CBCS SCHEME

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18CV33

Third Semester B.E. Degree Examination, June/July 2025
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Distinguish between :
i) Kinematic viscosity and dynamic viscosity with units.
ii) Ideal fluid and real fluid with examples. **(06 Marks)**

b. The dynamic viscosity of oil used for lubrication between a shaft and a sleeve is 6 poise. The shaft is of diameter 0.4 m and rotates at 190 rpm. Compute the power lost in the bearing for a sleeve length of 90 mm. Take the thickness of oil film as 1.5 mm. **(06 Marks)**

c. A U-tube differential manometer is connected between two pipes X and Y. Pipe X contains a fluid of specific gravity 1.6 under a pressure of 103 kPa (gauge) and pipe Y contains oil of specific gravity 0.8 under a pressure of 172 kPa (gauge). Centerline of pipe X is 2.5 m above the centerline of pipe Y. The level of mercury in the limb connected to pipe X is in level with centre of pipe Y. Estimate the manometer reading. Sketch the arrangement. Comment on why mercury is used in manometers? **(08 Marks)**

OR

2 a. State and deduce hydrostatic pressure law. **(06 Marks)**

b. Derive the expression for the capillary rise/fall of a liquid. Compute the capillary effect in a glass tube of 4 mm diameter when immersed in i) Water, ii) Mercury. Take $\sigma_w = 0.075$ N/m, $\sigma_{Hg} = 0.52$ N/m in contact with air, $\theta = 0°$ for water and 130° for mercury. **(06 Marks)**

c. State and explain Newtons law of viscosity with a sketch. A liquid has a dynamic viscosity of 0.035 stoke. Compute its specific gravity and specific weight. **(08 Marks)**

Module-2

3 a. Distinguish between:
i) Uniform flow and non-uniform flow with examples.
ii) Streamlines and equipotential lines with a sketch. **(06 Marks)**

b. The potential function for a 2D flow is, $\phi = x^2 - y^2$, verify that the flow is irrotational and determine the corresponding stream function. **(06 Marks)**

c. A circular gate in a vertical wall has 4 m diameter. The water surface on the upstream side is 8 m above the top of gate and on downstream side 1 m above the top of gate. Compute the resultant force on the gate and its location. The gate is hinged at the bottom. Sketch the diagram. **(08 Marks)**

OR

4 a. Discuss the procedure of finding the total pressure acting on a curved surface immersed in a liquid. **(06 Marks)**

b. A fluid flow is described by, $\vec{v} = (x^2y)i + (y^2z)j - (2xyz + yz^2)k$. Deduce that it represents a possible case of steady incompressible flow. Compute the velocity and acceleration at the point (2, 1, 3). **(06 Marks)**

c. Define potential function and stream function. The velocity components in a 2D flow are given by; u = xy, $v = \frac{1}{2}(x^2 - y^2)$. Arrive at the potential function and stream function for the flow. **(08 Marks)**

Module-3

5 a. Discuss Bernoulli's energy equation with a sketch. Comment on its limitations in applying for solving fluid flow problems. **(06 Marks)**

b. A pipe 300 m long having a gradient of 1 in 100 tapers from 1.2 m diameter at the higher end to 0.6 m diameter at the lower end. The rate of flow of water in the pipe is 5.4 m^3/minute. If the pressure at the higher end is 70 kPa, determine the pressure at the lower end. Neglect losses. Indicate the direction of flow. **(06 Marks)**

c. A venturimeter is to be fitted in a 200 mm diameter horizontal pipeline. The inlet pressure is 100 kPa. If oil is flowing through the pipeline with maximum discharge of 200 litres/second and specific gravity 0.85, compute the least diameter of the throat so that the pressure does not fall below 250 mm of mercury (vacuum). Assume that 3% of differential head is lost between the inlet and throat. Sketch the arrangement. **(08 Marks)**

OR

6 a. Deduce the Euler's equation of motion along a streamline. Hence arrive at the Bernoulli's equation. **(06 Marks)**

b. In a smooth pipe of uniform diameter 250 mm a pressure of 50 kPa was observed at a section 'A' at an elevation of 10.0 m. At another section 'B' at an elevation of 12.0 m, the pressure was 20 kPa. The velocity of water in the pipe was 1.25 m/sec. Compute the loss of head between the sections 'A' and 'B'. Indicate the direction of flow. **(06 Marks)**

c. Derive the discharge equation for a pitot tube. A pitot tube is inserted in a pipe of 300 mm diameter. The static pressure at the center of the pipe is 100 mm of mercury (vacuum). The stagnation pressure measured by the tube is 98.1 kPa. Compute the discharge in the pipe, if the mean velocity is 85% of central velocity. Take the coefficient of tube as 0.98. **(08 Marks)**

Module-4

7 a. Distinguish between :
   i) Orifice and mouthpiece.
   ii) Broad crested weir and submerged weir.
   iii) Small orifice and large orifice. **(06 Marks)**

b. The head of water over an orifice of diameter 10 cms is 10 m. Water coming out of orifice is collected in a circular tank of 1.5 m diameter. The water level rises by 1 m in 25 seconds in the tank. The coordinates of a point on the jet, measured from the vena contracta are (4.3 m, 0.5 m). Estimate the hydraulic coefficients of the orifice. Comment on their values. **(06 Marks)**

c. A flow from a channel is controlled by a trapezoidal notch so that the full supply discharge of 2.0 m^3/sec flows over the notch at a head of 1.2 m, measured over the crest. At half the head, the discharge was found to be 0.6 m^3/sec. Taking $C_d = 0.62$, Compute the base width and side-slope of the notch. Sketch the notch. **(08 Marks)**

OR

8 a. i) Compare triangular notch with rectangular notch.
ii) Discuss the importance of ventilation of weirs. **(06 Marks)**
b. Deduce the discharge equation for a large rectangular orifice. **(06 Marks)**
c. With a sketch, enumerate the salient features of a Cipoletti notch. A sharp crested cipoletti weir of crest length 60 cm is fitted in a rectangular channel of 1 m wide and 0.5 m deep. If the water level in the channel is 22.5 m above the weir crest, compute the discharge over the weir, considering the velocity of approach. Take $C_d = 0.62$. **(08 Marks)**

Module-5

9 a. Distinguish between: (with sketches)
i) Pipes in series and pipes in parallel.
ii) Hydraulic gradient line and energy gradient line in pipe flow. **(06 Marks)**
b. A reservoir discharges water through a horizontal pipeline into atmosphere. The pipeline consists of two pipes, one of 10 cm diameter and 25 m long and another 12 cm diameter and 35 m long, connected in series. The friction factor f = 0.02 for both the pipes. The water level in the tank is 10 m above the centre line of the pipe at the entrance. Considering all the minor losses, compute the discharge when the 10 cm diameter pipe is connected to the tank. **(06 Marks)**
c. Explain the concept of water hammer in pipes. A steel penstock 60 cm in diameter has a shell thickness of 12 mm. Modulus of elasticity of shell material is 210 GPa and bulk modulus of elasticity of water is 2.1×10^3 MPa. The pipe is designed to discharge water at a mean velocity of 2.1 m/sec. Compute the water hammer pressure rise caused due to sudden closure of a value at the downstream end by treating the pipe as i) rigid ii) elastic. **(08 Marks)**

OR

10 a. Deduce the expression for the loss of head due to sudden expansion in a pipe. **(06 Marks)**
b. A pipeline carrying water has a diameter of 0.5 m and length 2 km. To increase the discharge, another pipe of same diameter is introduced parallel to the first pipe in the second half of its length. Determine the increase in discharge. Assume the total head loss in both the cases as 15 m, friction factor f = 0.02 for all the pipes. **(06 Marks)**
c. Deduce the expression for the pressure rise in a pipe due to graduate closure of value. A steel pipe 200 mm in diameter and 1km long conveys crude oil at the rate of 40 litres/second. A value at the downstream end of the pipe in closed in 1.25 seconds. Thickness of the pipe = 10 mm, specific gravity of oil = 0.8, bulk modulus of oil = 520 MPa, Young's modulus of steel = 2.07×10^5 MPa. Compute the pressure rise in the pipe. **(08 Marks)**

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