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Question Paper Code : 10409

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Third Semester

Mechanical Engineering

ME 2204/113303/ME 34/CE 1208/10122 ME 305/080180007 — FLUID MECHANICS AND MACHINERY

(Common to Aeronautical Engineering, Automobile Engineering and Production Engineering)

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Two horizontal plates are placed 12.5 mm apart, the space between them being filled with oil of viscosity 14 poise. Calculate the shear stress in the oil if the upper plate moved with a velocity of 2.5 m/s. Define specific weight.

2. Calculate the height of capillary rise for water in a glass tube of diameter 1 mm.

3. What are the minor losses? Under what circumstances will they be negligible?

4. What factors account for the energy loss in laminar flow?

5. Under what circumstances, will the Buckingham-Pi theorem yield incorrect number of dimensionless group?

6. If two systems (model and prototype) are dynamically similar, is it implied that they are also kinematically and geometrically similar?

7. What precautions are to be taken while starting and closing the centrifugal pump?

8. Differentiate reaction turbine and impulse turbine.

9. What is the function of non-return valve in a reciprocating pump?

10. What factors govern the speed of reciprocating pump?

PART B — (5 × 16 = 80 marks)

11. (a) (i) The space between two large flat and parallel walls 25 mm apart is filled with a liquid of absolute viscosity 0.7 Pa.sec. Within this space a thin flat plate, 250 mm × 250 mm is towed at a velocity of 150 mm/s at a distance of 6 mm from one wall, the plate and its movement being parallel to the walls. Assuming linear variations of velocity between the plate and the walls, determine the force exerted by the liquid on the plate. (8)

(ii) Eight kilometers below the surface of the ocean the pressure is 81.75 MPa. Determine the density of sea water at this depth if the density at the surface is 1025 kg/m^3 and the average bulk modulus of elasticity is 2.34 GPa. (8)

Or

(b) (i) A 0.3 m diameter pipe carrying oil at 1.5 m/s velocity suddenly expands to 0.60 m diameter pipe. Determine the discharge and velocity in 0.6 m diameter pipe. (4)

(ii) Derive the momentum equation for steady flow. (12)

12. (a) (i) A pipe line 20 cm in diameter, 70 m long, conveys oil of specific gravity 0.95 and viscosity 0.23 N.sec/m^2. If the velocity of oil is 1.38 m/s, find the difference in pressure between the two ends of the pipe. (8)

(ii) Oil of mass density 800 kg/m^3 and dynamic viscosity 0.02 poise flows through 50 mm diameter pipe of length 500 m at the rate of 0.19 litres/sec. Determine

(1) Reynolds number of flow

(2) Centre line velocity

(3) Pressure gradient

(4) Loss of pressure in 500 m length

(5) Wall shear stress and

(6) Power required to maintain the flow. (8)

Or

(b) (i) Obtain expression for Darcy-Weishbach friction factor f for flow in a pipe. (6)

(ii) A smooth pipe carries 0.30 m^3/s of water discharge with a head loss of 3.0 m per 100 m length of pipe. If the water temperature is 20°C, determine the diameter of the pipe. (10)

13. (a) The power required by the pump is a function of discharge Q, head H, acceleration due to gravity g, viscosity μ, mass density of the fluid ρ, speed of rotation N and impeller diameter D. Obtain the relevant dimension less parameters.

Or

(b) Model tests have been conducted to study the energy loss in a pipeline of 1 m diameter required to transport kerosene of specific gravity 0.80 and dynamic viscosity 0.02 poise at the rate of 2000 litre/sec. Tests were conducted on a 10 cm diameter pipe using water at 20°C. What is the flow rate in the model? If the energy head loss in 30 m length of the model is measured as 44.0 cm of water, what will be the corresponding head loss in the prototype? What will be the friction factor for the prototype pipe?

14. (a) A centrifugal pump discharges 2000 l/s of water per second developing a head of 20 m when running at 300 rpm. The impeller diameter at the outlet and outflow velocity is 1.5 m and 3.0 m/s respectively. It vanes are set back at an angle of 30° at the outlet, determine

(i) Manometric efficiency

(ii) Power required by the pump.

If inner diameter is 750 mm, find the minimum speed to start the pump.

Or

(b) An inward flow reaction turbine discharges radially and the velocity of flow is constant, show that the hydraulic efficiency can be expressed by

$$\eta = \frac{1}{1 + \dfrac{0.5\tan^2\alpha}{1 - \dfrac{\tan\alpha}{\tan\theta}}}$$

Where α and θ are the guide and vane angles at inlet.

15. (a) (i) Determine the percentage of work saved in one cycle when an air vessel is provided on the delivery side of a single cylinder single acting reciprocating pump. (8)

(ii) Explain the working principle of reciprocating pump with neat diagram in detail and state its advantages and disadvantages over centrifugal pump. (8)

Or

(b) (i) A single cylinder double acting reciprocating pump has a piston diameter of 300 mm and stroke length of 400 mm. When the pump runs at 45rpm, it discharges 0.039 m^3/s under a total head of 15 m. What will be the volumetric efficiency, work done per second and power required if the mechanical efficiency of the pump is 75%? (10)

(ii) With an example, explain in detail the working principle and construction of rotary pumps with neat diagram. (6)

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