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ET-201(A)

B.Tech. Civil (Construction Management) / B.Tech. Civil (Water Resources Engineering) / B.Tech. (Aerospace Engineering)

01021

Term-End Examination

June, 2015

ET-201 (A) : MECHANICS OF FLUIDS

Time : 3 hours *Maximum Marks : 70*

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

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1. (a) State the Newton's law of viscosity and give examples of its application.

(b) The velocity distribution for flow over a flat plate is given by

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

where u is the point velocity in metres per second at a distance y metres above the plate. Determine the shear stress at y = 9 cm. Assume dynamic viscosity as 0·8 Ns/m^2. *5+5*

2. (a) What are the gauge pressure and absolute pressure at a point 4 m below the free surface of a liquid of specific gravity 1·53, if atmospheric pressure is equivalent to 750 mm of mercury ?

(b) A circular plate of diameter 3 m is immersed in water in such a way that its least and greatest depth from the free surface of water are 1 m and 3 m respectively. For the front side of the plate, find

(i) the total force exerted by water

(ii) the position of centre of pressure. *5+5*

3. (a) A flat plate 2 m × 2 m moves at 40 km/hour in stationary air of density 1·25 kg/m^3. If the coefficient of drag and lift are 0·2 and 0·8 respectively, find

(i) the lift force,

(ii) the drag force,

(iii) the resultant force, and

(iv) the power required to keep the plate in motion.

(b) A wooden block of width 2 m, depth 1·5 m and length 4 m floats horizontally in water. Find the volume of water displaced and the position of centre of buoyancy. The specific gravity of the wooden block is 0·70. *5+5*

4. (a) Differentiate between any ***two*** of the following :

(i) Dynamic viscosity and Kinematic viscosity

(ii) Absolute and Gauge pressure

(iii) Centre of gravity and Centre of buoyancy

(b) A 30 cm diameter pipe, conveying water, branches into two pipes of diameters 20 cm and 15 cm respectively as shown in Figure 1. 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 the 15 cm pipe, if the average velocity in the 20 cm diameter pipe is 2 m/s.

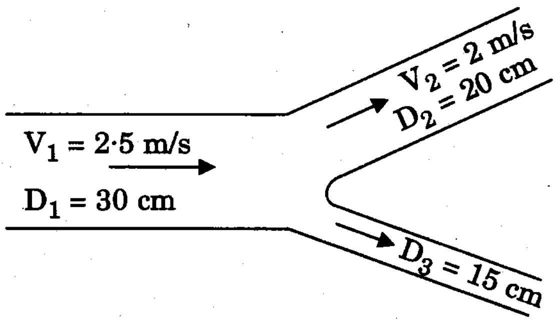

Figure 1 5+5

5. (a) Show that the following stream function

$$\psi = 6x - 4y + 7xy + 9$$

represents an irrotational flow. Find its velocity potential.

(b) If for a two-dimensional potential flow, the velocity potential is given by $\phi = 4x(3y - 4)$, determine the velocity at the point (2, 3). Determine also the value of stream function ψ at the point (2, 3). 5+5

6. (a) A pipe, through which water is flowing, is having diameters 20 cm and 10 cm at the cross-sections 1 and 2 respectively. The velocity of water at section 1 is given as 4·0 m/s. Find the velocity head at sections 1 and 2 and also the rate of discharge.

(b) A venturimeter is installed in a 300 mm diameter horizontal pipeline. The throat pipe rates is 1/3. Water flows through the installation. The pressure in the pipeline is 13·783 N/cm^2 (gauge) and vacuum in the throat is 37·5 cm of mercury. Neglecting head loss in the venturimeter, determine the rate of flow in the pipeline. *5+5*

7. (a) What is a venturimeter ? Derive an expression for the discharge through a venturimeter.

(b) For the laminar flow through a circular pipe, prove that the

(i) shear stress variation across the section of the pipe is linear, and

(ii) velocity variation is parabolic. *5+5*

8. (a) Water is flowing between two large parallel plates which are 2·0 mm apart. Determine

(i) the maximum velocity,

(ii) the pressure drop per unit length, and

(iii) the shear stress at walls of the plate if the average velocity is 0·4 m/s.

Take viscosity of water as 0·01 poise.

(b) Find the displacement thickness, and the momentum thickness for the velocity distribution in the boundary layer given by

$\frac{u}{U} = \frac{y}{\delta}$, where u is the velocity at a distance y from the plate and u = U at y = δ, where δ = boundary layer thickness. *5+5*

9. (a) A man weighing 981 N descends to the ground from an aeroplane with the help of a parachute against the resistance of air. The shape of the parachute is hemispherical of 2 m diameter. Find the velocity of the parachute with which it comes down. Assume C_d = 0·5 and ρ for air = 0·00125 gm/cc and ν = 0·015 stoke.

(b) The force exerted by a flowing fluid on a stationary body depends upon the length (L) of the body, velocity (V) of the fluid, density (ρ) of the fluid, viscosity (μ) of the fluid and acceleration (g) due to gravity. Find an expression for the force (F) using dimensional analysis. *5+5*

10. (a) Define the following terms :

(i) Boundary layer

(ii) Boundary layer thickness

(iii) Drag

(iv) Lift

(v) Momentum thickness

(b) What do you mean by dimensionless numbers ? Define and explain Reynolds number, Froude's number and Mach number. *5+5*