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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

December, 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.*

1. (a) Explain the following terms :

(i) Dynamic viscosity

(ii) Kinematic viscosity

Give their dimensions.

(b) The velocity distribution of a fluid over a plate is given by $u = \frac{3}{4}y - y^2$,

where u is the velocity in metres per second at a distance y metres above the plate. Determine the shear stress at y = 0·15 m. Take dynamic viscosity of the fluid as $8{\cdot}5 \times 10^{-5}$ kg-sec/m^2. *5+5*

2. (a) A tank contains a liquid of specific gravity 0·8. Find the absolute pressure and gauge pressure at a point which is 2 m below the free surface of the liquid. The atmospheric pressure head is equivalent to 760 mm of mercury.

(b) Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2 m long and 1 m wide. The density of air is 1·15 kg/m^3. The plate is kept at such an angle that the coefficients of lift and drag are 0·75 and 0·15 respectively.

Determine :

(i) Lift force

(ii) Drag force

(iii) Resultant force and its direction *5+5*

3. (a) What do you mean by boundary layer separation ? What is the effect of pressure gradient on boundary layer separation ?

(b) A wooden log of 0·8 m diameter and 6 m length is floating in river water. Find the depth of the wooden log in water when the specific gravity of the wooden log is 0·7. *5+5*

4. (a) (i) Define velocity potential function and stream function.

(ii) What are the conditions for flow to be irrotational ?

(b) Water flows through a pipe AB 1·2 m diameter at 3 m/s and then passes through a pipe 1·5 m diameter as shown in Figure 1. At C, the pipe branches. Branch CD is 0·8 m in diameter and carries one-third of the flow in AB. The flow velocity in branch CE is 2·5 m/s. Find the volume rate of flow in AB, the velocity in BC, the velocity in CD and the diameter of CE.

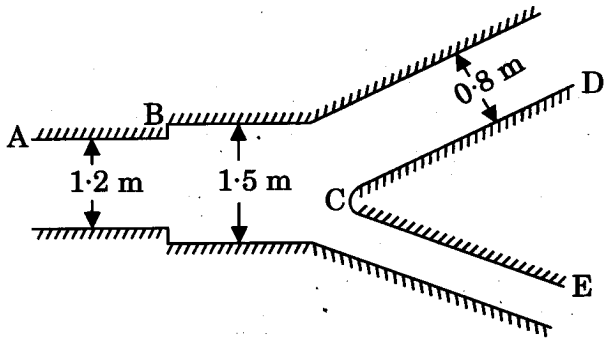

Figure 1 5+5

5. (a) Check if $\phi = x^2 - y^2 + y$ represents the velocity potential for 2-dimensional irrotational flow. If it does, then determine the stream function ψ.

(b) The stream function and velocity potential for a flow are given by

$$\psi = 2xy,$$

$$\phi = x^2 - y^2.$$

Show that the conditions of continuity and irrotational flow are satisfied. 5+5

6. (a) State Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's equation from the first principle.

(b) A venturimeter with a throat diameter of 7·5 cm is installed in a 15 cm diameter pipe. The pressure at the entrance to the meter is 70 kPa (gauge) and it is desired that the pressure at any point should not fall below 2·5 m of water absolute. Determine the maximum flow rate of water through the meter. Take C_d = 0·97 and atmospheric pressure as 100 kPa. *5+5*

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

(b) Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow. *5+5*

8. (a) A crude oil of viscosity 0·9 poise and specific gravity 0·8 is flowing through a horizontal circular pipe of diameter 80 mm and of length 15 m. Calculate the difference of pressure at the two ends of the pipe, if 50 kg of the oil is collected in a tank in 15 seconds.

(b) A man descends to the ground from an aeroplane with the help of a parachute which is hemispherical having a diameter of 4 m against the resistance of air with a uniform velocity of 25 m/s. Find the weight of the man, if the weight of the parachute is 9·81 N. Take C_D = 0·6 and density of air = 1·25 kg/m^3. *5+5*

9. (a) What do you understand by turbulent flow ? What factors decide the type of flow in pipes ?

(b) Explain in brief the following terms :

(i) Total energy line

(ii) Hydraulic gradient line

(iii) Pipes in series

(iv) Pipes in parallel

(v) Equivalent pipe *5+5*

10. (a) A fluid of density ρ and viscosity μ flows at an average velocity V through a circular pipe of diameter D. Show by dimensional analysis, that the shear stress at the pipe wall is given as

$$\tau_0 = \rho V^2 \phi\left[\frac{\rho VD}{\mu}\right].$$

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

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2,$$

where δ = boundary layer thickness. *5+5*
