D 143208 **(Pages : 3)** **Name.....**

Reg. No.....

FOURTH SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY) EXAMINATION, APRIL 2026

(CBCSS)

Mathematics

MTH4E10—FLUID DYNAMICS

(2019 Admission onwards)

Time : Three Hours Maximum : 30 Weightage

Part A

Answer **all** *the questions.*

Each question carries a weightage 1.

1. Check whether the surface $\frac{x^2}{a^2k^2t^4} + kt^2\left(\frac{y^2}{b^2} + \frac{z^2}{c^2}\right) - 1 = 0$ is possible form of boundary surface of a liquid at time t or not ?
2. Prove that the speed is everywhere the same, then the stream lines are straight.
3. Obtain the pressure equation for irrotational motion.
4. Obtain the equation satisfied by the velocity potential.
5. Show that the stream function is constant along a streamline.
6. State Blasius's theorem.
7. Let there be a source of strength m at $z = f$, where f is real, outside the cylinder of radius a whose center is at the origin. Determine the complex potential.
8. What is axisymmetrical motion ?

(8 × 1 = 8 weightage)

Turn over

Part B

Answer any **two** *questions from each module.*

Each question carries a weightage 2.

MODULE 1

9. Obtain the expression for rate of change linear momentum of a fluid.

10. In irrotational motion in two dimensions, prove that $\left(\frac{\partial q}{\partial x}\right)^2 + \left(\frac{\partial q}{\partial y}\right)^2 = q\nabla^2 q$.

11. Show that the velocity potential $\phi = \frac{1}{2}\log\frac{(x+a)^2 + y^2}{(x-a)^2 + y^2}$ gives a possible motion, and determine the form of the streamlines.

MODULE 2

12. State and prove Circle theorem.

13. Prove that the velocity potential $\phi = U\left(r + \frac{a^2}{r}\right)\cos\theta$ represents a streaming motion past a fixed circular cylinder.

14. 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 aerofoil shape in a perfect fluid.

MODULE 3

15. OX, OY are fixed rigid boundaries and there is a source at (a, b). Find the form of the streamlines and show that the dividing line is $xy\,(x^2 - y^2 - a^2 + b^2) = 0$.

16. A two-dimensional source of strength m is situated at the point $(a, 0)$, the axis of the y being a fixed boundary. Find the point in the boundary at which the fluid velocity is a maximum.

17. Verify that $\psi\left(\frac{A}{r^2}\cos\theta + Br^2\right)\sin^2\theta$ is a possible form of Stoke's stream function, and find the corresponding velocity potential.

(6 × 2 = 12 weightage)

Part C

Answer any **two** *questions.*

Each question carrics a weightage 5.

18. (a) Derive the the equation of motion of an inviscid fluid.

    (b) State and prove Kelvin's minimum energy theorem.

19. Explain the derivation of Joukowski aerofil by the transformation $\zeta = z + \sum_{r=1}^{n} \frac{a_r}{z_r}$ applied to the circle centre z_0 and radius a. Obtain the lift formula $L = 4\pi\rho U^2 \sin(\alpha + \beta)$ and show that the momentum about the point $\zeta = z_0$ is $M = 2\pi\rho b^2 U^2 \sin 2(\alpha + \gamma)$, where α is the angle of attack and b, β, γ constants of transformation.

20. (a) Discuss the irrotational motion of an incompressible fluid for which the complex potential is $w = ik \log z$, where k is real.

    (b) OX, OY are fixed rigid boundaries and there is a source at (a, b). Find the form of the streamlines and show that the dividing line is $xy(x^2 - y^2 - a^2 + b^2) = 0$.

21. Determine the effect on a wall of a source parallel to the wall.

(2 × 5 = 10 weightage)

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(CBCSS)

Mathematics

MTH 4E 10—FLUID DYNAMICS

(2019 Admission onwards)

(Multiple Choice Questions for SDE Candidates)

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.

MTH 4E 10—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 cannot exert a certain resistance to the alterations of form or to the sliding movement of one particle past another particle.

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

   (C) Viscid fluids. (D) Perfect fluids.

4. Perfect fluids are also known as ————————.

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

   (C) Newtonian fluids. (D) Viscid fluids.

5. 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.

6. The product of density, normal velocity, and surface area is termed ————————.

   (A) Vorticity. (B) Mass.

   (C) Acceleration. (D) Flux.

7. The equation of continuity is based on the conservation of ————————.

   (A) Mass. (B) Momentum.

   (C) Energy. (D) Equilibrium.

8. The energy equation is based on the conservation of ———————.

(A) Mass. (B) Momentum.

(C) Energy. (D) Equilibrium.

9. For an incompressible fluid or homogeneous liquid, density is ———————.

(A) Constant. (B) Zero.

(C) Infinity. (D) One.

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

(A) Energy. (B) Motion.

(C) Continuity. (D) Equilibrium.

11. The fluid motion is said to be steady when the local time rates are all ———————.

(A) Constant. (B) Zero.

(C) Infinity. (D) One.

12. The rate of change of circulation is also known as ——————— theorem.

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

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

13. The ——————— energy is given by $\frac{1}{2}\int_V \rho\vec{q}^2 \, dV$, where V is the volume occupied by the fluid.

(A) Internal. (B) Total.

(C) Potential. (D) Kinetic.

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

(A) Simply. (B) Doubly.

(C) Multiply. (D) n-ply.

Turn over

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

(A) Zero. (B) Constant.

(C) One. (D) Not defined.

16. When the motion is steady, the vectors $\nabla\psi, \nabla\left(\nabla^2\psi\right)$ are ————————.

(A) Orthogonal. (B) Zero.

(C) Perpendicular. (D) Parallel.

17. The velocity potential exists only where the motion is ————————.

(A) Rotational. (B) Steady.

(C) Irrotational. (D) Unsteady.

18. Let ϕ be the velocity potential, then ϕ = constant are called ———————— lines.

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

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

19. In two-dimensional motion, the equi-potential lines and the streamlines cut ————————.

(A) Orthogonally. (B) At multiple points.

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

20. The points where the complex velocity is zero are called ———————— points.

(A) Stagnation. (B) Intersecting.

(C) Stratification. (D) None of these.