



WEST BENGAL UNIVERSITY OF TECHNOLOGY

CE-401

FLUID MECHANICS

Time Allotted: 3 Hours

Full Marks: 70

The questions are of equal value.

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

All symbols are of usual significance.

GROUP A

(Multiple Choice Type Questions)

1. Answer *all* questions.

10×1 = 10

- (i) The centre of buoyancy of a submerged body
- (A) coincides with the centre of a gravity of the body
 - (B) coincides with the centroids of the displaced volume of fluid
 - (C) is always below the centre of gravity of the body
 - (D) is always above the centre of the displaced volume of liquid
- (ii) The flow in open channel is laminar if the Reynolds number is
- (A) 2000
 - (B) Less than 2000
 - (C) Less than 500
 - (D) None of these
- (iii) Reciprocating pump are suitable for
- (A) low discharge and low head
 - (B) low discharge and high head
 - (C) high discharge and low head
 - (D) high discharge and high head
- (iv) The co-efficient of friction for laminar flow through a circular pipe is
- (A) $f = \frac{0.0791}{(Re)^4}$
 - (B) $f = \frac{64}{Re}$
 - (C) $f = \frac{16}{Re}$
 - (D) None of these

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- (v) A potential function
- (A) is constant along a streamline
 - (B) is definable if a stream function is available for the flow
 - (C) describes the flow if it is rotational
 - (D) describes the flow if it is irrotational
- (vi) The differential manometer connected to two points along a pipeline gives a reading of h metre. The flow will be-
- (A) highest if the pipe is horizontal
 - (B) independent of the slope of pipe and direction of flow
 - (C) highest if flow is downwards
 - (D) highest if the flow is upward
- (vii) A venturimeter is used to measure
- (A) velocity of a flowing liquid
 - (B) pressure of a flowing liquid
 - (C) discharge of a flowing liquid
 - (D) all of these
- (viii) The power transmitted through a pipe is maximum, when the head lost due to friction is equal to,
- (A) one-half of the supply head
 - (B) one-third of the supply head
 - (C) one-fourth of the supply head
 - (D) two-third of the supply head
- (ix) Cavitation will take place if the pressure of the flowing fluid at any point is
- (A) more than the vapour pressure of the fluid
 - (B) equal to the vapour pressure of the fluid
 - (C) less than the vapour pressure of the fluid
 - (D) not related to the vapour pressure of the fluid
- (x) A hydraulic ram is a device used to
- (A) Store energy of water
 - (B) Increase the pressure of water
 - (C) Lift water from deep wells
 - (D) Lift small quantity of water to a greater height when a large quantity of water is available at a smaller height

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. www.makaut.com

3×5 = 15

2. The model of a boat is prepared to a scale 1: 10 and towed in a water tunnel. If the speed of the boat is 20 m/sec., determine the towing speed of the model. Assume that the boat is subjected to only wave resistance. 5
3. A centrifugal pump having an overall efficiency of 70% delivers 1500 l/min through a pipe 12 cm diameter and 100 m long. Calculate the power required to drive the pump if it lifts water to height of 22 m. The coefficient of friction for the pipe may be taken as 0.01. 5
4. (a) Water flows through a pipe of 200 mm in diameter and 60 m long with a velocity of 2.5 m/s. Find the head lost due to friction using Darcy's formula. Assume $f = 0.005$. 3
(b) Define metacentre and metacentric height. 2
5. A cylinder of diameter D and height H floats in fresh water with its longitudinal axis vertical. The cylinder is made of material of specific gravity 0.75. Find the H/D ratio for which the cylinder floats stably. 5
6. Define specific energy curve along with its diagram. Derive expressions for critical depth of flow. 3+2

GROUP C
(Long Answer Type Questions)

Answer any *three* questions.

3×15 = 45

7. (a) A cylindrical gate, 2 m diameter is kept on a floor in such a way that its longitudinal axis is horizontal. It has water on its both sides so that the depth of one side is 2 m whereas on the other side it is 1 m. Determine and show direction of the resultant hydrostatic force exerted on the gate per meter length of gate. Also calculate the minimum weight of the gate so that it will not float away from the floor. 8
(b) A closed cylinder of radius 10 cm and height 30 cm is filled with water. If the cylinder is rotated about its vertical axis at a speed of 240 rpm, calculate the force exerted at the top and bottom covers of the cylinder. 7

8. (a) Derive the expression for the time required to empty a Reservoir fitted with both (i) Rectangular weir (ii) Triangular weir. 7
- (b) The rate of flow of water through a horizontal pipe is $0.25 \text{ m}^3/\text{s}$. The diameter of the pipe which is 200 mm is suddenly enlarged to 400 mm. The pressure intensity of the smaller pipe is 11.72 N/cm^2 . Determine: (i) loss of head due to sudden enlargement (ii) pressure intensity of larger pipe (iii) Power lost due to enlargement. www.makaut.com 8
9. (a) Prove that for most economical rectangular section. 7
- (i) Depth of flow = Half bottom width.
(ii) Hydraulic Radius = Half the depth of flow.
- (b) An earthen channel with a base width 2 m and side slope 1 horizontal to 2 vertical carries water with a depth of 1 m. The bed slope is 1 in 625. Manning's constant $n = 0.03$. Calculate (i) Discharge (ii) Average shear stress at the channel boundary. 8
- 10.(a) A Kaplan turbine develops a shaft power of 24650 kW at an average head of 39 m. Assuming a speed ratio of 2, flow ratio of 0.6, diameter of the boss equal to 0.35 times the diameter of the runner and an overall efficiency of 90%; calculate the diameter, speed and specific speed of the runner. 8
- (b) A hydraulic jump is situated in a 4 m wide rectangular channel. The discharge in the channel is $7.5 \text{ m}^3/\text{s}$, and the depth upstream of the jump is 0.2 m. Determine the depth downstream of the jump. Also calculate head loss in the jump and the downstream Froude number. 7
- 11.(a) What do you mean by similitude and what are the different types of similarities that must exist between a model and a prototype? 3
- (b) State Buckingham's π theorem. 2
- (c) The efficiency η of a fan depends on density ρ , dynamic viscosity μ of the fluid, angular velocity ω , diameter D of the rotor and the discharge Q . Express η in terms of dimensionless parameters. 10
- 12.(a) State the working principle of a pelton wheel. 5+5+5
- (b) Derive the expression of discharge through a rectangular watch.
- (c) Write a short note on Francis turbine.