

[5060]-551

M.E. (Civil) (Water Resources and Environmental Engg)

FLUID MECHANICS

(2013 Pattern)

Time : 3 Hours]

[Max. Marks : 50

Instructions to the candidates:

- 1) Answer any five questions
- 2) Neat diagrams must be drawn wherever necessary
- 3) Figures to the right indicate full marks
- 4) Use of logarithms tables, slide rule, electronics pocket calculator is allowed
- 5) Assume suitable data if necessary

**Q1)** a) Prove that circulation per unit area is equal to twice the rotation about axis perpendicular to the plane of the area. [5]

b) Define nominal thickness, displacement thickness, momentum thickness, energy thickness of boundary layer and laminar sub-layer. [5]

**Q2)** a) Derive continuity equation for steady flow of incompressible fluid passing through a stream tube. [4]

b) The velocity distribution in the turbulent boundary layer over a flat plate

is given as  $\frac{u}{U_\infty} = 2 \frac{y}{\delta} - \left( \frac{y}{\delta} \right)^2$ . Obtain an expression for the displacement thickness, momentum thickness and energy thickness. [6]

**Q3)** a) Derive differential form of continuity equation in cylindrical polar coordinate system. [6]

b) Oil of viscosity 18 poise flows between two parallel plates which are kept at a distance 150 mm apart. The maximum velocity of flow is 1.5 m/s. Find (i) The pressure gradient (ii) Shear stress at the wall. [4]

**Q4)** a) What is conformal mapping? Give complex potential for (i) source at  $Z=a$  and (ii) source and sink. For uniform flow find velocity potential and stream function for Uniform flow using complex potential as  $w = AZ$  with  $A$  as real. [5]

b) Derive equation for velocity distribution for flow between parallel plates with one plate moving and the other at rest starting with Navier-Stokes equations. [5]

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- Q5)** a) What is boundary layer separation? What are its effects and how to control it? [5]  
b) Derive Reynolds' equation of motion. [5]
- Q6)** a) Derive equation for boundary layer starting from Navier-Stokes equation. [6]  
b) Write a short note on types of turbulent flow. [4]
- Q7)** a) Derive energy equation for adiabatic process. [5]  
b) Discuss the analogy between the normal shock wave and the hydraulic jump. [5]
- Q8)** a) Derive equation for stagnation density. [5]  
b) What is the effect of compressibility on drag. [5]

