Code : 011307

B.Tech 3rd Semester Exam., 2014

FLUID MECHANICS

Time : 3 hours *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*) : 2×7=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

(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) $\frac{\Delta_\rho}{\rho v^2}$

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

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

(iv) $\frac{v}{\sqrt{gd}}$

(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^2

(ii) 760 mm of mercury

(iii) 1·0135 N/m^2

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

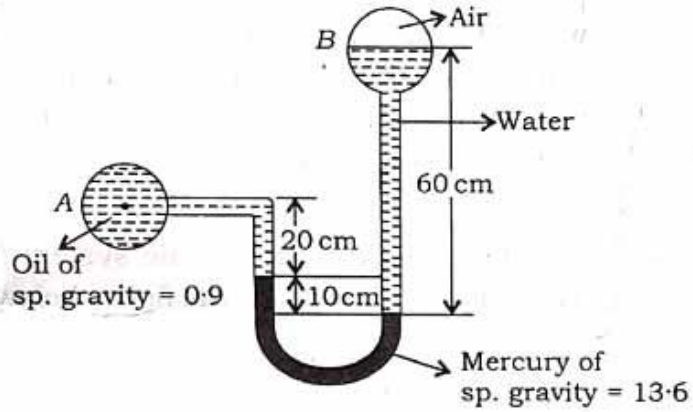
(b) Define surface tension. Prove that the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure is given by

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

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 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.

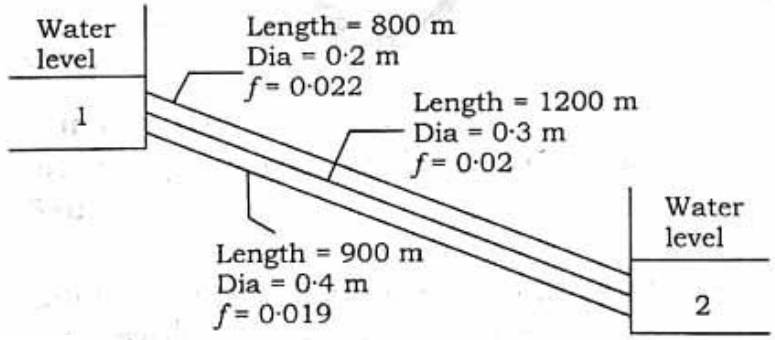
(b) A conical tube 1·5 m long is fixed vertically with its smaller end upwards and it forms a part of pipeline. Water flows down the tube and measurements indicate that velocity is 4·5 m/sec at the

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

$$\frac{0{\cdot}33(v_1 - v_2)^2}{2g}$$

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 m^3/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^3. 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 $C_d = 0{\cdot}62$. 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 ρ, dynamic viscosity μ 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. 14

9. Write short notes on any *three* of the following : 14

(a) Boundary layer separation and its control

(b) Different types of fluid

(c) Hydraulic Grade Line (HGL)

(d) Pitot tube

(e) Circulation and vorticity