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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. - 2014

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. Write the units of the following; 5

i) Viscosity ii) Specific weight iii) Kinematic viscosity ix) Surface tension v) Capillarity

b. Explain the No – slip condition of viscous fluid. 5

c. A hydraulic ram 200 mm diameter and 1.2 m long moves with in a concentric cylinder 200.4 mm diameter. The annular clearance is filled 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? 10

2 a. State and prove the Pascal's law of Hydrostatics. 6

b. Show the relation between atmospheric pressure, gauge pressure, Vacuum pressure and absolute pressure with the help of a sketch. 6

c. While one end of U – tube mercury manometer is connected to a horizontal pipe in which water is flowing; its other end is open to the atmosphere. If the difference of Mercury levels in the two limbs of this U – tube manometer is found to be 25 cm and the vertical height of water above mercury remains 10 cm below the pipe axis, find the absolute pressure in the pipe. Assume density of water as 1000 kg/m^3 and specific gravity of mercury as 13.6. Take atmospheric pressure as 101 kN/m^2. 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 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 depth of the plate below from 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. How will you determine the Meta centric height of a floating body experimentally? Explain with a neat sketch. 6

b. A solid cone of base diameter D and vertical height H floats in water with its apex downwards. If the specific gravity of the cone is S, show that for stable equilibrium. 14

$$H^2 < \frac{1}{4}\left[\frac{D^2 S^{1/3}}{1 - S^{1/3}}\right]$$

Unit - III

5 a. Define stream function and velocity potential. Show that the lines of constant stream function and velocity potential must interest orthogonally. 10

Contd.. 2

b. 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. 10

6 a. Derive Euler's equation of motion along a stream line. 6

b. Write down the advantages and disadvantages of using orifice meter over a venturimeter. 4

c. Water is flowing vertically upwards through a pipeline having diameter 1m and 0.5m at the base and top respectively. The pressure at the lower end is 450 mm of Hg, while the pressure at the upper end is 20 kN/m^2. If the loss of head is 20% of difference in velocity head, calculate the discharge. The difference in the elevation is 4 m. 10

Unit - IV

7 a. Prove that for a steady, fully developed laminar flow between two fixed parallel plates, the velocity distribution across the section is parabolic and the average velocity is two third of the maximum velocity. 8

b. An oil of viscosity 0.12 N-s/m^2 and density 900 kg/m^3 flows between two large parallel plates which are kept at a distance of 20 mm apart. The maximum velocity of flow is 1.5 m/s. Determine;

i) the average velocity

ii) the velocity of 5 mm from the plates

iii) the discharge per m width

iv) the velocity gradients at the plates

v) the shear stresses at the plates and

vi) the difference in pressure between two points 10 m apart. 12

8 a. What is sonic velocity? On what factors does it depend? 6

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

c. An airplane is flying at a Mach number of 1.6 in an atmosphere where the pressure is 14.8 kN/m^2 and the density is 0.23 kg/m^3. Compute the speed of the plane. Take; R = 287 J/kg-K and k = 1.4. 8

Unit -V

9 a. Derive an expression for Darcy – Weisbach formula to determine the head loss due to friction. 8

b. Derive an expression for Head loss due to sudden enlargement of a pipe. 7

c. Water is flowing through a pipe of diameter 30 cm and length 100 m. The loss of head over the length of pipe is 2 m of water. If the Darcy's friction factor of the pipe is 0.03, find the rate of flow through the pipe. 5

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

b. The resistance F of a ship is a function of its length L, velocity V, acceleration due to gravity 'g' and fluid properties like density ρ and viscosity μ. Establish a dimensionless relationship of these parameters with the help of Buckingham π relation. 12

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