

**COMPUTATIONAL FLUID DYNAMICS
(MECH 3221)**

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) The fluctuation intensity of flow parameters in laminar flow is
(a) 0 (b) 5 (c) 10 (d) ∞
- (ii) Conduction heat transfer is a kind of
(a) diffusion (b) convection
(c) radiation (d) both (a) and (b)
- (iii) Shear stress ' τ_{yz} ' acts on a plane perpendicular to _____ axis and along _____ axis.
(a) z, y (b) y, z (c) y, y (d) z, z
- (iv) Central differencing scheme is valid for Peclet number less than
(a) 10 (b) 5 (c) 4 (d) 2
- (v) Turbulence dominates the fluid flow when the _____ force dominates over viscous force.
(a) gravity (b) body (c) inertia (d) pressure
- (vi) Discretization means _____ conversion.
(a) integral to algebraic (b) differential to algebraic
(c) differential to integral (d) integral to differential.
- (vii) Pressure-Velocity coupling is performed on _____ grid configuration.
(a) normal (b) staggered
(c) non-staggered (d) both (b) and (c)
- (viii) False diffusion may occur due to _____ cell structure along the flow direction.
(a) aligned (b) unaligned (c) small (d) big

- (ix) Fluid velocity at static wall boundary condition following no-slip is
(a) ∞ (b) 1 (c) 0 (d) 10
- (x) Tetrahedral cells have
(a) 4 faces (b) 5 faces (c) 6 faces (d) 8 faces.

Group – B

2. (a) Establish a relation between Eulerian and Lagrangian form for a scalar variable ϕ in fluid flow systems. Also state the significance of different terms.
(b) Briefly explain the significance of conservation laws applicable for fluids in motion.
6 + 6 = 12
3. (a) Find out the resultant force acting along y-direction, on an infinitesimal control volume in a fluid flow domain for laminar flow.
(b) Express mean velocity, turbulent kinetic energy and turbulence intensity in turbulent flow conditions.
7 + 5 = 12

Group – C

4. What is Peclet number? With the help of a suitable grid structure, evaluate the applicability of upwind and central differencing schemes for convection and convection-diffusion problems.
(3 + 9) = 12
5. Consider steady state one-dimensional source free heat conduction in an insulated rod whose ends are maintained at constant temperatures of 500°C and 1000°C respectively. Form the algebraic equations for temperature intermediate nodes and boundary nodes using five equal cells in the domain and central differencing scheme. Given thermal conductivity $k = 1000\text{W/m.K}$, length of the rod $L = 2\text{m}$, cross sectional area of the rod $A = 0.05\text{m}^2$.
12

Group – D

6. (a) Solve the following set of equations using TDMA.
 $375A_1 - 125A_2 = 29000$ (1)
 $-125A_1 + 250A_2 - 125A_3 = 4000$ (2)
 $-125A_2 + 250A_3 - 125A_4 = 4000$ (3)
 $-125A_3 + 250A_4 - 125A_5 = 4000$ (4)
 $-125A_4 + 375A_5 = 54000$ (5)
12
7. Elaborate the basic architecture of CFD software. What are the advantages of structured grid-structure?
(9 + 3) = 12

Group – E

8. Write short notes on:

- (i) Grid interface
- (ii) Boundary conditions
- (iii) Multiphase domain.

(4 + 4 + 4) = 12

9. (a) Describe the importance of grid independence study followed in CFD analysis?

(b) What is meant by 'data export' in CFD software? When it is necessary?

6 + 6 = 12

Department & Section	Submission Link
ME	https://classroom.google.com/c/MzY0NTQxMTY4ODQ4?cjc=p56tnac