B.E. (Sem VII) (CBSGS) (Mechanical Engg.)

Computational Fluid Dynamics

Mechanical/Automobile

6th June 2016

11.00 am to 2.00 pm

QP Code : 31490

(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 a note on staggered grid.

b) Write the conservative form of the governing equations of CFD.

c) Explain the initial boundary value problem.

d) Derive the continuity equation in three dimension.

e) Enlist the properties of discretization schemes and explain any one.

Q.2

Consider one dimensional steady state heat conduction across an insulated rod of uniform cross section whose ends are maintained at 150 ^{0}C and 600 ^{0}C. The 1-D heat conduction is governed by the equation $\frac{d}{dx}\left[k\frac{dT}{dx}\right] = 0$. Divide the entire length of the rod into five control volumes and find the temperature distribution across the nodes. The thermal conductivity of the rod is 1050 W/mK, cross sectional area A is 0.012 m^2, length of the rod is 0.5 m.

- 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 $\frac{d}{dx}(\rho u \phi) = \frac{d}{dx}(\Gamma \frac{d\phi}{dx})$. The boundary

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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 a **central differencing scheme**, calculate the distribution of ϕ as a function of x for u = 0.18 m/s, L = 1.8 m, ρ = 1.1 kg/m^3, Γ = 0.14 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 **implicit** technique and a suitable time step; calculate the transient temperature distribution of the plate. The plate thickness is 2 cm, thermal conductivity is k = 20 W/mK and $\rho c = 10 \text{ X } 10^6 \text{ J / m}^3\text{K}$.

The governing equation of the phenomena is $\rho c \frac{\partial T}{\partial t} = \frac{\partial}{\partial x}(k \frac{\partial T}{\partial x})$ **14**

b) Discuss the characteristics of turbulent flows **06**

Q.5

a) What do you understand by QUICK scheme? Discuss its application to one dimensional convection diffusion problems. **10**

b) What is a SIMPLER algorithm used for? Explain the steps involved in the algorithm. **10**

Q.6

Write brief notes **20**

a) What is CFD? Give its application.

b) Explain the different boundary conditions used in a CFD solver with examples.

c) What do you understand by RANS?

d) Differentiate between FDM, FVM and FEM.
