SE309

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S.E. Mechanical (Sem-III) (Revised Course 2016-2017)
EXAMINATION Nov/Dec 2019
Fluid Mechanics

[Duration : Three Hours] **[Total Marks : 100]**

Instructions
1) Draw neat sketches, **wherever** necessary
2) Assume suitable data, if **required**.

PART - A

Answer **any two** questions from the following **2X20=40**

Q.1
a) State and prove Pascal's law. **05**
b) Define surface tension. Derive an expression for surface tension on a liquid droplet. **05**
c) Two large plane surfaces are 4.5cm apart. The space between the surfaces is filled with glycerine. What force is required to drag a very thin plate of surface area 1.5 square metre between the two large plane surfaces at a speed of 2m/s if: **10**
   i) The thin plate is in the middle of the two plane surfaces , and
   ii) The thin plate is at a distance of 3.5 cm from one of the plane surfaces? Take dynamic viscosity of glycerine = $8.10 \times 10^{-1} Ns/m^2$.

Q.2
a) Derive an expression for total pressure & centre of pressure for a vertical plane surface submerged in liquid. **10**
b) A siphon of diameter 200mm connects two reservoirs having a difference in elevation of 20m. The length of the siphon is 500m and the summit is 3 m above the water level in the upper reservoir . The length of the pipe from upper reservoir to the summit is 100m. Determine the discharge through the siphon and also pressure at the summit. Neglect minor losses. The coefficient of friction f= 0.005. **10**

Q.3
a) Derive Bernoulli's equation from Euler's equation of motion. **10**
b) 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 at the point P. **10**

PART –B

Answer **any two** questions from the following **2x20=40**

Q.4
a) Discuss boundary layer separation and methods of its prevention. **10**
b) The resistance force R of a supersonic plane during flight can be considered as dependent upon the length l, velocity v, air viscosity μ air density ρ and bulk modulus K. Express the functional relationship between these variables and the resisting force. **10**

Q.5
a) Define and describe any five dimensionless numbers used in fluid mechanics. **10**
b) Find the displacement thickness, momentum thickness and energy thickness for the velocity distribution in the boundary layer given by $\frac{u}{U} = \frac{y}{\delta}$, where u is the velocity at a distance y from the plate and u=U at y =δ. **10**

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Q.6 a) Derive an expression for power absorbed to overcome viscous resistance of a journal bearing. **10**

b) A ship 70m long & 10 m broad has a displacement of 19620 kN. A weight of 343.35 kN is moved across the deck through a distance of 6m. The ship is tilted through 6°. The moment of inertia of the ship at water – line about its fore and aft axis is 75% of M.O.I of the circumscribing rectangle . The centre of buoyancy is 2.25m below water line. Find the meta- centric height & position of centre of gravity of ship. Specific weight of sea water is $10104 N/m^3$. **10**

PART – C

Answer **any one** questions from the following **1x20=20**

Q.7 a) Derive the expression for continuity equation for a 3- dimensional flow. **10**

b) A circular opening, 3 m diameter , in a vertical side of a tank is closed by a disc of 3m diameter which can rotate about a horizontal diameter. Calculate: **10**

i) The force on the disc, and

ii) The torque required to maintain the disc in equilibrium in the vertical position when the head of water above the horizontal diameter is 4m

Q.8 a) Discuss the conditions of equilibrium of a submerged body. **10**

b) For the velocity profile given below, state whether the boundary layer has separated or on the verge of separation or will remain attached with the surface. **10**

i) $\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$

ii) $\frac{u}{U} = -2\left(\frac{y}{\delta}\right) + \frac{1}{2}\left(\frac{y}{\delta}\right)^3$

iii) $\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right)^2 + \frac{1}{2}\left(\frac{y}{\delta}\right)^3$