B.E. (Sem VII) (CBSGS) (Mechanical Engg.) 17th Dec. 2015

Computational Fluid Dynamics 11.00 am to 2.00 pm

Mechanical/Automobile

QP Code : 6097

(3 Hours) **[Total 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

a) Write the general scalar transport equation for any property Φ and explain the various terms and their significance

b) Explain the meaning and the significance of relaxation techniques used in a CFD solution

c) Explain the types of grids used in CFD

d) Discuss the characteristics of free turbulent flows.

e) Derive the continuity equation in three dimension

Q.2

Consider a large plate of thickness t = 4 cm with an internal heat generation of 1000 kW/m^3 and a constant thermal conductivity of 1 W/mK. The faces of the plate are maintained at 150 ^{0} C and 300 ^{0} 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 20

Q.3

a) A property ϕ 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 ϕ as a function of x for u = 0.2 m/s, L = 1.5 m, ρ = 1.0 kg/m^3, Γ = 0.15 kg/ms **16**

b) Give an account of the errors in CFD **04**

Q.4

a) A thin plate is initially at a uniform temperature of 300^{0}C. At a certain time t = 0 the temperature of the east side of the plate is suddenly reduced to 0^{0}C. The other surface is insulated. Use the explicit technique and a time step of 2 seconds; calculate the transient temperature distribution of the plate at the end of the first time step. The plate thickness is 30 mm, thermal conductivity is k = 20 W/mK and $\rho c = 10 \times 10^6$ J / m^{3}K . The governing equation of the phenomena is **$\rho c\,(\partial T/\partial t) = \partial/\partial x\,(k\,\partial T/\partial x)$**. **14**

b) Discuss the k - ε model used in turbulence modeling **06**

Q.5

a) What is CFD? Give its application. Also describe the working of a commercial CFD software. **10**

b) What is a SIMPLE algorithm used for? Explain the steps involved in the algorithm. How is it different from SIMPLER. **10**

Q.6

Write brief notes 20

a). Explain the concept of Peclet no.

b) What is QUICK? Give the distribution of flux ϕ at the face values of a control volume

c) What are the differences between FDM and FVM

d) LES turbulence model