PB **5721**

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M.A. / M.Sc. (Semester-IV) Examination - June - 2026
Mathematics
Paper - MATH 402
Fluid Dynamics-II

Time Allowed: Three Hours Max. Marks: 100

This question paper contains two sections as under :

Section-A **Max. Marks-20**

This section will have 10 questions, having 02 questions from each unit with no internal choice. Answer in about 20 words. All questions will have equal marks. (2×10=20)

Section-B **Max. Marks-80**

This section will have 10 questions, having 02 questions from each unit, one question to be attempted from each unit. Words limit approximately 400-500 words. Questions may have sub divisions. All questions will have equal marks. (16×5=80)

Section-A

1. (i) Define vortex tube.
   (ii) Define Stoke's stream function.
   (iii) Define Newtonian fluids.
   (iv) Define rate of strain.
   (v) Define dynamical similarity.
   (vi) Define drag and lift coefficients.
   (vii) Define exact solution of Navier-Stoke's equations.
   (viii) Define Laminar flow.
   (ix) Define boundary layer.
   (x) What is displacement thickness?

Section-B

Unit-I

2. Show that the product of the angular velocity of any vortex into its cross-section is constant with respect to the time, and is the same throughout its length.

OR

Determine the velocity potential for the motion of sphere in an infinite mass of liquid at rest at infinity.

Unit- II

3. Prove the symmetry of stress tensor for fluid motion.

OR

Derive the Navier-Stoke's equations of motion for a viscous fluid in cylindrical coordinates.

4. Unit – III

Write short note for the following :

a) Froude number 6

b) Reynolds number 5

c) Mach number 5

OR

State and prove Buckingham's π theorem.

5. Unit- IV

Derive the velocity distribution for the flow between parallel plates for plane poiseuille flow. Also determine maximum velocity, average velocity, shearing stress and frictional coefficient for this flow.

OR

Derive the velocity distribution for the flow through a circular pipe for Hagen-Poiseuille flow. Also determine maximum velocity, average velocity, shearing stress and frictional coefficient for this flow.

6. Unit- V

Derive Karman's integral condition and deduce that

$$\frac{To}{\rho}=\frac{\partial}{\partial t}\int_0^{\delta}(U-u)\,dy+\frac{\partial}{\partial x}\int_0^{\delta}(U-u)\,u dy+\left(\frac{\partial U}{\partial x}\right)\int_0^{\delta}(U-u)\,dy$$

OR

For a velocity distribution in a boundary layer

$$\frac{u}{U}=\alpha+\beta\left(\frac{y}{\delta}\right)+\gamma\left(\frac{y}{\delta}\right)^2+\in\left(\frac{y}{\delta}\right)^3$$

Determine the constants $\alpha,\beta,\gamma,\in$. Also, find displacement thickness and the skin friction coefficient.

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