B.TECH/ME/7TH SEM/MECH 4144/2018
COMPUTATIONAL FLUID DYNAMICS
(MECH 4144)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Steady state means
(a) time dependent (b) time independent
(c) uniform in space (d) both (a) and (b).

(ii) Rate of normal deformation component along *x* direction is
(a) $\frac{\partial v}{\partial z}$ (b) $\frac{\partial u}{\partial y}$ (c) $\frac{\partial u}{\partial x}$ (d) $\frac{\partial v}{\partial x}$.

(iii) The time average of turbulent fluctuations is
(a) 0 (b) 10 (c) 100 (d) 1000.

(iv) Tetrahedral computational cells have
(a) 5 faces (b) 2 faces (c) 3 faces (d) 4 faces.

(v) Shear force in fluid flow is a type of
(a) body force (b) surface fore
(c) both (a) and (b) (d) pressure force.

(vi) Rate of shearing deformation in y-z plane is
(a) $\left(\frac{\partial w}{\partial y}+\frac{\partial v}{\partial z}\right)$ (b) $\frac{1}{2}\left(\frac{\partial w}{\partial y}+\frac{\partial v}{\partial z}\right)$
(c) $\frac{1}{2}\left(\frac{\partial w}{\partial y}-\frac{\partial v}{\partial z}\right)$ (d) $\left(\frac{\partial w}{\partial y}-\frac{\partial v}{\partial z}\right)$

(vii) Energy dissipation takes place in
(a) largest eddies (b) medium sized eddies
(c) smallest eddies (d) both (a) and (c).

(viii) Isotropic means
(a) grid dependency (b) grid independency
(c) directional dependency (d) directional independency.

(ix) Mixing –length turbulence model relates kinematic turbulent viscosity with
(a) turbulent length scale only (b) turbulent velocity scale only
(c) both (a) and (b) (d) turbulence intensity.

(x) For pure diffusion problem, Peclet number is
(a) 0 (b) 1 (c) 2 (d) ∞.

Group – B

2. (a) State the different forces acting on fluid particles in fluid flow system.

(b) Derive the three-dimensional general mass continuity equation for fluid flow in differential form. Therefore, deduce an expression of continuity equation for incompressible fluid.

3+ (7 + 2)=12

3. Derive general momentum equation in Cartesian form for three-dimensional fluid flow problem.

12

Group – C

4. (a) Briefly describe the upwind differencing scheme.

(b) Explain the mixing length turbulence model.

5 + 7 = 12

5. Heat is transferred across a large plate of thickness 0.02m with thermal conductivity 0.5W/m.K and uniform heat generation 400kW/m^3. The faces are kept at temperatures 150°C and 250°C respectively. Assuming the temperature gradients are significant along the thickness of the plate, form the set of equations for the temperature distribution along the rod using finite volume method.

12

Group – D

6. Describe the method of 'Pressure-Velocity Coupling' for steady flow condition. **12**

7. What is 'SIMPLE' algorithm? Describe the 'SIMPLE' algorithm in flowchart form. **12**

Group – E

8. Explain the general procedure for solving equations using Tri-Diagonal Matrix Algorithm.

12

9. Write notes on:
   (i) Structured grid
   (ii) Steps to solve a fluid flow problem using CFD software

4 + 8 = 12