Roll No. : .....

Total No. of Questions : **11**] [Total No. of Printed Pages : **3**

APF–2171

M.A./M.Sc. (Final) Examination, 2022

MATHEMATICS

Paper - Opt.-IV

(Fluid Dynamics)

*Time : **3** Hours*] [*Maximum Marks : **100***

Section–A **(Marks : 2 × 10 = 20)**

Note :– Answer all *ten* questions (Answer limit **50** words). Each question carries **2** marks.

Section–B **(Marks : 4 × 5 = 20)**

Note :– Answer all *five* questions. Each question has internal choice (Answer limit **200** words). Each question carries **4** marks.

Section–C **(Marks : 20 × 3 = 60)**

Note :– Answer any *three* questions out of five (Answer limit **500** words). Each question carries **20** marks.

Section–A

1. (i) Write the statement of Bernoulli's theorem.

   (ii) Define Path Line.

   (iii) Define Complex Potential.

   (iv) Define Doublets.

(v) Define Reynold's Number.

(vi) Explain plane couette flow.

(vii) Define flow in convergent channels.

(viii) Explain Stokes' second problem.

(ix) Write the Oseen's equation.

(x) Write the Stokes' equation.

Section–B

2. If the lines of motion are curves on the surface of cones having their vertices at the origin and the axis of z for the common axis, prove that the equation of continuity is :

$$\frac{\partial p}{\partial t}+\frac{\partial(\rho u)}{\partial r}+\frac{2\rho u}{r}+\frac{\text{cosec }\theta}{r}\frac{\partial(\rho w)}{\partial \phi}=0$$

Or

Show that :

$$\frac{x^2}{a^2}\tan^2 t+\frac{y^2}{b^2}\cot^2 t=1$$

is a possible from of the bounding surface of a liquid and find an expression for the normal velocity.

3. Find the lines of flow in the two-dimensional fluid motion given by :

$$\phi+i\psi=-\frac{1}{2}n(x+iy)^2 e^{2int}$$

Prove that the paths of the particle of the fluid may be obtained by eliminating t from the equation :

$$r\cos(nt+\theta)-x_0=r\sin(nt+\theta)-y_0=nt(x_0-y_0)$$

Or

An elliptic cylinder, the semi-axes of whose cross-section are a and b, is moving with velocity u parallel to the major axis of the cross-section, through an

infinite liquid of density ρ which is at rest at infinity the pressure there being II. Prove that in order that pressure may everywhere be positive :

$$\rho u^2 < \frac{2a\Pi}{(2ab + b^2)}$$

4. Obtain relation between stress and rate of strain components.

Or

Derive Navier-Stokes' equation for the motion of a viscous compressible fluid.

5. Write the short note on stagnation point flows.

Or

Discuss flow due to a plane wall suddenly set in motion.

6. Discuss Oseen's flow past a sphere.

Or

Discuss Stokes' flow past a sphere.

Section–C

7. Derive the Cauchy's integrals.
8. Obtain image of a source with respect to a circle in two dimensions.
9. Explain velocity distribution and temperature distribution for Hagen-Poiseuille flow.
10. Discuss flow due to a rotating disc (Kármán flow).
11. Explain Lubrication theory.