E 081

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2009.

THIRD SEMESTER

CIVIL ENGINEERING

CE 35 — MECHANICS OF FLUIDS

(REGULATIONS 2008)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is a fluid? How are fluids classified?
2. State Newton's law of viscosity.
3. Define the centre of pressure.
4. Differentiate between stream line and streak line.
5. State Bernoulli's equation in term of head.
6. What is an impulse momentum equation?
7. What is the physical significance of Reynolds number?
8. Define displacement thickness.
9. What is dimensional analysis?
10. Discuss about model analysis.

PART B — (5 × 16 = 80 marks)

11. (a) (i) A glass tube of 1.2 mm diameter gives a capillary depression of 8 mm when it is dipped in mercury. What diameter tube will give a depression of 4 mm?

(ii) One cubic metre of alcohol of relative density 0.788 and bulk modulus 1.32×10^6 N/m^2 is subjected to an increase of pressure of 45000 N/m^2. Find the change in volume and the value of the final density of fluid.

Or

(b) (i) A cylinder of 0.122 m radius rotates concentrically inside a fixed cylinder of 0.128 m radius. Both cylinders are 0.305 long. Determine the viscosity of the liquid that fills the space between the cylinders, if a torque of 0.881 N. m is required to maintain an angular velocity of 60 rpm.

(ii) A needle 35 mm long rests on a water surface at 20°C. What force over and above the needle's weight is required to lift the needle from contact with the water surface? Take the surface tension for water, σ at 20° C = 0.0728 N/m.

12. (a) (i) With a neat sketch explain the working principle of Laser Doppler Velocimetry.

(ii) Examine whether the following velocity components can constitute two or three dimensional incompressible flows. If three dimensional, determine the third component $u = x^2 - y^2; v = y^2 + bx$.

Or

(b) (i) The velocity potential for a certain flow field is $\Phi = 4xy$. Determine the corresponding stream function.

(ii) A rectangular plane surface 3 m wide and 4 m deep lies in water in such a way that its plane makes an angle of 30° with the free surface of water. Determine the total pressure force and position of centre of pressure, when the upper edge is 2 m below the free surface.

13. (a) (i) A fluid of kinematic viscosity v = 20 × 10^{-6} m^2/s and ρ = 800 kg / m^3 is contained between two parallel plates, 15 cm apart. The lower plate is fixed and the upper movable. A positive pressure gradient of 12.5 N/m^3 exists in the direction of motion of the upper plate. Estimate the force required to move the upper plate at a uniform speed of 4.5 m/s, if the plate surface cross section is 60 cm by 130 cm.

(ii) The diameter of the pipe changes uniformly from 450 mm to 150 mm. One end of the pipe is 6 m above the datum line and other end is 2.5 m above the datum line. The pressure at the large diameter is 540 kPa and velocity is 1.4 m/s. Determine the velocity and the pressure at the smaller diameter.

Or

(b) (i) A 300 mm × 150 mm Venturimeter is provided in a horizontal pipe line carrying oil of relative density 0.9. The differential U tube mercury manometer shows a gauge deflection of 250 mm. Calculate the discharge of oil, if the coefficient of meter is 0.98.

(ii) What sized pipe should be installed to carry 7 l/s of fuel oil with a permissible head loss of 2 m per 100 m length of pipe if relative density and kinematic viscosity of oil are 0.9 and 2.04 stokes respectively?

14. (a) (i) How much time will be required to collect 50 cm^3 of kerosene in a capillary tube viscometer of diameter 2 mm, length 0.5 m, under a head of 0.3 m, if density and dynamic viscosity for kerosene are 800 kg/m^3 and 2×10^{-3} kg / m s respectively?

(ii) A smooth two dimensional flat plate is exposed to a wind velocity of 360 km/h. If the laminar boundary layer exists up to a value of Re = 2×10^5, find the maximum distance from the leading edge up to which laminar boundary layer exists and the hydrodynamic boundary layer thickness. Take kinematic viscosity, $\gamma = 1.49 \times 10^{-5} m^2/s$.

Or

(b) (i) Glycerine of viscosity 0.835 Ns/m^2 flows through a 150 mm diameter, 40 m long pipe of wrought iron at a velocity of 3.25 m/s. Find the loss of head in the pipe. Take the density of Glycerine equal to 1260 kg/m^3.

(ii) Find the loss of head when a pipe of diameter 250 mm is suddenly enlarged to a diameter 500 mm. The rate of flow water through the pipe is 350 litre/s.

15. (a) (i) The Reynolds number (Re) is a function of density, viscosity and velocity of a fluid and a characteristics length. Establish the Reynolds number relation by dimensional analysis.

(ii) Assuming the drag force exerted by a flowing fluid on a body is a function of the density, viscosity and velocity of the fluid and a characteristic length of the body, develop a general equation.

Or

(b) (i) A model of a torpedo is tested in a towing tank at a velocity of 24.4 m/s. The prototype is expected to attain a velocity of 6.1 m/s in 16° C water. (1) What model scale has been used? (2) What would be the model speed if tested in a wind tunnel under a pressure of 20 atm and a constant temperature of 27° C?

(ii) Assuming the power delivered to a pump is a function of the specific weight of the fluid, the flow rate and the head delivered, establish an equation by Buckingham pi theorem.
