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10ME/AU46B

Fourth Semester B.E. Degree Examination, June/July 2014
Fluid Mechanics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Define the following fluid properties and state their units:
i) Specific weight ii) Viscosity
iii) Surface tension iv) Specific volume **(06 Marks)**

b. Classify the various types of fluids with the help of a diagram and briefly explain them. **(05 Marks)**

c. An oil film of thickness 1.5 mm is used for lubrication between a square plate of size 0.9 m × 0.9 m and an inclined plane having an angle of inclination 20° with the horizontal. The weight of the square plate is 392.4 N and it slides down the plane with a uniform velocity of 0.2 m/s. Find the dynamic viscosity of oil. **(09 Marks)**

2 a. State and prove hydrostatic law. **(06 Marks)**

b. The measurements of pressure at the base and top of a mountain are 74 cm and 60 cm of mercury respectively. Calculate the height of the mountain if air has a mass density of 1.22 kg/m^3. **(06 Marks)**

c. Derive expressions for total pressure and centre of pressure for a plane surface immersed vertically in a static mass of fluid. **(08 Marks)**

3 a. Define the terms buoyancy, centre of buoyancy, meta-centre and meta-centric height. **(06 Marks)**

b. A block of wood of specific gravity 0.8 floats in water. Determine the meta-centric height of block if its size is 3 m long, 2 m wide and 1 m height. State whether equilibrium is stable or unstable. **(08 Marks)**

c. Derive continuity equation in Cartesian coordinates. **(06 Marks)**

4 a. Derive Euler's equation of motion for ideal fluids and hence deduce Bernoulli's equation of motion. State the assumptions made. **(10 Marks)**

b. A pipe line carrying oil of specific gravity 0.8 changes in diameter from 300 mm at position (1) to 600 mm in diameter at position(2), which is 5 m at a higher level. If the pressure at position (1) and (2) are 100 kN/m^2 and 60 kN/m^2 respectively and discharge is 300 ℓps, determine (i) loss of head and (ii) direction of flow. **(10 Marks)**

PART – B

5 a. Derive an expression for discharge through a venturi-meter. **(08 Marks)**

b. State Buckingham's π theorem. **(04 Marks)**

c. The frictional torque 'T' of a disc of diameter 'D' rotating at a speed of 'N' in a fluid of viscosity 'μ' and density 'ρ' in a turbulent flow is given by $T = D^2N^2\rho\phi\left[\frac{M}{D^2N\rho}\right]$. Prove this relation using Buckingham's π theorem. **(08 Marks)**

6 a. Derive Darcy's relation for a turbulent flow through a circular pipe. **(10 Marks)**

b. Find the diameter of a pipe of length 2000 m when the rate of flow of water through the pipe is 200 ℓps and head lost due to friction is 4 m. Take the value of 'C' = 50 in Chezy's formula. **(10 Marks)**

7 a. Prove that the ratio of maximum velocity to average velocity in a viscous flow of fluid through a circular pipe is 2.0. **(10 Marks)**

b. Lubricating oil of specific gravity 0.85 and dynamic viscosity 0.1 N-s/m^2 is pumped through a 3 cm diameter pipe. If the pressure drop per metre length of the pipe is 15 kPa, determine:

i) The mass flow rate of oil in kg/min.
ii) The shear stress at the pipe wall.
iii) Reynolds number of the flow and
iv) The power required per 40 m length of the pipe to maintain the flow. **(10 Marks)**

8 a. The experiments were conducted in a wind tunnel with a wind speed of 50 km/hr on a flat plate of size 2 m long and 1 m wide. The density of air is 1.15 kg/m^3. The coefficients of lift and drag are 0.75 and 0.15 respectively. Determine:

i) Lift force
ii) Drag force
iii) The resultant force
iv) Direction of resultant force
v) Power exerted by air on plate. **(10 Marks)**

b. Briefly explain, what is meant by boundary layer and hence define,

i) Displacement thickness
ii) Momentum thickness **(06 Marks)**

c. Define Mach number and derive an expression for the same. **(04 Marks)**

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