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Question Paper Code : 10216

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

Third Semester

Civil Engineering

CE 2202/101302/CE 35/CE 1203/10111 CE 305/080100015 — MECHANICS OF FLUIDS

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Distinguish between a real fluid and an ideal fluid.

2. The surface tension of water in contact with air is 0.0725 N/m. The difference in pressure between inside and outside of water droplet is 250 N/m². What is the diameter of the droplet?

3. With the help of a sketch, show the relationship between absolute pressure and gauge pressure.

4. Can there be flow across a streamline? Why?

5. State the assumptions involved in the derivation of Bernoulli's equation.

6. Explain Couette flow.

7. Differentiate between 'drag' and 'lift'.

8. A 200 mm diameter pipe 30 km long transports oil from a tanker to the shore at 0.01 m³/s. Find the Reynold's number to classify the flow. Take dynamic viscosity of the fluid = 0.1 Ns/m² and mass density = 900 kg/m³ for oil.

9. Define scale ratio.

10. Define kinematic similarity.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Show the rheological classification of fluids and define each type of fluid giving an example. (6)

(ii) Two large vertical plates parallel to each other are 2 mm apart. A thin flat plate 1 mm thick, 0.6 m × 0.6 m size and 25 N weight is towed vertically up between the two large plates with a velocity of 0.2 m/s. The inner plate is equidistant from the two stationary plates. The gap between the large plates is filled with oil of viscosity 1.6 poise. Calculate the vertical force required. (6)

(iii) The capillary rise in a glass tube is to be restricted to 3 mm. What should be the size of the tube if the surface tension of water in contact with the air is 0.0725 N/m. (4)

Or

(b) (i) In a pipe of diameter 300 mm, the velocity distribution is parabolic and is given as $v = ay^2 + by + c$, where v is the velocity at a distance y from the wall of the pipe. The maximum velocity of flow is 1.2 m/s. Calculate the velocity gradients and shear stresses at y = 50 mm and y = 100 mm. Take dynamic viscosity of fluid as 8.5 poise. (Hint : To find the coefficients a, b and c, use the boundary conditions v = 0 at y = 0; v = 1.2 m/s at y = 150 mm and $\frac{dv}{dy} = 0$ at y = 150 mm.) (10)

(ii) Explain the phenomena responsible for the viscosity of a fluid. Discuss the influence of temperature and pressure on the viscosity of fluids. (6)

12. (a) (i) Match the following : (4)

(1)	U-tube manometer	(A)	Moderately low pressures
(2)	Single tube manometers	(B)	Negative pressures
(3)	Inverted U– tube manometers	(C)	High pressures
(4)	U-tube differential manometer	(D)	Differences in pressure between two points

(ii) The water level in a canal is regulated by a flat tipper gate inclined at 60° to the bed. The tipping takes place about a fulcrum placed at a height of 1 m from the bed when the water level in the canal reaches a maximum value of H. Determine H. (8)

(iii) A piece of metal weighing 1.5 N in air is found to weigh 1.1 N when submerged in water. What is its volume and what is its specific gravity? (4)

Or

(b) (i) Differentiate between the following :

(1) Steady flow and uniform flow

(2) Laminar flow and turbulent flow $(2 \times 3 = 6)$

(ii) A three dimensional flow field is given by

$V = 2x^2y\vec{i} + 3y^2z\vec{j} - (4xz + 3yz^2)\vec{k}$.

Show that it is a case of possible steady, incompressible fluid flow. (4)

(iii) Explain a Pitot-Static tube with a sketch. How do you determine the flow velocity at any point using a Pitot-Static tube? (6)

13. (a) (i) Water is flowing through a tapering pipe having diameters 300 mm and 200 mm at sections 1 and 2 respectively. The discharge through the pipe is 400 litres per minute. The section 1 is 10 m above datum and section 2 is 8 m above datum. Find the pressure at section 2 if the pressure at section 1 is 400 kN/m². (6)

(ii) A venturimeter of diameters 200 mm and 100 mm at inlet and throat respectively is installed in a vertical pipe carrying oil of specific gravity 0.8. The inlet is 1.5 m above the throat. Pressure gauges installed at the throat and inlet indicate a pressure difference of 9.81 kN/m².

(1) Determine the discharge through the pipe

(2) If the throat and inlet are connected to a U-tube manometer containing mercury instead of the pressure gauges, find the difference in mercury levels in the two limbs of U-tube manometer. (10)

Or

(b) (i) An oil of viscosity 0.096 Nsm^{-2} and specific gravity of 1 .59 flows through a horizontal pipe of 50 mm diameter with a pressure drop of 6 kN/m² per metre length of pipe. Determine

(1) Rate of flow

(2) The shear stress at the pipe wall

(3) The power required for 100 m length of the pipe to maintain the flow. (12)

(ii) Explain Plane Poiseuille flow and show the velocity distribution is such a flow. (4)

14. (a) (i) With the aid of a neat sketch, explain the characteristics of the boundary layer by considering a free stream approaching parallel to a sharp-edged, thin, smooth, flat plate under zero pressure gradient. (10)

(ii) A free stream of water has a velocity of 4 m/s and a smooth flat plate with a sharp leading edge is placed in it. Find the distance from the leading edge where the boundary layer transition from laminar to turbulent flow occurs. Find also the thickness of the boundary layer at that point. Take ρ for water = 1000 kg m^{-3} and $\mu = 1$ centipoise. (6)

Or

(b) (i) Consider a simple pipeline taking-off from a reservoir. The pipe has a sharp-edged entrance at the reservoir end. It has a nozzle at the discharge end. Draw neatly the HGL and TEL for the system described. (6)

(ii) Two reservoirs 1 km apart are connected by two pipes in parallel. One is 300 mm in diameter and the other is 200 mm in diameter. If the combined flow is 1 m^{3}s^{-1}, find the velocity of flow in each pipe. Assume friction factor to be the same for both pipes. (10)

15. (a) The pressure difference $\Delta\rho$ in a pipe of diameter D and length L due to viscous flow depends on the velocity V, viscosity μ and density ρ. Using Buckingham's π-theorem, obtain an expression for $\Delta\rho$. (16)

Or

(b) (i) Differentiate between the following :

(1) Geometric similarity and Kinematic similarity

(2) Froude number and Weber number

(3) Distorted model and Undistorted model. (6)

(ii) A spillway model is to be built to a scale ratio of 1: 40 across a flume of 600 mm width. The prototype is 10 m high and the maximum head expected is 1.5 m.

(1) Find the height of the model and the head on the model

(2) Find the flow over the prototype when the flow over the model is 12 litres per second.

(3) If a negative pressure of 0.15 m occurs in the model, what will be the negative pressure in the prototype? Is this practically possible to occur? (10)
