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B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

Third Semester

Mechanical Engineering

CE 3391 – FLUID MECHANICS AND MACHINERY

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

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Determine the specific gravity of a fluid having viscosity 0.07 poise and kinematic viscosity 0.042 stokes.

2. Define Buoyancy.

3. Define the terms hydraulic gradient line and total energy line.

4. Write any four examples for minor losses in pipes.

5. Prove that $h = \frac{P}{\rho g}$ is dimensionally homogeneous. Where, P is pressure, ρ is density and h is pressure head.

6. Write the units for discharge, force and power.

7. Classify turbines based on energy available at inlet of the vane.

8. Mention the purpose of using draft tube in turbines.

9. Suggest the pumps when the water need to be pumped from a depth of (a) 150 m and (b) 300 m.

10. At what condition, the actual discharge of reciprocating pump is more than its theoretical discharge?

PART B — ($5 \times 13 = 65$ marks)

11. (a) Derive the Continuity equation in Three-Dimensional form.

Or

(b) A gas is contained in a vertical, frictionless piston – cylinder device. The piston has a mass of 4 kg and a cross sectional area of 35 cm^2. A compressed spring above the piston exerts a force of 60 N on the piston as shown in figure 1. If the atmospheric pressure is 95 kPa, determine the pressure inside the cylinder.

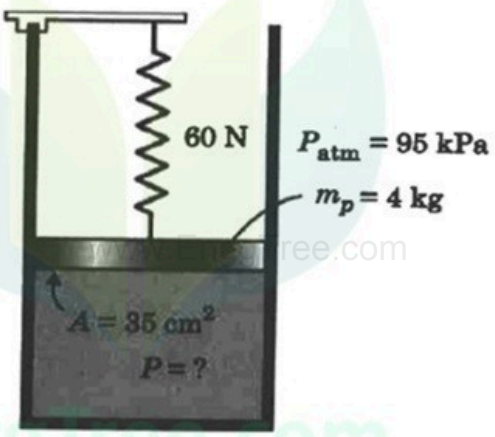

Figure. 1

12. (a) A laminar flow is taking place in a pipe of diameter 200 mm. The maximum velocity is 1.5 m/s. Find the mean velocity and radius at which this occurs. Also calculate the velocity at 4 cm from the wall of the pipe.

Or

(b) Water is flowing through a pipe of diameter 20 cm and length 50 m when one end of the pipe is connected to a tank and other end of the pipe is open to the atmosphere. The pipe is horizontal and the height of water in the tank is 4 m above the center of the pipe. Assuming $f = 0.009$, calculate the flow rate in the pipe by considering all the losses.

13. (a) Using Buckingham's π theorem, show that the discharge Q consumed by an oil ring is given by,

$$Q = Nd^3\varphi\left[\frac{\mu}{\rho Nd^2}, \frac{\sigma}{\rho N^2 d^3}, \frac{w}{\rho N^2 d}\right]$$

Where d is the internal diameter of the ring, N is rotational speed. ρ is density, μ is viscosity, σ is surface tension and w is the specific weight of oil.

Or

(b) A ship 250 m long moves in sea-water, whose density is 1030 kg/m^3. A 1:125 model of this ship is to be tested in wind tunnel. The velocity of air in the wind tunnel around the model is 20 m/s and the resistance of the model is 50 N. Determine the velocity of 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 the kinematic viscosity of sea-water and air as 0.012 stokes and 0.018 stokes respectively.

14. (a) Describe the working and the function of various components of Francis turbine with a neat sketch.

Or

(b) A pelton wheel is to be designed for a head of 60 m when running at 200 r.p.m. The pelton wheel develops 95.6475 kW shaft power. The velocity of the buckets is 0.45 times the velocity of jet, overall efficiency is 0.85 and co-efficient of the velocity is equal to 0.98.

15. (a) With neat sketch, explain the construction and working principle of centrifugal pump. Also draw its performance curve.

Or

(b) The length and diameter of a suction pipe of a single reciprocating pump are 5 m and 10 cm respectively. The pump has a plunger of diameter 15 cm and a stroke length of 35 cm. The centre of the pump is 3 m above the water surface in the pump. The atmospheric pressure head is 10.3 m of water and pump is running at 35 r.p.m. Determine,

(i) The pressure head due to acceleration at the beginning of the suction stroke. (6)

(ii) Pressure head in the cylinder at the beginning and at the end of the stroke. (7)

PART C — (1 × 15 = 15 marks)

16. (a) A U-tube differential manometer connects two pipes A and B. Pipe A contains carbon tetrachloride having specific gravity 1.594 under a pressure of 11.772 N/cm² and pipe B contains oil of sp.gr 0.8 under a pressure of 11.772 N/ cm². The pipe A lies 2.5 m above pipe B. Find the difference of pressure measured by mercury as fluid filling U-tube.

Or

(b) The following data is given for a francis turbine. Net head H = 60 m, N = 700 rpm, shaft power = 294.3 KW, $\eta_{\text{over all}} = 84\%$, $\eta_{\text{hydraulic}} = 93\%$, flow ratio = 0.20, breadth ratio $n = 0.1$, Outer diameter of runner = 2 × inner diameter of runner. The thickness of vanes occupies 5% of circumferential area of the runner, velocity of flow is constant at inlet and outlet and discharge is radial at outlet. Determine :

(i) Guide blade angle (4)

(ii) Runner vane angles at inlet and outlet (4)

(iii) Diameters of runner at inlet and outlet (4)

(iv) Width of wheel at inlet. (3)