

B.Tech 3rd Semester Exam., 2017

FLUID MECHANICS

Time : 3 hours

Full Marks : 70

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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) The resultant hydrostatic force acts through a point is known as
 - (i) centre of gravity akubihar.com
 - (ii) centre of buoyancy
 - ~~(iii)~~ centre of pressure
 - (iv) None of the above
- (b) For a floating body, the buoyant force passes through the
 - (i) centre of gravity of the body
 - ~~(ii)~~ centre of gravity of the submerged part of the body
 - (iii) metacentre of the body
 - (iv) centroid of the liquid displaced by the body

- (c) The streamline is a line
 - (i) which is along the path of particle
 - (ii) which is always parallel to the main direction of flow
 - (iii) across which there is no flow
 - ~~(iv)~~ on which tangent drawn at any point gives the direction of the velocity akubihar.com
- (d) An orifice is known as large orifice when the head of liquid from the centre of the orifice is
 - (i) more than the 10 times the depth of the orifice
 - (ii) less than 10 times depth of the orifice
 - (iii) less than 5 times depth of the orifice
 - (iv) None of the above akubihar.com
- (e) Bernoulli's theorem deals with the law of conservation of
 - (i) mass
 - (ii) momentum
 - ~~(iii)~~ energy
 - (iv) None of the above

- (f) Irrotational flow means
- (i) the fluid does not rotate while moving
 - (ii) the fluid moves in straight line
 - ~~(iii)~~ the net rotation of fluid particles about their mass centre is zero
 - (iv) None of the above

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- (g) The coefficient of friction of laminar flow through a circular pipe is given by

$$(i) f = \frac{0.0791}{(R_e)^{1/4}}$$

$$(ii) f = \frac{16}{R_e}$$

$$(iii) f = \frac{64}{R_e}$$

- (iv) None of the above

- (h) Models are known undistorted model, if

- ~~(i)~~ the prototype and model are having different scale ratios
- (ii) the prototype and model are having same scale ratios
- (iii) model and prototype are kinematically similar
- (iv) None of the above

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- (i) The geometric similarity between model and prototype means

- (i) the similarity discharge
- ~~(ii)~~ the similarity of linear dimensions
- (iii) the similarity of motion
- (iv) the similarity of forces

- (j) Poise is the unit of

- (i) mass density
- (ii) kinematic viscosity
- ~~(iii)~~ viscosity
- (iv) velocity gradient

2. (a) Define the terms 'buoyancy' and 'centre of buoyancy'. Derive an expression for the metacentric height of a floating body. akubihar.com 9

- (b) Find the volume of the water displaced and position of centre of buoyancy for a wooden block of width 2.5 m and of depth 1.5 m when it floats horizontally in water. The density of wooden block is 650 kg/m³ and its length is 6.0 m. 5

3. (a) The velocity components for a steady flow are given as $u=0$, $v=-y^3-4z$, $w=3y^2z$. Determine (i) whether the flow field is one-, two- or three-dimensional, (ii) whether the flow is compressible and (iii) the stream function for the flow. 7

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(b) Show that the equation of continuity reduces to Laplace's equation when the liquid is incompressible and irrotational.

7

4. (a) A plate, 0.025 mm distance from a fixed plate, moves at 60 cm/s and requires a force of 2 newton per unit area, i.e., 2 N/m^2 to maintain this speed. Determine the fluid viscosity between the plates.

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(b) A pipe branches into two pipes as shown in Fig. 1 below :

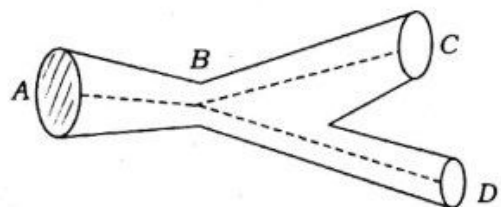


Fig.1

The pipe has diameter of 55 cm at A, 25 cm at B, 28 cm at C and 17 cm at D. If the velocity at A and C be 2 m/sec and 4 m/sec respectively, then find the total quantity of liquid at A and velocities at B and D.

7

5. (a) State Bernoulli's theorem for steady flow of an incompressible fluid. Derive an expression for Bernoulli's equation from first principle and state the assumption made for such a derivation.

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(b) Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43 N/cm^2 (gauge) and with mean velocity of 2.0 m/s. Find the total head or total energy per unit weight of the water at cross section, which is 5 m above the datum line.

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6. (a) Discuss the relative merits and demerits of venturimeter with respect to orifice-meter.

7

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

7

7. (a) Discuss the Hardy cross method for pipe network.

7

(b) Calculate the discharge in each pipe of the network shown in the Fig. 2 given below. The pipe network consists of 5 pipes. The head loss h_f in pipe is given by $h_f = rQ^2$. The values of r for various pipes and also the inflow or outflows at nodes are shown in the Fig. 2 below :

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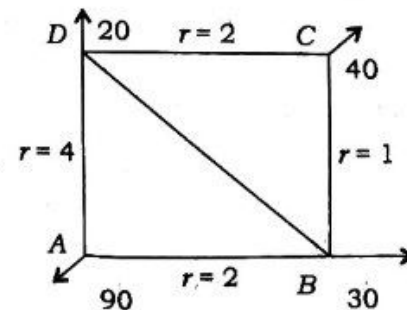


Fig. 2

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8. (a) Define laminar flow. Discuss generalized plane Couette flow between parallel plates. Determine the volumetric flow rate, shear stress and coefficient of friction. 7
- (b) Oil flows between two parallel plates, one of which is at rest and the other moves with a velocity U . If the pressure is decreasing in the direction of the flow at a rate of 0.10 lbf/ft^3 , the dynamic viscosity is $10^{-3} \text{ lbf-sec/ft}^2$, the spacing of the plates is 2 inches and volumetric flow Q per unit width is $0.15 \text{ ft}^2/\text{sec}$, what is the value of U ? 7

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9. (a) Discuss types of similarity and explain each of them. 7
- (b) Using Buckingham's π theorem, show that the frictional torque T of a disk of diameter D rotating at a speed N in a fluid of viscosity μ , density ρ in a turbulent flow is given by

$$T = D^5 N^2 \rho \phi \left(\frac{\mu}{D^2 N \rho} \right) \quad 7$$

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