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

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Automobile Engineering

Semester End Examination; May/June - 2019

Fluid Mechanics

Time: 3 hrs *Max. Marks: 100*

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

ii) Draw neat sketches wherever necessary.

iii) Missing data if any, May be suitably assumed.

UNIT - I

1 a. Derive expressions for;

i) Surface tension on a; Liquid droplet, Hollow bubble and Liquid jet

ii) Capillary rise and Capillary fall — 12

b. An Oil of viscosity 5 poise is used for lubrication between a shaft and sleeve. The diameter of the shaft is 0.5 m and rotates at 200 rpm. Calculate the power lost in oil for a sleeve length of 100 mm. The thickness of oil film is 1.0 mm. — 8

2 a. Derive expressions for measuring difference of pressures between two points in a pipe or in two different pipes for an;

i) U-tube differential manometer; Two pipes at different level and Two pipes at same level

ii) Inverted U-tube differential manometer — 12

b. Calculate the pressure due to column of 0.3 of;

i) Water ii) An oil of specific gravity 0.8

iii) Mercury of specific gravity 13.6. Take density of water, $\rho = 1000$ kg/m^3 — 8

UNIT - II

3 a. How do you determine the horizontal and vertical components of the resultant pressure on a submerged curved surface? Derive the same. — 12

b. Find the total pressure and position of centre of pressure on a triangular plate of base 2 m and height 3 m which is immersed in water in such a way that the plan of the plate makes an angle of 60° with free surface of the water? The base of the plate is parallel to water surface and at a depth of 2.5 m from water surface. — 8

4 a. Derive the expressions for the meta-centric height of a floating body by;

i) Analytical Method ii) Experimental Method — 14

b. A solid cylinder of diameter 4.0 m has a height of 4.0 m. Find the meta-centric height of the cylinder, if the specific gravity of the material of cylinder is 0.6 and it is floating in water with its axis vertical. State whether the equilibrium is stable or unstable. — 6

Contd…2

UNIT - III

5 a. Prove that, if velocity potential (φ) exists, the flow should be irrotational i.e., $\omega_z = \omega_y = \omega_x = 0$. 10

b. The following cases represent the two velocity components, determine the third component of velocity such that they satisfy the continuity equation; 10

i) $u = x^2 + y^2 + z^2; v = xy^2 - yz^2 + xy$ *ii*) $v = 2y^2; w = 2xyz$

6 a. State Bernoulli's theorem for steady flow of an *n* incompressible fluid. Derive an expression for Bernoulli's equation from first principles and state the assumptions made for such a derivation. 12

b. The water is flowing through a pipe having diameters 20 cm and 10 cm at sections 1 and 2 respectively. The rate of flow through pipe is 35 *lts*/s. The section 1 is 6 m above datum and section 2 is 4 m above datum. If the pressure at section 1 is 39.24 N/cm^2, find the intensity of pressure at section 2. 8

UNIT - IV

7 a. Prove that the velocity distribution for viscous flow between two parallel plates when both plates are fixed across a section is parabolic in nature. Also prove that maximum velocity is equal to one and a half times the average velocity. 12

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 *lts*/s. Find the pressure drop in a length of 300 m and also the shear stress at the pipe wall. 8

8 a. Derive the continuity equation for one dimensional compressible flow in differential form. 6

b. Define Mach number. What is the significance of Mach number in compressible fluid flows? 6

c. Find the sonic velocity for the following fluids :

i) Crude oil of Sp. Gr. and bulk modulus 153036 N/cm^2 8

ii) Mercury having a bulk modulus of 2648700 N/cm^2

UNIT - V

9 a. Derive expressions;

i) Darcy Weisbach equation 14

ii) Chezy's equation for the loss of head due to friction in pipes

b. Water is flowing through a horizontal pipe of diameter 200 mm at a velocity of 3.0 m/s. A circular solid plate of diameter 150 mm is placed in the pipe to obstruct the flow. Find the loss of the head due to obstruction in the pipe of $C_C = 0.62$. 6

10 a. Explain;

i) Methods of Selecting repeating variables in Buckingham's π theorem 10

ii) Types of Forces acting in moving fluid

b. The efficiency η of a fan depends on density ρ, dynamic viscosity μ of the fluid, angular viscosity ω, diameter *D* of the rotor and Discharge *Q*. Express η in terms of dimensionless parameters. 10

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