Register number:

Date and session:

ST JOSEPH'S UNIVERSITY, BENGALURU-27
M.Sc (MATHEMATICS) - IV SEMESTER
SEMESTER EXAMINATION: April 2024
(Examination conducted in May/June 2024)

MT 0222: FLUID MECHANICS

(For current batch students only)

Duration: 2 Hours **Max. Marks:** 50

1. The paper contains **TWO** printed pages and **ONE** part.
2. Attempt any **FIVE FULL** questions, each carrying 10 marks.

1. a) State Bernoulli's theorem for a fluid flow, along with its assumptions made.
   b) Water is flowing through a pipe having diameter $300mm$ and $200mm$ at the bottom and upper end respectively. The intensity of pressure at the bottom end is $24.525N/cm^2$ and the pressure at the upper end is $9.81N/cm^2$. Determine the difference in datum head if the rate of flow through pipe is $40lit/sec$. (3+7)

2. a) Obtain the Laplace equation for fluid flow. Also, show that the velocity potential is irrotational.
   b) Describe source and sink for a $2-D$ flow. (5+5)

3. Obtain the mass flow rate expression for a plane Poiseuille flow.

OR

   a) Check the dimensional homogeneity of the equation $\frac{p}{\rho}+\frac{q^2}{2g}+z=constant$ and write the different laws on which models are designed for geometric similarity.
   b) Show that an equation in physical variables which is dimensionally homogeneous, can be reduced to a relationship among a complete set of dimensionless products. [4+6]

4. a) Define and derive the expression for Mach number and Prandtl number.
   b) The viscous force F_D exerted by the fluid on a sphere of diameter D depends on the viscosity μ, mass density of the fluid ρ and velocity of the sphere U. Show that the drag co-efficient $C_D=\frac{F_D}{\rho U^2 D^2}$ is a function of Reynolds's number, using $\pi-$ theorem. (4+6)

5. a) Explain the adiabatic and isothermal boundary conditions.
   b) Discuss the stability of the system given by $\frac{d^2U}{dx^2}-3R\frac{dU}{dt}+5U=0$ where R is a non-dimensional number. [4+6]

6. Derive the non dimensional set of equations for a Rayleigh Bènard problem, that includes the solution of both basic and perturb state.
7. Derive the Prandtl boundary layer equations for an incompressible viscous fluid over a flat surface.

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