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ET-201(A)

B. TECH. CIVIL (CONSTRUCTION MANAGEMENT)/B. TECH. CIVIL (WATER RESOURCES ENGINEERING)/ B. Tech. (AEROSPACE ENGINEERING)

Term-End Examination

June, 2019

ET-201(A) : MECHANICS OF FLUIDS

Time : 3 Hours *Maximum Marks : 70*

Note : *Attempt any* ***ten*** *questions. All questions carry equal marks. Use of scientific calculator is permitted.*

1. (a) What is Viscosity ? How does the dynamic viscosity of liquid and gases vary with temperature ? 4

   (b) Define Streamline. What do streamlines indicate ? 3

2. (a) Consider the following steady, incompressible, two-dimensional velocity field : 4

$$V = x^2\hat{i} + (-2xy - 1)\hat{j}$$

Is this flow rotational or irrotational ? Justify your answer.

(b) What is π-theorem ? Also, give its significance. 3

3. (a) The absolute pressure in water at a depth of 5 m is read to be 145 kPa. 4

Determine :

(i) The local atmospheric pressure

(ii) The absolute pressure at a depth of 5 m in a liquid whose specific gravity is 0.78 at the same location.

(b) The u velocity component of a steady, two-dimensional, incompressible flow field is :

$$u = 3ax^2 - 2bxy,$$

where a and b are constants. Velocity component v is unknown. Generate an expression for v as a function of x and y. 3

4. (a) What is the dimensional representation of: 3

   (i) Power

   (ii) Modulus of elasticity

   (iii) Viscosity

   (b) Show that the Reynolds number of flow in a circular pipe of diameter D can be expressed as: 4

$$Re = \frac{4\dot{m}}{\pi D^{\mu}},$$

   where $\dot{m}$ = mass flow rate and μ = dynamic viscosity of fluid.

5. (a) Someone claims that the shear stress at the centre of circular pipe during fully developed laminar flow is zero. Do you agree with this claim ? Explain. 4

   (b) In fully developed laminar flow in a circular pipe, the velocity at $\frac{R}{2}$(midway between the wall surface and the centre line) is measured to be 8 m/s. Determine the velocity at the centre of the pipe. 3

6. (a) What is a Pitot-tube ? How will you determine the velocity at any point with the help of Pitot-tube ? 4

   (b) What are drag and lift ? Why do we usually try to minimize drag ? 3

7. If the velocity distribution of a fluid over a plate is given by : 7

$$u = \frac{3}{4} y - y^2,$$

where u is the velocity in m/s at a distance of y metres above the plate, determine the shear stresses at $y = 0.15$ m. Take dynamic viscosity of the fluid as 8.5×10^{-4} N-sec/m^2.

8. Determine the total pressure and depth of centre of pressure on a plane rectangular surface of 1 m width and 3 m depth when its upper edge is horizontal, and : 7

   (i) coincides with water surface

   (ii) 2 m below the free water surface

9. A 30 m diameter pipe, conveying water, branches into two pipes of diameter 20 cm and

15 cm respectively. If the average velocity in the 30 cm diameter pipe is 2.5 m/s, find the discharge in this pipe. Also determine the velocity in 15 cm pipe, if the average velocity in 20 cm diameter pipe is 2 m/s. 7

10. The resistance R, to the motion of a completely sub-merged body depends upon the length of the body L, velocity of flow V, mass density of fluid ρ, and kinematic viscosity of fluid ν. By dimensional analysis prove that : 7

$$R = \rho V^2 L^2 \phi\left(\frac{VL}{\nu}\right).$$

11. Derive the expression for the velocity distribution for viscous flow through a circular pipe. Also sketch the velocity distribution and shear stress distribution across a section of the pipe. 7

12. A flat plate 1.5 m × 1.5 m moves at 50 km/hour in stationary air of density 1.15 kg/m^3. If the co-

efficient of drag and lift are 0.15 and 0.75 respectively, determine : 7

(i) The lift force

(ii) The drag force

(iii) The resultant force