PG – 145

III Semester M.Sc. Degree Examination, December 2014
(NS)
MATHEMATICS
M – 304 : Fluid Mechanics

Time : 3 Hours Max. Marks : 80

***Instructions** : 1) Answer **any five** questions choosing atleast **one** from **each** Part.*
*2) **All** questions carry **equal** marks.*

PART – A

1. a) With usual notations, derive the Helmholtz vorticity equation in the form $\frac{D}{Dt}\left(\frac{\overline{\omega}}{\rho}\right)=\left(\frac{\overline{\omega}}{\rho}\cdot\nabla\right)\overline{q}$. Hence deduce that $\frac{\overline{\omega}}{\rho}$ = constant for two-dimensional flows. **8**

   b) State and prove Kelvin's minimum energy theorem. **8**

2. a) Discuss the flow for which the complex potential is given by w = f(z) = $\frac{\mu}{z}$. **8**

   b) Obtain the complex potential for a uniform flow that is incident at an angle 'α' to the x-axis. **8**

3. a) State and prove Milne-Thomson circle theorem. **11**

   b) Find the potential and stream functions for a uniform flow of a Newtonian, incompressible liquid in the presence of a stationary cylinder of radius 'a'. **5**

PART – B

4. a) Derive the energy equation for an incompressible viscous fluid in the form

   $(\rho C_v)\frac{DT}{Dt}=K\,\nabla^2 T+\bar{\phi}+Q$ where the quantities have their usual meaning. **11**

   b) Obtain velocity distribution for plane Poiseuille flow. **5**

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5. a) Explain briefly Stokes' first and second problems. **4**

b) Obtain the velocity distribution for steady flow of an incompressible viscous fluid between two concentric rotating cylinders. **12**

6. a) Explain the concept of boundary layer. Derive Von Karman's integral equation in its usual form. **10**

b) Write a short note on : **6**

i) Prandtl number

ii) Reynolds number

iii) Dimensional analysis.

PART – C

7. a) Define Mach number and using the same discuss the classification of flows into subsonic, transonic, supersonic, sonic and hypersonic flows. **8**

b) Derive the equation of conservation of mass for a viscous, compressible fluid. **8**

8. a) Explain the following in brief :

i) Reynolds stress

ii) Homogeneous turbulence

iii) Isotropic turbulence. **8**

b) Starting from the Navier – Stokes equation for an incompressible viscous fluid in the absence of body forces, derive the equation of motion for a turbulent flow. Use the gradient-diffusion model for closure. **8**