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

*(An Autonomous Institution affiliated to VTU, Belagavi)*

**Fourth Semester, B.E. - Mechanical 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) Missing data if any, suitably assumed.*

## UNIT - I

1 a. Define the term viscosity, surface tension and capillarity effect. 6

b. Derive an expression for the pressure difference caused by surface tension on a soap bubble. 6

c. Calculate the capillary rise or depression in a glass tube of 2.5 mm diameter when immersed vertically in (i) water and (ii) mercury. Take surface tension as 0.0725 N/m and 0.52 N/m for water and mercury respectively in contact with air. The specific gravity for mercury as 13.6 and angle of contact 130°. 8

2 a. Define the terms density, specific volume, weight density, specific gravity, vapour pressure and vacuum pressure. 6

b. Derive an expression for capillary rise or depression, given the value of the contact angle $\beta$ and the density and surface tension of the liquid. 6

c. A rectangular plate of base area 2500 $cm^2$ and mass 50 kg is slides down an inclined plane making 30° angle with horizontal. If the 2 mm gap between the plate and surface is filled with lubricating oil of viscosity 11.42 Poise. Estimate the steady state velocity of the plate. 8

## UNIT - II

3 a. Derive an expression for total pressure force and center of pressure for an inclined plane surface submerged in a liquid. 8

b. Explain the conditions of equilibrium of a floating body in terms of Metacentric height. 4

c. A circular plate of 3 m diameter and with a concentric hole of 1.5 m diameter is immersed in water in such a way that it's greatest and least depth below the free surface are 4 m and 1.5 m respectively. Determine the total pressure force and center of pressure. 8

4 a. With the help of sketch, explain inverted *U* tube differential manometer. 6

b. Differentiate between the following :

i) Simple manometer and differential manometer 4

ii) Center of buoyancy and Metacentric height

c. A differential manometer is connected to two pipes whose centers are at 3 m difference in height. Higher level pipes is carrying liquid of specific gravity 0.9 at a pressure of 1.8 bar and another pipe is carrying liquid of specific gravity 1.5 at a pressure of 1 bar. The center of carrying low pressure liquid is 2 m above the higher level of the mercury in the manometer. Find the difference in level of mercury in the manometer. 10

## UNIT - III

5 a. Distinguish between the following :

i) Laminar flow and Turbulent flow ii) Compressible and Incompressible flow 6

iii) Steady and Unsteady flow

Contd…2

b. Derive the expression for the continuity equations for three dimensional flows in Cartesian coordinate. 6

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 $\phi$. 8

6 a. Distinguish between :

i) Uniform and Non-uniform flow ii)Stream line and Path line 6

iii) Rotational and Irrotational flow

b. Develop Euler's equation of motion and then derive Bernoulli's equation. 6

c. A 20 cm x 10 cm Venturimeter is inserted in a vertical pipe carrying oil of specific gravity 0.8.The flow of oil is in upward direction. The difference of levels between the throat and inlet section is 50 cm. The oil mercury differential monometer gives a reading of 30 cm of mercury. Neglect losses, find; 8

i) The discharge of oil ii) The pressure difference between inlet and throat section

**UNIT - IV**

7 a. Define the following :

i) Drag force and Lift force ii) Drag coefficient and Lift coefficient 8

iii) Boundary layer thickness iv) Critical Reynolds's number

b. Derive Darcy-Weisbatch formula to calculate the frictional head loss in pipe in terms of friction factor. 12

8 a. Distinguish between;

i) Displacement thickness and momentum thickness ii) Major and minor losses 8

iii) Hydraulic gradient and total energy line iv) Pipes in series and pipes in parallel

b. A reservoir has been built 4.5 km away from a town having a population of 5000, water is to be supplied from the reservoir to the town. The per person consumption of water is 200 liters /day and one half of the daily supplied is to be pumped in 10 hours. The head at the entry is 25 m and that at the exit is 5 m. Assuming that the head lost is due to friction in the pipe. Calculate the diameter of the supply pipe. Take coefficient of friction for the pipe as 0.032. Neglect the remaining all other minor losses. 12

**UNIT - V**

9 a. Derive Hagen Poiseuille equation for head loss due to friction in a pipe. 10

b. Define the following dimensionless numbers giving their significance :

i) Reynolds's number ii) Euler's number iii) Froude's number 10

iv) Weber's number v) Mach number

10 a. Prove that the frictional torque T of a disc of diameter D rotating at a speed N in a fluid of viscosity $\mu$ and density $\rho$ in a turbulent flow is given by, 10

$$T = (D^5 N^2 \rho) f\left[\frac{\mu}{D^2 N \rho}\right]$$

b. A rectangular plate of height *a* and width *b* is held perpendicular to the flow of a fluid. The drag force on the plate is influenced by the dimensions *a* and *b*, the velocity u, and the fluid properties, density $\rho$ and viscosity $\mu$. Obtain a correlation for the drag force in terms of dimensionless parameters. i.e. show that; 10

$$\frac{F}{\rho u^2 b^2} = f\left[\frac{a}{b}, \frac{\rho u b}{\mu}\right]$$

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