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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/July - 2015
Fluid Mechanics

Time: 3 hrs   *Max. Marks: 100*

Note: Answer **FIVE** full questions, selecting **ONE** full question from each *Unit*.

UNIT - I

1. a. Define surface tension, prove that the relationship between surface tension and pressure inside a droplet of liquid on excess of outside pressure is given by $P = \dfrac{4\sigma}{d}$ 6

   b. One liter of crude oil weighs 9.5 N. Calculate its specific weight density, specific gravity and specific volume.   4

   c. A Steel shaft of 30 mm diameter rotates at 240 rpm, in a bearing of diameter 32 mm. Lubricant oil of viscosity 5 poise is used for lubricant of shaft in the bearing. Determine the torque required at the shaft and power lost in maintaining the lubrication. Length of bearing is 90 mm.   10

2. a. Differentiate between: (i) Liquids and gases   (ii) Real fluids and ideal fluids.   4

   b. State and prove the Pascal's Law.   6

   c. Two large surfaces are 2.5 cm apart. This space is filled with glycerin of absolute viscosity 0.82 N-s|m^2. Find what force is required to drag a plate of area 0.5 m^2 between the two surfaces at a speed of 0.6 m|s. (i) when the plate is equidistant from the surfaces   10

   (ii) When the plate is at 1cm from one of the surfaces.

UNIT – II

3. a. Derive an expression for total pressure force and position of Centre of pressure of a vertical plane surface submerged in liquid.   10

   b. A Single column vertical manometer is connected to a pipe containing oil of specific gravity 0.9. The cross section area of the reservoir is 80 times the C|S area of the manometer tube. The reservoir contains mercury of specific gravity 13.6. The level of mercury in the reservoir is at a height of 30 cm below the centre of the pipe and difference of mercury levels in the reservoir and right limb is 50 cm. Find the pressure in the pipe.   10

4. a. What is the difference between U tube and inverted U tube differential manometers? Where they are used?   4

   b. Describe the analytical method of determining the meta centric height.   10

   c. A block of wood of specific gravity 0.8 floats in water. Determine the meta centric height of the block if its size is 3m x 2m x 1m.   6

UNIT - III

5. a. Derive continuity equation for a three dimensional steady in compressible fluid flow in Cartesian co ordinates.   8

b. Distinguish between: (i) Laminar and turbulent flows

(ii) Compressible and incompressible flows (iii) Rotational and Irrotational flows.   6

c. A stream function for a 2D flow is given by $\psi = 8xy$. Calculate the velocity at a point P(4, 5). Find also the velocity potential function ϕ.   6

6. a. Derive an expression for Bernoulli's equation starting from fundamentals by considering the gravitational effect. State the assumptions.   10

b. A Venturimeter is used for measurement of discharge of water in a horizontal pipe line, if the ratio of upstream pipe diameter to that of throat is 2:1, upstream diameter is 300 mm, the difference of pressure between the throat and upstream is equal 3 m head of water and loss of head through meter is one eighth of the throat velocity head, calculate discharge in the pipe.   10

UNIT – IV

7 a. Define energy thickness and prove that energy thickness for boundary layer flow over a flat plate is given by   8

$$\delta^{**} = \int_0^8 \frac{u}{U}\left(1 - \frac{u^2}{U^2}\right)dy$$

b. Derive an expression for drag and lift force.   8

c. A projectile travels in air of pressure 8.829 N/cm^2 at -10^{0}c at a speed of 1200 km/hr. Find the Mach number and the Mach angle. Take; k = 1.4 and R = 287 J/kgK.   4

8 a. Derive Darcy-Weisbach equation for the loss of head due to friction in a pipe.   10

b. The population of a town is 25000, which is projected to grow at a rate of 2% annually over a period of 25 years. It is stipulated that half of its daily supply of 100 litre per head of water is consumed in 8 hours. The town is to the supplied water from a reservoir situated at a distance of 2 km. The supply head is 12 m out of which 8 m should be available at the delivery end. For this perspective planning what size of steel pipe should be laid? The Chezy's constant of the pipe. C = 50.   10

UNIT - V

9 a. Derive an expression for the velocity distribution for viscous flow through a circular pipe.   10

b. An oil of viscosity 0.1 N-s/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300 m. The rate of flow of fluid through the pipe is 3.5 litres / sec. Find the pressure drop in a length of 300 m and also the shear stress at the pipe wall.   10

10 a. Define the following dimension less numbers and state their significance :

i) Reynold's number (ii) Froude's number   10

(iii) Euler's number (iv) Weber's number (v) Mach's number.

b. Show that frictional torque T of a disc of diameter D rotating at a speed N in a fluid of viscosity μ and density ρ in a turbulent flow is given by   10

$$T = \rho N^2 D^5 \phi\left(\frac{\mu}{\rho ND^2}\right)$$

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