Indian Maritime University

(A Central University, Govt of India)

Mar/Apr'26 SE

Programme Name: B.Tech. Marine Engineering

Semester: V

Subject Code: UG11T4501

Subject Name: Introduction to CFD

Date: 02.03.2026	Max Marks: 70
Duration: 03 Hrs	Pass Marks: 35

General Instructions

(i) All Sections (A, B & C) are to be attempted.
(ii) Options, if any, are specified in the respective section.
(iii) Clearly highlight any assumptions made

Section A

Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable.

1. The Runge-Kutta method is used for solving:
   A) Algebraic equations
   B) Partial differential equations
   C) Ordinary differential equations
   D) Integral equations
2. The Navier–Stokes equations describe:
   A) Inviscid flow
   B) Heat conduction
   C) Viscous flow motion
   D) Potential flow only
3. What are the different methods used to solve real-life problems:
   A) Experimental method
   B) Analytical method
   C) Numerical method
   D) All of the options
4. The finite difference method is primarily based on:
   A) Taylor series expansion
   B) Fourier series
   C) Laplace transforms
   D) Green's theorem
5. $\frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} = 0$ Describe the category of the equation:

A) Parabolic
B) Hyperbolic
C) Elliptic
D) All of the options

6. The Crank–Nicolson method is classified as:
   A) Explicit
   B) Implicit
   C) Semi-implicit
   D) Steady-state
7. Von Neumann analysis is used to study:
   A) Consistency
   B) Convergence
   C) Stability
   D) Accuracy
8. Which of the following is an iterative method for solving elliptic equations?
   A) Lagrange method
   B) Gauss–Seidel method
   C) Finite volume method
   D) Euler method
9. Which one or are the following a model of flow?
   A) Fixed finite control volume
   B) Moving finite control volume
   C) Fixed infinitesimal fluid element
   D) All of the options
10. Which one of the following is the method of discretization?
   A) Finite difference method
   B) Finite volume method
   C) Finite element method
   D) All of the options

Section B

Five Questions of 02 Marks each

11. Discuss the applications of CFD in the marine field
12. What is the physical meaning of the divergence of velocity?
12. Explain space and time marching.
14. Discuss the steps used to solve problems in CFD
15. Write the continuity equation for unsteady and compressible flow.

Section C

Seven Questions of 10 Marks each, of which any 05 questions are to be answered.

16. Apply Runge- Kutta fourth order method to find an approximate value of y when x = 0.2, given that $\frac{dy}{dx} = x + y$ and y = 1, where x = 0. Assume the step size is equal to 0.1 (10)

17. Derive the momentum equation in non-conservation form using the moving infinitesimal fluid element approach. (10)

18. A) Write the discretized forms of the PDEs for the following schemes derived from the Taylor series: Forward difference, Backward difference, Central difference. (6)

    B) Write the difference between a structured and an unstructured grid. (4)

19. Solve the equation using Schmidt relation.

$$2\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$$

with boundary and initial conditions

$$u(x,0) = x(4-x), \quad 0 \le x \le 4,$$
$$u(0,t) = 0, \; u(4,t) = 0 \quad 0 \le t \le 5$$

(10)

20. A) Explain in a short total variation diminishing scheme. (5)

    B) Evaluate by using the Trapezoidal Rule and dividing the range of integration into 6 equal parts. (5)

$$I = \int_0^6 \frac{dx}{1+x^2}$$

21. A) Explain FTCS explicit method. (5)

    B) Explain Elliptic Grid Generation. (5)

22. Derive the equation of the substantial derivative. (10)