PG – 653

III Semester M.Sc. Degree Examination, Dec. 2016
(Y2K11) (RNS) (Repeaters)
MATHEMATICS
M 304 : Fluid Mechanics

Time : 3 Hours Max. Marks : 80

Instructions : *Answer **any five** questions. Choosing atleast **two** from Part – **A** and **B** and **one** from Part – **C**.*

PART – A

1. a) Stating the assumptions made, establish the following :
   i) Permanence of irrotational motion and
   ii) Vortex lines move with the fluid. **10**

   b) Derive the general equation of impulsive motion and hence deduce that the motion generated from rest by the impulsive pressure only is irrotational. **6**

2. a) Show that $w = Uz + m\ln(z) - m\ln(z - z_0)$ represents a system with a uniform flow, a sink of strength m at $z = 0$ and a source of strength m at $z = z_0$. **8**

   b) Obtain the complex potential of a flow system comprising of a source of strength m at $z = \varepsilon$ and a sink of strength m at $z = -\varepsilon$. **8**

3. a) Discuss the flow whose complex potential is given by $w = \frac{ik}{2\pi}\ln(z)$, (k : constant). **5**

   b) Verify whether the complex potential of the image system of $w = \frac{ik}{2\pi}\ln(z + a)$ is $w = \frac{-ik}{2\pi}\ln(z - a)$. **5**

   c) State and prove Blasius theorem. **6**

P.T.O.

PART – B

4. Obtain the velocity distribution for Plane-Poiseuille and Hagen-Poiseuille flows. **16**

5. a) Discuss the slow and steady flow of an incompressible viscous fluid past a fixed rigid cylinder. **9**

   b) Show that the vorticity diffuses very rapidly for an unsteady motion of an incompressible viscous fluid which are in circles with centers on the z-axis. **7**

6. a) Obtain expression for the rate of energy dissipation due to viscosity in the form $W = \mu \int \omega^2 dv$, where the quantities have their usual meaning. **5**

   b) Explain the concept of boundary layer. Derive the Blasius equation for a two-dimensional Prandtl boundary layer. **11**

PART – C

7. a) Define Reynolds number and use it to classify flows into laminar, transition and turbulence regions. **5**

   b) Starting from the Navier-Stokes equation with no body forces and using Reynolds decomposition show that turbulence leads to additional stresses. **7**

   c) Discuss the K-model of closure of the turbulence equations. **4**

8. a) Derive the wave equation that represents sound waves in a gas. **6**

   b) Derive the equations of conservation of mass and linear momentum for compressible fluid flow. **10**