Roll No. .....

(05/19-I)

11662

M. Sc. (2 Year) EXAMINATION

(For Batch 2017 & Onwards)

(Third Semester)

MATHEMATICS

MTHCC-2302

Fluid Mechanics

Time : Three Hours *Maximum Marks :* 70

Note : Attempt *Five* questions in all including Q. No. **1** which is compulsory. Select *one* question from each Unit. All questions carry equal marks.

1. (a) Define source, sink and doublet.

   (b) Define velocity potential function for fluid flow.

(c) Discuss Lagrangian and Eulerian approach in fluid flow.

(d) Define stress at a point in the fluid and principal stress.

(e) Define viscosity of a fluid its dimension and role in the fluid flow.

(f) Discuss the differences between Couette flow and Poiseuille flow.

(g) Define Newton's law of viscosity and discuss :

(i) Newtonian fluid

(ii) Incompressible fluid

(iii) Non-Newtonian fluid.

Unit I

2. (a) State and prove Reynold's transport theorem.

(b) Derive equation of continuity in polar coordinates and hence deduce the condition for the incompressible fluid.

3. (a) A velocity field pin a particular flow is given by $\vec{q} = 2xy^2\hat{i} - 9xy^2\hat{j}$. Calculate the acceleration, the angular velocity, the vorticity vector and any non-zero rate of strain components at the point (1, –1, 2).

(b) Show that $\frac{x^2}{a^2}\tan^2 t + \frac{y^2}{b^2}\cot^2 t - 1 = 0$, where t is time, is a possible form of boundary surface and find an expression for normal velocity.

Unit II

4. (a) Define circulation and vorticity. Using Euler's equation derive equation of and explain its advantage.

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

5. (a) Define uniqueness theorem of kinetic energy of liquid.

(b) Derive Bernoulli's equation for the steady flow of an ideal fluid subject to conservative body forces.

Unit III

6. (a) Derive Navier-Stoke's equations of motion for viscous incompressible fluid flow.

   (b) Derive constitutive equation for an isotropic Newtonian Fluid Flow.

7. (a) Prove that stress tensor is a symmetric tensor.

   (b) Discuss viscous dissipation of energy. Also, explain the viscous dissipation is zero only when there is no deformation of fluid element.

Unit IV

8. (a) Find velocity profile and volume flow rate through a cylinder of uniform cross-section of elliptice shape.

   (b) Find velocity expression and volume flow rate through a circular annulus.

9. (a) Derive velocity and volume flow rate of viscous incompressible fluid flow through a tube of uniform triangular cross-section.

   (b) Find exact solution of the Navier-Stoke's equation in case of generalized Couette flow and Plane Poiseuille flow.