TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

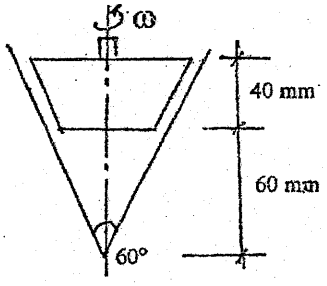
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, BAG	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Fluid Mechanics *(CE 505)*

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

1. a) A pressure gauge consists of U tube with equal enlarged ends and is filled with water on one side and oil of specific gravity 0.97 on the other, the surface of separation being in the tube below the enlarged ends. Calculate the diameter of each enlarged end if the tube diameter is 5 mm and the surface of separation moves 25 mm for a difference in pressure head of 1mm of water. [6]

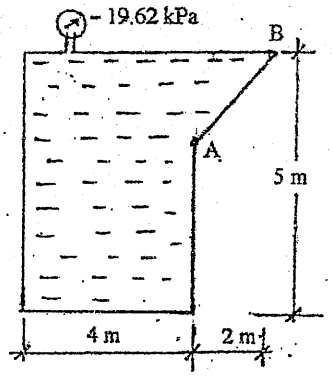
   b) Oil of viscosity $\mu = 2$ poise fills the small gap of thickness 0.2 mm. Determine the torque required to rotate the truncated cone at constant speed of 100 rpm. Neglect fluid stress exerted on the circular bottom. [6]



   c) Write Navier-Stoke's equation in three dimensional form (derivation not required). If the flow is steady and incompressible; no flow or property variation in z-direction, fully developed flow (no property variation in x direction), model the above written Navier Stoke's equation in simplified form using the assumptions. Can you develop simplified velocity distribution equation from the simplified model? [1+2+1]

2. a) A test vehicle contains a U-tube manometer for measuring differences of air pressure. The manometer is so mounted that, when the vehicle is on level ground, the plane of the U is vertical and in the fore-and-aft direction. The arms of the U are 60 mm apart, and contain alcohol of relative density 0.79. When the vehicle is accelerated forwards down an incline at 20° to the horizontal at 2 m/s^2 the difference in alcohol levels (measured parallel to the arms of the U) is 73 mm, that nearer the front of the vehicle being the higher. What is the difference of air pressure to which this reading corresponds? [8]

   b) A tank full of oil (S = 0.8) as shown in figure. Determine total pressure and centre of pressure on surface AB of the tank. Check your result with pressure diagram also. Take length of the tank 6m. [6+2]

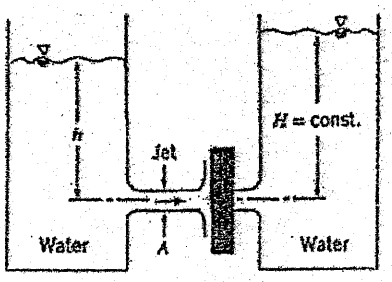


3. a) An incompressible, frictionless flow specified by $\psi = -6Ax - 8Ay$; x, y in meters, A = 1m/s. Find

(i) sketch streamlines $\psi = 0$ and $\psi = 8m^2/s$
(ii) velocity vector at (0, 0) and its direction.
(iii)flow rate between streamlines passing through points (1, 1) and (4, 1). [2+2+2]

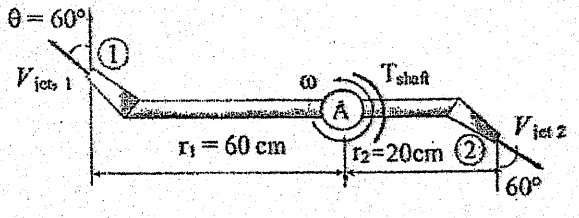
b) Prove that in Cippoletti weir the sides have a slope of 1:4. A sharp-edged notch is in the form of a symmetrical trapezium. The horizontal base is 100 mm wide, the top is 500 mm wide and the depth is 300 mm. Develop from first principles a formula relating the discharge to the upstream water level, and estimate the discharge when the upstream water surface is 228 mm above the level of the base of the notch. Assume that Cd = 0.6 and that the velocity of approach is negligible. [2+6+2]

4. a) Two large tanks containing water have small smoothy orifices of equal area. A jet of liquid issues from the left tank. Assume the flow is uniform and unaffected by the friction. The jet impinges on the vertical flat plate covering the opening of the right tank. Determine the minimum value for height, h, required to keep the plate in place over the opening of the right tank. [6]



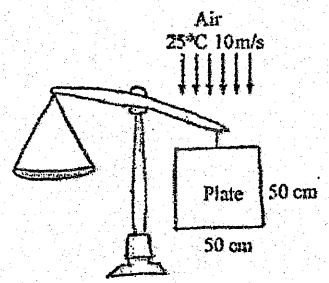
b) Flow takes place over a flat plate exposed parallel to free stream. Mention characteristics of flow and draw a neat sketch of the boundary layer development showing, (i) Laminar boundary layer, (ii) Turbulent boundary layer, (iii) Transition zone, (iv) Laminar sub layer. What is displacement thickness? [4]

c) Water enters two armed sprinkler vertically at rate of 10 litre/sec, and leaves the nozzle horizontally. The diameter of both the nozzle is 12 mm. Calculate the torque required to hold the arm stationary. [6]



5. a) The speed of propagation C of a capillary wave in deep water is known to be function only of density ρ, wavelength λ, and surface tension σ. Find the proper functional relationship, completing it with a dimensionless constant. For a given density and wavelength, how does the propagation speed change if surface tension is doubled? [8]

b) The weight of a thin flat plate 50cm × 50cm in size is balanced by a counter weight that has a mass of 2kg as shown in figure below. Now a fan is turned on, and air flows downward over both surfaces of the plate with a free-stream velocity of 10m/s. Determine the mass of the counter weight that needs to be added in order to balance the plate in this case. [8]



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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

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

Subject: - Fluid Mechanics *(CE 505)*

- ✓ 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**.*
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1. a) An oil and water manometer consists of U-tube 4mm diameter with both limbs vertical. The right-hand limb is enlarged at its upper end to 20mm diameter. The enlarged end contains oil with its free surface in the enlarged portion and the surface of separation between water and oil is below the enlarged end. The left hand limb contains water only, its upper end being open to the atmosphere.

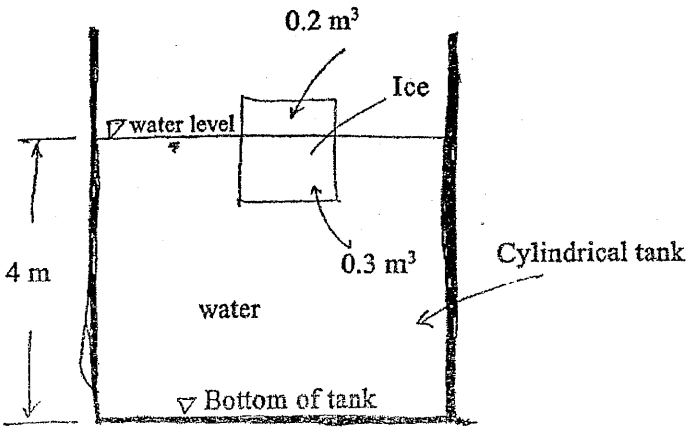
   When the right-hand side is connected to a cylinder of gas the surface of separation is observed to fall by 25mm, but the surface of oil remains in the enlarged end. Calculate the gauge pressure in the cylinder. Assume that the specific gravity of the water is 1.0 and that of the oil 0.9. [8]

   b) Write down the expression for Navier-Strokes equations and Euler equations of fluid motion in 2D with definition of each term. Also write their applications. [4]

   c) Explain the concept of control volume and continiuum in fluid mechanics. Define viscosity with its expression. [2+2]

2. a) A pipe 25mm in diameter is connected to the centre of the top of a drum 0.5m in diameter, the cylindrical axis of the pipe and the drum being vertical. Water is poured into the drum through the pipe until the water level stands in the pipe 0.6m above the top of the drum. If the drum and pipe are now rotated about their vertical axis at 600rev/min what will be the upward force exerted on the top of the drum. [8]

   b) $0.5m^3$ of ice floats in a cylindrical tank maintaining 4m depth as shown in figure below. What will be the depth of water if ice completely melt in the tank? [8]



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3. a) Velocity field $\vec{v} = Bx(1+At)\vec{i} + cy\vec{j}$ with A=0.5s^{-1}, B=C=1s^{-1}. The coordinates are measured in meters.

   i) Plot the pathline of the particle that passed through the point(1,1,0) at time t=0.
   ii) Plot the streamlines through the same point (1,1,0) at instants t=0,1 and 2s. [4+4]

   b) A tank of constant cross-sectional area of 3.2m^2 has two orifices each 8.8mm^2 in area in one of its vertical sides at heights 5m and 2m respectively above the bottom of the tank. Calculate the time taken to lower the water level from 8m to 3m above the bottom of tank. Assume C_d=0.62. [8]

4. a) Explain concept of Boundary layer thickness. Displacement thickness and Momentum thickness with their applications each. [6]

   b) A jet of water with a velocity U and jet area. A strikes a flat plate normal to it. Determine the force of impingement, power developed and efficiency

   i) when the plate is at rest. [3]
   ii) when the plate is permitted to move along the direction of a velocity u. Also determine condition of maximum possible efficiency. [3]
   iii) what would be the possible maximum efficiency if series of plates were to face the jet in quick succession? [4]

5. a) A 3mm diameter sphere made of steel (sp. wt. 75KN/m^3) falls in glycerine (sp. wt. 12.5 KN/m^3) of viscosity 0.893 NS/m^2 at a terminal velocity. Determine the terminal velocity and drag force on the sphere. [4]

   b) In a flow through a small orifice discharging freely into atmosphere under a constant head (H), the flow discharge (Q) depends on diameter of pipe (d), constant head, dynamic viscosity (μ), density of fluid (ρ) and acceleration due to gravity (g). Using Rayleigh's methods develop the relation in terms of non-dimensional terms. [6]

   c) A spillway model is to be built geometrically similar scale of 1/16 across a flume of 60cm width. The prototype is 12.5m high and the maximum head on it is expected to be 2m. (i) What height of the model and what head on the model should be used? (ii) If the flow over the model at a particular head is 20 lps, what flow per m length of the prototype is expected? [6]

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TRIBHUVAN UNIVERSITY
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Examination Control Division
2076 Ashwin

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

Subject: - Fluid Mechanics *(CE 505)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
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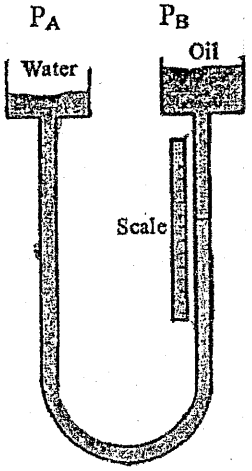
1. a) A manometer consists of a U-tube, 7 mm internal diameter, with vertical limbs each with an enlarged upper end 44 mm diameter. The left hand limb and the bottom of the tube is filled with water and the top of the right-hand limb is filled with oil of specific gravity 0.83. The free surfaces of the liquids are in the enlarged ends and the interface between the oil and water is in the tube below the enlarged end. What would be the difference in pressures applied to the free surfaces which would cause the oil/water interface to move 1cm. [10]

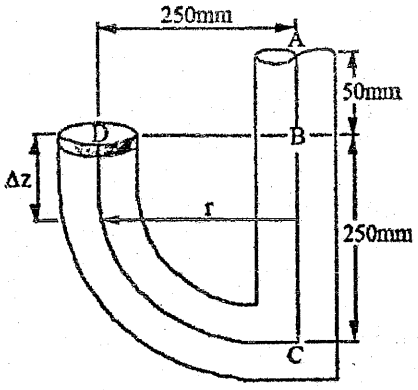


   b) Explain Capillarity phenomenon. [1]

   c) A 2.2 cm wide gap between two vertical plane surfaces is filled with liquid of specific gravity 0.9 and dynamic viscosity 1.75 NS/m^2. A metal plate 1.5m×1.5m×0.2cm thick and weighing 40N is placed midway in the gap. Find the force required if the plate is to be lifted with constant velocity of 0.15 m/s. [5]

2. a) Cylindrical tank 2 m diameter and 4 m long, with its axis horizontal, is half filled with water and half filled with oil of density 880 kg/m^3. Determine the magnitude and position of the net hydrostatic force on one end of the tank. [8]

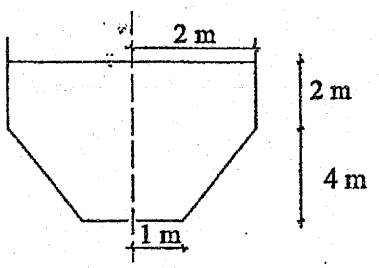
   b) A tube ABCD has the end A open to atmosphere and the end D closed as shown in figure below. The portion ABC is vertical while the portion CD is a quadrant of radius 250 mm with its centre is B, the whole being arranged to rotate about its vertical axis ABC. If the tube is completely filled with water to a height in the vertical limb of 300 mm above C find (a) the speed of rotation which will make the pressure head at D equal to pressure head at C, (b) the value and position of the maximum pressure head in the curved portion CD when running at the speed. [5+3]



3. a) Steady, incompressible flow in xy plane with $\vec{V} = \frac{A}{x}\vec{i} + \frac{Ay}{x^2}\vec{j}$ where $A = 2m^2/s$ and coordinates are in meters. Find
   i) equation for steamline through (x,y) = (1,3)
   ii) time required for a fluid particle to move from x=1m to x=3m. [3+3]

   b) The velocity of a fluid varies with time t. Over the period from t=0 to t=8 s the velocity components are u= 0 m/s and v = 2 m/s; while form t= 8s to t = 16 s the components are u= 2 m/s and v = -2 m/s. A dye streak is injected into the flow at a certain point commencing at time t=0 and the path of a particle of fluid is also traced from that point starting at t=0. Draw to scale the streakline and pathline of the particle. [4]

   c) Find the time of emptying a cylindrical vessel attached with conical vessel as shown in the figure below with the provided data herein. There is no inflow into the tank. Orifice of diameter 10cm is at the bottom of the tank. Take discharge coefficient as 0.6. [6]



4. a) Air flows over a flat plate 2m long and 1.5m wide at a velocity of 6.5 m/s. Determine the shear stress, and displacement thickness at distance of 1.8m form the leading edge. Also determine the drag force on the face of the plate. [2+2+4]

   b) The diameter of a bend is 300 mm at inlet and 150 mm at outlet and the flow is turned through 120° in vertical plane, the axis of inlet is horizontal and the centre of the outlet section is 1.5 below the centre of the inlet section, the total volume of fluid contained in the bend is 0.09 m^3. Neglecting friction, calculate the magnitude and direction of the force exerted by the water on the bend by the water flowing through it at 300 lps when the inlet pressure is 130 KPa. [8]

5. a) A river carrying a discharge of 3500 m^3/s has a depth of 2.25 m width of 1500m. From the point of view of availability of space the horizontal scale of 1:400 is chosen. Assuming slope scale to be unity, determine the depth and discharge scales for the model. [8]

   b) A jet plane which weighs 170 KN has a wing area of $25m^2$. It is flying at a speed of 200 km/hr. When the engine develops 580 KW, 70% 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 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.*
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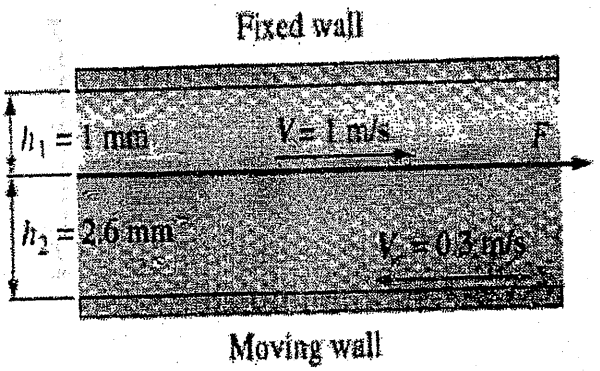
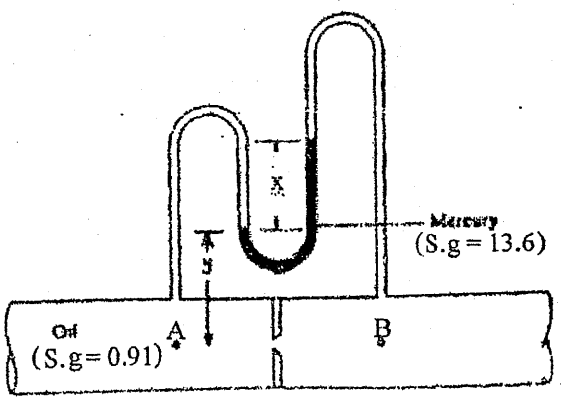
1. a) Thin 40 cm × 40 cm flat plate is pulled at 1 m/s horizontally through a 3.6 mm thick oil layer sandwiched between two plates, one stationary and the other moving at a constant velocity of 0.3 m/s, as shown in figure. The dynamic viscosity of oil is 0.027 pa.s. Assuming the velocity in each oil layer to vary linearly i) plot the velocity profile and find the location where the oil velocity is zero. ii) determine the force that needs to be applied on the plate to maintain this motion. [4+4]



b) A differential manometer is attached to a pipe as shown in figure. Calculate the manometric height difference x, for pressure difference 2.68 KPA. [8]



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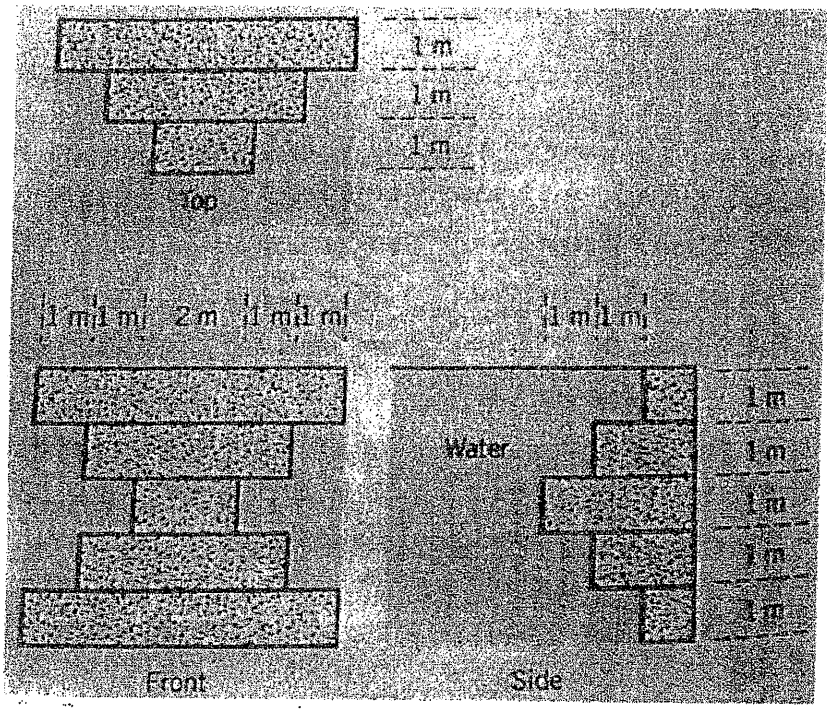
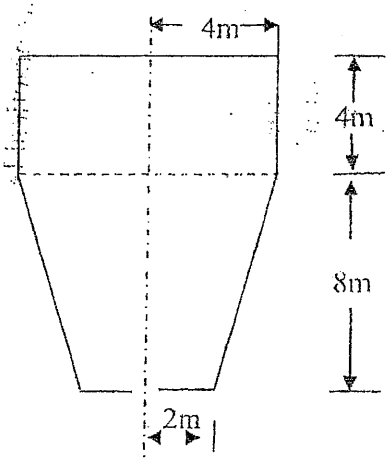
2. a) For the geometry shown, what is the vertical force on the dam? [10]



b) An open-topped tank, in the form of a cube of 900 mm side, has a mass of 340 kg. It contains 0.105 m^3 of oil of relative density 0.85 and is accelerated uniformly up along slope at arctan (1/3) to the horizontal. The base of the tank remains parallel to the slope, and the side faces are parallel to the direction of motion. Neglecting the thickness of the walls of the tank, estimate the net force (parallel of the slope) accelerating the tank if the oil is just on the point of spilling. [6]

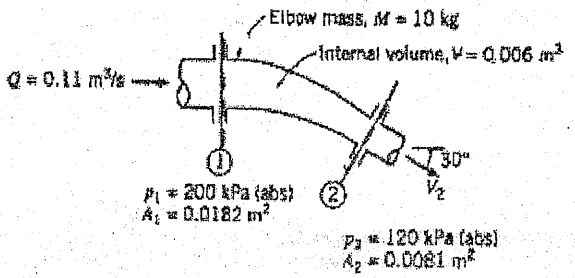
3. a) Find the time of emptying of cylindrical vessel with conical vessel as shown in the figure. There is no inflow into the tank. An orifice of 10 cm diameter is at the bottom of the tank. Take $C_d = 0.6$. [6]



b) The velocity field is given by $\vec{V} = Ax\,\vec{i} - Ay\,\vec{j}$; the units of velocity are m/s; x and y are given meters; $A = 0.3s^{-1}$

(i) Obtain an equation for the streamlines in the xy plane [3]
(ii) Plot the streamline passing through the point $(x_o, y_o) = (2, 8)$ [1]
(iii) Determine the velocity of a particle at the point (2, 8) [1]
(iv) If the particle passing through the point (x_o, y_o) is marked at time t = 0, determine the location of the particle at time t = 6 s. [3]
(v) Show that the equation of the particle path (pathline) is the same as the equation of the streamline. [2]

4. a) Reducing elbow is shown in figure. Fluid is water. Find the force components needed to keep elbow from moving. [8]



b) With appropriate sketches define boundary layer thickness and momentum thickness and discuss their application. [2×4]

5. a) For models governed by gravity forces, obtain the scaling ratios for time, discharge, force and power. [8]

b) Water flows over 0.3 m long and 0.1 m wide flat plate at 15 m/s parallel to it. Calculate (i) drag force on that portion of plate over which the boundary layer is laminar (ii) total drag force on both sides of the plate. $\rho = 998$ kg/m^3 and viscosity = 10^{-6} m^2/s. [8]

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01 TRIBHUVAN UNIVERSITY
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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.*
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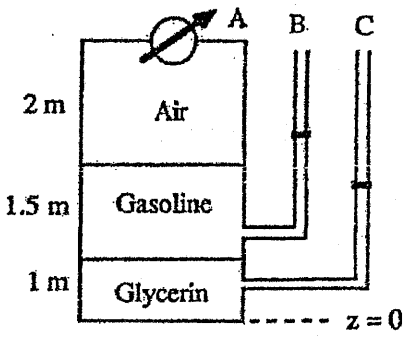
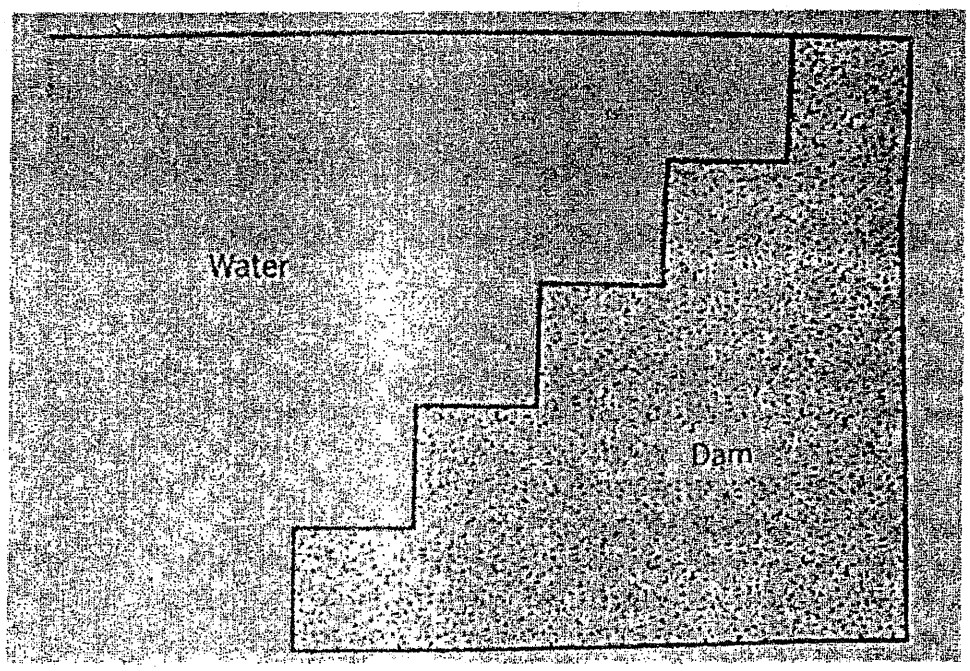
1. a) A stationary bearing of length 30 cm and internal radius 8.025 cm has been used to provide lateral stability to a 8 cm radius shaft rotating at a constant speed of 200 rpm. The space between the shaft and bearing is filled with a lubricant having viscosity 2.5 poise. Find the torque required to 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]

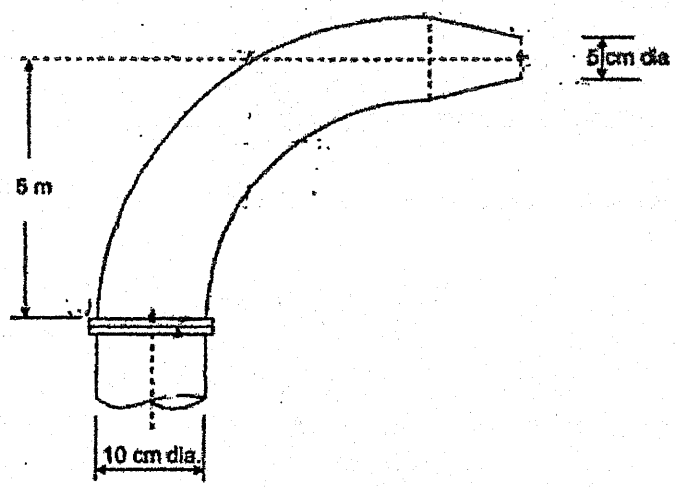


b) A thin-walled, open-topped tank in the form of a cube of 500 mm side is initially full of oil of relative density 0.88. It is accelerated uniformly at 5 m/s2 up a long straight slope at arctan (1/4) to the horizontal, the base of the tank remaining parallel to the slope, and the two side faces remaining 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
2073 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.
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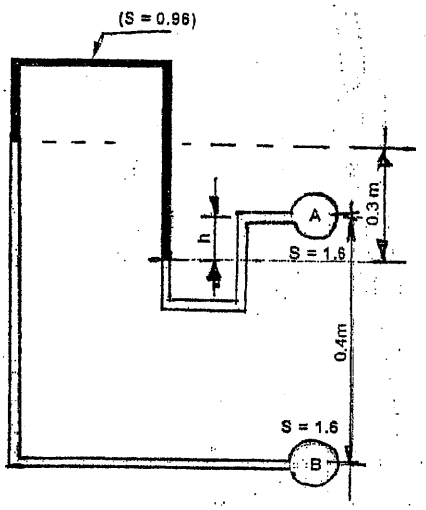
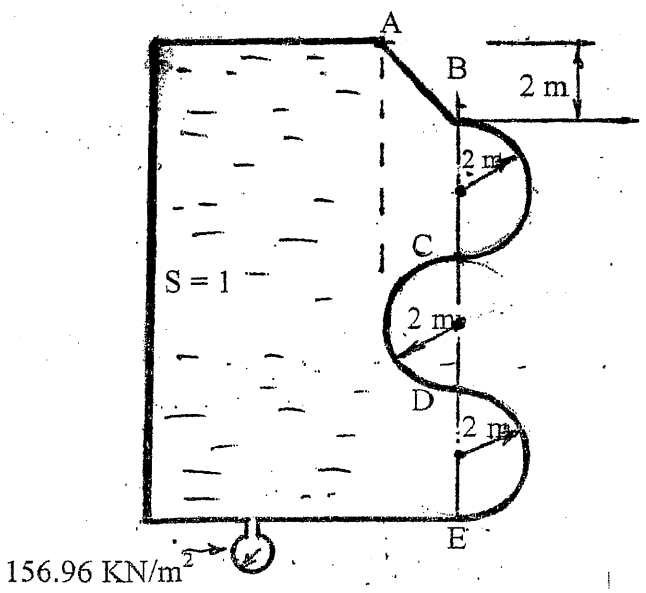
1. Explain Cavitation and vapor pressure. Prove that capillary depression (**h**) in the tube of radius **r** when inserted in mercury (sp.gr.S_1) above which a liquid of sp.gr. S_2 lies is given by $h = \frac{2\sigma\cos\theta}{r\gamma(S_1 - S_2)}$ [2+4]

2. Find the pressure difference between pipes A and B which filled with liquid of sp.gr. 1.6 and monometric reading as shown in figure. [6]

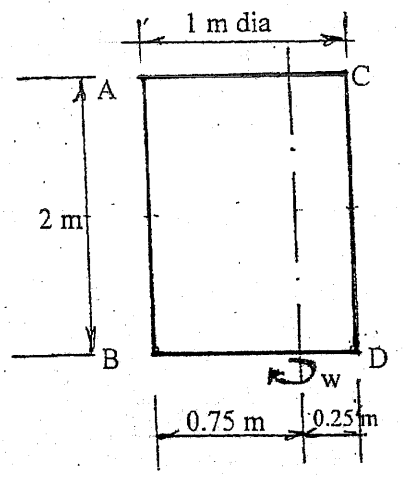


3. a) Find the resultant hydrostatic pressure force due to water on a curved surface BCDE as shown in figure below. Consider the length of the surface is 10 m. [8]



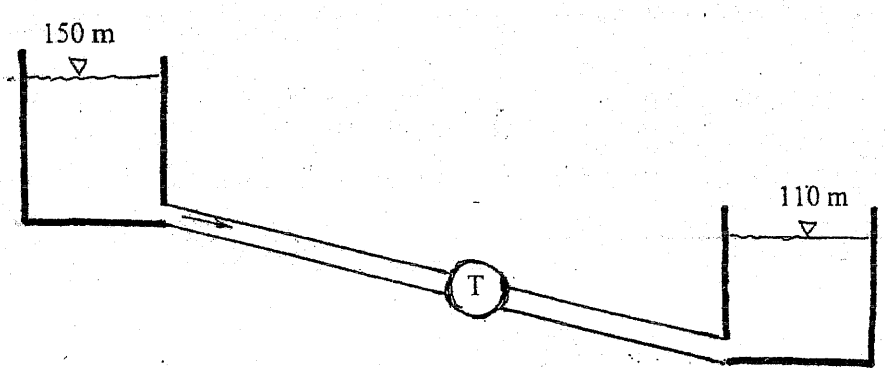
b) Define metacentre and find the expression for metacentric height. [6]

c) A closed cylindrical tank completely filled with water is being rotated with constant speed of 100 rpm about its axis vertical as shown in figure below. Draw the pressure intensity diagram along AB and AC, with values. [6]



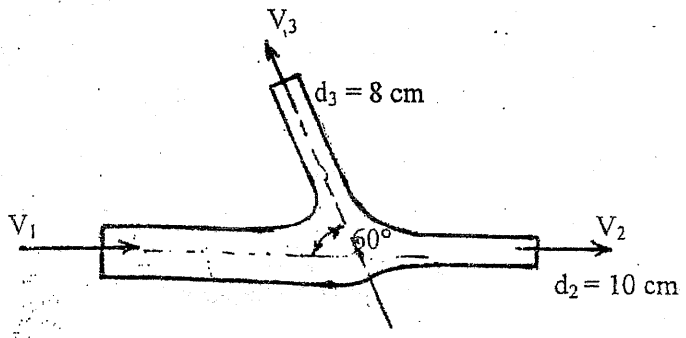
4. Given $\vec{V} = 4xy\hat{i} + 2y^2\hat{j}$, find stream function and plot several streamlines in first quandrant. The coordinates are in meters. [3+3]

5. The turbine system in figure below draws water from the upper reservoir through a uniform diameter pipe to produce power for a city. For a design flow rate of 1.2 m^3/s, the friction loss in 5 m. Estimate the power in KW extracted by the turbine. Draw TEL and HGL. [5+3]



6. A sharp-edged notch in the form of a symmetrical trapezium. The horizontal base is 100 mm wide, the top is 500 mm wide and the depth is 300 mm. Derive from the first principles a formula relating the discharge to the upstream water level, and estimate the discharge when the upstream water surface is 228 mm above the level of the base of notch. Assume that $C_d = 0.6$ and that the velocity of approach is negligible. [7+2]

7. Ignoring friction losses, calculate the magnitude and the 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 15 m/sec. The axes of systems are lie in a horizontal plane. [8]



8. Define boundary layer concept with sketch. Explain clearly the phenomenon of boundary layer separation and how it can be prevented. [5]

9. Find the expression for pressure and friction drags. What do you understand by a streamline body? Give some examples of streamline body. [5]

10. Explain the laws of similarity between model and prototype. In a flow through a small orifice discharging freely into atmosphere under a constant head (H), the flow discharge (Q) depends on diameter of pipe (d), constant head, dynamic viscosity (μ), density of fluid (ρ) and acceleration due to gravity (g). Using Rayleigh's methods develop the relation in terms of non-dimensional terms. [2+5]

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02 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ashwin

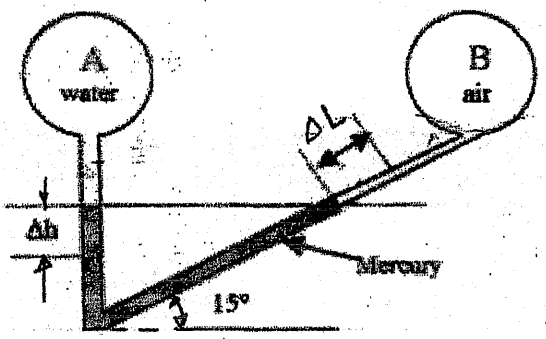
Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE, B. Agri.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Fluid Mechanics *(CE505)*

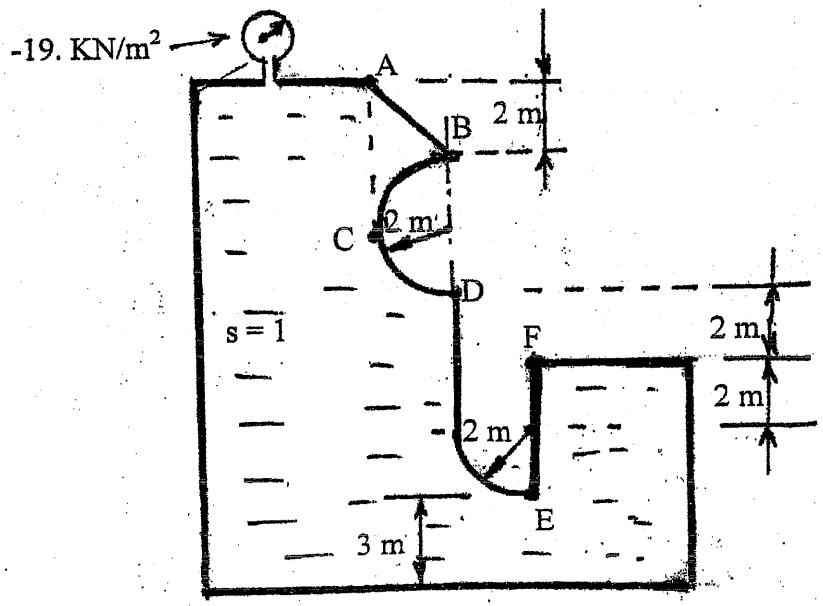
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

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]



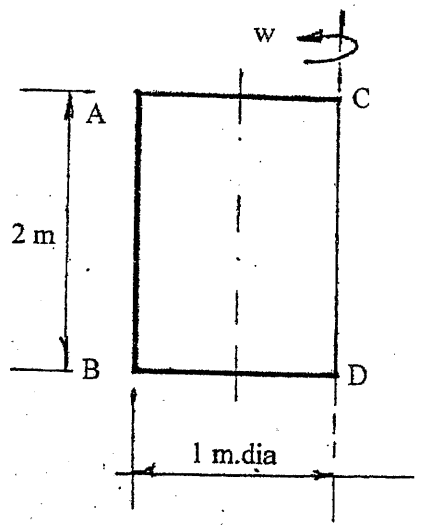
3. a) Find the resultant pressure force due to water on a curved surface BCDEF of 10 m length as shown in figure below. [8]



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

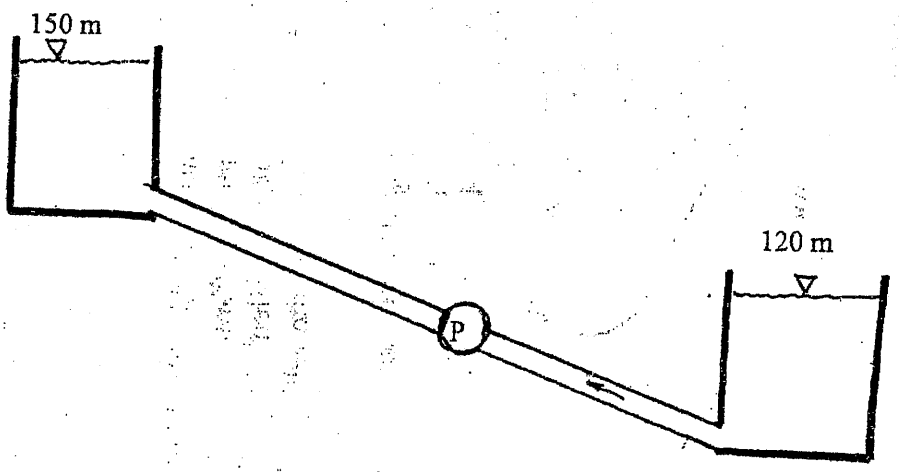
P.T.O.

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]

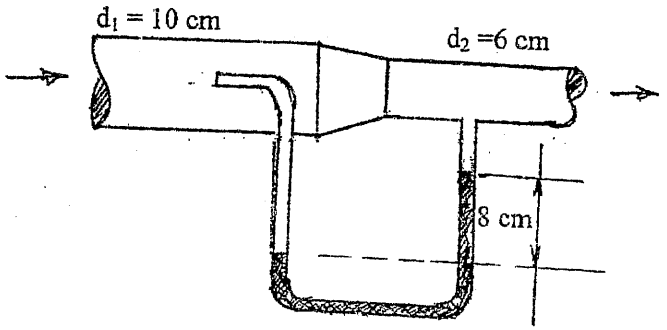


4. Sketch the streamlines represented by the stream function $\psi = x^2+y^2$. Find also the velocity and its direction at point (3,4). [3+3]

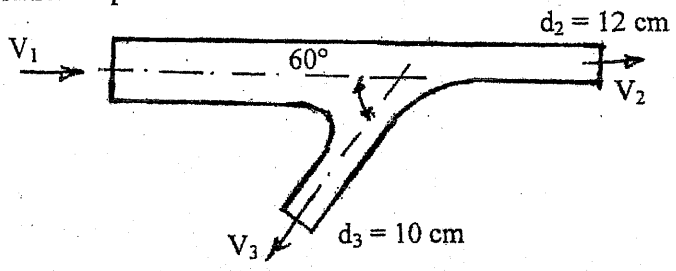
5. Water is pumped at $0.12 m^3/s$ from the lower to the upper reservoir as shown in figure below. Pipe friction losses $h_f = 27v^2/2g$, where V is the average velocity in the pipe (diameter = 15 cm). If pump is 75% efficient, what horse power is needed to drive it? Draw TEL and HGL. [5+3]



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
2072 Chaitra

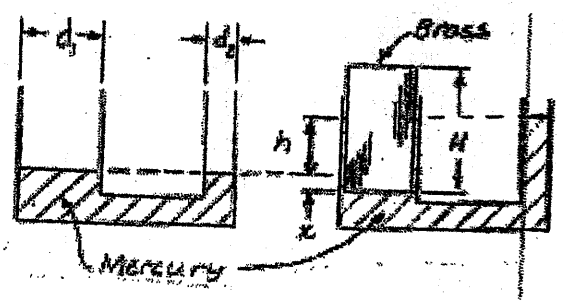
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, B. Agri.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

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.*

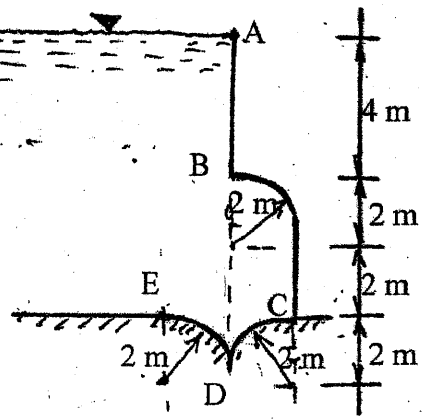
1. Explain the determination of viscosity by viscometer. A U-tube is made up of two capillaries of bores 1.5 mm and 2mm respectively. The U tube is held vertical and partially filled with liquid whose surface tension σ = 0.075 N/m. Find out the mass density of the liquid if the difference in two menisci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

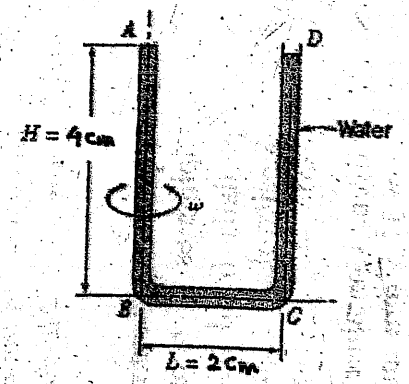


Find: (a) Pressure on bottom of cylinder
(b) New equilibrium level; h, of mercury

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 $\left(\frac{dP}{dx}\right.$ is constant and negative$\left.\right)$. 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?

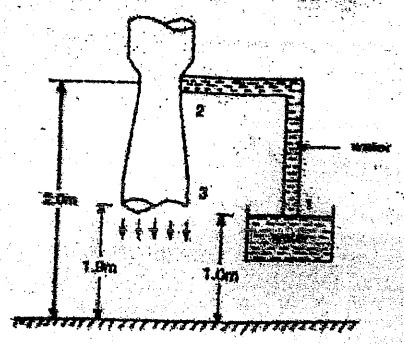
b) A steady, incompressible, two dimensional velocity field is given by [3]

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

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 μ = 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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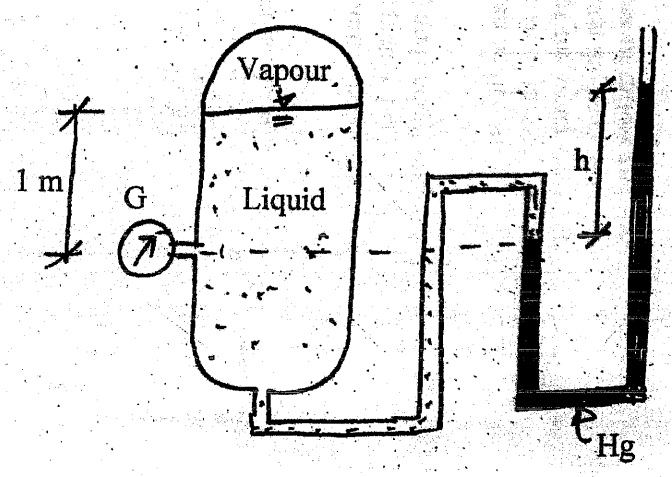
02 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

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.

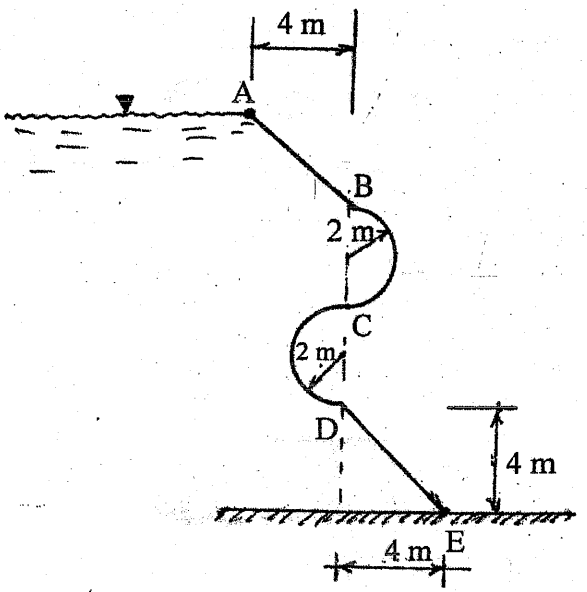
Subject: - Fluid Mechanics *(CE505)*

- ✓ 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.*

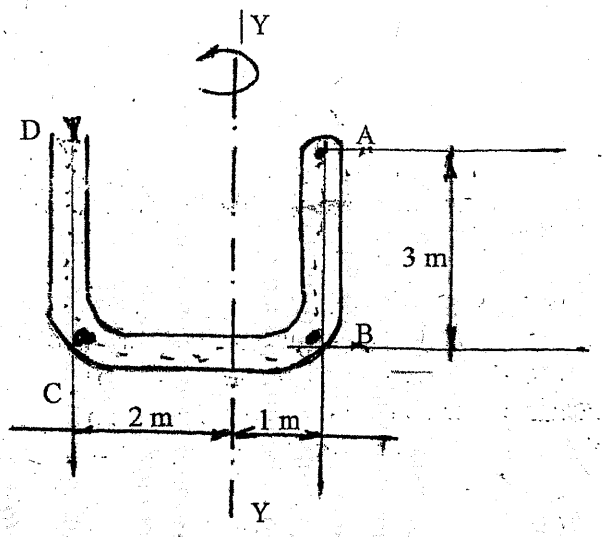
1. Explain the determination of viscosity by viscometer. A pressure vessel has an internal volume of 0.5 m^3 at atmospheric pressure. It is desired to test the vessel at 3000 bar by pumping water into it. The estimated variation in the change of the empty volume of the container due to pressurization 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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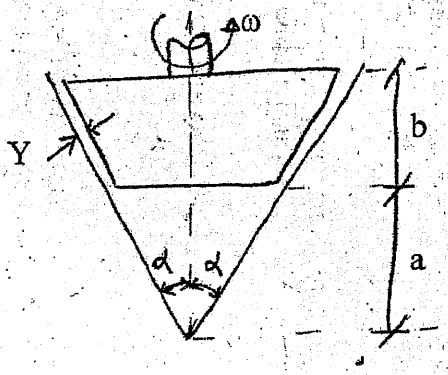
02 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Chaitra

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

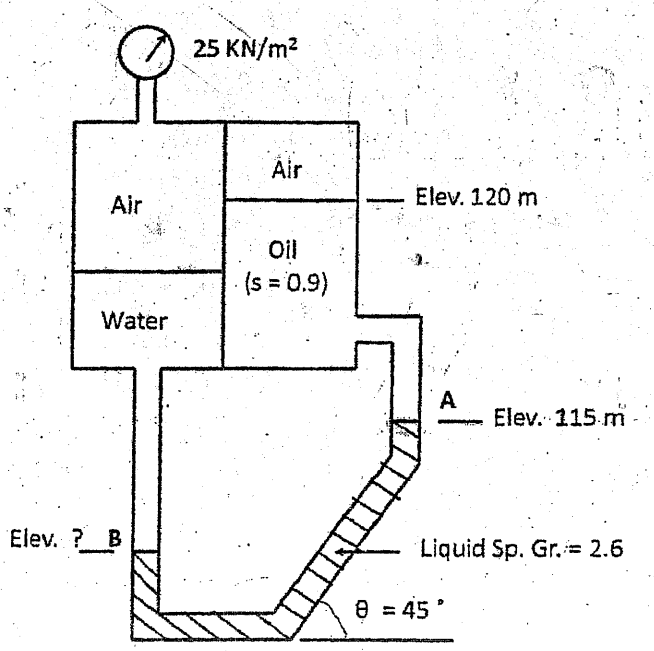
Subject: - Fluid Mechanics *(CE505)*

- ✓ 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.*
- ✓ *Graph paper will be provided.*

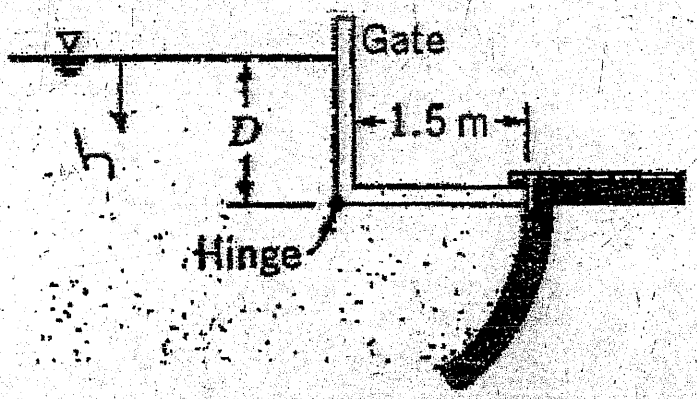
1. Oil of viscosity μ fills the gap of thickness Y as shown in figure below. Determine an expression for the torque T required to rotate the truncated cone at constant speed ω-Neglect fluid stress exerted on circular bottom. [6]



2. In the figure below, find the elevation of the gauge liquid in the left hand column at B if the air pressure at right hand side is -225 mm of Hg. [6]



3. a) Given:
Water rising on the left side of the gate canses it to open, automatically. Neglect weight of gate.
Find: Depth D, above the hinge at which the gate begins to open. [9]

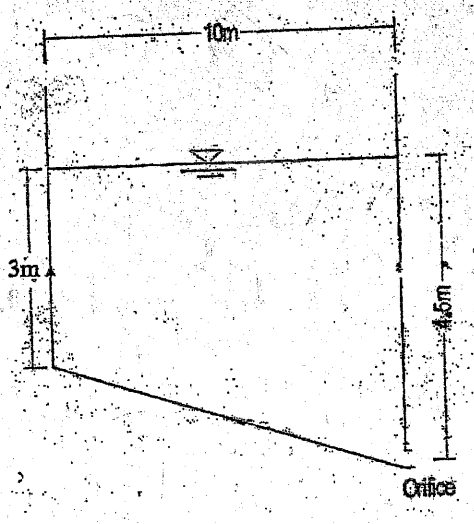


b) A cylinder of diameter 500 mm having specific gravity, s = 0.9 floats in water. What is the maximum permissible length in that the cylinder may float in stable equilibrium with its axis vertical? [6]

4. Given: Flow field represented by the velocity Potential $\phi = Ax + Bx^2 - By^2$ [2+1+3]
Where A = 1m/s, B = $1s^{-1}$ and Coordinates are measured in meters
Find:
i) Expression for the velocity field
ii) Stream function
iii) Pressure difference between points $(x_1, y_1) = (0, 0)$ and $(x_2, y_2) = (1, 2)$
The fluid is water.

5. Water is flowing at a rate of 2.4 liters/s in the figure below. The water is discharging into the atmosphere at point 2 through a nozzle. The loss of heat between point 1 and 2 is 3 mm of mercury. Find the manometer reading, h. [4]

6. a) Determine time required to empty the swimming pool of length 15 m by an orifice of diameter 20 cm at bottom shown in the figure below. Take coefficient of discharge as 0.65. [6]



b) What is the difference between small and large orifice. Deduce the formula for discharge through large rectangular orifice. [2+4]

02 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2072 Kartik

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.

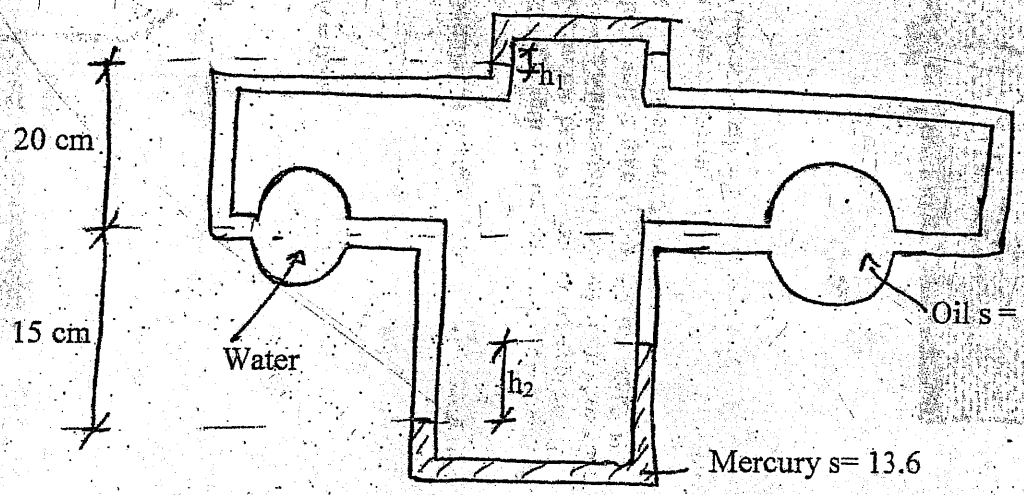
Subject: - Fluid Mechanics *(CE505)*

- ✓ 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.*
- ✓ *Graph paper will be provided.*

1. a) Explain the lab experiment to determine the viscosity of fluid using capillary tube viscometer. [4]

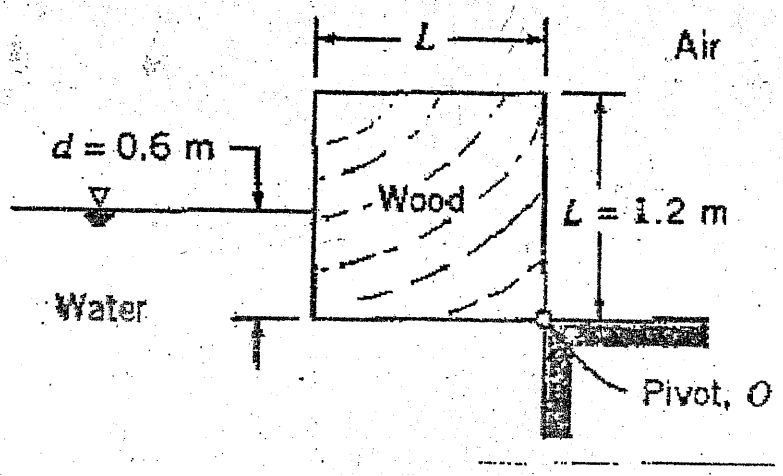
   b) Define compressibility of fluid. [2]

2. Two U-tube manometers are upright and the other inverted type, are connected across a water line and an oil line as shown in figure below. If h_1 = 5cm what shall h_2 be? [6]

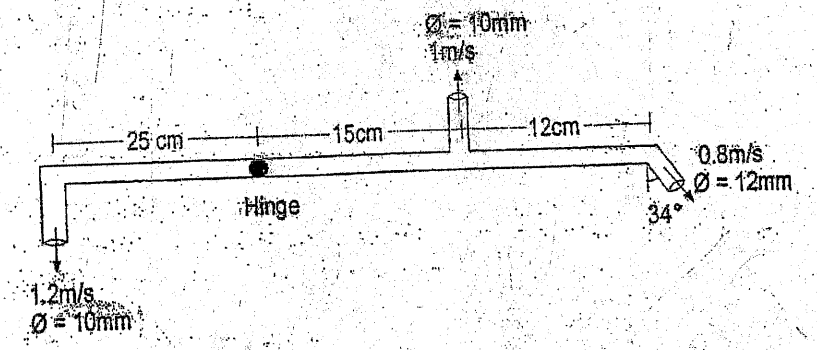


3. a) Given: Long, square wooden block pivoted on one edge, in equilibrium in water as shown. Friction in pivot is negligible. [7]

   Find: Specific gravity of the wood



7. Determine the torque required to hold the sprinkler shown in figure below stationary. Also find the constant speed if it is free to rotate. [8]



8. a) Write down the characteristics of boundary layer formation, if thin plate is kept in the moving liquid. [3]

   b) For the laminar boundary layer zone, the velocity distribution is parabolic. Prove that displacement thickness δ^* 1/3 δ, where δ is thickness of boundary layer. [4]

9. A 2000kg aircraft is designed to carry a payload of 5000N when cruising at 300 km/hr. The effective wing area is $25m^2$. Assuming a conventional airfoil, calculate the take off speed if an angle of attack of 10° is desired and the stall speed when landing. (Refer the attached graph) [4+4]

10. Given: Draining of a tank from initial level ho, time T, depends on tank diameter D, orifice diameter d, acceleration of gravity g, density ρ and viscosity μ. [2+2+4]

    Find

    i) Number of dimension less parameters
    ii) Number of repeating variables
    iii) π-parameters containing viscosity

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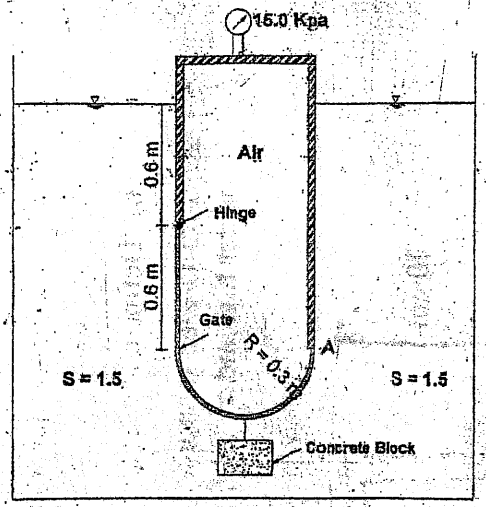
b) A rigid gate is hinged at one end and is located between partitions in an open tank containing liquid (S = 1.5) as shown in figure. A concrete block (Sp.wt = 25 KN/m^3) is to be hung from curve portion of gate. Determine the required volume of the block so that the reaction of the gate on the partition A is zero. The gate is 0.75 m wide with a negligible weight and hinge is smooth. [8]



4. Given: Velocity field $\vec{V} = (Ax - B)\vec{i} - Ay\vec{j}$; $A = 0.2\,s^{-1}, B = 0.6\,s^{-1}$, x in m. [6]

   Find: (a) Acceleration at (x,y) = (2,4)

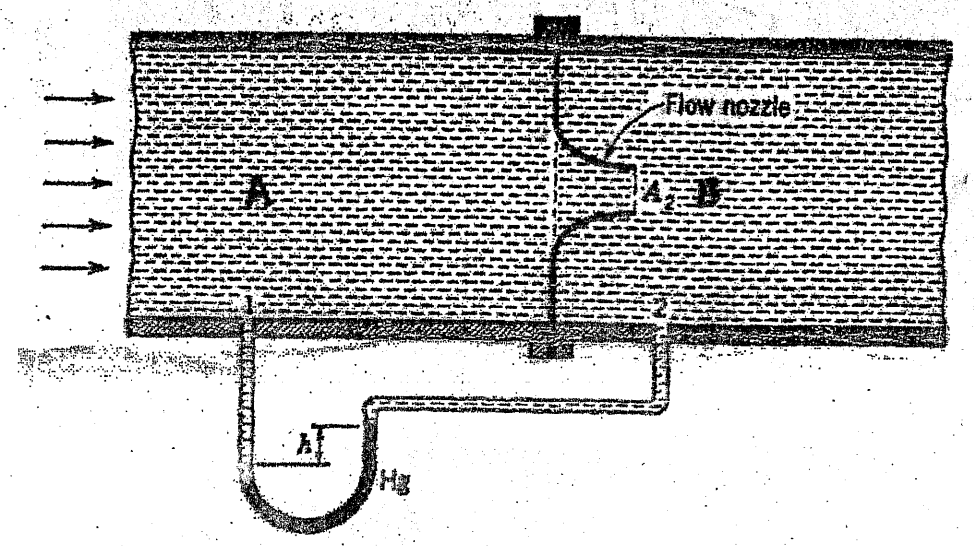
   (b) Plot of streamlines

5. Explain the physical meaning of terms in Bernoulli's energy equation. Also write the limitation of this equation. [4]

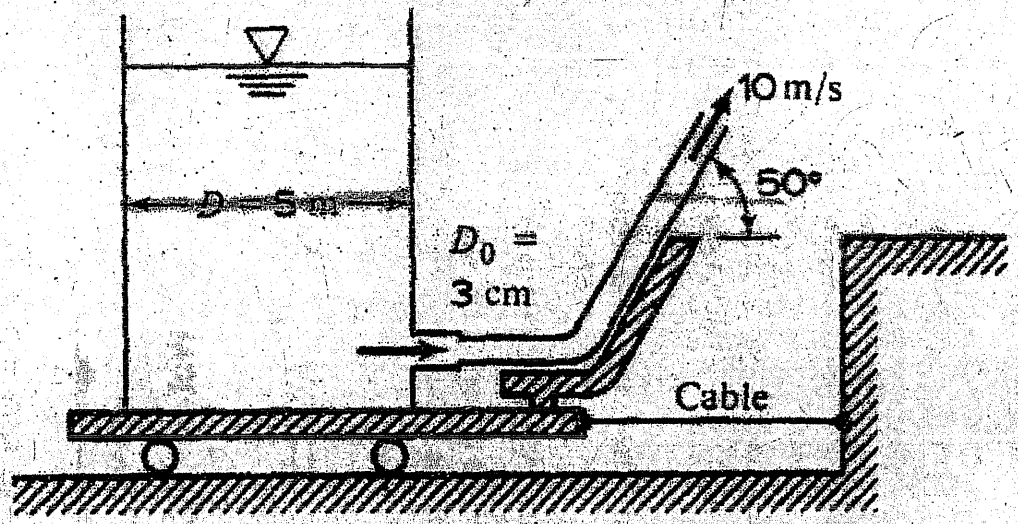
6. a) A cylindrical tank of internal diameter 0.5 m, length 1.4 m and axis vertical has a 5 cm diameter sharp-edged orifice (C_d = 0.6) in the bottom, open to atmosphere. The tank is open at the top and empty. If water were admitted into the tank from above at a constant rate of 900 liters/minute, how long will it take to just fill the tank? How much water will escape through the orifice during that period? [4+2]

   b) A flow nozzle is a device inserted in to a pipe as shown in figure below. If A_2 is the exit area of the flow nozzle, show that for incompressible flow we get for Q. [6]

$$Q = C_d\left[\frac{A_2}{\sqrt{1-(A_2/A)^2}}\cdot\sqrt{2g\left(\frac{p_1 - p_2}{\gamma}\right)}\right]$$



7. The water tank in figure below stands on a frictionless cart and feeds a jet of diameter 3 cm and velocity 10 m/s which is deflected 50° by a vane. Compute the tension in the supporting cable. [8]



8. Differentiate between boundary layer thickness and displacement thickness. Derive an expression for the displacement thickness. [3+4]

9. Define aerofoil with accepted terminology with neat sketch. A wing with a span of 22 m and 64 m^2 planform area moves horizontally with a velocity of 760 kmhp. If the wing supports 280 KN. Find: [3+5]

   a) Required value of lift coefficient
   b) Induced drag
   Take density of air = 0.526 kg/m^3

10. List out the steps of Rayleigh's method used for dimensional analysis. In 1:20 model of a spillway, the velocity and discharge are 1.3m/s and 1.85 m^3/s. Compute the corresponding velocity and discharge in the prototype. [3+5]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Shawan

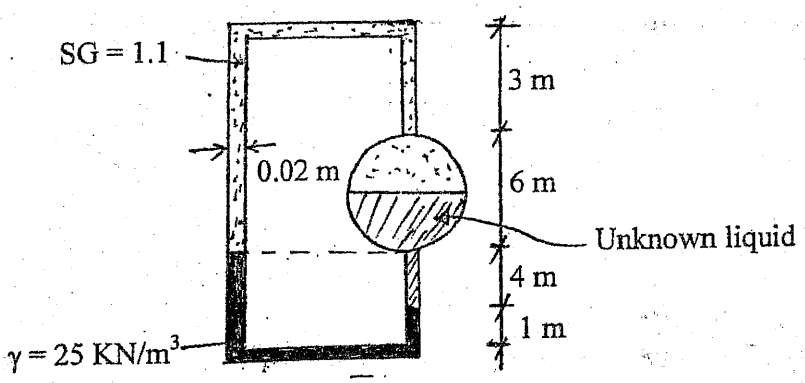
Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Fluid Mechanics *(CE505)*

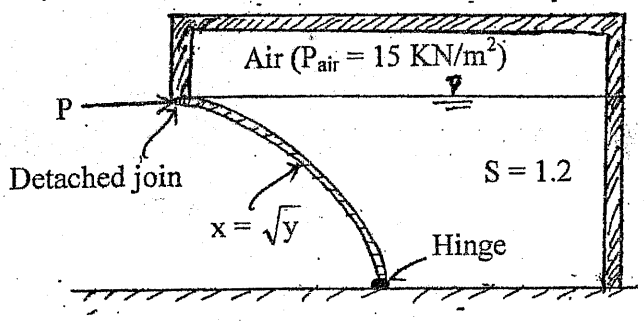
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Explain the determination of viscosity of fluid in lab using capillary tube viscometer. Show that the capillary rise of liquid of specific gravity γ between two concentric glass tubes of radii R_1 and R_2 ($R_2 > R_1$) and contact angle θ is given by $h = \frac{2\sigma Cos\theta}{\gamma(R_2 - R_1)}$. (3+3)

2. State Pascal's law of pressure distribution. A 0.02 m diameter manometer tube is connected to a 6m diameter tank as shown in figure. Determine the density of the unknown liquid in the tank. (2+4)



3. Figure shows a gate whose profile is given by $x = \sqrt{y}$. It holds water to a depth of 2m behind it. If the width of gate is 5m, determine the force P required to hold the gate in place. (7)



4. An oil tanker 3 m wide, 2 m deep and 10 m long contains oil of density 800 kg/m^3 to a depth of 1 m. Determine the maximum horizontal acceleration that can be given to the tanker such that the oil just reaches its top end. Further, if the tanker is closed completely with the oil and accelerated horizontally at 3 m/sec^2, determine the total liquid thrust on the front and rear ends and on one its longitudinal vertical sides. (2+2+2+2)

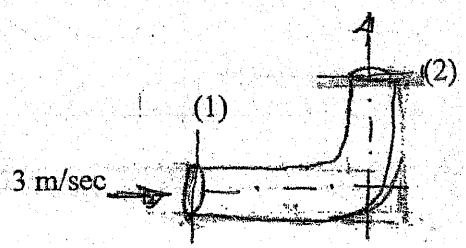
5. For the flow of an incompressible fluid, the velocity component in x direction is $u = ax^2 + by$ and velocity component in z-direction is $w = 0$. Find the velocity component v in y-direction such that $v = 0$ at $y = 0$. Also determine equation of stream function and velocity potential function. (2+2+2)
6. A pump delivers 0.08 m^3/s of water at 70 KN/m^2 to a machine which is 6m higher than the reservoir surface. The losses between the reservoir surface and machine inlet are estimated to be $7.5\frac{V^2}{2g}$ where V is the velocity of flow in 7.5 cm diameter delivery pipe from pump to machine. Determine the power required to derive pump if it is 80% efficient. (4)
7. Prove that equation of head loss in venturimeter is given by $h_L = h(1-C_d^2)$, where C_d is coefficient of discharge and h is venturihead or piezometeric head. (6)

OR

Write a program to find the time required to empty the hemispherical tank from H_1 level to H_2 level. The program should display the times required to empty by each ΔH level. (6)

8. A broad crested weir of 50m length has 50 cm height of water above its crest. Find the maximum discharge through the channel considering approach velocity when the channel has a flow depth 1m and width 50m on the upstream side of weir. (6)

9. A reducing right angled bend lies in a horizontal plane. Water enters from section 1 with velocity 3 m/sec with pressure 30 kPa and leaves towards section 2 as shown in figure below. The diameter at the entrance is 500 mm and the exit it is 400 mm. Neglecting any friction loss find the magnitude and direction of the resultant force on the bend. (8)



10. Define boundary layer concept and its phenomenon. Write down the characteristics of boundary layer formation on a thin plate, kept in flowing liquid. Describe the viscous sub-layer and absolute roughness height; explain the use of this concept in engineering application. (2+2+3)

11. a) Define airfoil with net sketch and also explain its importance. (1+1+1)

    b) Auto mobile having a projected area of $1.6m^2$ and drag coefficient $C_d = 0.35$ travels at a uniform speed of 60Km/hr in still air of density 1.2 kg/m^3. Calculate the power required to overcome the air resistance. If the drag coefficient of the automobile is reduced by 15% by improving streamlining, what percentage increase in speed could be obtained with the same power? (5)

12. a) Explain the concept of Dimension Analysis by using Buckingham's Π-theorem and principle of selecting repeating variables. (4)

    b) Distinguish between undistorted and distorted model and their advantages. For Froude model law find the discharge and velocity scale ratios for distorted modelling. (4)

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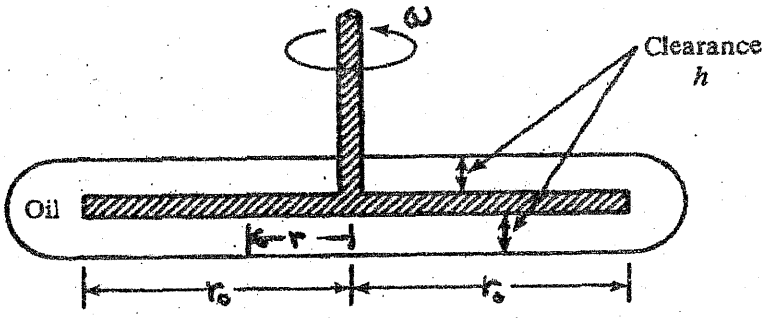
05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

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

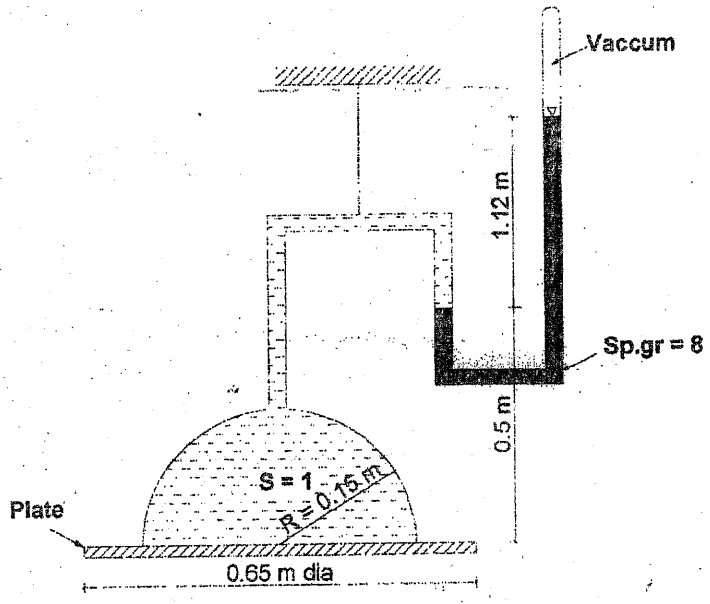
Subject: - Fluid Mechanics *(CE505)*

- ✓ 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.*

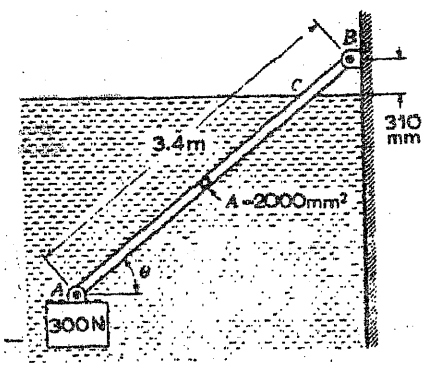
1. A disk of radius r_0 rotates at angular velocity ω inside an oil bath of viscosity μ as shown in figure below. Assuming a linear velocity profile and neglecting shear on the outer disk edges, derive an expression for the viscous torque on the disk. [6]



2. A suction cup is used to support a plate of weight W as shown in figure. For the condition shown, determine weight of plate W. [6]



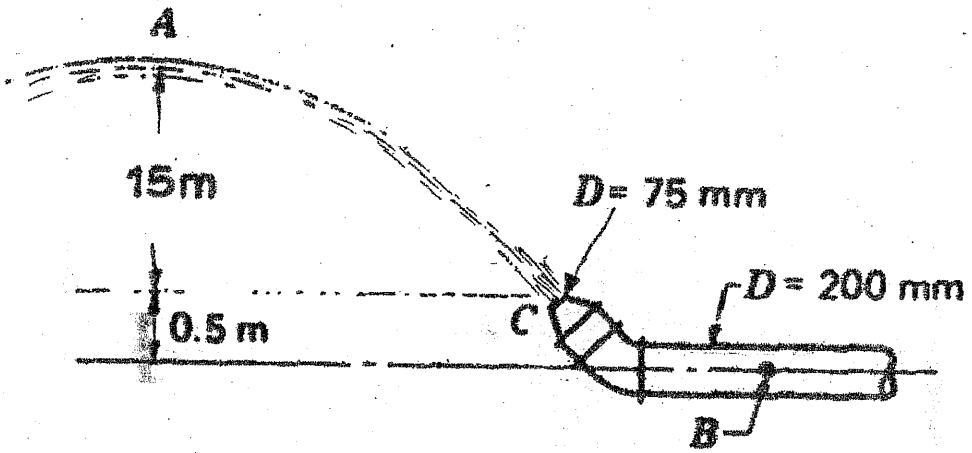
3. a) A block of wood having volume of 0.034 m^3 and weighing 300 N is suspended in water as shown in figure below. A wooden rod of length 3.4 m and cross sectional area 2000 mm^2 is attached to the weight and also to the wall. If the weight of rod is 16 N, what will angle θ be for equilibrium? [8]



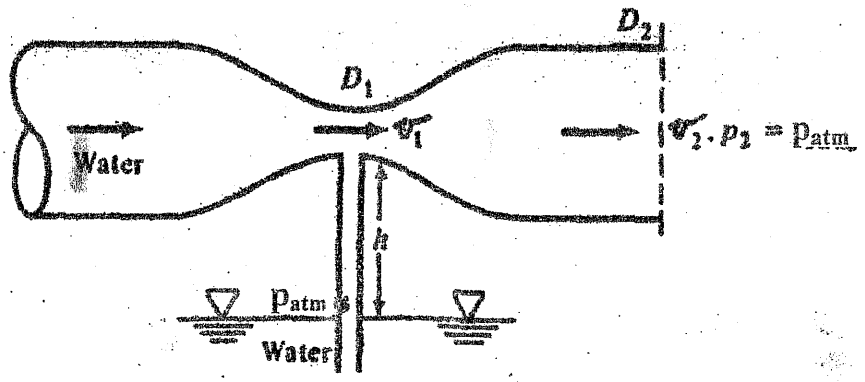
b) A student sneaks a glass of cola onto a roller coaster ride. The glass is cylindrical, twice as tall as it is wide, and filled to the brim. He wants to know what percent of the cola he should drink before the ride begins, so that none of it spills during the big drop, in which the roller coaster achieves 0.55g acceleration at a 45° angle below the horizontal. Make the calculation for him, neglecting sloshing and assuming that the glass is vertical at all times. [7]

4. Given: Velocity field $\vec{V} = (Ax - B)\hat{i} - Ay\hat{j}$; $A = 0.2S^{-1}$, $B = 0.6S^{-1}x$ in m [6]
   Find:
   a) General expression for acceleration of a fluid particle
   b) Acceleration at (x,y) = (0,4/3), (1,2) and (2,4)
   c) Plot of streamlines
   d) Acceleration vectors on plot

5. If the velocity at point A in figure is 18m/s, What is the pressure at point B if we neglect friction? [4]

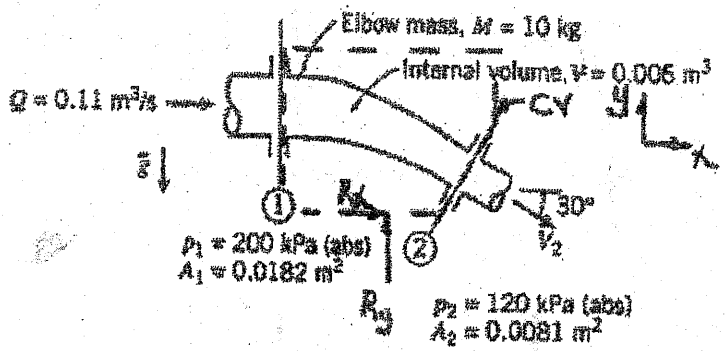


6. a) A necked-down or venturi, section of a pipe flow develops a low pressure which can be used to aspirate fluid upward from a reservoir as shown in figure below. Using Bernoulli's equation with no losses, derive an expression for the exit velocity v_2 that is just sufficient to cause the reservoir fluid to rise in the tube up to section 1. [8]



b) Derive an expression for the discharge over a triangular notch or weir. [4]

7. Given: Reducing elbow shown Fluid is water.
Find: Force components needed to keep elbow from moving. [8]



8. The velocity distribution in a laminar boundary layer on a flat plate is given by $\frac{u}{U} = a + bm + cm^2 + dm^3$ Where u = local velocity, U = free stream velocity, m = y/δ, δ = boundary layer thickness. Find the coefficients a, b, c and d and compute the displacement thickness. [4+3]

9. Given: Military aircraft with M = 8000 kg, lands at 350 km/hr and is slowed by a parachute with A = 10 m^2 area. [8]

Find:
a) Estimate of time needed to slow to 200 km/hr
b) Maximum deceleration rate
Model the chute as an open hemisphere.

(Neglect drag of aircraft)

10. a) What is similitude? Explain kinematic and dynamic similarity. [3]
b) Describe Reynold's and Froude's model law with their applications. [5]

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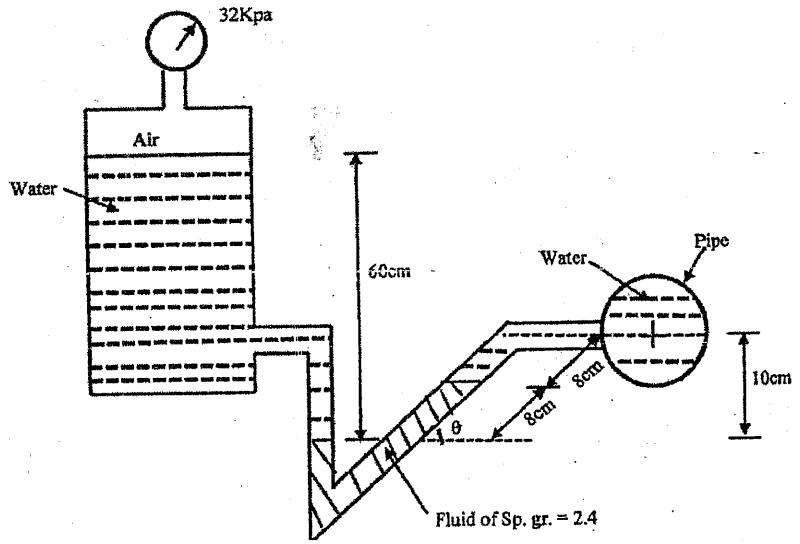
07 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Ashad

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.

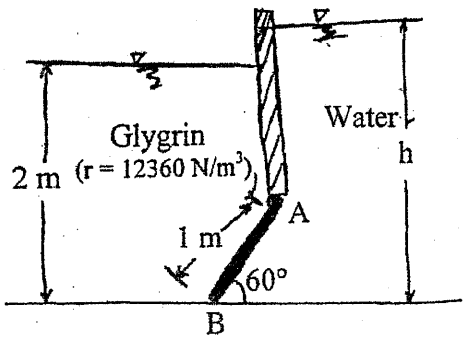
Subject: - Fluid Mechanics (CE505)

- ✓ 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**.*
- ✓ *Graph paper will be provided.*
- ✓ *Assume suitable data if necessary.*

1. What is continnum concept in fluid? Explain the cavitation phenomena. [3+3]
2. Compute the pressure of water flowing through a pipe shown in the figure below. [6]



3. Gate AB in figure below is a homogeneous mass of 180 kg, 1.2 m wide into the paper, resting on smooth bottom B. For what depth h will the force at point B be zero? [8]

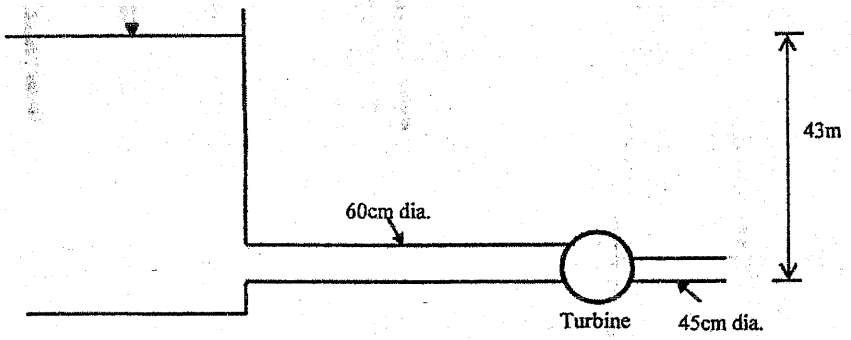


4. A very tall 10 cm diameter vase contains 1178 cm^3 of water. When spun steadily to achieve rigid body rotation, a 4 cm diameter dry spot appears at the bottom of the vase. What is the rotation rate, in rev/min, for this condition? [7]
5. The x- and y- components of fluid velocity in a two-dimensional flow field are u = x and v = -y respectively. Determine the stream function and plot the stream lines for φ = 1, 2, 3 [6]

6. From Euler's equation, derive the Bernoullis equation. [4]

7. Derive an expression which calculates time required to completely emptying the hemi spherical tank which was full at the beginning. [6]

8. A turbine is set 43 m below water level of a reservoir and is fed by a 60 cm diameter pipe as shown in figure below. A short pipe of 45 cm diameter discharges the water at a rate of 0.9 m^3/s from the turbine to the atmosphere. If the total loss of head is 3m of oil of sp.gr.0.9 and the turbine efficiency is 85%, find the power output of the turbine. [6]



9. A flat plate is struck normally by a jet of water 50 mm in diameter with a velocity of 18 m/s. Calculate (a) the force on the plate when it is stationary (b) the force on the plate when it moves in the same direction as the jet with a velocity of 6 m/s. [2+2]

10. When a jet of fluid strikes series of flat vanes, show that the maximum efficiency of the system is 1/2. [4]

11. The laminar boundary layer profile in a case is approximated by a cubic parabola as, $\frac{\mu}{U}=\frac{3}{2}\left(\frac{y}{\delta}\right)^2-\frac{1}{2}\left(\frac{y}{\delta}\right)^3$ where, u is the velocity at a distance y from the surface and $y\rightarrow\delta$, $u\rightarrow U$. Calculate the displacement thickness and momentum thickness in terms of δ and workout the shear stress at the surface. [7]

12. A kite has an effective area of 0.6 m^2 and mass 0.4 kg. It experiences a drag of 15 N in a wind speed of 40km/hr. Determine (a) the tension in the chord if it makes an angle 45° with the horizontal (b) lift coefficient for the kite, consider the density of air 1.2kg/m^3. [1+2+5]

13. The force F on a circular cylinder depends on the free stream velocity V, the diameter of the cylinder D, density of the fluid ρ, viscosity of the fluid μ and time t. By using Buckingham's π theorem, show that $F = \rho V^2 D^2 \phi\left(\frac{\mu}{\rho VD}, \frac{Vt}{D}\right)$. Take ρ, V and D as repeating variables. [8]

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07 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Chaitra

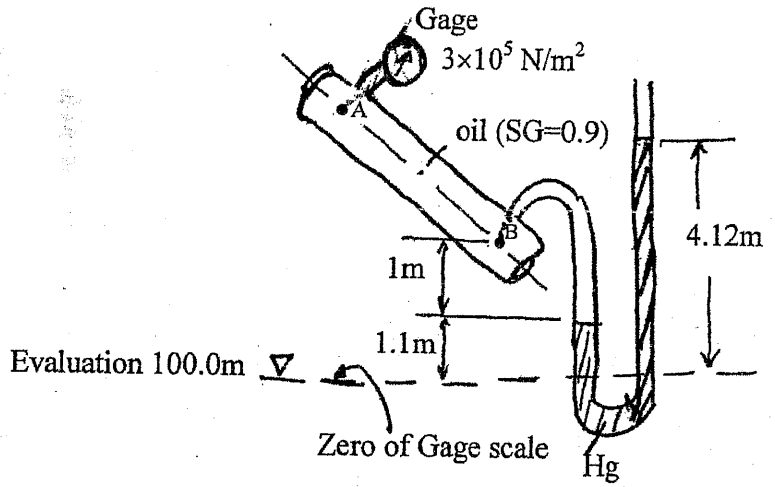
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE, B.Agri.	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Fluid Mechanics *(CE505)*

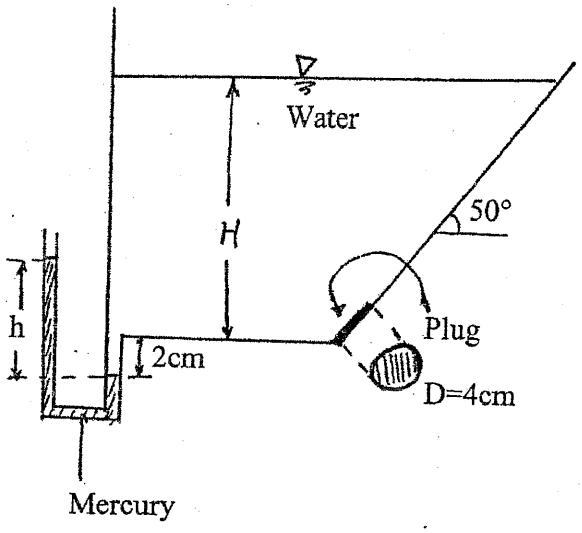
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Graph paper will be provided.*
- ✓ *Assume suitable data if necessary.*

1. A solid cone of maximum radius R and vertex angle 2θ is to rotate at angular velocity ω. An oil of viscosity μ and thickness t fills the gas between the cone and the housing. Derive an expression for the torque required and the rate of heat dissipation in the bearing. [6]

2. The pipe and connection B as shown in figure below are full of oil of specific gravity 0.9 under pressure. If the U-tube contains mercury, find the elevation of point A in meters. [6]



3. The tank in figure has a 4 cm diameter plug which will pop out if the hydrostatic force on it reaches 25 N. What will be the reading h on the manometer when this happen? [9]



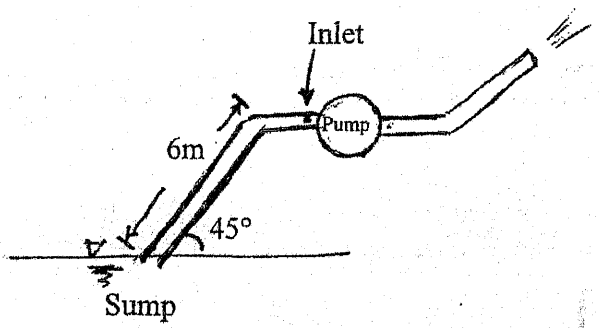
4. Prove that the rise of water equals the fall in case of forced vortex motion in cylindrical tank at side and center of the tank. [6]

5. The stream function for the two dimensional flow of a liquid is given by $\psi = 2xy$. In the range of values of x and y between 0 and 5 plot the stream lines and equipotential lines passing through coordinates (1,1), (1,2), (2,2). Also determine the velocity in magnitude and direction at the point (1,2) [6]

6. Write down and explain the terms of Euler's and Navier-stoke's equations of motion of fluid. [4]

7. Derive an expression for the time required to empty a conical tank without inflow. [6]

8. The inlet pipe of a pump rises at an angle of 45° to the horizontal and is 10cm in diameter. For design reasons it is undesirable that the pressure at the inlet to the pump should fall below 25 KN/m^2. The inlet pipe is 6m long, the lower end being just below the surface of the water in the sump. Find the maximum discharge that the pump may deliver. [6]



9. When a jet of fluid strikes a moving vertical plate, show that the maximum efficiency of the system is $\frac{8}{27}$ [8]

10. Explain with neat sketches Boundary layer concept along a thin plate. [7]

11. A jet plane a wing area of 30 m^2 and weighing 28 KN flies at 900 km/hr. The engine develops 8000 KW and has a mechanical efficiency of 70%. Determine the lift and drag coefficient for the wind taking density of air as 1.2 kg/m^3. [4+4]

12. Show that the resistance F to the motion of a sphere of diameter D moving with a uniform velocity V through a real fluid of density ρ and viscosity μ is given by.

$$F = \rho D^2 V^2 f\left(\frac{\mu}{VD\rho}\right)$$ [8]

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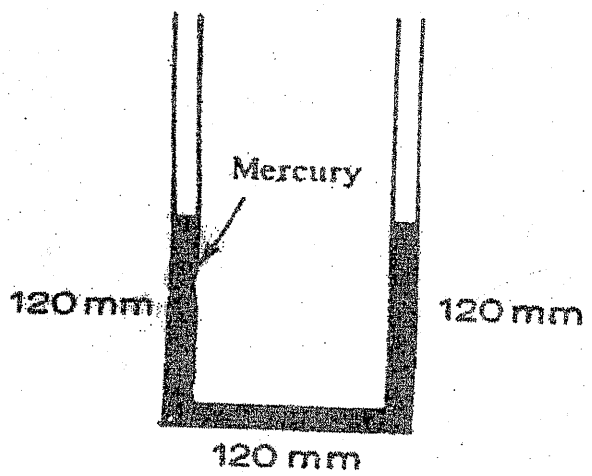
07 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Chaitra

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

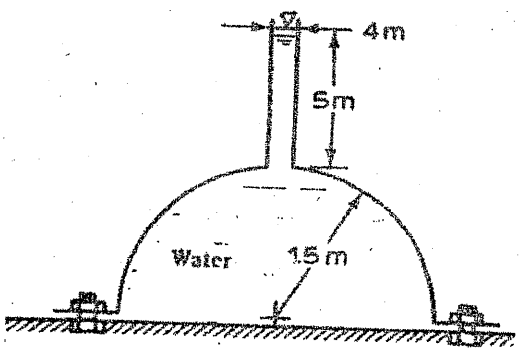
Subject: - Fluid Mechanics *(CE 505)*

- ✓ 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. Define Kinematic and dynamic viscosity. A small thin plane surface is pulled through the liquid filled space between two large horizontal planes in the parallel direction. Show that the force required will be minimum if the plate is located midway between the planes. [2+4]
2. Define absolute, gauge and atmospheric pressure. A U-tube shown in figure is 10mm in diameter and contains mercury. If 12ml(milliliter) of water is poured into the right hand leg, what are the ultimate heights in the two legs? [2+4]



3. Prove that in case of forced vortex, the rise of liquid level at the ends is equal to the fall of liquid level at the axes of rotation. The hemispherical dome as shown in figure is filled with water and is attached to the floor by two diametrically opposite bolts. What force in either bolt is required to hold the dome down, if dome weights 25kN? [4+6]



4. Show that if 'B' is the centre of buoyancy and 'M' is the metacentre of a partially immersed floating body then BM = I/V where I is the second moment of area of the surface of floatation about the longitudinal axis and 'V' is the immersed volume. [5]

5. Explain Lagragian and Eulerian methods of describing fluid flow. [2]

6. A flow is described by the stream function $\psi = 3\sqrt{2}\,xy$. Locate the point at which the velocity vector has a magnitude 6 unit and makes an angle 145° with the X-axis. [4]

7. Prove that the Cippoletti weir is a trapezoidal weir having side slopes 14.2° with vertical. Water flows over a rectangular sharp crested weir 2m long (divided into two bays of 1m each by pier). The head over the sill is 0.75m. The weir is fitted at the end of the long rectangular channel 3m wide and flow depth 1.5m. Starting from the first principles, determine the rate of discharge over the weir. Consider the velocity of approach and the effect of end contraction. Coefficient of discharge for the weir is 0.7. [4+8]

8. A pipe bend placed in a horizontal plane tapers from 50cm diameter at inlet to 25cm diameter at outlet. An oil of density 850kg/m^3 enters the reducing bend horizontal and get turned by 45° clockwise direction. The discharge is of 0.45m^3/sec and pressure at the inlet of 40KN/m^2 drops to 23KN/m^2 at the outlet due to frictional effect. Find out the magnitude and direction of resultant force on the bend. [8]

9. What is hydrodynamic boundary layer? Workout the shape factor $\left(\frac{\delta^*}{\delta}, \frac{\theta}{\delta}\right)$ parameter for the velocity distribution given by $\frac{v}{V_o} = \left(\frac{v}{\delta}\right)^{1/7}$. [3+4]

10. A 2mm diameter spherical ball of unit weight 117.5 kN/m^3 is dropped in a mass of fluid of viscosity 15 poise and sp.gr.0.95. Find out drag force, pressure drag, skin drag and terminal velocity of ball. [8]

11. Discuss types of modal studies. If gravity, viscosity and surface tension are equally important in a model, show that for dynamic similarity the relationship between viscosity ratio μ_r, surface tension ratio σ_r and model scale ratio L_r is given by $\frac{\mu_r L_r^{1/2}}{\sigma_r} = 1$. [2+6]

12. Derive an expression representing Euler's equation of motion. [4]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Baishakh

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

Subject: - Fluid Mechanics

- ✓ 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.*

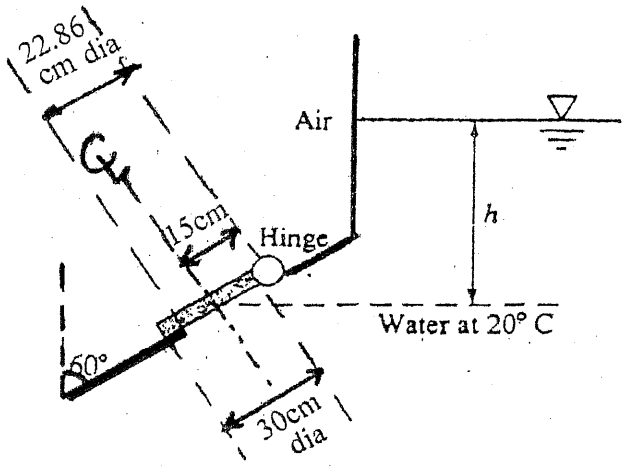
1. Define steam line with its drawing equation. A steady, three dimensional velocity field is given by $\vec{V} = (0.657 + 1.73x + 0.948y + az)\vec{i} + (2.61 + cx + 1.91y + bz)\vec{j} + (-2.73x - 3.66y - 3.64z)\vec{k}$. Calculate constants a, b, and c such that flow field is irrotational. [2+4]

2. Define the term pressure and skin friction drag with neat sketch. Describe briefly, with neat sketches, the changes in flow pattern and the drag coefficient with the variation of Reynold's number when a thin circular cylinder of infinite length is placed in a fluid stream. [2+4]

3. Derive the expression for centre of pressure on a plane inclined surface immersed in liquid. Also show pressure diagram for such surface. [6+2]

OR

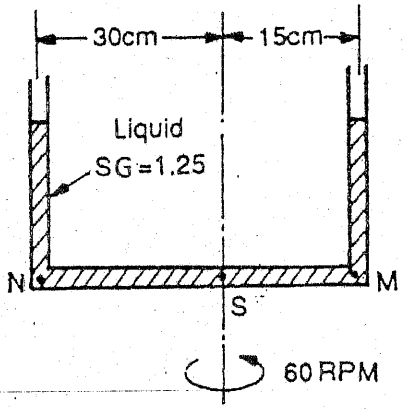
The swing check valve in figure below covers a 22.86cm diameter circular opening in a slanted wall. The hinge is 15cm from the centre line. The valve will open when the hinge moment is 50N.m. Find the value of h for the water to cause this condition. [8]



4. Consider a homogeneous right circular cylinder of length L, radius R, and specific gravity SG, floating in water (SG =1) with its axis vertical. Show that the body is stable if $\frac{R}{L} = [2.SG(1-SG)]^{1/2}$. [8]

OR

A U-tube shown in figure is filled with a liquid specific gravity 1.25 to a height of 15cm in both the limbs. It is rotated about a vertical axis 15cm from one limb and 30cm from the other. If the speed of rotation is 60 rpm, find the difference in the liquid levels in the two limbs. Also find the pressure at points M and N at the base of U tube. [8]



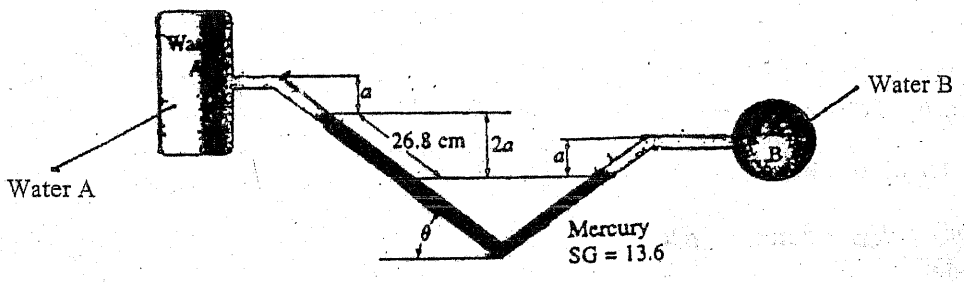
5. Write precisely how boundary layer theory helped in simplifying complex motion of fluid. Why does boundary layer increase with distance from the upstream edge? A simplistic laminar boundary layer model is: [2+2+2]

$$\frac{u}{U} = \sqrt{2}\frac{y}{\delta} \text{ for } 0 < y \le \frac{\delta}{2}$$

$$\frac{u}{U} = (2-\sqrt{2})\frac{y}{\delta} + (\sqrt{2}-1) \text{ for } \frac{\delta}{2} < y \le \delta.$$

Does this expression satisfy boundary conditions applicable to the laminar boundary layer velocity profile?

6. Two water tanks are connected to each other through a mercury manometer with inclined tubes, as shown in figure below. The pressure difference between the two tanks is 20kPa. Calculate "a" and "θ". [6]

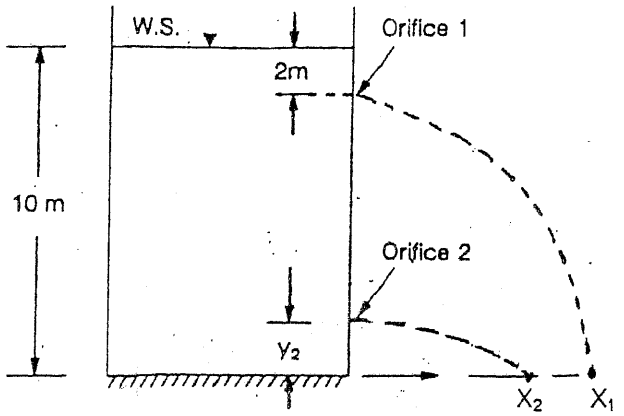


7. A tank of area A is provided with an orifice 40mm in diameter at its bottom. Water flows into the tank at a uniform rate and is discharged through the orifice. It is found that when the head of water over the orifice is 0.68m, the water surface rose at a rate of 0.0014m/sec. But, when the head of water is 1.24m, the water surface rose at 0.00062m/sec. Find the rate of inflow and the cross sectional area of the tank. Take $C_d = 0.62$. [6]

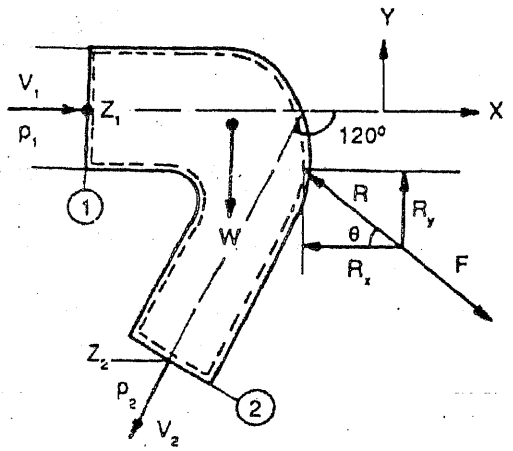
OR

A tank is in the form of frustum of a cone having top diameter of 2m, a bottom diameter of 0.8m and height 2m and is full of water. Find the time of emptying the tank through an orifice 100mm in diameter provided at the bottom. Take $C_d = 0.625$. [6]

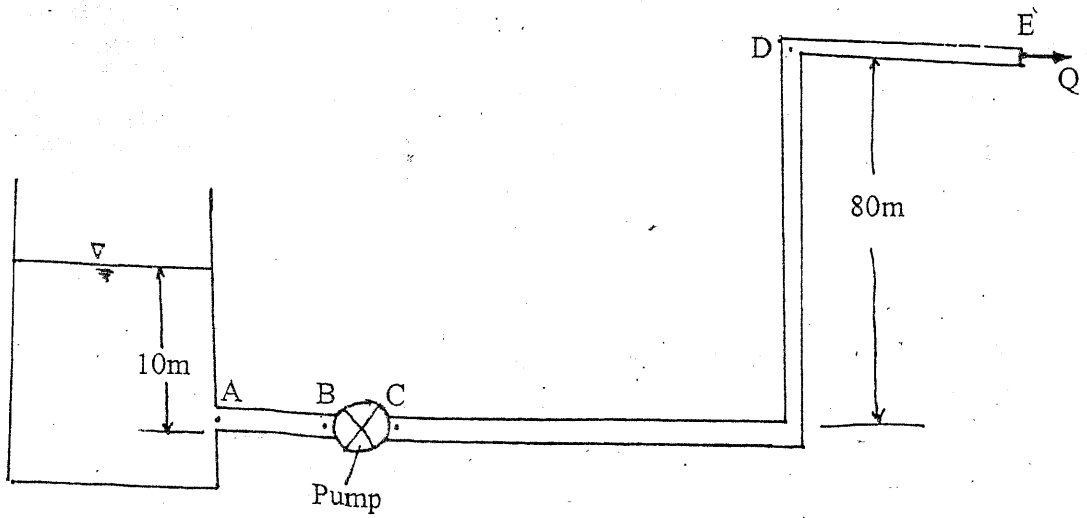
8. For the two orifices shown in figure below, determine Y_2 such that $x_2 = \frac{3x_1}{4}$. [6]



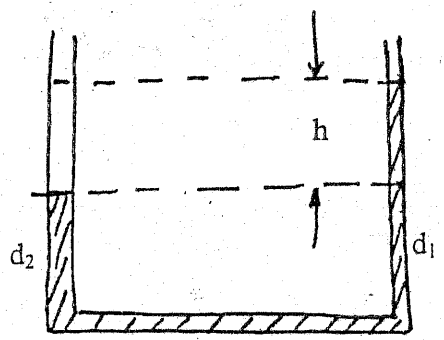
9. The diameter of a pipe bend is 30cm at inlet and 15cm at outlet and the flow is turned through 120° in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5m below the centre of the inlet section. Total volume of water in the bend is $0.9m^3$. Neglecting friction, calculate the magnitude and direction of the force exerted on the bend by water flowing through it at 250L/S and when the inlet pressure is $0.15N/mm^2$. [7]



10. The pipe flow in the figure is driven by the pump. What gauge pressure is needed to be supplied by the pump to provide water flow rate of $Q = 60m^3/h$? Neglect head loss from A to B. Head loss from C to D $= 30\frac{V_{CD}^2}{2g}$; Head loss from D to E $= 20\frac{V_{DE}^2}{2g}$; d_{AB} (diameter AB pipe) = d_{CD} = 5cm; d_{DE}=2cm. Where V_{CD} = velocity in pipe CD and V_{DE} = velocity in pipe DE. [7]



11. Express the kinematic viscosity in stokes for a liquid with specific gravity 0.95 and dynamic viscosity 0.011 poise. A U-tube is made up of two capillaries of diameters 1.0 mm and 1.5mm respectively. The U-tube is kept vertically and partially filled with water of surface tension 0.0075kg/m and zero contact angle. Calculate the difference in the level of the miniscii caused by the capillarity. [2+3]



12. The pressure drop in an air duct depends on the length and diameter of the duct, the mass density, viscosity of the fluid and the velocity of flow. Obtain an expression for the pressure drop in dimensionless form using Buckingham-π method. Estimate the pressure drop in a 20m long air duct if a model of the duct operating with water produces a pressure drop of 10KN/m^2 over 10m length. The scale ratio is 1:50. Given,

$\rho_{water} = 100kg/m^3$, $\rho_{air} = 1.2kg/m^3$,
$\mu_{water} = 0.001N.S/m^2$, $\mu_{air} = 0.0002N.S/m^2$, [5]

OR

How are the repeating variables selected for dimensional analysis? Prove that the scale ratio for discharge for a distorted model is given as $\frac{Q_p}{Q_m} = (L_r)_H \times (L_r)_v^{3/2}$ Where, Q_p = discharge through proto type; Q_m = discharge through model $(L_r)_H$ = horizontal scale ratio, $(L_r)_v$ = vertical scale ratio. [4+5]

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