D 121288 **(Pages : 2)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. (CBCSS) (REGULAR/SUPPLEMENTARY) DEGREE EXAMINATION, APRIL 2025

Mathematics

MTH4E10—FLUID DYNAMICS

(2019 Admission onwards)

Time : Three Hours Maximum Weightage : 30

Part A

Answer **all** *questions.*
Each questions carries a weightage 1.

1. Show that a vortex filament cannot terminate at a point within the fluid.
2. Obtain the pressure equation for irrotational motion.
3. Write down the equation of motion in terms of the stream function.
4. Determine the condition that $u = ax + by, v = cx + dy$ may give the velocity components of an incompressible fluid.
5. What is Cavitation ?
6. Write a note on Aerofoil.
7. Find the image of line source outside the circular cylinder.
8. How are air ship forms formed ?

(8 × 1 = 8 weightage)

Part B

Answer any **two** *questions from each module.*
Each question carries a weightage of 2.

Module 1

9. Establish the equation of continuity for an incompressible fluid in the form :

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0.$$

10. Derive Bernoulli's equation.
11. A pulse travelling along a fine straight uniform tube filled with gas causes the density at time t and distance x from an origin where the velocity is u_0 to become $\rho_0\phi(V_t - x)$. Prove that the velocity u is given by $V + \frac{(u_0 - V)\phi(V_t)}{\phi(V_t - x)}$.

Module 2

12. State and prove Circle theorem.
13. Discuss the type of transformation that will convert the flow past a circular cylinder (with or without circulation) to the flow past a body of acrofoil shape in a perfect fluid.
14. State and prove the theorem of Kutta and Joukowski.

Module 3

15. If we map the z-plane on the plane by a conformal transformation $\zeta = f(z)$ then show that, a source in the z-plane will transform into a source at the corresponding point of the ζ-plane.
16. Discuss the force exerted on a circular cylinder by a source.
17. Describe uniform stream with source.

(6 × 2 = 12 weightage)

Part C

Answer any **two** *questions.*
Each question carries a weightage of 5.

18. Establish the equation of continuity for an incompressible fluid in the form $\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0$.

    Show that $u=\frac{-2xyz}{\left(x^2+y^2\right)^2}, v=\frac{\left(x^2-y^2\right)}{\left(x^2+y^2\right)^2}, w=\frac{y}{\left(x^2+y^2\right)^2}$ are the velocity components of a possible fluid motion. Is this motion irrotational ?
19. (a) What is two-dimensional motion ? Define function and give a physical interpretation.
    (b) Explain Rankine's method of constructing stream lines. Using this method find the stream lines corresponding to a source and a uniform flow.
20. Discuss the streaming and circulation for a circular cylinder.
21. In the case of a source at a point S outside a circular disc, prove that the velocity of slip of the fluid in contact with the disc is greatest at the points where the circle is cut by the lines joining S to the ends of the diameter perpendicular to OS, and that its magnitude at these points is

$$\frac{2m \cdot \mathrm{OS}}{\mathrm{OS}^2-a^2}$$

where is the centre and a the radius of the disc.

(2 × 5 = 10 weightage)

D 121288-A **(Pages : 4)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. (CBCSS) (REGULAR/SUPPLEMENTARY) DEGREE EXAMINATION, APRIL 2025

Mathematics

MTH4E10—FLUID DYNAMICS

(2019 Admission onwards)

(Multiple Choice Questions for SDE Candidates)

[Improvement Candidates need not appear for MCQ part]

Time : 20 Minutes	**Total No. of Questions : 20**	**Maximum : 5 Weightage**

INSTRUCTIONS TO THE CANDIDATE

1. This Question Paper carries Multiple Choice Questions from 1 to 20.
2. The candidate should check that the question paper supplied to him/her contains all the 20 questions in serial order.
3. Each question is provided with choices (A), (B), (C) and (D) having one correct answer. Choose the correct answer and enter it in the main answer-book.
4. The MCQ question paper will be supplied after the completion of the descriptive examination.

MTH4E10—FLUID DYNAMICS

(Multiple Choice Questions for SDE Candidates)

1. A substance that is capable of ———— is termed as fluid.

   (A) Flowing. (B) Osmosis.

   (C) Melting. (D) Solidification.

2. Which among the following is compressible ?

   (A) Liquid. (B) Gases.

   (C) Solid. (D) Fluid.

3. ———— are those fluids that exert a certain resistance to the alterations of form or to the sliding movement of one particle past another particle.

   (A) Viscid fluids. (B) Non-Newtonian fluids.

   (C) Newtonian fluids. (D) Perfect fluids.

4. A ———— is a line whose direction coincides with the direction of the resultant velocity of the fluid.

   (A) Timeline. (B) Curving line.

   (C) Line of flow. (D) Optimal line.

5. The equation of motion is based on the conservation of ————.

   (A) Mass. (B) Momentum.

   (C) Energy. (D) Equilibrium.

6. $\frac{d\rho}{dt} + \rho\left(\nabla \cdot \vec{q}\right) = 0$ represents the ———— form of equation of continuity.

   (A) First. (B) Second.

   (C) Third. (D) Fourth.

7. $\frac{d\vec{q}}{dt} = \overline{F} - \frac{\nabla P}{\rho}$ represents the equation of ———— for an inviscid fluid.

   (A) Energy. (B) Motion.

   (C) Continuity. (D) Equilibrium.

8. The motion of a fluid is said to be irrotational, if the value of the ———— vector is zero.

   (A) Vorticity. (B) Unit.

   (C) Normal. (D) Unit normal.

9. The ———— motion of a liquid occupying a simply connected region has less kinetic energy than any other motion consistent with the same normal velocity of the boundary.

(A) Irrotational. (B) Steady.

(C) Rotational. (D) Unsteady.

10. Stream function is ———— along a streamline.

(A) Zero. (B) Constant.

(C) One. (D) Not defined.

11. The stream function and the velocity potential both satisfy ———— equation.

(A) Bernouilli's. (B) Laplace's.

(C) Kelvin's. (D) Newton's.

12. In two-dimensional motion, the ———— lines and the streamlines cut orthogonally.

(A) Mono-potential. (B) Bi-potential.

(C) Tri-potential. (D) Equi-potential.

13. The points where the complex velocity is ———— are called stagnation points.

(A) Infinity. (B) Zero.

(C) Constant. (D) One.

14. The streamlines for the comlex potential $w = uz$ are ————.

(A) Straight lines parallel to y-axis.

(B) Straight lines parallel to x-axis.

(C) Both (A) and (B).

(D) None of these.

15. Fluid dynamics is also known as ————.

(A) Magnetohydrodynamics.

(B) Hydrodynamics.

(C) Electromagnetohydrodynamics.

(D) None of these.

16. The streamline that divides on the contour is called the ———— streamline.

(A) Divergent. (B) Intersecting.

(C) Separating. (D) Dividng.

Turn over

17. When the circulation in a circuit is ———— then κ is called the strength of circulation.

(A) $2\pi\kappa$. (B) 2κ.

(C) $\pi\kappa$. (D) κ.

18. A ———— is a negative source.

(A) Aerofoil. (B) Sink.

(C) Cavity. (D) Source.

19. Doublet is also known as ————.

(A) Di-pole. (B) Double source.

(C) Both (A) and (B). (D) None of these.

20. A simple ———— is a point of outward radial flow.

(A) Aerofoil. (B) Sink.

(C) Cavity. (D) Source.