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

(An Autonomous Institution affiliated to VTU, Belgaum)

Fourth Semester, B.E. - Mechanical Engineering

Semester End Examination; June - 2016

Fluid Mechanics

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume suitably missing data if required.

UNIT - I

1 a. Define the following properties of the fluid : 6
i) Surface tension ii) Capillarity iii) Vapour pressure.

b. With a schematic diagram explain the relation between absolute pressure, gauge pressure, vacuum pressure and local atmospheric pressure. 5

c. A cylinder of 0.12 m radius rotates concentrically inside a fixed hollow cylinder of 0.013 m radius. Both the cylinders are 0.3 m long. Determine the viscosity of the liquid which fills the space between the cylinders if a torque of 0.88 N-m is required to maintain an angular velocity of 2π rad/s. 9

2 a. What is Newton's law of viscosity? What are the effects of temperature on viscosity of liquids and gases? 6

b. State and prove Pascal's law. 6

c. The space between two square flat parallel plates is filled with oil. Each side of the plate is 60 cm. The thickness of the oil film is 12.5 mm. The upper plate, which moves at 2.5 m/s requires a force of 98.1 N to maintain speed. Determine; 8
i) The dynamic viscosity of the oil in poise,
ii) The kinematic viscosity of the oil in stokes if the specific gravity of the oil is 0.95.

UNIT - II

3 a. What are body and surface forces? 2

b. With neat sketches explain briefly : 8
i) Stable equilibrium ii) Unstable equilibrium
iii) Neutral equilibrium of a submerged body.

c. What is a Piezometer? How do you measure pressure using this? 4

d. For a manometer which measure the pressure difference, in course of flow, across a restriction in a horizontal pipe, show that the difference in heads in given by, 6

$h_1 - h_2 = \left(\frac{\rho_m}{\rho_w} - 1\right) x$, Where x is the difference in the level of manometric fluid. ρ_m and ρ_w are the density of the manometric and the fluid flowing through the pipe.

Contd….2

4 a. Define :

i) Buoyancy ii) Buoyant force iii) Centre of buoyancy 10

iv) Meta centre v) Meta centric height.

b. With neat sketch explain briefly inclined single column manometer. 4

c. A differential manometer is connected at the two points A and B as shown in Fig. Q 4C. At B air pressure is 9.81 N/cm^2 (Abs), find the absolute pressure at A. 6

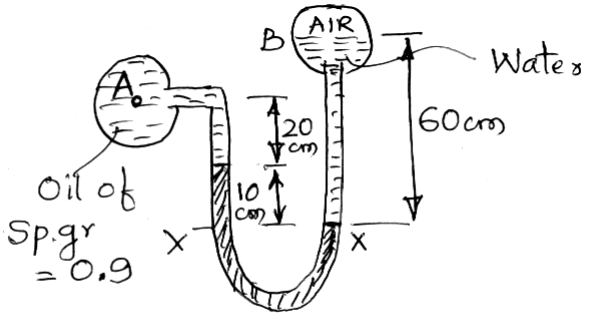

Fig Q4c

UNIT - III

5 a. List the types of fluid flow. 3

b. Derive the expression for continuity equation in three dimensions in Cartesian coordinates. 8

c. What is velocity potential function and stream function? 4

d. The velocity potential function is given by $\phi = 5\left(x^2 + y^2\right)$. Calculate the velocity components at the point (4, 5). 5

6 a. State the Bernoulli's theorem. Derive an expression for Bernoulli's equation stating the assumption made. 10

b. The inlet and throat diameters of a horizontal venturimeter are 30 cm and 10 cm respectively the liquid flowing through the meter is water. The pressure intensity at inlet is 13.734 N/cm^2. While the vacuum pressure head at the throat is 37 cm of mercury. Find the rate of flow. Assume that 4% of the differential head is lost between the inlet and throat. Find also the value of C_d for the venturimeter. 10

UNIT - IV

7 a. Differentiate between : 6

i) Stream line body and bluff body ii) Friction drag and pressure drag.

b. With a neat sketch of flow over a flat plate explain briefly, 6

i) Laminar boundary layer ii) Turbulent boundary layer iii) Laminar sub layer.

c. Find the thickness of the boundary layer at the end of the plate and the drag force on one side of a plate 1 m long and 0.8 m wide when plate in water flowing with a velocity of 150 mm/s. Calculate the value of coefficient of drag also. Take μ for water as 0.01 poise. 8

Contd….3

8 a. What do you mean by major and minor energy losses in pipes? Write the expression for Darcy-Weisbach Formula and Chezy's formula for loss of head due to friction in pipes. 6

b. Define : i) Hydraulic gradient line ii) Total energy line. 4

c. Determine the rate of flow of water through a pipe of diameter 20 cm and length 50 m when one of the end is connected to a tank and other end is open to the atmosphere. The pipe is horizontal and the height of water in the tank is 4 m above the centre of the pipe. Consider all minor losses and take $f = 0.009$ in the formula. 10

$$h_f = \frac{4fLV^2}{2gd}$$

UNIT - V

9 a. Derive Hagen Poiseuille formula starting from the equation of average velocity, 8

$$\bar{u} = \frac{1}{8\mu}\left(\frac{-\partial p}{\partial x}\right)R^2$$

b. What is Reynolds's number? What is its significance? 4

c. Water at 15ºC flows between two large parallel plates at a distance of 1.6 mm apart. Determine; 8

i) The maximum velocity

ii) The pressure drop per unit length

iii) The shear stress at the walls of the plates if the average velocity is 0.2 m/s. The viscosity of water at 15ºC is given as 0.01 poise.

10 a. What do you mean by dimensional homogeneity? Explain with an example. 4

b. Define the following dimensionless numbers, 8

i) Froude's number ii) Euler's number

iii) Weber's number iv) Mach's number.

c. The pressure difference Δp in a pipe of diameter D and length l due to viscous flow depends on the velocity V, viscosity μ and density ρ. Using Buckingham's π-theorem, obtain an expression for ΔP. 8

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