Reg. No.															

B.Tech. DEGREE EXAMINATION, NOVEMBER 2023
Sixth Semester

18ASE307T – COMPUTATIONAL HEAT TRANSFER AND FLUID DYNAMICS
(For the candidates admitted from the academic year 2020-2021 & 2021-2022)

Note:
(i) **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40th minute.
(ii) **Part - B & Part - C** should be answered in answer booklet.

Time: 3 hours Max. Marks: 100

PART – A (20 × 1 = 20 Marks)
Answer ALL Questions

Question	Marks	BL	CO	PO
1. Which theorem is used to convert all the laws of system into control volume approach? (A) Reynolds transport theorem (B) Gauss theorem (C) Taylor series theorem (D) Lagrangian theorem	1	1	1	1
2. Which law is used to derive the momentum equations of fluid flows? (A) First law of thermodynamics (B) Newton's 2nd law (C) Newton's 3rd law (D) Conservation of energy	1	1	1	1
3. In the continuity equation of steady 3D, incompressible fluid flows (A) Pressure gradient is zero (B) Unsteady term is involved (C) Divergence of velocity is not zero (D) Unsteady term is not involved	1	2	1	1
4. An approach in which flow variables are determined at fixed points in space as fluid flows is called (A) Lagrangian approach (B) Eulerian approach (C) Navier approach (D) Fixed mass approach	1	1	1	1
5. How many partial differential equations are required to get a numerical solution of compressible flow through a 2D nozzle? (A) 2 (B) 3 (C) 4 (D) 5	1	2	2	1
6. Test used to check accuracy of solution is called (A) Grid independence test (B) Solution test (C) Optimal test (D) Stability test	1	1	2	1
7. Error occurred by approximating infinite sum by finite sum is called (A) Finite error (B) Infinite error (C) Truncation error (D) Zero error	1	2	2	1
8. Formula of forward differencing is (A) $\Delta h f'(x) = f(x+h) - f(x)$ (B) $2\Delta h f'(x) = f(x+h) - f(x-h)$ (C) $\Delta h f'(x) = f(x) - f(x+h)$ (D) $\Delta h f'(x) = f(x+h) + f(x-h)$	1	2	2	1

9. Truncation error becomes zero as mesh spacing tends to 1 2 3 1

(A) Maximum (B) Minimum
(C) Zero (D) Infinity

10. If flow across boundary is zero, normal velocities are set to be 1 2 3 1

(A) Maximum (B) Zero
(C) Minimum (D) Values of nearest node

11. The property of a numerical method to produce a solution which approaches the exact solution as the grid spacing is reduced to zero 1 1 3 1

(A) Convergence (B) Consistent
(C) Stability (D) Divergence

12. The area in the western face of a 2-D steady-state diffusion grid (uniform) is ________. 1 2 3 1

(A) Grid size in the x-direction (B) Grid size in the y-direction
(C) Product of the grid sizes in the x and y-directions (D) Ratio of the grid sizes in the x and y-directions

13. If the error introduced in the numerical solution grows up as the computation progresses, then the solution is called as 1 2 4 1

(A) Stable solution (B) Unstable solution
(C) Converged solution (D) Diverged solution

14. Which of these theorems is used to transform the general diffusion term into boundary based integral in the FVM? 1 1 4 1

(A) Gauss divergence theorem (B) Stoke's theorem
(C) Kelvin stokes theorem (D) Curl theorem

15. When one unknown dependent variable at the present time level is expressed in terms of many unknowns at the same time level, computation is said to be 1 1 4 1

(A) Implicit (B) Explicit
(C) Unique (D) Dependent

16. Wen is the central differencing scheme suitable for convection term? 1 1 4 1

(A) The Peclet number value is less than 2 (B) The Peclet number value is greater than 2
(C) The Peclet number value is 0 (D) The Peclet number value can be anything

17. Which grid arrangement is used to avoid the unrealistic behaviour of the discretized momentum equation for spatially oscillating pressure like the checker-board field? 1 1 5 1

(A) Staggered grid (B) Collocated grid
(C) Cell-centred grid (D) Multi-grid

18. How many governing equations are required to get a 2D numerical solution of non-isothermal incompressible flow through a rectangular channel? 1 2 5 1

(A) 2 (B) 3
(C) 4 (D) 1

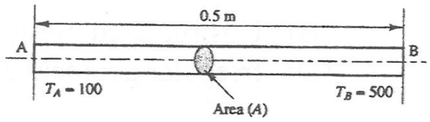
19.	Rectangular mesh is common in (A) Structured mesh (B) Unstructured mesh (C) Dirichlet mesh (D) Irregular geometries	1	1	5	1
20.	The equation of state is required to solve (A) Incompressible flows (B) Compressible flows (C) Isothermal incompressible flows (D) Creeping flows	1	2	5	1

PART – B (5 × 4 = 20 Marks)
Answer **ANY FIVE** Questions

		Marks	BL	CO	PO
21.	Explain the Lagrangian and Eulerian approaches used for fluid flow model.	4	1	1	1
22.	Explain the following steps used in CFD computation (i) Pre-processor (ii) Post-processor	4	1	1	1
23.	Find the forwarddifference approximation of $\partial u / \partial x$.	4	2	2	1
24.	Explain the grid independence test.	4	1	2	1
25.	Differentiate the explicit and implicit methods with examples.	4	1	3	1
26.	Explain the necessity of using upwind schemes in convections term discretization.	4	2	4	1
27.	Write down the governing equations to be solved for 2D steady incompressible laminar viscous flows.	4	2	5	1

PART – C (5 × 12 = 60 Marks)
Answer **ALL** Questions

		Marks	BL	CO	PO
28. a.	Derive the continuity equation for unsteady three-dimensional compressible, laminar flows and deduce it for 2D incompressible flows.	12	2	1	1
	(OR)				
b.	Explain the followings with examples		2	1	1
	(i) Uniform and non-uniform grids and governing equations for solving 2D unsteady incompressible laminar viscous flows	6			
	(ii) Reynolds transport theorem and structured and unstructured grids	6			
29. a.	Discretize a two-dimensional diffusion equation without source term using FVM with uniform grid layout in both the directions and write the final algebraic equation in general form.	12	3	2	2
	(OR)				
b.	Consider the problem of source-free heat conduction in an insulated rod whose ends are maintained at constant temperatures of 100 °C and 500 °C respectively.	12	3	2	2



The one- dimensional problem sketched in Figure is governed by

$$\frac{d}{dx}\left(k\frac{dT}{dx}\right) = 0$$

Thermal conductivity k equals 2000 W/m/K, number of control volumes is 4, cross-sectional area is 20×10^{-4} m^2. Write the FVM discretized equations in a matrix form AX=B.

30. a. Find the discretized form of one-dimensional unsteady heat conduction equation with source term using Finite Volume Method. The explicit scheme and central differencing scheme should be used for the time derivative and the spatial derivative, respectively with a proper grid layout. 12 3 3 2

$$\rho c\frac{\partial T}{\partial t} = \frac{\partial}{\partial x}\left(k\frac{\partial T}{\partial x}\right) + S$$

(OR)

b. Find numerically the temperature values at different locations in one-dimensional heat conduction Aluminium rod of 10 cm length with thermal conductivity, k = 240 W/m.K, Density (ρ) = 2700 kg/m^3, and Specific Heat (c) = 900 J/kg.K. Initially, the rod is at 0°C and left and right sides of it are exposed to fixed temperature values of 200°C and 50°C, respectively. Discretize the domain with 4 grid points and time interval (Δt) is 3 seconds and repeat the calculation up to 6 seconds. 12 3 3 2

31. a. Find the discretized form of two-dimensional convection-diffusion equation by FVM using central-difference scheme for convection term with grid layout. 12 3 4 2

(OR)

b. Find the discretized form of two-dimensional convection-diffusion equation by FVM using 1st order upwind scheme for convection term with grid layout. 12 3 4 2

32. a. Explain the SIMPLE algorithm for solving two-dimensional momentum equations using FVM. 12 2 5 2

(OR)

b. Discretize the steady v-velocity momentum equation using Finite Volume Method in a uniform grid layout. 12 3 5 2

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