CBCS SCHEME

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21AU43

Fourth Semester B.E. Degree Examination, June/July 2023
Fluid Mechanics and Fluid Machines

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Assume missing data suitably.***

Module-1

1 a. Derive an expression for capillary rise and fall. **(10 Marks)**

b. If the velocity profile of a fluid over a plate is a parabola with vertex 20 cm from the plates where the velocity is 120 cm/s. Calculate the velocity gradients and shear stresses at a distance of 0, 10 and 20 cm from the plate, if viscosity of the fluid is 8.5 poise. **(10 Marks)**

OR

2 a. Discuss the classification of the fluids depending on viscosity. **(10 Marks)**

b. A circular plate 3.0 m diameter is immersed in water in such a way that its greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure on one face of the plate and position of centre of pressure. **(10 Marks)**

Module-2

3 a. A stone weighs 392.4 N in air and 196.2 N in water. Compute the volume of the stone and its specific gravity. **(10 Marks)**

b. Derive an expression for metacentric height of a floating body. **(10 Marks)**

OR

4 a. Define velocity potential function and stream function. Prove that equipotential line and equal stream function lines are perpendicular to each other. **(10 Marks)**

b. The velocity potential function ϕ is given by an expression

$$\phi = \frac{-xy^3}{3} - x^2 + \frac{x^3y}{3} + y^2$$

(i) Find the velocity components in x and y directions.

(ii) Show that ϕ represents a possible case of flow. **(10 Marks)**

Module-3

5 a. Derive Bernoulli's equation from first principles. State the assumptions made. **(10 Marks)**

b. A conical tube of length 2.0 m is fixed vertically with its smaller end upwards. The velocity of flow at smaller end is 5 m/s while at the lower end is 2 m/s. The pressure head at the smaller end is 2.5 m of liquid. The loss of head in the tube is $\frac{0.35(V_1 - V_2)^2}{2g}$ where V_1 is the velocity at the smaller end and V_2 at the lower end respectively. Determine the pressure head at the lower end. Flow takes place in the downward direction. **(10 Marks)**

OR

6 a. Derive an expression for rate of flow through venturimeter. **(10 Marks)**

b. A rectangular channel 2.0 m wide has a discharge of 250 litres per second, which is measured by a right angled V-notch. Find the position of the apex of the notch from the bed of the channel if maximum depth of water is not to exceed 1.3 m. Take $C_d = 0.62$. **(10 Marks)**

Module-4

7 a. Derive Cheny's equation from Darcy-Weisback equation. (10 Marks)

b. Calculate the discharge through a pipe of diameter 200 mm when the difference of pressure head between the two ends of a pipe 500 m apart is 4m of water. Take the value of f = 0.009 in the formula $h_f = \frac{4fLV^2}{2gd}$. (10 Marks)

OR

8 a. A horizontal pipe line 40 m long is connected to a water tank at one end and discharge freely into atmosphere at other end. For the first 25 m of its length from the tank, the pipe is 150 mm diameter and its diameter suddenly enlarged to 300 mm. The height of water level in the tank is 8m above the center of the pipe. Considering all losses of head which occur, determine the rate of flow. Take f = 0.01 for both sections of the pipe. (10 Marks)

b. Derive Hagen-Poiseullie equation for viscous flow through pipe. (10 Marks)

Module-5

9 a. Find an expression for the drag force on smooth sphere of diameter D, moving with a uniform velocity V in a fluid of density ρ and dynamic viscosity μ. (10 Marks)

b. Discuss different types of similarity that exist between a model and prototype. (10 Marks)

OR

10 a. For a single stage reciprocating air compressor find the expressions for:
(i) Work done/cycle
(ii) Volumetric efficiency (10 Marks)

b. A gas is compressed in a two stage reciprocating compressor from 1 bar, 300 K to 9 bar. Assuming perfect intercooling, estimate the compressor work and total heat transfer. Take $R = 0.287$ kJ/kgK, $C_p = 1.042$ kJ/kgK and $n = 1.3$. (10 Marks)

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