(FOR THE CANDIDATES ADMITTED DURING THE ACADEMIC YEAR 2023 ONLY)

23PMS415

REG.NO. :

N.G.M.COLLEGE (AUTONOMOUS) : POLLACHI

END-OF-SEMESTER EXAMINATIONS : MARCH - 2025

M.Sc.- MATHEMATICS **MAXIMUM MARKS: 75**

SEMESTER: IV **TIME : 3 HOURS**

PART - III
FLUID DYNAMICS
SECTION – A (10 X 1 = 10 MARKS)

ANSWER THE FOLLOWING QUESTIONS.
MULTIPLE CHOICE QUESTIONS. (K1)

1. In which method of fluid flow analysis do we describe the motion parameters at a point?
   a) Langragian method b) Eulerian Method
   c) Control volume analysis d) None of the mentioned

2. Which of the following is a key characteristic of an inviscid incompressible flow?
   a) High Reynolds number b) Varying density
   c) Significant shear stress d) No viscosity

3. Which of the following is true?
   a) Flow is rotational inside the boundary layer and irrotational outside
   b) Flow is irrotational inside the boundary layer and rotational outside
   c) Flow is rotational both inside and outside of the boundary layer
   d) Flow is irrotational both inside and outside of the boundary layer

4. Find the value of $\int_0^{2\pi} sin^3\theta \, d\theta$

   a) 0 b) 1 c) -1 d) 2

5. The shearing stress at the stationary wall is zero for α___ -1.
   $a) \leq$ $b) \geq$ $c) =$ $d) \equiv$

ANSWER THE FOLLOWING IN ONE (OR) TWO SENTENCES. (K2)

6. Define Streak Lines.
7. State Circulation Theorem.
8. What is meant by Stokes' stream function.
9. Define Magnus effect.
10. Write the Navier-Stokes equation for the axial direction.

SECTION – B (5 X 5 = 25 MARKS)

ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS. (K3)

11. a) The velocity vector q is given by $q = ix - jy$ Determine the equation of the streamlines.

(OR)

b) Consider a two-dimensional incompressible steady flow field with velocity components in rectangular coordinates given by $u(x,y) = \frac{k(x^2-y^2)}{(x^2+y^2)^2}$ $v(x,y) = \frac{2kxy}{(x^2+y^2)^2}$ with k an arbitrary non-zero constants. Is the equation of continuity satisfied?

(CONTD……..2)

12.a) Calculate the force exerted by a jet of water 10 mm in diameter which strikes a flat plate at an angle of $30°$ to the normal of the plate with a velocity of 10 m/s if **i)** the plate is stationary, **ii)** the plate is moving in the direction of the jet with a velocity of 2 m/s.

(OR)

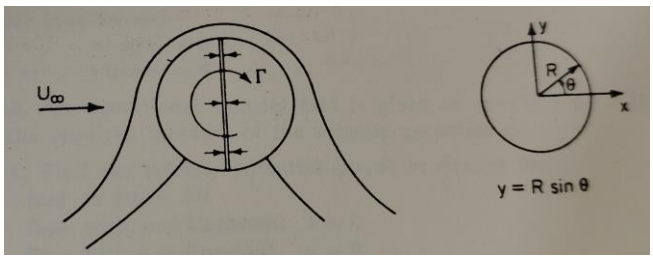
b) Give an examples of irrotational and rotational flows.

13.a) Show that the velocity vector q is everywhere tangent to lines in the x-y plane along which $\psi(x, y) = constant$.

(OR)

b) Verify that the stream function ψ and velocity potential ϕ of a two-dimensional vortex flow satisfies the Laplace equation.

14.a) In figure is shown the flow around a circular cylinder (consisting of two halves) with circulation. Determine the force required to hold the two halves together. The weight of the cylinder is neglected.



(OR)

b) Explain in detail about Superposition of source and Rectilinear Flow in two-dimensional case.

15.a) Water at $20° C$ flows between two large parallel plates at a distance of 1.5 mm apart. If the average velocity is 0.15m/s. Find i) the maximum velocity ii) the pressure drop iii) the wall shearing stress and iv) the frictional coefficient.

(OR)

b) Describe the Boundary layer equations in two-dimensional Flow.

SECTION – C (5 X 8 = 40 MARKS)

ANSWER EITHER (a) OR (b) IN EACH OF THE FOLLOWING QUESTIONS.

(K4 (Or) K5)

16. a) Given the velocity field $q = iAx^2y + jBy^2zt + kCzt^2$, Determine the acceleration of a fluid particle of fixed identity.

(OR)

b) Derive the Navier-Stokes equations of motion of a viscous compressible fluid.

17.a) State and prove Stokes theorem.

(OR)

b) Derive the equation of motion by Euler's equation.

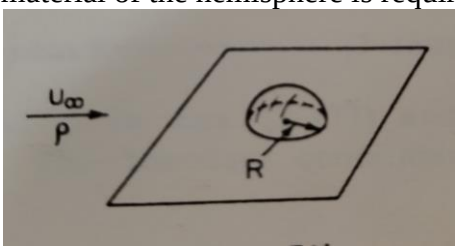
(CONTD……..3)

18. a) Explain in detail about Stream function in Three-Dimensional Motion.

(OR)

b) Show that the velocity potential $\phi = \frac{a}{2}(x^2 + y^2 - 2z^2)$ satisfies the Laplace equation and represents the flow against a fixed plane wall

19. a) A hemisphere lying on a flat plate (not fastened) is shown in the following figure What density of the material of the hemisphere is required in order to keep it staying on the plate?



(OR)

b) Explain in detail about Superposition of source and sink with Rectilinear Flow- The Rankine Body.

20. a) Explain in detail about Flow between Two Concentric Rotating Cylinders.

(OR)

b) Explain in detail about the Boundary Layer along a Flat plate for the Blasius Solution.

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