nodes and an Upwind scheme, calculate the distribution of  $\phi$  as a function of  $x$  for  $u = 0.15$  m/s,  $L = 2.5$  m,  $\rho = 1.1$  kg/m<sup>3</sup>,  $\Gamma = 0.15$  kg/ms

**16**

b) Give an account of the errors in CFD

**04**

**Q. No.3****20**

Consider a large plate of thickness  $t = 3$  cm with an internal heat generation of  $1200 \text{ kW/m}^3$  and a constant thermal conductivity of  $1.1 \text{ W/mK}$ . The faces of the plate are maintained at  $150^\circ \text{C}$  and  $300^\circ \text{C}$ . Assume that the dimensions in the directions perpendicular to the thickness are so large that the temperature gradients due to conduction are significant in the direction of thickness only

- Write the one dimensional governing equation for the above phenomena
- Obtain the discretized equation for each node
- Arrange the equations in the matrix form and solve it to find the steady state temperature at five equally spaced nodes using TDMA

**Q.No.4**

- a) What is a SIMPLER algorithm used for? Explain the steps involved in the algorithm. How is it different from SIMPLE? **10**
- b) Discuss the  $k - \epsilon$  and  $k - \omega$  models used in turbulence modeling **10**

**Q.No.5** Write brief notes**20**

- a) Explain the concept of Peclet no.
- b) What is QUICK? Give the distribution of flux  $\phi$  at the face values of a control volume.
- c) What are the differences between FDM and FVM.
- d) Application of CFD in automobile engineering.
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