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

(An Autonomous Institution affiliated to VTU, Belagavi)

Third Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec - 2017/Jan - 2018

Fluid Mechanics

Time: 3 hrs *Max. Marks: 100*

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

UNIT - I

1 a. Distinguish between :

i) Ideal fluid and Real fluid ii) Dynamic viscosity and Kinematic viscosity 6

iii) Absolute pressure and Gauge pressure.

b. A liquid when poured into a graduated cylinder is found to weigh 8 N when occupying a volume of 500 ml. Determine its specific weight, density, specific volume and specific gravity 4

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. 10

2 a. State Hydrostatic law and hence show that pressure increases linearly vertically downwards in incompressible fluid. 6

b. Define Surface tension and vapour pressure. 4

c. A thin 20-cm x 20-cm flat plate is pulled at 1 m/s horizontally through a 3.6 mm-thick oil layer sandwiched between two plates, one stationary and the other moving at a constant velocity of 0.3 m/s, as shown in Fig. Q 2(c). The dynamic viscosity of oil is 0.027 Pa.s, determine the force that needs to be applied on the plate to maintain this motion. 10

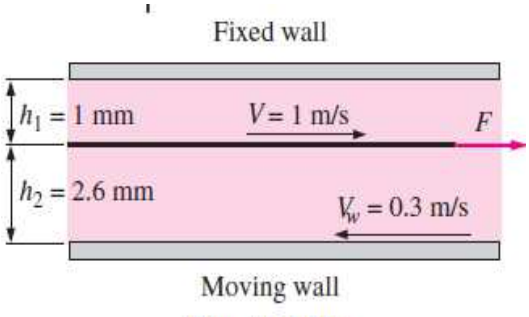

Fig. Q.2 (c)

UNIT - II

3 a. Differentiate between U tube differential manometer and inverted U tube differential manometer 5

b. Derive an expression for total pressure force and centre of pressure for an inclined plane surface submerged in a liquid. 5

Contd…2

c. A room in the lower level of a cruise ship has a 30 cm-diameter circular window. If the midpoint of the window is 5 m below the water surface, determine hydrostatic force acting on the window, and pressure center. Take specific gravity of seawater as 1.025. 10

4 a. Define meta centre and meta centric height. Develop an analytical method to determine the meta centric height of a floating object. 10

b. The gage pressure of the air in the tank shown in Fig. Q. 4(b) is measured to be 65 kPa. Determine the differential height *h* of the mercury column. 10

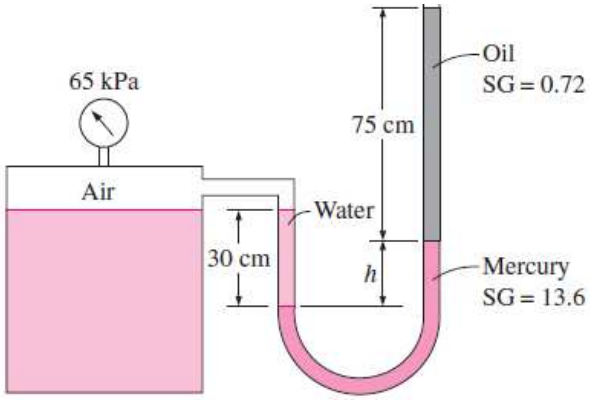

Fig. Q.4(b)

UNIT - III

5 a. Distinguish between:

i) Laminar and turbulent flow ii) Steady and unsteady flow 6

iii) Compressible and incompressible flow.

b. Derive the expression for the continuity equations for three dimensional flow 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 ϕ. 8

6 a. Distinguish between :

i) Uniform and non uniform flow ii) Stream function and velocity potential function 6

iii) Rotational and Irrotational flow.

b. Derive an expression for discharge through the orifice meter 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 manometer gives a reading of 30cm of mercury. Neglect losses. 8

Find;

i) The discharge of oil

ii) The pressure difference between inlet and throat section.

Contd…3

UNIT - IV

7 a. Define; i) Pressure drag and friction drag ii) Bondary layer thickness iii) Drag coefficient and lift coefficient iv) Critical Reynold's number. 08

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

8a. Distinguish between :

i) Drag force and Lift force ii) Major and Minor losses 08

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

b. A flat plate of 2 m x 2 m moves with a velocity of 50 km/hr in air of specific weight of 1.15 kg/m^3. If the coefficients of lift and drag are 0.75 and 0.15 respectively. 06

Calculate;

i) Drag force ii) Lift force iii) Resultant force.

c. A 20 cm diameter pipe 5000 m long conveys 0.05m^3/s of water which is to be pumped through a height of 6 m. Find the power required by the pump if its efficiency is 75%. Take friction factor as 0.006. 06

UNIT - V

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

b. The resisting force of a supersonic plane during flight can be considered as dependent on the length of the aircraft L, velocity V, viscosity μ, mass density ρ, Bulk modulus K. Express the fundamental relationship between resisting force and these variables as : 10

$R = L^2V^2\rho\,\varphi\left(\frac{K}{V^2\rho}, \frac{\mu}{\rho VL}\right)$.

10 a. Define the following dimensionless numbers giving their significance :

i) Reynold's number ii) Eulers's number iii) Froude's number 10

iv) Weber's number v) Mach number.

b. Consider fully developed Couette flow-flow between two infinite parallel plates separated by distance *h*, with the top plate moving and the bottom plate stationary. The flow is steady, incompressible, and two-dimensional in the *xy*-plane. Using Buckingham's π theorem generate a dimensionless relationship for the *x* component of fluid velocity *u* as a function of fluid viscosity μ , top plate speed *V*, distance *h*, fluid density ρ , and distance *y*. Or Show that $u/V = f$ (Re, y/h). 10

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