MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

Paper Code : ME-401

FLUID MECHANICS & HYDRAULIC MACHINES

Time Allotted : 3 Hours　　　　　　　*Full Marks : 70*

The figures in the margin indicate full marks.

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

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following :

$$10 \times 1 = 10$$

i) Bernoulli equation is applicable between any two points

 a) In any rotational flow an incompressible fluid

 b) In any type of irrotational flow of a fluid

 c) In steady rotational flow of an incompressible fluid

 d) None of these.

ii) Kaplan turbine is a turbine of

 a) Impulse and axial flow type

 b) Reaction and radial flow type

 c) Impulse and mixed flow type

 d) None of these.

iii) The steam function is

 a) Constant along an equipotential line

 b) Along a stream line

 c) Define only in irrotational flow

 d) None of these.

iv) The dynamic viscosity is $1 \cdot 2 \times 10^{-4}$ N/m^2, the density is 600 kg/m^3. The Kinematic viscosity in m^2/s is :

 a) 72×10^{-3}　　　b) 20×10^{-8}

 c) $7 \cdot 2 \times 10^3$　　　d) 70×10^6.

v) Manometric head of a centrifugal pump is given by

 a) Static head + losses

 b) Static head

 c) $\dfrac{u2 * vw2}{g}$

 d) Static head + losses + exit kinetic head.

vi) Multiple jets are used in a Pelton wheel for

 a) Increasing the power output with same specific speed

 b) Increasing the speed of rotational while sleeping same specific speed

 c) Increasing specific speed with the same power output

 d) Increasing the power output with the same head.

vii) Dracy-Weisbach equation is used to find loss of head due to

   a) Sudden enlargement

   b) Sudden contraction

   c) Friction

   d) None of these.

viii) When pitot tube is put to use it must be ensured that its alignment is such that

   a) Its opening faces upstream and horizontal leg is perfectly aligned with the directional of flow

   b) The horizontal leg should be inclined at 45° in plane

   c) Its horizontal leg is at right angle to the flow direction

   d) None of these.

ix) To produced a high head by multistage centrifugal pumps. the impellers connected

   a) In parallel

   b) In series

   c) In parallel and in series both

   d) None of these.

x) A dimensionless group formed with the variables, ρ (density), ω (angular velocity), μ (dynamic viscosity), D (characteristic viscosity) is

   a) $P\omega\mu/D^2$
       b) $P\omega D^2/\mu$

   c) $\mu D^2\omega\rho$
       d) $P\omega\mu D$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.   3 × 5 = 15

2. The velocity vector in a fluid flow is given $\vec{V} = 4x^3\hat{i} - 10x^2y\hat{j} + 2t\hat{k}$. Find the velocity and acceleration of a fluid particle at (2, 1, 3) at time $t = 1$ second. $2\frac{1}{2} + 2\frac{1}{2}$

3. A rectangular plane surface 3m wide and 4m deep lies in water in such a way that its plane makes an angle 30° with the free surface of water. Determine the total pressure force and position of centre of pressure, when the upper edge is 2m below the free surface. $2\frac{1}{2} + 2\frac{1}{2}$

4. An orifice-meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. Pressures at upstream and downstream of the office-meter are 19·62 Ncm^{-2} and 9·81 Ncm^{-2} respectively. Co-efficient of discharge for the meter is given as 0·6. Find discharge of water through the pipe.

5. A circular disk of radius R is kept at a small height h above a fixed bed by means of a layer of oil of dynamic viscosity μ. If the disk is rotated at an angular velocity ω. Considering a linear variation of velocity within the oil film, show that the torque required to maintain this speed is expressed as, $\dfrac{\pi\mu\omega R^4}{2h}$.

6. Why is draft tube used in reaction turbine ? Explain how the net head on the reaction turbine increased with the use of draft tube. 2 + 3

7. a) What is dimensional Homogeneity ?

   b) 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. Determine the velocity of the 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 kinematic viscosity of sea-water and air as 0·012 stokes and 0·018 stokes respectively. 1 + 4

GROUP – C
(Long Answer Type Questions)
Answer any *three* of the following.   3 × 15 = 45

8. a) Explain different types of Draft tube. What is the difference between impulse and reaction turbine ? Derive the work done of Pelton wheel and also calculate the maximum value the efficiency.

   b) A Pelton wheel has a mean bucket speed of 10 m/sec with a jet of water flowing at the rate of 700 litres/sec under a head of 30 m. The buckets deflect the jet through an angle of 160 degree. Calculate the power given by water to the runner and the hydraulic efficiency of the turbine. Assume co-efficient of velocity as 0·98.

   c) Specific Speed of Hydraulic Turbines is given by $Ns = (N\sqrt{P})/H^{5/4}$.   (3 + 3) + (3 + 3) + 3

9. a) The diameter and stroke length of a single acting reciprocating pump are 12 cm and 20 cm respectively. The lengths of suction and delivery pipes are 8 m and 25 m respectively and their diameters are 7·5 cm . If the pump is running at 40 rpm and suction and delivery heads are 4 m and 14 m respectively, find the pressure head in the cylinder ; (i) at the beginning of the suction and delivery stroke, (ii) in the middle of suction and delivery stroke and (iii) at the end of the suction and delivery stroke.