Code : 011307

2012

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.*

(v) Assume any suitable data, if required.

1. Write short notes on any *seven* of the following, preferably one or two sentence(s) : 2×7=14

(a) Hydraulics

(b) Cohesion

(c) Stoke

(d) Metacentre

(e) Vorticity

(f) Hydraulic grade line

(g) Streamline

(h) Stagnation point

(i) Model analysis

(j) Drag force

2. *(a)* Is there any analogy of Hooke's law in fluids? If so, state the parallel law in fluids. 6

(b) A conical thrust bearing idealized as a cone of semi-angle 30°, maximum cone diameter 20 cm rests and revolves over a uniform fluid layer of thickness 0·1 cm at 600 r.p.m. If the fluid has a viscosity of 1 poise, calculate the rate of heat dissipated in the bearing. 8

3. *(a)* Define the following and give one example of each : 6

(i) Steady and unsteady flows

(ii) Uniform and non-uniform flows

(iii) Laminar and turbulent flows

(iv) Rotational and irrotational flows

(b) Calculate the capillary effect in millimeters in a glass tube of 4 mm diameter, when immersed in *(i)* water and *(ii)* mercury. The temperature of the liquid is 20 °C and the values of surface tension of water and mercury at 20 °C in contact with air are 0·0735 N/m and 0·51 N/m respectively. The contact angle for water = 0° and for mercury = 130°. Take specific weight of water at 20 °C as equal to 9790 N/m^3. 8

4. *(a)* Define metacentre and metacentric height. Derive an expression for metacentric height for experimental method. 6

(b) A 1 m wide and 1·5 m deep rectangular plane surface lies in water in such a way that its plane makes an angle of 30° with the free water surface. Determine the total pressure and position of centre pressure when the upper edge is 0·75 m below the free water surface. 8

5. *(a)* Define and explain briefly the velocity potential and stream function. 6

(b) If for a two-dimensional flow the stream function is given by $\psi = 2xy$, calculate the velocity at the point (3, 6). Show that the potential ϕ exists for this case and deduce it. 8

6. *(a)* State and prove Bernoulli's equation and write the assumptions involved in deriving it. 6

(b) A 0·225 m diameter cylinder is 1·5 m long and contains water up to a height of 1·05 m. Estimate the speed at which the cylinder may be rotated about its vertical axis so that the axial depth becomes zero. 8

7. *(a)* Define dimensionless Reynolds' number, Froude's number and Mach's number and state their significance for fluid flow problems. 4

(b) Using the method of dimensional analysis, obtain an expression for the discharge Q over a rectangular weir. The discharge depends on the head H over the weir, acceleration due to gravity g, length of the weir crest L, height of the weir crest over the channel bottom Z and the kinematic viscosity ν of the liquid. 10

8. *(a)* What are the major and minor losses in pipe flow? Under what circumstances will they be negligible? 6

(b) Water flows through a pipeline whose diameter varies from 25 cm to 15 cm in a length of 10 m. If the Darcy-Weisbach friction factor is assumed constant at 0·018 for the whole pipe, determine the head loss in friction when the pipe is flowing full with a discharge of 0·06 m^3/s. 8

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

(a) Types of fluids

(b) Free vortex

(c) Venturi meter

(d) Stability of floating body

(e) Water hammer

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Code : 011307

B.Tech 3rd Semester Exam., 2013

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.*

(v) Assume any suitable data, if required.

1. Answer any *seven* questions from the following is short, preferably *1* or *2* sentence(s).

What are the following? 14

Fluid

Capillarity

Stoke

Piezometer

Stream tube

Weir

(a) Hydraulic Grade Line (HGL)

(b) Stagnation point

(c) Friction loss in pipe

(d) Drag force

2. (a) Define the following and give one example of each : 6

(i) Steady and unsteady flows

(ii) Uniform and non-uniform flows

(iii) Laminar and turbulent flows

(iv) Rotational and irrotational flows

(b) Calculate the capillary effect in millimeters in a glass tube of 4 mm diameter, when immersed in *(i)* water and *(ii)* mercury. The temperature of the liquid is 20 °C and the values of surface tension of water and mercury at 20 °C in contact with air are 0·0735 N/m and 0·51 N/m respectively. The contact angle for water = 0° and for mercury = 130°. Take specific weight of water at 20 °C as equal to 9790 N/m^3. 8

3. (a) State Newton's law of viscosity and distinguish between Newtonian and non-Newtonian fluids with examples. 6

(b) A cylinder of 120 mm diameter rotates concentrically inside a fixed cylinder of diameter 125 mm. Both cylinders are 300 mm long. Find the viscosity of the liquid that fills the space between the cylinders if a torque of 0·90 N m is required to maintain a speed of 60 r.p.m. 8

4 (a) Define centre of buoyancy and metacentre. Explain stable, unstable and neutral equilibrium of a floating body. 6

(b) A rectangular pontoon 12 m long and 8 m broad and 3 m deep weighs 800 kN. It carries on its upper deck a boiler 5 m diameter weighing 500 kN. The centre of gravity of the boiler and pontoon may be assumed as their centres of figure and on the same vertical line. Find the metacentric height. Weight of sea water is 10055 N/m^3. 8

5. (a) Define laminar flow, turbulent flow, give one example of each and distinguish between streamlines, streak lines and path lines.

(b) In a two-dimensional incompressible flow, the fluid velocity components are given by $u = x - 4y$ and $v = -y - 4x$. Show that velocity potential exists and determine its form. Find also the stream function. 8

6. (a) State Buckingham's pi theorem. Explain how dimensionless constants can be framed from a set of variables influencing a phenomenon. What is the utility of Buckingham's theorem? 6

(b) The discharge Q over a weir depends on the head of water H, the acceleration due to gravity g, the density ρ, the viscosity μ, and the surface tension σ. Obtain an expression for the discharge using Buckingham's pi theorem. 8

7 (a) What are the different energies of a fluid? Explain each of them. 6

(b) A cylindrical tank 0·9 m in diameter and 2 m high open at top is filled with water to a depth of 1·5 m. It is rotated about its vertical axis at N r.p.m. Determine the value of N which will raise water level even with the brim. 8

 (Continued)

8. (a) Derive Darcy-Weisbach formula for calculating loss of head due to friction in a pipe. 6

(b) A pipeline of 600 mm diameter is 1·5 km long. To increase the discharge another line of the same diameter is introduced parallel to the first in the second-half of the length. If $f = 0 \cdot 01$ and head at inlet is 300 mm, calculate the increase in discharge. 8

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

(a) Real and Ideal Fluids

(b) Circulation and Vorticity

(c) Venturi Meter

(d) Major Losses in Pipe

(e) Syphon

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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) $1{\cdot}0132\ kgf/cm^2$

(ii) 760 mm of mercury

(iii) $1{\cdot}0135\ N/m^2$

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

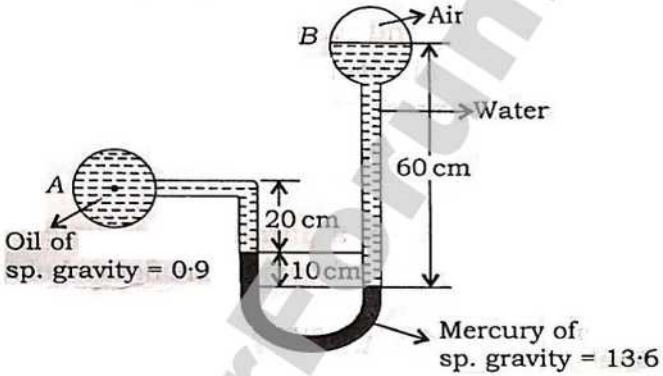
(b) Define surface tension. Prove that the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure is given by

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

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.

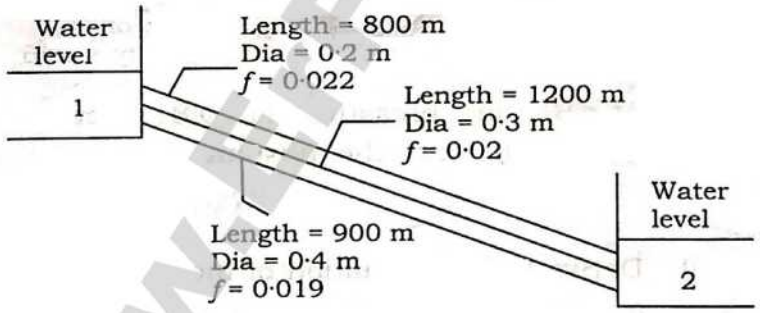
(b) A conical tube 1·5 m long is fixed vertically with its smaller end upwards and it forms a part of pipeline. Water flows down the tube and measurements indicate that velocity is 4·5 m/sec at the

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

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

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