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

(An Autonomous Institution affiliated to VTU, Belgaum)

Third Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec - 2016/Jan - 2017

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 any.

.UNIT - I

1 a. Define :
i) Specific volume ii) Viscosity iii) Specific Gravity of a fluid with their unit. 6

b. 2 litre of petrol weighs 14 N. Calculate the specific weight, mass density, specific volume, and specific gravity of petrol. 6

c. The clearance space between a shaft and a concentric sleeve has been filled with a Newtonian fluid of dynamic viscosity 10 poise. The shaft is of diameter 0.5 m and rotates at 200 rpm, calculate the power lost in the bearing for a sleeve length of 100 mm. The thickness of the oil film is 1.5 mm. 8

2 a. State and prove Pascal's law. 8

b. Derive an expression for the capillary rise of a liquid. 6

c. The capillary rise in the glass tube is not to exceed 0.2 mm of water. Determine its minimum size, given the surface tension from water in contact with air = 0.0725 N/m. 6

UNIT - II

3 a. Define the terms gauge pressure, vacuum pressure and absolute pressure. Indicate their relative position on a chart. 8

b. Explain how vacuum pressure can be measured with the help of U-tube manometer? 4

c. A circular plate 2.5 m diameter is immersed in water its greater and lowest depth below the free surface being 3 m and 1 m respectively. Find; 8
i) The total pressure on one face of the plate ii) The position of the centre of pressure.

4 a. Explain the terms: Meta centre and Meta centric height. 4

b. Derive an expression for the meta centric height of a floating body. 8

c. A wooden cylinder of diameter 'd' and length '2d' floats in water with its axis vertical. Is the equilibrium stable? Locate the meta centre with reference to water surface. Specific gravity of wood is 0.6. 8

UNIT - III

5 a. Define:
i) Steady flow and Unsteady flow ii) Uniform flow and non-uniform flow 6
iii) One dimensional, two dimensional and the three dimensional flows.

b. Derive the continuity equation in three dimensional Cartesian coordinate. 8

c. The following case represents the two velocity components, determine the third component of velocity such that the continuity equation is satisfied. 6

$u = x^2 + y^2 + z^2; \quad v = xy^2 - yz^2 + xy.$

6 a. What are the assumptions made in deriving Euler's equation of motion? Derive the Euler's equation of motion and hence obtain the Bernoulli's equation. 10

b. A pilot static tube placed in the centre of a 200 mm pipeline has one orifice pointing upstream and the other perpendicular to it. If the pressure difference between the two orifices is 40 mm of water when the discharge through the pipe is 0.02275 m^3/s, calculate the coefficient of the Pitot tube. Take the mean velocity in the pipe to be 0.83 of the central velocity. 6

c. Water is flowing upwards through a pipeline having diameters of 15 cm and 30 cm at the bottom and upper end respectively. When a discharge of 50 liters/s is passing through the pipe, the pressure gauge at the bottom and upper section read 30 kPa and -54 kPa respectively. If the frictional loss in the pipe is 2 m. Determine the difference in elevation head. Take Specific weight of water 10,000 N/m^3. 4

UNIT - IV

7 a. Differentiate between pressure drag and friction drag. 4

b. Define displacement thickness. Derive an expression for the displacement thickness. 10

c. Find the difference in drag force exerted on a flat plate of size 2m x 2m when the plate is moving at a speed of 4 m/s normal to its plane: 6

i) In water ii) Air of density 1.24 kg/m^3.

8 a. Derive an expression for the loss of head due to friction in pipe flow. 10

b. A horizontal pipeline 40 m long is connected to a water tank at one end and discharged freely into atmosphere at the other end. For the first 25 m of its length from the tank, the pipe is 15 cm diameter and its diameter is suddenly enlarged to 30 cm. The height of water level in the tank is 8 m above the centre of the pipe. Considering all losses of head which occur, determine the rate of flow. Take f = 0.01 for both sections of the pipe. 10

UNIT - V

9 a. Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of flow. 10

b. A fluid of viscosity 0.7 N-s/m^2 and specific gravity 1.3 is flowing through a circular pipe of diameter 10 cm. The maximum shear stress at the pipe wall is given as 196.2 N/m^2. Find; 10

i) The pressure gradient ii) The average velocity

iii) Reynold number of the flow.

Contd…3

10 a. What do you understand by Fundamental quantities and derived quantities? Explain them giving examples. 6

b. Define the following non dimensional number giving their significance,

i) Reynolds number   ii) Euler's number. 4

c. The resulting force 'F' of a supersonic plane during flight can be considered as dependent upon the length 'L', velocity 'v' of aircraft and air viscosity μ, air density ρ, Bulk modulus of air $'K'\left[ML^{-1}T^{-2}\right]$. Using Bucking ham π theorem show that, 10

$$F = \rho l^2 v^2 \phi\left[\frac{\mu}{\rho L v}, \frac{K}{\rho v^2}\right].$$

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