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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Automobile Engineering

Semester End Examination; May/June - 2018

Fluid Mechanics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Draw neat sketches wherever necessary.

UNIT - I

1 a. Define: i) Specific weight ii) Specific gravity iii) Dynamic viscosity iv) Kinematic viscosity v) Bulk modulus of Elasticity — 10

b. Derive an expression for capillary rise of a liquid. — 3

c. A hydraulic ram 200 mm diameter and 1.2 m long moves within a concentric cylinder 200.4 mm diameter. The annular clearance is fitted with oil of relative density 0.85 and kinematic viscosity 400 mm^2/s. What is the viscous force resisting the motion when the ram moves at a speed of 120 mm/s? — 7

2 a. State hydrostatic law and derive the expression for the same. — 10

b. A differential U-tube mercury manometer is used to measure the pressure difference between points (*1*) and (*2*) in a pipeline conveying water. The point (*1*) is 0.5 m lower than point (*2*). The difference in level of Manometric fluid on two limbs is 0.8 m. Calculate the pressure difference between point (*1*) and (*2*). Assume density of mercury as 13600 kg/m^3 and density of water as 1000 kg/m^3. — 10

UNIT - II

3 a. Deduce the equation of the total hydrostatic force and the location of the centre of pressure on one side of an inclined plane area submerged within a liquid. — 10

b. A circular plate 3.5 m in diameter is submerged in water in such a way that least and greatest depths of the plate below free surface of water are 2.5 m and 4 m respectively. Find the total pressure force on the plate and the position of centre of pressure. — 10

4 a. Discuss the stability criteria of a floating body. — 6

b. Determine the Metacentric height of a floating body experimentally. — 6

c. A solid cylinder of diameter 1 m and height 1 m floats in fresh water with its axis vertical. The cylinder is made of a material of specific gravity 0.7. Determine the Metacentric height and state the condition of its equilibrium. — 8

UNIT - III

5 a. Explain: i) Steady flow and Unsteady flow ii) Uniform flow and Non-Uniform flow iii) Incompressible and Compressible flow — 6

Contd…2

b. Define stream function and velocity potential. Show that the lines of constant stream function and velocity potential must intersect orthogonally. 8

c. The stream function for a two-dimensional flow is given by $\Psi = 2xy$. Calculate the velocity at the point *P(2, 3).* Find the velocity potential function ϕ. 6

6 a. Derive Euler's equation of motion along a streamline. 6

b. Why is the angle of the converging cone in a venturimeter steeper than the diffusion angle? 4

c. A vertical venturimeter is fitted with a circular pipe of diameter 30 cm. Diameter of the throat of the venturimeter is 15 cm. The loss of head from the entrance to the throat is 1/6 times the throat velocity head. The difference in reading of the two limbs of the differential mercury-manometer is 50 cm. Determine the quantity of water flowing through the pipe. 10

UNIT - IV

7 a. Derive the expression for the velocity distribution and shear stress for viscous flow through a circular pipe. Also sketch the velocity distribution and shear stress distribution across a section of the pipe. 10

b. SAE 10 W having density of 900 kg/m^3 and viscosity of 0.018 N-s/m^2 is pumped at a rate of 3 litre/s through a 30 cm diameter pipe, 500 m long. Verify that the flow is laminar. If the pressure at the inlet end of the pipe is 400 kPa. Find the pressure at the outlet end of the pipe. Also find the shear stress at the wall. 10

8 a. Show that the velocity of sound wave in compressible fluid is given by $C = \sqrt{E/\rho}$. 8

b. Explain the terms Mach number, Mach cone and Mach angle. 6

c. A rocket is travelling in air of pressure 35 kN/m^2 and temperature - 40°C. If the Mach angle is 40°, find the Mach number and the velocity of the rocket. Take R = 287 J/kg-K and k = 1.4. 6

UNIT - V

9 a. Determine the loss of head due to friction in pipes by using Chezy's formula. 8

b. Obtain expression for the head loss in a sudden expression in the pipe. 6

c. Water is flowing through a horizontal pipe of 15 cm diameter and of length 30 m. While one end of the pipe is connected to a tank, the other end is open to the atmosphere. If the height of water in the tank is 5 m above the centre of pipe. Determine rate of flow of through the pipe. The Darcy's friction factor = 0.03. 6

10 a. What do you mean by repeating variables? How are the repeating variables selected for dimensional analysis? 8

b. The size of droplets '*d*' produced by a liquid spray nozzle depends upon the nozzle diameter '*D*', jet velocity '*V*', liquid density 'ρ' and viscosity 'μ' and surface tension 'σ'. Using Buckingham's π theorem, obtain the dimensionless parameters. 12

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