ST. JOSEPH'S COLLEGE (AUTONOMOUS), BENGALURU-27
M.Sc. MATHEMATICS - IV SEMESTER
SEMESTER EXAMINATION: APRIL 2022
(Examination conducted in July 2022)
MTDE0418-FLUID DYNAMICS

Time- 2 ½ hrs   Max Marks-70
This question paper contains TWO printed pages

Answer any <u>SEVEN</u> full questions. Each carrying 10 marks.

1. a) The water is flowing through a taper pipe of length $100m$ having diameters $600mm$ at
      the upper end and $300mm$ at the lower end, at the rate of 50 $litres/s$. The pipe has a
      slope of 1:30. Find the pressure at the lower end if the pressure at the higher level
      is 19.62 N/cm^2.

    b) Discuss the motion given by the complex potential $w = \frac{Ua^2}{z}$ (U and a are constant).
      Obtain the stream and potential function of the flow. Sketch the stream lines.   (6+4)

2. a) Find the complex potential of a system that has source strength m at $z = \pm a$ and
        hence find the stream function.

    b) State Blasius theorem and drive the expression for force.   (3+7)

3. Derive the expression for velocity distribution for a flow between two concentric rotating
    cylinder. Also, deduce the velocity expression for the flow inside and outside a rotating
    cylinder of an infinite length.   (10)

4. a) Find the velocity distribution expression for a plane Couette flow.

    b) Describe the boundary condition:
        (i) on temperature, where the temperature remains constant at the boundaries.
        (ii) on velocity for boundaries that are rigid.   (6+4)

5. a) For a linearized system, write a note on normal mode analysis.

    b) State and prove Fjortoft's theorem.   (7+3)

6. a) What is the difference between thermodynamics and heat transfer?

   b) Explain the laws that governs the heat transfer. (4+6)

7. a) The efficiency η of a fan depends on: the density ρ, the dynamic viscosity of the
      fluid μ, the angular velocity ω, diameter of the rotor D and the discharge Q. Express η
      in terms of dimensionless parameters.

   b) Water is flowing through a pipe of diameter 30 cm at a velocity of 4 m/s. Assuming the
      dynamic similarity is satisfied between the two pipes, find the velocity of oil flowing in
      another pipe of diameter 10 cm. The viscosity of water and oil is given as 0.01 poise
      and 0.025 poise. (The specific gravity of oil is 0.8) (5+5)

8. a) State and prove Buckingham's π-theorem.

   b) The pressure difference Δp in a pipe of diameter D and length l due to viscous flow
      depends on the velocity V, viscosity μ and density ρ. Using Buckingham's π-theorem,
      obtain an expression for Δp. (4+6)

9. Assuming that the principle of exchange of stability is valid for a Rayleigh Bènard
   convection, discuss the different boundary combination involved in the boundary
   conditions. Also, derive the analytical solution for free-free, isothermal case. (10)

10. Derive Orr-Sommerfeld equation for a parallel flow. (10)