

## B.Tech 3rd Semester Exam., 2014

## FLUID MECHANICS

Time : 3 hours akubihar.com Full Marks : 70

Instructions :

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. 1 is compulsory.

1. Choose the correct answer (any seven) :  $2 \times 7 = 14$ 

(a) Falling drops of water become spherical due to

- (i) adhesion
- (ii) cohesion
- (iii) viscosity
- (iv) absorption
- (v) surface tension

b) The coefficient of viscosity is a property of

- (i) the fluid
- (ii) the boundary condition
- (iii) the body over which flow occurs
- (iv) the flow velocity

(c) The continuity equation represents conservation of

- ~~(i) mass~~
- (ii) momentum
- (iii) energy
- (iv) vorticity

(d) A streamline is a line

- (i) connecting midpoints of a flow cross-section
- (ii) connecting points of equal velocity in a flow field
- (iii) tangent to which at any point gives the direction of velocity vector at that point
- (iv) drawn normal to the velocity vector at any point

(e) Navier-Stokes equations are associated with

- (i) buoyancy
- ~~(ii) turbulence~~
- (iii) viscosity
- ~~(iv) compressibility~~
- (v) vorticity and circulation

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(f) The velocity distribution at any section of a pipe for steady laminar flow is

- (i) linear
- (ii) exponential
- (iii) parabolic
- (iv) hyperbolic

(g) Which of the following has the form of Reynolds number?

(i)  $\frac{\Delta p}{\rho v^2}$

(ii)  $\frac{v^2 l \rho}{\sigma}$

~~(iii)  $\frac{v d \rho}{\mu}$~~

(iv)  $\frac{v}{\sqrt{g d}}$

(h) The square root of inertia force to gravity force is known as

- (i) pressure coefficient
- ~~(ii) Froude's number~~
- (iii) Weber number
- (iv) Mach number

(i) One atmospheric pressure equals

- (i) 1.0132 kgf/cm<sup>2</sup>
- ~~(ii) 760 mm of mercury~~
- (iii) 1.0135 N/m<sup>2</sup>
- (iv) 10.3 mm of water
- ~~(v) Any of the above~~

(j) The range of coefficient of discharge for a venturimeter is

- (i) 0.6-0.7
- (ii) 0.7-0.85
- (iii) 0.85-0.92
- ~~(iv) 0.92-0.98~~

2/ (a) Check whether the following functions represent possible flow phenomenon of irrotational type :

(i)  $\phi = x^2 - y^2 + y$

(ii)  $\phi = \sin(x + y + z)$

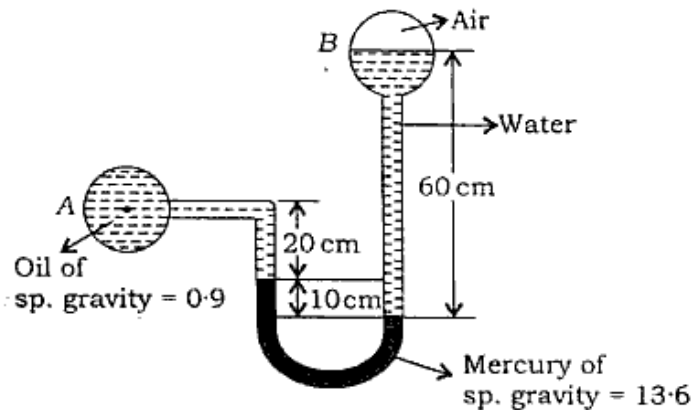
(iii)  $\phi = \frac{4x}{x^2 + y^2}$

(b) Define surface tension. Prove that the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure is given by

$$P = \frac{4\sigma}{d}$$

$$6+8=14$$

3. (a) With neat sketches, explain the conditions of equilibrium for floating and submerged bodies.
- (b) A differential manometer is connected at the two points A and B as shown in the figure below :



At B, air pressure is  $9.81 \text{ N/cm}^2$  (absolute), find the absolute pressure at A. 6+8=14

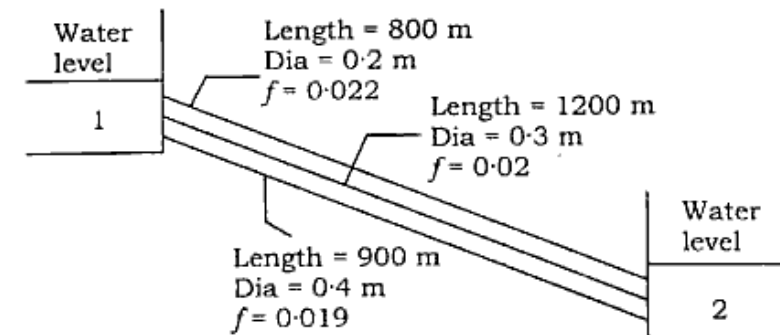
4. (a) Derive Euler's equation of motion along a streamline and hence derive the Bernoulli's theorem.
- (b) A conical tube 1.5 m long is fixed vertically with its smaller end upwards and it forms a part of pipeline. Water flows down the tube and measurements indicate that velocity is 4.5 m/sec at the

smaller end, 1.5 m/sec at the larger end and the pressure head is 10 m of water at the upper end. Presuming that loss of head in the tube is expressed as

$$\frac{0.33(v_1 - v_2)^2}{2g}$$

where  $v_1$  and  $v_2$  are the velocities at the upper and lower ends, make calculations for the pressure head at the lower end of the conical tube. 14

5. (a) The details of a parallel-pipe system for water flow are shown in the figure below :



- (i) If the frictional drop between the junctions is 15 m of water, determine the total flow rate.
- (ii) If the total flow rate is  $0.66 \text{ m}^3/\text{sec}$ , determine the individual flow and the friction drop.

- (b) Find the difference in drag force exerted on a flat plate of size 2 m × 2 m when the plate is moving at a speed of 4 m/sec normal to its plane in (i) water and (ii) air of density 1.24 kg/m<sup>3</sup>. Coefficient of drag is given as 1.15.

8+6=14

6. (a) Prove that the discharge through a triangular notch or weir is given by

$$Q = \frac{8}{15} C_d \tan(\theta/2) \sqrt{2g} H^{5/2}$$

- (b) The head of water over a rectangular notch is 900 mm. The discharge is 300 litres/sec. Find the length of the notch, when  $C_d = 0.62$ .

8+6=14

7. (a) Using Rayleigh's method, determine the rational formula for discharge  $Q$  through a sharp-edged orifice freely into the atmosphere in terms of constant head  $H$ , diameter  $d$ , mass density  $\rho$ , dynamic viscosity  $\mu$  and acceleration due to gravity  $g$ .

- (b) Define the following :

- (i) Laminar and turbulent flow  
(ii) Rotational and irrotational flow  
(iii) Uniform and non-uniform flow

8+6=14

8. (a) Define the equation of continuity. Obtain an expression for continuity equation for a three-dimensional flow.

- (b) (i) What do you mean by equipotential line and a line of constant stream function?

- (ii) Describe the uses and limitations of the flow nets.

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9. Write short notes on any three of the following :

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- (a) Boundary layer separation and its control

- (b) Different types of fluid

- (c) Hydraulic Grade Line (HGL)

- (d) Pitot tube

- (e) Circulation and vorticity