8. (c) Starting with Navier-Stoke's equation of motion of fluid in an electric and magnetic field, show that the original body force is equivalent to two kinds of surface force given by $\frac{\mu H}{4\Pi}(\eta o H)\delta s$ and $\frac{-\mu H^2}{8\Pi}\eta\delta s$ on each surface element δs. 8

(d) Prove that for a perfectly conducting fluid the flux of magnetic field intensity through any closed circuit of fluid particles moving along with the fluid remain constant. 8

UNIT—V

9. (a) Explain Laminar flow and turbulent flow with the help of experiment with Reynold's apparatus, explaining the importance of Reynold's number. 8

(b) Derive the Boundary layer equation in 2-dimensional flow. 8

10. (c) Assuming Navier-Stokes equation of motion for a viscous incompressible fluid. Show that the quantities $\frac{LX}{V^2}, \frac{P}{\rho V^2}, \frac{V}{VL}$ are dimensionless. 8

(d) Explain :

(i) Boundary thickness

(ii) Displacement thickness

(iii) Separations of boundary layer flow.

(iv) Boundary layer. 8

M.A./M.Sc. Part–II (Semester–IV) (CBCS) Examination

MATHEMATICS

(Fluid Dynamics–II)

Paper–404

Time—Three Hours] [Maximum Marks—80

N.B. :— Solve **ONE** question from each unit.

UNIT–I

1. (a) Derive isentropic relations in different forms for the ratios T/T_0, P/P_0, and ρ/ρ_0. Also determine the relations at sonic or critical speeds. 8

(b) Derive $\phi(x,t) = f(x-ct) + g(x+ct)$ which represents the super position of forward and a backward travelling wave each moving with speed c. Hence, find the profile $\phi(x,t)$ of a one dimensional wave propagation if at $t = 0$, $\phi = F(x)$, $\frac{\partial\phi}{\partial t} = \ell_1(x)$. 8

2. (c) Describe a simplified model explaining shock formation in the tube with a piston. Show that if each small disturbance propagates itself at a velocity equal to the local speed of sound relative to the fluid and fluid moves with velocity u then show that velocity of propagation of disturbance $= u + a = a_0 + \frac{1}{2}(r+1)u$. 8

(d) Derive wave equation in three dimensions. Hence derive, $\phi(r, t) = \left(\frac{1}{r}\right) \{f(r-ct) + g(r+ct)\}$. 8

UNIT–II

3. (a) In a viscous fluid motion, explain rate of dilation Δ.

Deduce equations that line principal stresses with principal rates of strain in each case when fluid is incompressible and compressible. 8

(b) Explain stress matrix. Hence find the equations of the translational motion of fluid element taking into account of surface forces and body forces in $\hat{i}, \hat{j}, \hat{k}$ directions. 8

4. (c) Explain the coefficient of viscosity and Laminar flow. 8

(d) Show that the stress matrix is diagonally symmetric. 8

UNIT–III

5. (a) Obtain Navier-Stokes equations of motion of a viscous fluid. Compare the equation of motion in case of incompressible flow with the Euler's equation of motion in inviscid flow. 8

(b) For an incompressible viscous fluid flow, if the body forces are conservative, then for vorticity vector $\xi, \frac{d\xi}{dt} = (\xi.\nabla)q + \nu\nabla^2\xi$ and ξ decays rapidly with time. Prove this. 8

6. (c) Consider a tube having uniform elliptic cross-section. Determine expression W(x,y) and hence show that y = the volume discharged through the tube per unit time $= \frac{\Pi P a^3 b^3}{4\mu(a^2+b^2)}$, where the cross-section of the tube has equation $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$, when a = b. 8

(d) Show that in a steady flow through a tube of uniform circular cross section the velocity profile is parabolic. 8

UNIT–IV

7. (a) Determine equation of motion of a conducting fluid and also determine an equation expressing the rate of flow of charge moving along with the fluid. 8

(b) Prove, Ferraro's law of isorotation which states that the angular velocity is constant over a magnetic stream surface when the star is rotating steadily about its axis of symmetry. 8

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