(NO. OF PAGES: 3)

(FOR THE CANDIDATES ADMITTED DURING THE ACADEMIC YEAR 2022 ONLY)

22PMS415

REG.NO. :

N.G.M.COLLEGE (AUTONOMOUS) : POLLACHI
END-OF-SEMESTER EXAMINATIONS : MAY-2024
COURSE NAME: M.Sc.-MATHEMATICS **MAXIMUM MARKS: 50**
SEMESTER: IV **TIME : 3 HOURS**

FLUID DYNAMICS

SECTION – A (10 X 1 = 10 MARKS)

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

1. Water contains which of the following energies?
   a) Solar energy and nuclear energy b) Thermal energy
   c) Kinetic energy and potential energy d) Geothermal energy
2. Which of the following is NOT a type of force considered in the Navier-Stokes equation?
   a) Gravity force b) Pressure force c) Viscous force d) Surface tension force
3. In which type of fluid flow do particles move along a well-defined path?
   a) Turbulent flow b) Laminar flow c) Steady Flow d) Incompressible flow
4. Which of the following assumption made in the derivation of Bernoulli's equation is incorrect?
   a) The fluid is ideal b) The flow is unsteady
   c) The flow is incompressible d) The flow is irrational
5. The layer of fluid that sticks to a solid surface is called _____.
   a) Boundary layer b) Fluid layer c) Liquid layer d) Solid layer

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

6. Define: Fluid
7. What is Dynamic Pressure?
8. What does a pitot tube measure? Upon which principle does a pitot tube work?
9. A student wishes to find the velocity of air flowing through a pipe. He has a pressure gauge which displays only the dynamic pressure. The pressure gauge reads 0.018 mm Hg. Assume density of air to be 1.225 kg/m^3, find the velocity V of air (ρHg = 13600 kg/m^3).
10. Can the fluid withstand shear force?

SECTION – B (5 X 3 = 15 MARKS)

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

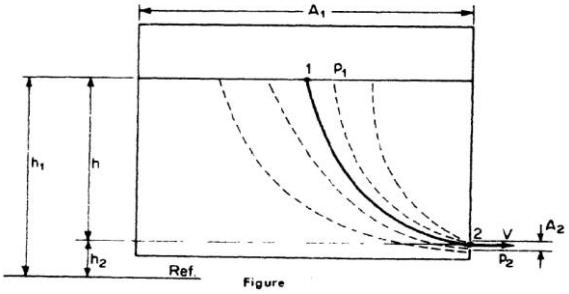
11. a) The velocity vector q is given by $q = ix - jy$. Determine the equation of streamlines.

(OR)

b) Consider the case of simple Couette flow with the velocity and temperature distribution as follows: $u = \frac{Uy}{h}, v = o, p = constant, \frac{T-T_w}{T_\infty - T_w} = \frac{y}{h} + \frac{\mu U^2}{2k(T_\infty - T_w)}\left(\frac{y}{h}\right)\left(1 - \frac{y}{h}\right)$, where T_w and T_∞ are the temp3eratures of the stationary and moving plates and μ, h, k are constants. Verify the above equations are the solution of the energy equation $k\nabla^2 T + \varphi_{(1)} = \rho C_T \frac{\partial T}{\partial t} + \rho C_T q.(\nabla T)$.

(CONTD……2)

12.a) Calculate the velocity of the water jet as shown in the following figure for $p_2 = 14.7\ lb/in^2, p_1 = 30\ lb/in^2, A_2/A_1 = 0.01\ and\ h = 10\ ft.$



Figure

(OR)

b) Calculate the circulation Γ of the circulatory flow $(v_r = v_\theta = 0)$ with the constant velocity $(\Omega_z = const.)$ from both the circulation concept and Stoke's theorem.

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

(OR)

b) Explain Rectilinear Flow.

14.a) Explain shortly the Three – Dimensional Motion – Sphere in a uniform stream.

(OR)

b) In the following figure, the flow around a circular cylinder with circulation. Determine the force required to hold the two halves together. The weight of the cylinder is neglected.

15. a) Determine the maximum value of the velocity profile in the annular space between two coaxial cylinders.

(OR)

b) Explain shortly Boundary Layer Thickness.

SECTION – C (5 X 5 = 25 MARKS)

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

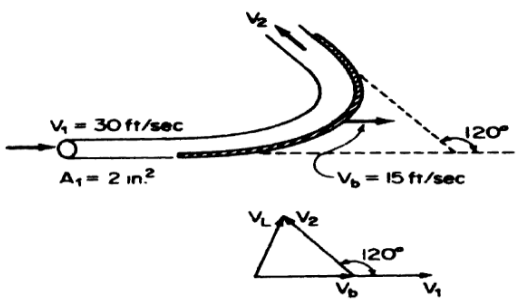
(K4 (Or) K5)

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 Navier – Stokes equations

17.a) Determine the force components due to the water jet for a moving vane of following figure.



(CONTD……3)

(OR)

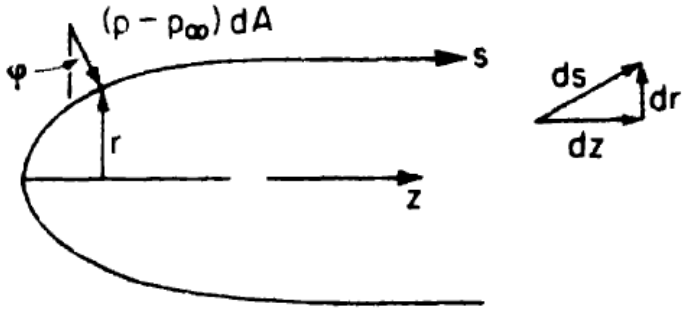
17. b) Explain i) Steady Motion ii) Irrational Flow

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

(OR)

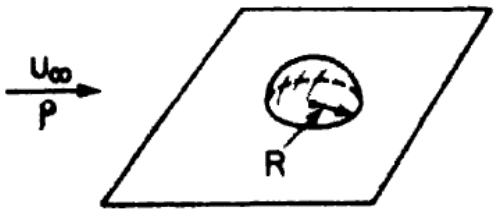
b) Verify that the stream function ψ and velocity potential φ of a three – dimensional doublet flow satisfies the Laplace equation.

19. a) Find a total force on a half streamline body as shown below:



(OR)

b) A hemisphere lying on a flat plate as shown in figure. What density of the material of the hemisphere is required in order to keep it saying on the plate?



20.a) Calculate the average and maximum velocities of the Couette flow between two parallel straight walls.

(OR)

b) Water at $70^{\circ}F$ flows between two large parallel plates at a distance of $\frac{1}{16}$ in apart. If the average velocity if 0.5 ft/sec, find

i) The maximum velocity
ii) The pressure drop
iii) The wall of shearing stress
iv) The fractional coefficient

****