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B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Third Semester

Civil Engineering

CE 6303 – MECHANICS OF FLUIDS

(Common to Environmental Engineering)

(Regulations 2013)

(Also Common to PTCE 6303 – Mechanics of Fluids for B.E. (Part-Time) for Second Semester – Civil Engineering – Regulations 2014)

Time : Three Hours Maximum : 100 Marks

Answer ALL questions.

PART – A (10×2=20 Marks)

1. Write the expression for capillary fall in terms of surface tension for mercury.
2. What is meant by centre of pressure ?
3. Write the continuity equation in three dimensional differential form for compressible fluids.
4. State the impulse-momentum principle.
5. What is Hagen Poiseuille's formula ?
6. What are the factors influencing the frictional loss in pipe flow ?
7. Define boundary layer thickness.
8. Enlist the methods of preventing the separation of boundary layers.
9. What is dimensional homogeneity ?
10. List the types of similarities between model and prototype.

PART – B (5×13=65 Marks)

11. a) A 150 mm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 151 mm. Both the cylinders are 250 mm high. If the torque of 12 Nm is required to rotate the inner cylinder at 100 r.p.m., determine the viscosity of the fluid filled in the space between the above two cylinders. (13)

(OR)

b) Determine the total pressure on a circular plate of diameter 1.5 m which is placed vertically in water in such a way that the centre of the plate is 3 m below the free surface of water. Also find the position of centre of pressure. (13)

12. a) i) A pipe 200 mm long slopes down at 1 in 100 and tapers from 600 mm diameter at the higher end to 300 mm diameter at the lower end and carries 100 litres/sec of oil having specific gravity 0.8. If the pressure gauge at the higher end reads 60 kN/m^2, determine the velocities at the two ends and also the pressure at the lower end. (7)

ii) The water is flowing through a taper pipe of length 100 m having diameters 600 mm at the upper end and 300 mm at the lower end, at the rate of 50 litres/s. The pipe has a slope of 1 in 30. Find the pressure at the lower and if the pressure at the higher level is 19.62 N/m^2. (6)

(OR)

b) i) A 0.3 m diameter pipe carrying oil at 1.5 m/s velocity suddenly expands to 0.6 m diameter pipe. Determine the discharge and velocity in 0.6 m diameter pipe. (3)

ii) Derive the momentum equation for steady flow. (10)

13. a) Determine the pressure gradient, the shear stress at the two horizontal plates and the discharge per width for the laminar flow of oil with a maximum velocity of 3 m/s between two horizontal parallel fixed plates which are 120 mm apart. Take the dynamic viscosity of oil = 2.5 N.s/m^2. (13)

(OR)

b) A pipe of diameter 0.4 m and of length 2 km is connected to a reservoir at one end. The other end of the pipe is connected to a junction from which two pipes of lengths 1 km and diameter 0.3 m run in parallel. These parallel pipes are connected to another reservoir, which is having a level of water 10 m below the water level of the above reservoir. Determine the total discharge if Darcy's co-efficient of friction is 0.015. Neglect minor losses. (13)

14. a) Find the displacement thickness, the momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $u/U = y/\delta$, where u is the velocity at a distance y from the plate and $u = U$ at $y = \delta$, where δ = boundary layer thickness. **(13)**

(OR)

b) For the velocity profile in laminar boundary layer as $u/U = 3/2(y/\delta) - 1/2(y/\delta)^3$. Find the thickness of the boundary layer and the shear stress 1.5 m from the leading edge of a plate. The plate is 2 m long and 1.4 m wide and is placed in water which is moving with a velocity of 200 mm per second. Find the total drag force on the plate if μ for water = 0.01 poise. **(13)**

15. a) The frictional torque 'T' of a disc of diameter 'D' rotating at a speed 'N' in a fluid of viscosity 'μ' and density 'ρ' in a turbulent flow is given by $T = D^5N^2\rho\varphi[\mu(D^2N\rho)]$. Prove this by Buckingham's π – theorem. **(13)**

(OR)

b) i) Explain about Reynold's number and Froude's number. **(5)**

ii) Write short notes on Euler's model law. **(5)**

iii) Mention the drawbacks of Rayleigh's method. **(3)**

PART – C **(1×15=15 Marks)**

16. a) i) For plane Poiseuille flow, prove $\frac{\text{average velocity}}{\text{maximum velocity}} = \frac{2}{3}$. **(10)**

ii) Discuss loss of energy at the pipe entrance. **(5)**

(OR)

b) i) When a sudden contraction is introduced in a horizontal pipeline from 50 cm diameter to 25 cm diameter, the pressure changes from 105 kPa to 69 kPa. If coefficient of contraction is assumed to be 0.65, calculate the flow rate.

The contraction is subsequently followed by a sudden enlargement from 25 cm diameter to 50 cm diameter. If the pressure at the 25 cm section is 69 kPa, workout the pressure at the 50 cm enlarged section.

Take specific weight of water = 10 kN/m^3. **(10)**

ii) Write the expression of 'Borda Carnot' equation and state its usefulness. **(5)**