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Roll No. of candidate | 10 | | | | | | | | | |

2024

B.Tech. 4th Semester End-Term Examination

Civil Engineering

HYDRAULICS AND HYDRAULICS MACHINES

New Regulation (w.e.f. 2017-18) &

New Syllabus (w.e.f. 2018-19)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Questions No. 1 and any *four* from the rest.

1. In the following multiple choice questions, Choose the correct answer :$(10 \times 1 = 10)$

(i) Newton's law of viscosity states to which of the following?

(a) Pressure, velocity and viscosity

(b) Shear stress and rate of angular deformation in a fluid

(c) Shear stress, temperature and viscosity of a fluid

(d) Shear stress and pressure of a fluid

(ii) The exact analysis of viscous flow problems can be made by

(a) Continuity equation

(b) Bernoulli's equation

(c) Navier-Stokes equation

(d) Euler's equation

(iii) In a laminar flow between two fixed parallel plates, the shear stress is

(a) Constant across the passage

(b) Maximum at the centre and zero at the boundary

(c) Zero at boundary of lower plate and maximum at the boundary of upper plate

(d) Maximum at the boundary and zero at the centre

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(iv) In pipe flow the Prandtl's mixing length l is assumed as equal to

(a) Ky^2 (b) Ky

(c) Ky^3 (d) K/y

(v) The value of friction factor for smooth pipes for Reynolds number equal to 10^5 is approximately

(a) 0.02 (b) 0.002

(c) 0.001 (d) 0.01

(vi) For solving the pipe network problems, necessary condition is

(a) Continuity equation

(b) Energy equation

(c) Darcy-Weisbach equation

(d) All of the above

(vii) Efficiency of a jet of water having velocity V striking a vertical plate moving with a velocity of v is maximum when

(a) v = V/3

(b) v = V/2

(c) v = V/4

(d) v = V

(viii) A Pelton wheel is a

(a) Tangential flow impulse turbine

(b) Inward flow impulse turbine

(c) Outward flow impulse turbine

(d) Inward flow reaction turbine

(ix) Francis turbine is used when the available head of water is

(a) 0-25 m

(b) 25-250 m

(c) Above 250 m

(d) None of the above

(x) A draft tube is not required for

(a) A Francis turbine

(b) A Kaplan turbine

(c) A Pelton wheel turbine

(d) None of the above

2. (a) Considering laminar flow of an incompressible fluid through a horizontal pipe, derive the relationship between mean velocity and maximum velocity of flow. (10)

(b) A fluid of specific gravity 0.8 and viscosity 9 poise is flowing in a fully developed laminar regime through a horizontal circular pipe of length 20 m and diameter 0.2 m.If the head loss between two sections of pipe is 5 m, find the average velocity and friction factor for the flow. (5)

3. (a) Explain the factors which affect the thickness of boundary layer. (3)

(b) If the velocity distribution in a turbulent boundary layer is expressed as, $\frac{v}{V}=\left(\frac{y}{\delta}\right)^{1/4}$, find the ratio of

(i) Displacement thickness to momentum thickness and

(ii) Momentum thickness to energy thickness. (8)

(c) A thin smooth plate of 0.5 m width and 1.5m length moves at 2.5 m/s along its length in still atmospheric air of density 1.2 kg/m^3 and kinematic viscosity 1.5 × $10^{-5}\,m^2/s$. Calculate the maximum thickness of the boundary layer and the drag force on the plate. (4)

4. (a) Differentiate between (2 + 2 = 4)

(i) Hydrodynamically smooth and rough surfaces

(ii) Form drag and friction drag

(b) An airplane weighing 120 kN has a wing area of $20\,m^2$ and is flying at a velocity of 720 km/h at a steady level in still air. Determine

(i) Coefficient of lift

(ii) Total drag on the wing

(iii) Power required to keep the airplane at this velocity (Assume $\rho_{air}=1.25\,kg/m^3$, $C_D=0.65$). (6)

(c) A penstock (water main) of concrete 3.2 km long and 30 cm diameter, discharges water into a reservoir at the rate of 12×10^6 lit/day .The pipeline is gradually closed in 20 seconds by operating a valve at the reservoir end. If the test pressure for the concrete main is 30m, indicate whether there is any risk of pipe burst. (5)

5. (a) Differentiate between the turbine and pump. (3)

(b) A jet of water of diameter 50mm strikes a fixed plate in such a way that the angle between the plate and the jet is 30°. The force exerted by the jet of water in the direction of jet is 1471.5 N. Determine the rate of flow of water. (4)

(c) Find an expression for the work done per sec on a series of moving curved vanes when a jet of water strikes the vanes at one of its tips. (8)

6. (a) A jet of water having a velocity of 15 m/s, strikes on a curved vane which is moving with a velocity 6 m/s in the same direction as that of the jet at inlet. The vane is so shaped that the jet is deflected by an angle 135°. The diameter of the jet is 150 mm. Assuming the vane to be smooth, find

(i) The force exerted by the jet on the vane in the direction of motion

(ii) Power of the vane and

(iii) Efficiency of the vane. (8)

(b) Obtain an expression for the work done by impeller of a centrifugal pump on water per unit weight of water. (7)

7. (a) What is outward flow reaction turbine? How does it differ from inward flow reaction turbine? Draw its velocity triangles. (5)

(b) An inward flow reaction turbine has external and internal diameters as 1.3 m and 0.6 m respectively. The velocity of flow through the runner is constant at 1.8 m/sec. Determine the discharge and width at outlet if width at inlet is 20 cm. (5)

(c) Explain the principle of working of a reciprocating pump with figure, naming the different component parts. (5)