01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

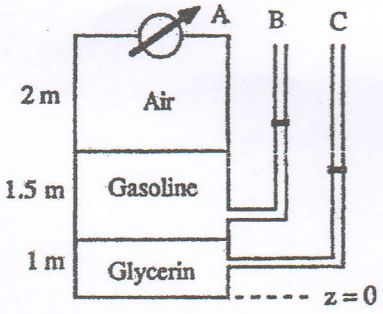
Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Fluid Mechanics *(CE505)*

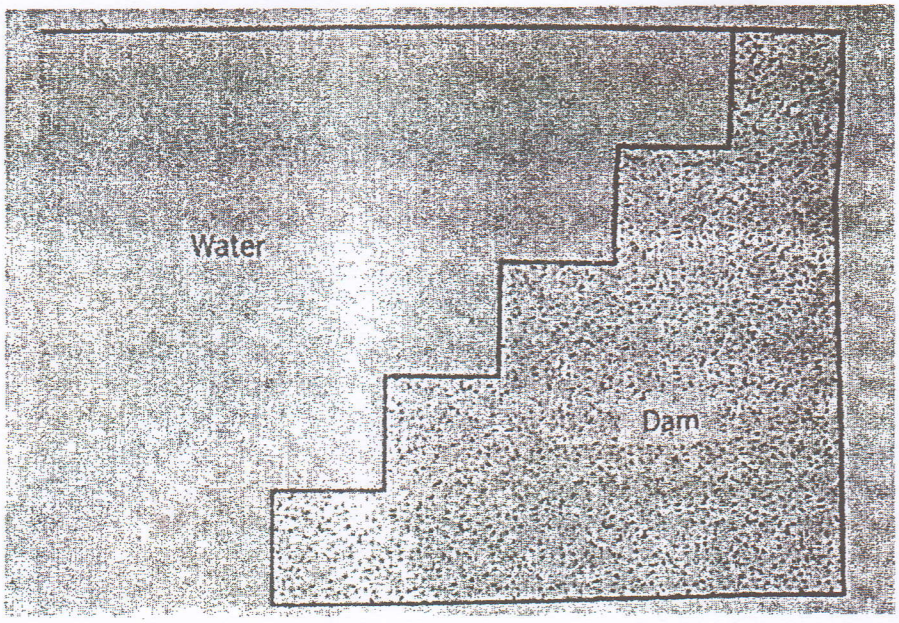
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Assume suitable data if necessary.***

1. a) A stationary bearing of length 30 cm and internal radius 8.025 cm has been used to provide lateral stability to a 8 cm radius shaft rotating at a constant speed of 200 rpm. The space between the shaft and bearing is filled with a lubricant having viscosity 2.5 poise. Find the torque required to overcome the friction in bearing. Take the velocity profile as linear. [8]

   b) In Fig. below, sensor A reads 1.5 kPa (gage). All fluids are at 20°C. Determine the elevations Z in meters of the liquid levels in the open piezometer tubes B and C. [8]



2. a) For the geometry shown, what is the vertical force on the dam? The steps are 0.3m high, 0.3 m deep and 3 m wide. [6]

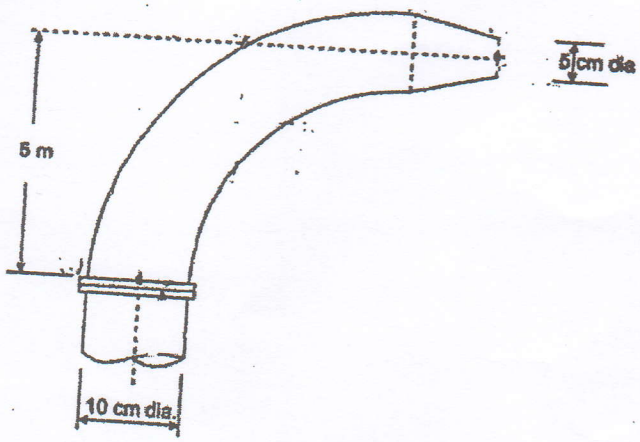


b) A thin-walled, open-topped tank in the form of a cube of 500 mm side is initially full of oil of relative density 0.88. It is accelerated uniformly at 5 m/s2 up a long straight slope at arctan (1/4) to the horizontal, the base of the tank remaining parallel to the slope, and the two side faces remaining parallel to the direction of motion. Calculate (a) the volume of oil left in the tank when no more spilling occurs, and (b) the pressure at the lowest corners of the tank. [4+6]

3. a) A discharge of 12 lps is passed over a 45 degree sharp-edged triangular notch under a head of 21 cm. The same discharge is passed over a sharp-crested rectangular notch of length 30 cm, the head being 7.8 cm. Calculate the coefficient of discharge of two notches. What is the magnitude of error that would cause 2 percent error in discharge in the two cases. [8]

b) A velocity for a steady, in compressible flow in the xy plane is given by $\vec{V} = \vec{i}\, A/x + \vec{j}\, Ay/x^2$, where $A = 2\ m^2/s$, and the coordinates are measured in meters. Obtain an equation for the streamline that passes through the point (x, y) = (1, 3). Calculate the time required for a fluid particle to move from x = 1m to x = 2m in this flow field. [8]

4. a) Water flows into atmosphere through a vertical bend nozzle assembly as shown in figure below. The pipe diameter is 10 cm and nozzle exit diameter is 5 cm. The rate of flow of water is 2400 lpm. The interior volume of the assembly is 18.2 litres. The head loss in the bend is $0.5\frac{v^2}{2g}$ and in the nozzle it is $2\frac{v^2}{2g}$, where V is the velocity of water in the pipe. Compute the hydrodynamic force on the system. [8]



b) Define boundary layer separation and stagnation point with the help of figure. [3]

c) When a jet of fluid strikes series of Semicircular vanes, show that the maximum efficiency of the system is 1. [5]

5. a) The wall shear stress τ_w in a boundary layer is assumed to be a function of stream velocity U, boundary layer thickness δ, local turbulence velocity u', density ρ, and local pressure gradient dp/dx. Using (ρ, U,δ) as repeating variables, rewrite this relationship as a dimensionless function. [8]

b) A jet plane which weighs 19920N has a wing area of $25m^2$. It is flying at a speed of 200km/hr. When the engine develops 588.5KW, 80% of this power is used to overcome the drag resistance of the wing. Calculate the coefficient of lift and coefficient of drag for the wing. Take density of air = $1.25\ kg/m^3$. [8]

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02 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

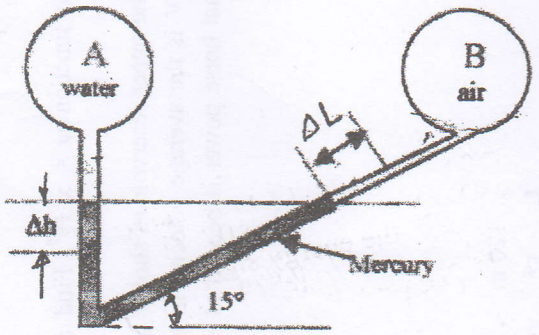
Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, B. Agri.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Fluid Mechanics *(CE505)*

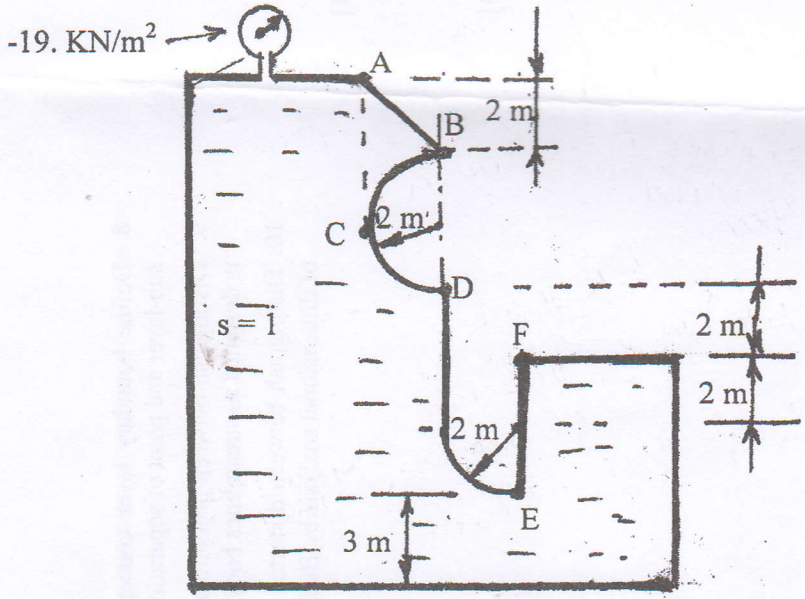
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Derive an expression for surface tension and capillarity. A 15 cm diameter vertical cylinder rotates concentrically inside another cylinder of diameter 15.10 cm both cylinders are 25 cm high. The space between the cylinders is filled with a liquid whose viscosity is unknown. If a torque of 12 Nm is required to rotate the inner cylinder at 100 rpm determine the viscosity of the fluid. [2+4]

2. In the figure below the pressures at A and B are the same, 100 kPa. If water is introduced at A to increase P_A to 130 kPa, find the new positions of the mercury. The connecting tube is an uniform 1-cm in diameter. Assume no change in the liquid densities. [6]

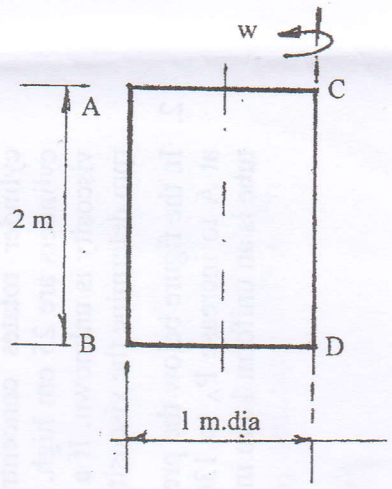


3. a) Find the resultant pressure force due to water on a curved surface BCDEF of 10 m length as shown in figure below. [8]



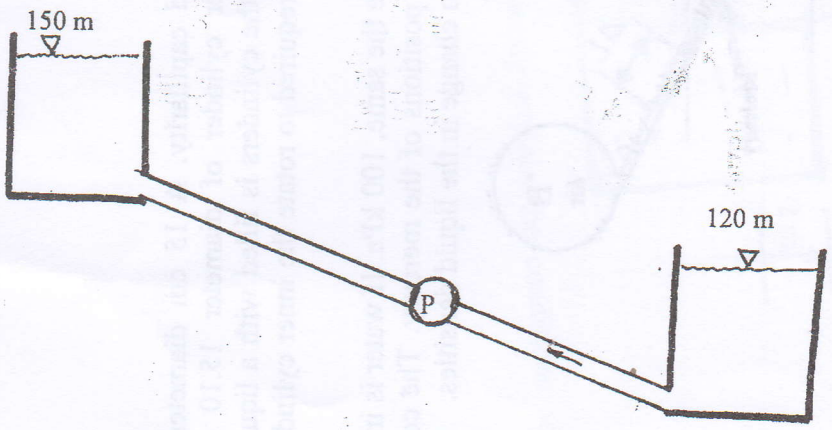
b) Explain the use of hydrometer and shortly explain the conditions of stability of floating bodies. [6]

c) A closed cylindrical tank of 1 m diameter and 2 m high is completely filled with water. If it is being rotated about its vertical axis with uniform speed of 100 rpm, Draw pressure intensity diagram along surface AB and AC with values. [6]

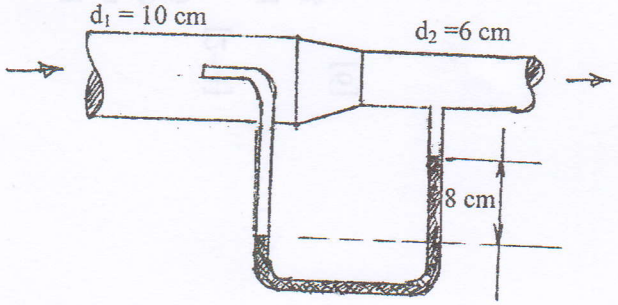


4. Sketch the streamlines represented by the stream function $\psi = x^2+y^2$. Find also the velocity and its direction at point (3,4). [3+3]

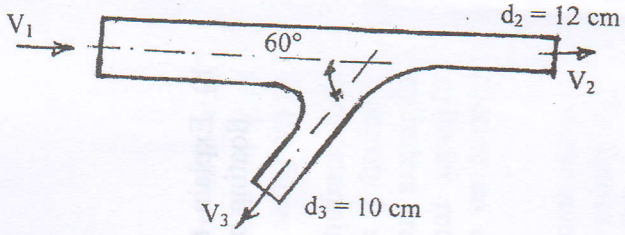
5. Water is pumped at $0.12 m^3/s$ from the lower to the upper reservoir as shown in figure below. Pipe friction losses $h_f = 27v^2/2g$, where V is the average velocity in the pipe (diameter = 15 cm). If pump is 75% efficient, what horse power is needed to drive it? Draw TEL and HGL. [5+3]



6. In figure below the flowing fluid is CO_2 (density = 3 kg/m^3). Neglect losses. If p_1 = 170 kPa and the manometer fluid is meriam red oil (S.G = 0.827). Estimate : (a) p_2 and (b) the gas rate in m^3/h. [4+5]



7. Ignoring friction losses, calculate the magnitude and direction of resultant force, exerted on the bend when water discharges at the atmosphere as shown in figure below. Both nozzles discharge water with a velocity of 20 m/sec. Consider the axes of the pipe and the nozzles lie in a horizontal plane. [8]



8. Define boundary layer concept. Explain the terms boundary layer thickness, laminar sub-layer and point of separation of boundary layer with sketch. [5]
9. Distinguish between pressure and friction drags. Explain with sketches, why the aerofoil is designed as streamlines body. [5]
10. Distinguish between distorted and undistorted modeling. Explain the working principle of dimensional analysis by Buckingham's Π theorem. [2+5]

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02 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

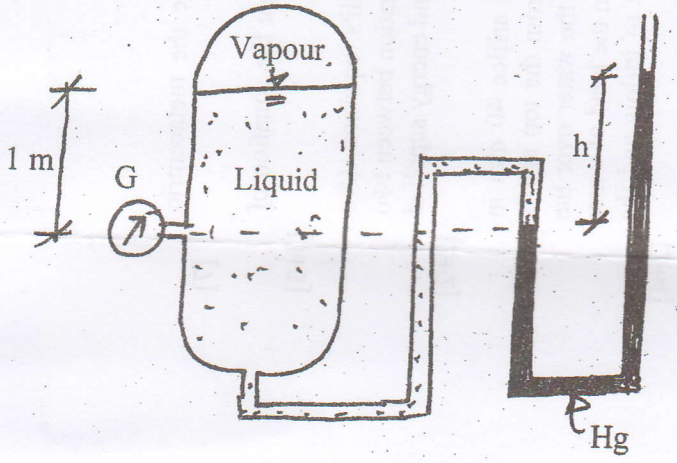
Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, B. Agri.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Fluid Mechanics *(CE505)*

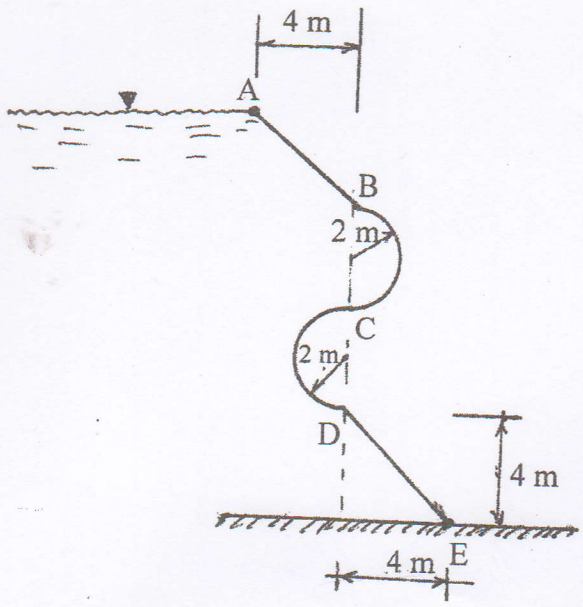
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Explain the determination of viscosity by viscometer. A pressure vessel has an internal volume of 0.5 m^3 at atmospheric pressure. It is desired to test the vessel at 3000 bar by pumping water into it. The estimated variation in the change of the empty volume of the container due to pressurization to 3000 bar is 0.6 percent. Calculate the mass of water to be pumped into the vessel to attain the desired pressure level given the bulk modulus of water as 2000 Mpa. [2+4]

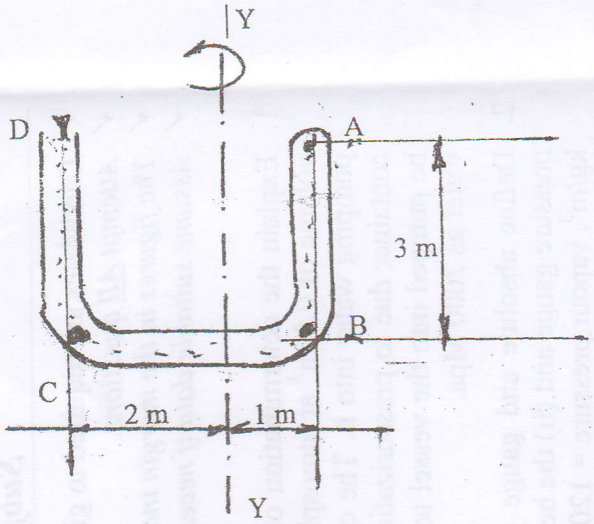
2. Define absolute and gauge pressure. Determine (i) the gauge pressure reading on the pressure gauge and (ii) the height h, of the mercury monometer. Take liquid density = 800 kg/m^3, vapour pressure = 120 Kpa (abs) and atmospheric pressure = 101 kpa (abs). [2+5]



3. a) Find the resultant pressure force on curved surface ABCDE due to liquid with specific gravity S = 1..1 take length of the curved surface (normal to the paper as 20 m.) [8]



b) The U-tube AB and CD shown in figure below filled with water. The tube AB is sealed where as tube CD is open to atmosphere. Find the pressure intensities at the points A, B and C where it is rotating with axis Y-Y with uniform rotation of 60 rpm. [7]



c) What are the importance of Metacentre? How do you determine the metacentric height of a rectangular vessel in laboratory? [7]

4. Velocity vector of flow field is given by $\vec{V} = 2x^3\,\vec{i} - 6x^2y\,\vec{j}$. Determine the equation of stream line. Also determine expression of ψ and ϕ. [3+3]

5. Integrate Euler's equation along a streamline and obtain Bernoulli's equation (No derivation of Euler equation required). What will be the Bernoulli's equation between two points where there are head losses, work done by a machine (turbine) and energy supplied by the machine (pump) between those points. [2+2]

6. a) What is Cippoletti notch? A tank of area A is provided with an arifice 40 mm in diameter at its bottom. Water flows into tank at a uniform rate from the top and is discharged through the orifice. It is found that when the head of the water over the orifice is 0.68 m, the water surface rose at 0.0014 m/sec. but, when the head of water is 1.24 m, the water surface rose at 0.00062 m/sec. Find the rate of inflow and the cross-sectional area of the tank. Take $C_d = 0.62$. [2+4]

   b) A venturimeter is to be fitted in a horizontal pipe of 0.15 m diameter to measure a flow of water which may be anything up to 240 m^3/ hour. The pressure head at the inlet for this flow is 18 m above atmospheric and the pressure head at the throat must not be lower than 7 m below atmospheric. Between the inlet and the throat there is an estimated frictional loss of 10% of the difference in pressure head between these points. Calculate the minimum allowable diameter for the throat. [6]

7. A 5 cm diameter jet delivering 56 liters of water per sec impinges without shock on a series of vanes moving at 12 m/s in the same direction as the jet. The vanes are curved so that they would, if stationary, deflect the jet through an angle of 135°. Fluid resistance reduces the relative velocity at exit from the vanes to 0.90 of that at entrance. Determine (a) the magnitude and direction of the resultant force on the vanes (b) The work done per second by the vanes. [5+3]

8. Define the concept of boundary layer. Explain the growth of boundary layer in a close canduit (pipe flow). Give three examples of use of boundary layer concept. [1+3+1]

9. An aircraft weighting 1000KN when empty has a wing area of 220 m^2. It is to take off at a velocity of 300 Km/hr and a 20° angle of attack. Determine the allowable weight of cargo and power required for the engine. Take density of air as 1.2 kg/m^3. Assume coefficient of lift for the wing at 20°, angle of attack as 1.42 and coefficient of drag as 0.17. [3+2]

10. List out the guiding rules for the choice of repeating variables in Buckingham π method. Also state the rules that apply to form the groups of dimensionless π-term. A pipe line of 2 m diameter is to be designed to carry the oil at the rate of 5 m^3/s with specific gravity 0.8 and viscosity of 0.042 poise. Test were conducted using a pipe of 20 cm diameter with water having viscosity of 0.01 poise. Calculate the velocity and rate of flow required for model. [2+3]

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02 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

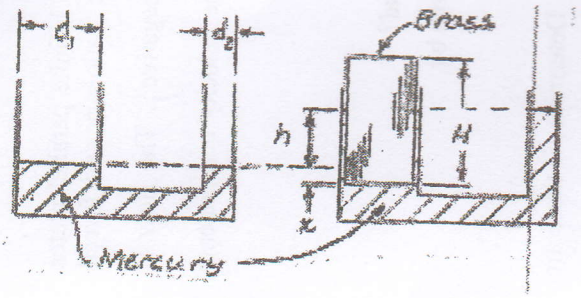
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, B. Agri.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Fluid Mechanics *(CE505)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

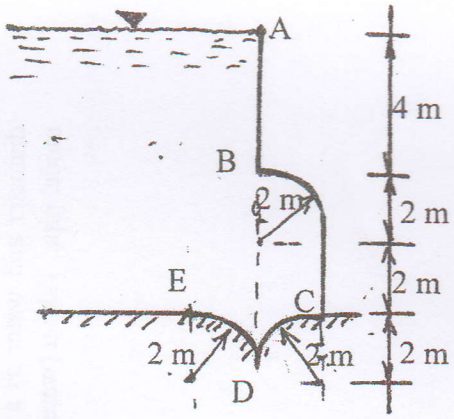
1. Explain the determination of viscosity by viscometer. A U-tube is made up of two capillaries of bores 1.5 mm and 2mm respectively. The U tube is held vertical and partially filled with liquid whose surface tension σ = 0.075 N/m. Find out the mass density of the liquid if the difference in two menisci is 2 mm. Assume angle of contact is zero. [3+3]

2. Given: Container of mercury with vertical tubes d_1 = 39.5 mm Brass cylinder with D = 37.5 mm and H = 76.2 mm is introduced into larger tube, where it floats. Take S_{brass} = 8.5. [3+3]

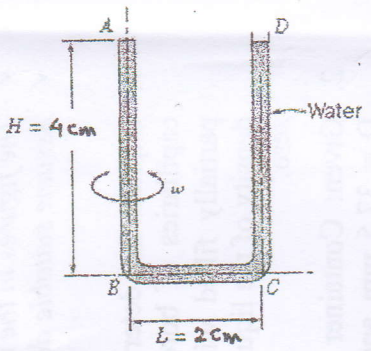


Find: (a) Pressure on bottom of cylinder
(b) New equilibrium level; h, of mercury

3. a) Find the resultant pressure force on curved surface ABCDE due to liquid with specific gravity S = 1.25 take length of the curved surface (normal to the paper) as 10 m. [8]



b) The U-tube shown in figure below is filled with water. It is sealed at A and open to the atmosphere at D. The tube is rotated about vertical axis AB at 1600 rpm. If the U-tube is now spun at 300 rpm, what will the pressure be at A? If a small leaks appear at A, how much water will be lost at D? [6]



c) Explain the metacentre with appropriate diagram. Write down the steps for determining metacentric height in laboratory experiment. [6]

4. a) Consider fully developed two-dimensional flow between two infinite parallel plates separated by distance h, with the both top and bottom plate stationary and forced pressure gradient $\frac{dP}{dx}$ driving the flow $\left(\frac{dP}{dx}\text{ is constant and negative}\right)$. The flow is steady, incompressible and two-dimensional in x-y plane. The velocity components are given by. [3]

$$u = \frac{1}{2\mu}\frac{dP}{dx}(y^2 - hy); \quad v = 0$$

Where μ is fluid's viscosity. Is this flow rotational or irrotational?

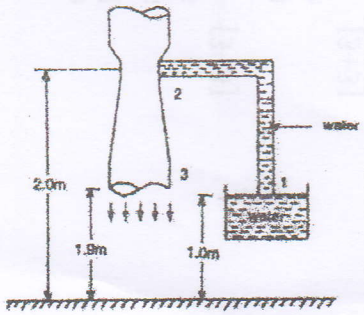
b) A steady, incompressible, two dimensional velocity field is given by [3]

$$\vec{V} = (1 + 2.5x + y)\hat{i} + (-0.5 - 3x - 2.5y)\hat{j}$$

Where 'x' and 'y' are in m and magnitude of velocity in m/s. Determine, if there are any stagnation points in this flow field and if so, where they are.

5. Develop Bernoulli's equation based on Euler's equation of motion. Explain the four applications of this principle in engineering. [2+2]

6. a) Figure below shows a venturimeter with its axis vertical and arranged as a suction device. The throat area and the outlet area of the venturi are $0.00025m^2$ and $0.001m^2$ respectively. If the venturi discharges into the atmosphere, determine the minimum discharge in the venturi at which flow will occur up the suction pipe. [7]



b) A sharp edged rectangular notch 30 cm long and a right-angled triangular notch are to be used alternatively for gauging a discharge estimated to be about 20 lit/s. Find in each cases the percentage error in computing the discharge that would be introduced by an error of 1 mm in observing the head over the Notch. [5]

7. A 120° bend-cum reducer has 300 mm diameter at inlet and 200 mm diameter at the outlet end. When the bend-cum reducer carries 0.30 m^3/s of water, pressure at section 1(inlet) is 210 KN/m^2. Assume no energy losses in the bend and determine the components of force exerted by the bend on the flow. Assume the weight of the bend plus water in it to be 1500 N. Assume section 2 (outlet) to be 0.40 m above sections 1(inlet). [8]

8. Define the concept of boundary layer. Explain the growth of boundary layer along a thin plate, when liquid is flowing over it, both for laminar and turbulent flow. Give two examples of use of boundary layer concept. [1+3+1]

9. A thin circular cylinder of infinite length is placed transversely in fluid stream, draw (Sketch only) the changes in flow pattern and drag coefficient with respect to variation in Reynold number. Define the terms associated with the Aerofoil with neat sketch. [3+2]

10. a) Define distored model and its importance in model analysis. [1+2]

b) A pipeline of 2 m diameter is to be designed to carry the oil at the rate $5m^3/s$ having sp.gr. 0.92 and viscosity $\mu = 0.04$ poise. Tests were conducted using a pipe of 20 cm diameter and water as a liquid. Find the velocity and rate of flow required for the model pipe. Take μ (water) = 0.01 poise. [5]

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