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10ME/AU/IP/IM/MA36B

Third Semester B.E. Degree Examination, June/July 2013
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Give reasons:
   i) Viscosity of liquids decreases on heating where as viscosity of gases increases on heating. Rain drops and tiny dew drops are spherical in shape.
   ii) The miniscus of water is concave upwards while miniscus of mercury is convex upwards. **(06 Marks)**

b. Derive the expression for surface tension on a liquid droplet and soap bubble. **(06 Marks)**

c. The space between two square flat parallel plates is filled with oil. Each side of the plate is 800mm. Thickness of oil film is 20mm. The upper plate moves at a uniform velocity of 3.2 m/sec, when a force of 50N is applied to upper plate. Determine:
   i) Shear stress.
   ii) Dynamic viscosity of oil in poise.
   iii) Power absorbed in moving the plate.
   iv) Kinematic viscosity in stokes if the specific gravity of oil is 0.9. **(08 Marks)**

2 a. Define: i) Total pressure; ii) Centre of pressure. **(02 Marks)**

b. Obtain the expressions for horizontal and vertical components of the resultant hydrostatic force on a submerged curved surface. **(08 Marks)**

c. An equilateral triangular plate of 6m side is immersed in water with its base at 5m below the free surface. The apex a plate is 9m below free surface of water. Determine the total pressure on the plate and location of centre of pressure below the free surface. **(10 Marks)**

3 a. Define Buoyancy and centre of Buoyancy. **(02 Marks)**

b. Write the differences between Langrangian and Eulerian approaches. **(02 Marks)**

c. A cone of sp-gravity S1 is floating in water with its apex downwards. It has a diameter D and vertical height H. Show that for stable equilibrium of cone $H < \frac{1}{2}\left[\frac{D^2 S^{1/3}}{1-S^{1/3}}\right]^{1/2}$. **(08 Marks)**

d. If for a two dimensional potential flow, the velocity potential function is $\phi = x(2y-1)$. At point P(4, 5), determine;
   i) The velocity at that point; ii) The value of stream function. **(08 Marks)**

4 a. Derive Euler's equation of motion along a stream line. **(06 Marks)**

b. State the momentum equation. How will you apply the momentum equation for determining the force exerted by a flowing liquid on a pipe bend? **(06 Marks)**

c. A conical tube is fixed vertically with its smaller end upwards and it forms a part of pipeline. The velocity at the smaller end is 4.5 m/s and at the large end is 1.5 m/s. Length of the conical tube is 1.5m. The pressure at the upper end is equivalent to head of 10m of water.
   i) Neglecting the frictional loss, determine the pressure at the lower end of tube.
   ii) If head loss in the tube is $0.3\,(V_1-V_2)^2/2g$, where V_1 and V_2 are velocities at smaller and larger end respectively, determine the pressure at the larger end assuming flow downward. **(08 Marks)**

PART – B

5 a. Derive an expression for discharge over a V-notch. **(07 Marks)**

b. Explain briefly the three types of similarities. **(03 Marks)**

c. Define and explain i) Reynold's number; ii) Euler's number. **(02 Marks)**

d. The variables controlling the motion of a floating vessel in water are the drag force F, which depends on speed V, the length L, mass density ρ, dynamic viscosity μ and accln due to gravity g. Derive the expression for F using Buckingham's π-theorem. **(08 Marks)**

6 a. Derive Darcy-Weisbach expression for friction head loss in pipe flow. **(06 Marks)**

b. Define the following terms and briefly explain:

i) Hydraulic gradient line (HGL).

ii) Total energy line (TEL). **(04 Marks)**

c. A horizontal pipeline 40m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 25m of its length from the tank, the pipe is 150m diameter and its diameter suddenly enlarged to 300mm. The height of water level in the tank is 8m above the centre of pipe. Considering all the losses of head which occur, determine the rate of flow f = 0.01 for both sections of pipe. **(10 Marks)**

7 a. Derive Hagen-Poseuille equation for a laminar flow in a circular tube. **(10 Marks)**

b. Water at 15°C flows between two large parallel plates at a distance of 1.6mm apart. Determine:

i) The maximum velocity.

ii) The pressure drop/unit length.

iii) The shear stress at the walls of the plates if the average velocity is 0.2 m/s.

The viscosity of water at 15°C is given as 0.01 poise. **(10 Marks)**

8 a. Define the following and write their equations:

i) Drag; ii) Lift; iii) Displacement thickness; iv) Momentum thickness. **(08 Marks)**

b. Explain Mach angle and Mach cone. **(02 Marks)**

c. A kite 0.8m × 0.8m weighing 3.924 N assumes an angle of 12° to horizontal. The string attached to the kite makes an angle of 45° to the horizontal. The pull on the string is 24.525 N when the wind is blowing at a speed of 30 km/hr. Find the corresponding coefficient of drag and lift. Density of air is given as 1.25 kg/m^3. **(10 Marks)**

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