



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 **at least 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 10
 - ii) Vortex lines move with the fluid.
- 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



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**
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