VIT
Vellore Institute of Technology

Course: BMEE204L - Fluid Mechanics and Machines
Class NBR(s): 2047 / 2048 / 2049 / 2050 / 2051
Time: Three Hours
Slot: D1+TD1
Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instruction: Use of Moody's chart is permitted

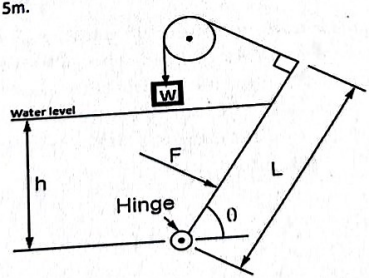
COs	CO Statements
CO1	Demonstrate the significance of fluid properties and laws of fluid statics to engineering systems.
CO2	Describe the flow fields using Lagrangian and Eulerian approaches.
CO3	Formulate suitable governing equations to solve fluid flow problems.
CO4	Analyse the viscous flow through pipes and determine various losses.
CO5	Perform dimensional analysis of various flow problems.
CO6	Apply the boundary layer concept and predict the flow separation.
CO7	Analyse the performance of hydraulic pumps and turbines.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions
(10 X 10 = 100 Marks)

1. Two spheres, one heavier and weighing 12000 N and of diameter 1.2 m and the other lighter and weighing 4000 N, are tied with a rope and placed in water. It was found that the spheres floated vertically with the lighter sphere just submerging. Determine the diameter of the lighter sphere and the tension in the rope. CO1 BL3

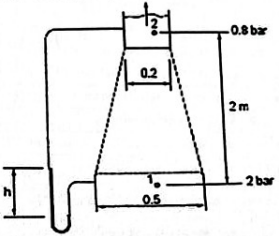
2. A rectangular gate 5 m x 2 m is hinged at its base and inclined at 60° to the horizontal. To keep the gate in a stable position, a counterweight of 50 kN is attached at the upper end of the gate. Find the depth of water (h) at which the gate begins to fall. Neglect the weight of the gate and friction at the hinge and pulley. Take L, 5m. CO1 BL4



3. Given that $u = x^2 - y^2$ and $v = -2xy$, determine the stream function and potential function for the flow. CO2 BL3

4. In a 45° bend of a rectangular air duct of 1 m^2 cross-sectional area is gradually reduced to 0.5 m^2 area. Find the magnitude and direction of the force required to hold the duct in position if the velocity of flow at the 1 m^2 section is 10 m/s. and pressure is 2.943 N/cm^2. Take density of air as 1.16 kg/m^3 CO3 BL4

5. Calculate the flow rate of oil (sp. gravity, 0.8) in the pipeline. Also calculate the reading "h" shown by the differential manometer fitted to the pipeline which is filled with mercury of specific gravity 13.6. CO3 BL4



6. A fluid of viscosity 0.7 Ns/m^2 and specific gravity 1.3 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is given as 196.2 N/m^2, determine the following parameters: CO4 BL4

   i. The pressure gradient,
   ii. The average velocity and
   iii. Reynolds number of the flow.

7. Obtain on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that the thrust P depends upon the angular velocity ω, speed of advance V, diameter D, dynamic viscosity μ, mass density ρ, elasticity of the fluid medium which can be denoted by the speed of sound in the medium C. CO5 BL3

8. A ship 300 m long moves in sea water, whose density is 1030 kg/m^3. A 1:100 model of this ship is to be tested in a wind tunnel. The velocity of air in the wind tunnel around the model is 30 m/s and the resistance of the model is 60 N. Evaluate the velocity of ship in sea water and also the resistance of the ship in sea water. The density of air is given as 1.24 kg/m^3. Take the kinematic viscosity of sea water and air as 0.012 stokes and 0.018 stokes. CO5 BL4

9.a) Ascertain the displacement thickness, momentum thickness, and energy thickness for the velocity profile in the boundary layer expressed as follows: CO6 BL4

$$\frac{u}{U} = \frac{2y}{\delta} - \frac{y^2}{\delta^2}$$

OR

9.b) The velocity profile for laminar boundary layer is given by, CO6 BL4

$$\frac{u}{U} = \frac{2y}{\delta} - \frac{2y^3}{\delta^3} + \frac{y^4}{\delta^4}$$

obtain an expression for boundary layer thickness, shear stress, drag force on one side of the plate and co-efficient of drag in terms of Reynolds number.

10.a) Pelton Wheel is working under a gross head of 400 m. The water is supplied through penstock of diameter 1 m and the length 4 km from reservoir to the Pelton wheel. The co-efficient of friction for the penstock is given as 0.008. The jet of water of diameter 150 mm strikes the buckets of the wheel and gets deflected through an angle of 165°. The relative velocity of water at outlet is reduced by 15% due to friction between inside surface of the bucket and water. If the velocity of the buckets is 0.45 times the jet velocity at inlet and mechanical efficiency as 85%, determine: CO7 BL4

i. Power given to the runner

ii. Shaft power

iii. Hydraulic efficiency and overall efficiency

OR

10.b) A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 rpm, works against a total head of 40 m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of 40° at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50 mm. Determine the following parameters: CO7 BL4

(i) Vane angle at inlet,

(ii) Work done by impeller on water per second, and

(iii) Manometric efficiency.

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