Printed Pages – 4

I-1056

M.A./M.Sc. (Final) Examination, 2020

MATHEMATICS

(Optional-VI)

(Fluid Mechanics)

Time Allowed : Three Hours

Maximum Marks : 100

Minimum Pass Marks : 36

Note : Attempt any five questions. All questions carry equal marks.

Q. 1. (a) The velocity components for a two dimensional fluid system can be given in the Eulerian system by U = 2x + 2y + 3t, V = x + y + $\frac{1}{2}$t. Find the displacement of a fluid partical in the lagrangian system.

(b) Derive the equation of continuity in cylindrical co-ordinates.

Q. 2. (a) Show that $\frac{x^2}{a^2}\tan^2 t+\frac{y^2}{b^2}\cot^2 t=1$ is a possible form for the bounding surface of a liquid and find an expression for the normal velocity.

(b) Derive the Lagrange's equation.

Q. 3. (a) State and prove that Bernoulli's theorem (due to steam line).

(b) To prove that any relation of the form w = f(z) where w = ϕ + iψ and z = x + iy, represents a two dimensional irrotational motion, in which the magnitude of velocity is given by :

$$\left|\frac{dw}{dz}\right|=\sqrt{u^2+v^2}$$

Q. 4. (a) State and prove that the Milne : Thomson circle theorem.

(b) What is the use of conformal transformation.

Q. 5. (a) Derive the kinetic energy.

(b) Derive the equation of motion of circular cylinder with circulation.

Q. 6. (a) Define Stoke's steam function $\psi(r, \theta)$ in spherical polar co-ordinates.

(b) Find the stream functions $\psi(x, y, t)$ for the given velocity field V = Ut, v = x.

Q. 7. State and prove that Blasius theorem.

Q. 8. Describe the Navier-Stokes equation.

Q. 9. (a) What is normal-strain and shearing-strain.

(b) Consider a rectangular flow $q = \{0, 0, \phi(x_1, x_2)\}$ of an isotropic in compressible fluid. Show that the strain rate tensor has non zero components as :

$$\epsilon_{13} = \epsilon_{31} = \frac{1}{2}\frac{\partial \phi}{\partial x_1}$$

$$\epsilon_{23} = \epsilon_{32} = \frac{1}{2}\frac{\partial \phi}{\partial x_2}$$