



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

(An Autonomous Institution affiliated to VTU, Belgaum)

**Third Semester, B.E. - Automobile Engineering**

**Semester End Examination; Dec. - 2015**

**Fluid Mechanics**

Time: 3 hrs

Max. Marks: 100

**Note:** i) Answer **FIVE** full questions, selecting at least **ONE** full question from each **unit**.

ii) Write Sketches wherever necessary.

iii) Missing data may suitably be assumed.

### UNIT - I

- 1 a. Show that the relationship between surface tension and pressure inside a droplet of liquid in excess of outside pressure is given by  $\Delta P = \frac{2\sigma}{r}$ . 6
- b. Explain the No-slip condition of Viscous fluid. 4
- c. A hydraulic ram 200 mm diameter and 1.2 m long moves with a concentric cylinder 200.4 mm diameter. The annular clearance is filled with oil of relative density 0.85 and Kinematic viscosity 400 mm<sup>2</sup>/s. What is the viscous force resisting the motion when the ram moves at a speed of 120 mm/s? 10
- 2 a. State and prove the Pascal's law of hydrostatics. 8
- b. Define atmospheric pressure, gauge pressure, vacuum pressure and absolute pressure. 4
- c. 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 13,600 kg/m<sup>3</sup> and density of water as 1000 kg/m<sup>3</sup>. 8

### 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 with in a liquid. 10
- b. A square plate of 2 m side is immersed in water with one of the diagonals vertical. The top edge of the plate is 1.2 m below the water surface. If the width of the plate is 1.5 m, Find the pressure force on one side and the location of centre of pressure. 10
- 4 a. Clearly explain how metacentric height is determined analytically. 10
- b. 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. 10

### UNIT - III

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

- b. Define stream function and velocity potential. Show that the lines of constant stream function and velocity potential must intersect orthogonally. 7
- c. If stream function for steady flow is given by  $\psi = y^2 = x^2$ , determine whether the flow is rotational or irrotational. Find the potential function, if the flow is irrotational and vorticity, if it is rotational. 7
- 6 a. Derive Euler's equation of motion along a streamline. 6
- b. Derive an expression for measurement of flow rate across a venturimeter. 6
- c. At a certain location A of a pipe line carrying an oil of density  $850 \text{ kg/m}^3$ , the diameter is 80 cm, the pressure is  $180 \text{ kN/m}^2$  and the average velocity is 5 m/s. At another section B which is 3 m higher than A, the diameter is 50 m and the pressure is  $100 \text{ kN/m}^2$ . What is the direction of flow? 8

#### 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. 9
- b. An oil viscosity  $0.096 \text{ N-s/m}^2$  and density  $900 \text{ kg/m}^3$  is flowing through a horizontal pipe of 20 cm diameter and if length 20 m. If 90 kg of oil is collected in a tank in 1 minute, Find the difference of pressure at the ends of the pipe. 11
- 8 a. What is sonic velocity? On what factors does it depend? 4
- b. Explain briefly the phenomenon of propagation of elastic waves. 9
- c. A projectile is travelling in air with a velocity of 1450 km/hr. If the temperature of the air is  $5^\circ\text{C}$ , find the Mach number and Mach angle. Take  $R = 287 \text{ J/kg-K}$  and  $k = 1.4$  7

#### UNIT - V

- 9 a. Show that the loss of head due to fluid friction in a circular pipe can be expressed as,  

$$h_f = \frac{4fLV^2}{2gD}$$
, Where f = coefficient of friction. 10
- b. Two tanks containing water are connected by a horizontal pipe of length 250 m and diameter 20 cm. If the volume flow rate of water through the pipe is  $0.02 \text{ m}^3/\text{s}$ , Find the difference in the elevations between the water surfaces in the tanks. The Darcy's friction factor = 0.02. 10
- 10 a. What do you mean by repeating variables? How are the repeating variables selected for dimensional analysis? 6
- b. Differentiate between Kinematic similarity and dynamic similarities. 6
- c. The resistance F of a ship function of its length L, velocity V, acceleration due to gravity of and fluid properties like density  $\rho$  and viscosity  $\mu$ . Establish a dimension less relationship of these parameters with the help of bucking  $\Pi$  theorem. 8