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B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024.

Second/Third/Fourth Semester

CE 3391— FLUID MECHANICS AND MACHINERY

(Common to Aeronautical Engineering/Aerospace Engineering/ Industrial Engineering/Industrial Engineering and Management/Manufacturing Engineering/Material Science and Engineering/Mechanical Engineering/ Mechanical Engineering (Sandwich)/Mechanical and Automation Engineering/Production Engineering/Safety and Fire Engineering)

(Also common to PTCE 3391 – Fluid Mechanics and Machinery for Regulations 2023)

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish Surface tension and capillarity.
2. Draw the stress-strain relationship for Newtonian fluid, Pseudoplastic fluid, Dilatant fluid, Bingham fluid and plastic fluid under an external shear stress.
3. State the William Froude laws for fluid friction in case of turbulent flow.
4. Define total energy line(TEL) and hydraulic gradient line(HGL) in case of fluid flow through pipes.
5. What do mean by dimensional homogeneity and explain with simple equation?
6. Obtain the Euler's number from fundamental.
7. Define 100% reaction turbine.
8. What is the use of surge tank?
9. What is the difference between rotodynamic Pumps and positive displacement pumps?
10. State reciprocating pump is whether steady state or unsteady state with valid reason?

PART B — (5 × 13 = 65 marks)

11. (a) A shaft 70.0 mm in diameter is being pushed at a speed of 400 mm/s through a bearing sleeve 70.2 mm in diameter and 250 mm long. The clearance, assumed uniform, is filled with oil at 20°C with kinematic viscosity (y) = 0.005 m^2/s and specific gravity = 0.9. Find the force exerted by the oil on the shaft. If the shaft is fixed axially and rotated inside the sleeve at 2000 rpm, determine the resisting torque exerted by the oil and the power required to rotate the shaft.

Or

(b) Determine the pressure difference between A and B shown in Figure 11(b). All dimensions are in meter.

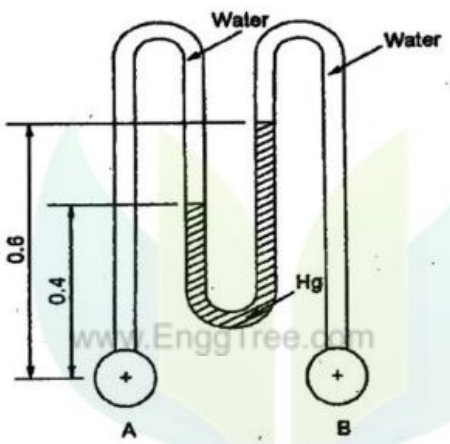

Fig. 11(b)

12. (a) Two reservoirs have a constant difference of levels of 70 m and are connected by a 250 mm diameter pipe which is 4 km long. The pipe is tapped mid-way between the reservoirs and water is drawn at the rate of 0.04 m^3/s. Assuming friction factor = 0.04, determine the rate at which water enters the lower reservoir.

Or

(b) Glycerine of density 1250 kg/m^3 and dynamic viscosity of 0.75 Pa.s flows through a pipe of 85 mm diameter. If the shear stress at the wall is 300 N/m^2, calculate the following :

(i) The average velocity in the pipe

(ii) The flow rate

(iii) The Reynolds number of flow

(iv) The pressure gradient along the flow.

13. (a) State Buckingham's π-theorem and discuss the method of selecting the repeated variables and Show that the velocity through a circular orifice is given by

$$V = \sqrt{2gH}\, f\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$$

Where, H denotes head causing flow, D is the diameter of the orifice, μ is the coefficient of viscosity, ρ is the density of fluid and g represents the acceleration due to gravity.

Or

(b) The ratio of length of a submarine and its model is 30:1 . The speed of the sub marine (prototype) is 10 m/s. The model is to be tested in a wind tunnel. Find the speed of air in wind tunnel. Also determine the ratio of the drag (resistance) between the model and its prototype. Take the value of kinematic viscosities for sea water and air as 0.012 stokes and 0.016 stokes, respectively. The density for sea water and air is given as 1030 kg/m^3 and 1.24 kg/m^3 respectively.

14. (a) Draw the general layout of reaction turbine and explain clearly.

Or

(b) A pelton wheel is to be designed for the following specifications: shaft power = 12 MW, head 390 m, speed = 900 rpm, overall efficiency = 86%, jet diameter is not to exceed one sixth of the wheel diameter. Determine the

(i) wheel diameter

(ii) number of jets required and

(iii) diameter of the jet.

Take the jet velocity coefficient and bucket velocity coefficient as 0.985 and 0.45 respectively.

15. (a) Find the rise in pressure in the impeller of a centrifugal pump through water is flowing at the rate of 0.01 m^3/s. The internal and external diameters of the impeller are 15 cm and 30 cm respectively. The widths of the impeller at the inlet and outlet are 1.2 cm and 0.6 cm. The pump is running at 1500 rpm. The water enters the impeller radially at inlet and impeller vane angle at outlet is 45°. Neglect losses through the impeller.

Or

(b) A centrifugal pump is running at 1000 rpm. The outlet vane angle of the impeller is 30° and the velocity of the flow at outlet is 3 m/s. The pump is working against a total head of 30 m and the discharge through the pump is 0.3 m^3/s. If the manometric efficiency of the pump is 75%, determine

(i) the diameter of the impeller

(ii) the width of the impeller at the outlet.

PART C — (1 × 15 = 15 marks)

16. (a) Design the centrifugal pump layout to drain the stagnation water in the underground floor during rainy season while the average rain fall per day is 30 cm and floor area is 80 m^2. Assume the insufficient data.

Or

(b) Explain different types of draft tubes used in hydraulic power plants and state their purpose.