TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2079 Baishakh**

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

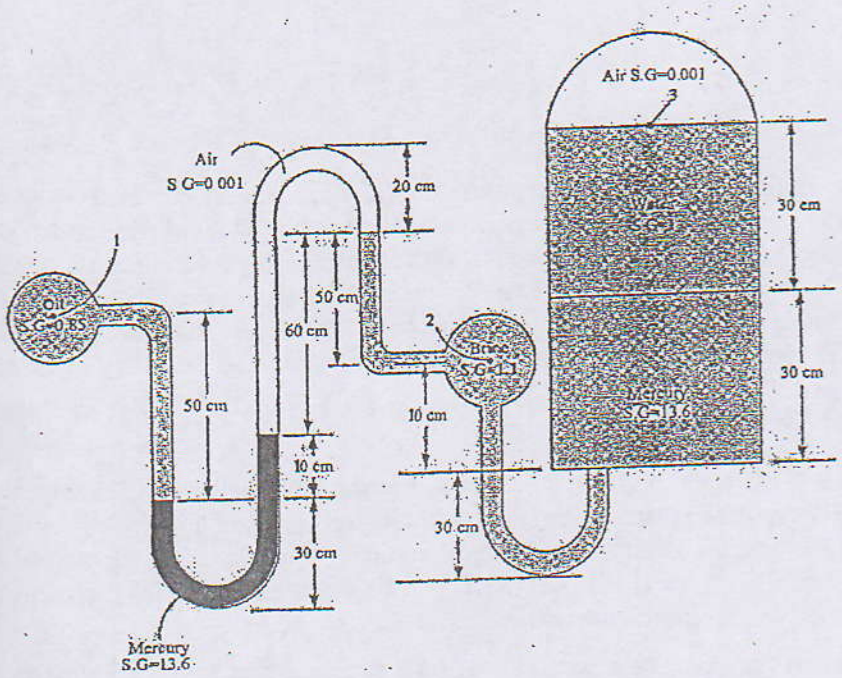
## *Subject:* - Fluid Mechanics (*CE 505*)

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

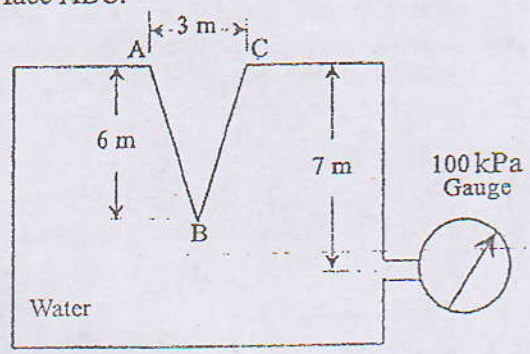
1. a) A square plate of size 1m × 1m and weighing 350 N sides down an inclined plane with a uniform velocity of 1.5 m/s. The inclined plane is laid on a slope of 5 vertical to 12 horizontals and has an oil film of 1 mm thickness. Calculate dynamic viscosity of oil. [4]

   b) Suppose the water rise predicted by the capillarity formula exceeds the height of the capillary tube. Does the water overflow? Explain with mathematical expression. [2]

   c) The two pipes are connected by a double U-tube manometer as shown in figure where the brine pipe is connected to a tank filled with different fluids. Oil and brine are flowing in parallel horizontal pipes. The pressure at the centre of oil pipe is 200 kPa. Calculate pressures at point 2 & 3. [5+5]




2. a) Pressurized water fills the tank as shown in figure below. Compute the net hydrostatic force on the conical surface ABC. [8]



b) What is the significance of metacentric height? When will the centre of gravity and centre of pressure coincide in case of plane immersed surfaces? [2+2]

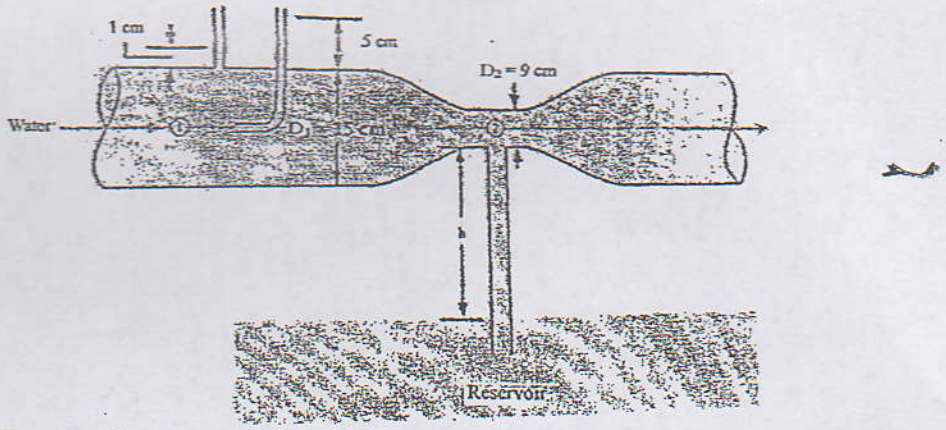
c) A water body is subjected to an acceleration in the vertically upward direction. At what acceleration will the pressure difference between two points, separated by a vertical distance, h, be zero? [4]

3. a) Given the velocity field $V = (5x)\,\hat{i} + (15y + 11)\,\hat{j} + (19t^2)\,\hat{k}$ m/s. Determine the path of particle which is at (4,6,2) m at time t = 3 s. [6]

b) The figure shows below a venturimeter where the reservoir open to atmosphere is connected to the throat by a tube.

i) What is the fluid velocity in the smaller diameter section of pipe?

ii) What is maximum height of fluid that can be lifted from reservoir (h)? Assume the fluid in lifting pipe is not moving. [5+5]




4. a) An orifice plate is used to measure the flow in hydropower canal 500m wide with a water depth of 300mm. A rectangular orifice size of 300mm wide and 100mm high is placed 5cm above the canal bed. If downstream water depth in canal is 225mm, what is the flow in the canal? Take coefficient of discharge of an orifice plate 0.63. [4]

b) What is boundary Layer? Explain boundary layer thickness and displacement thickness. Compute the ratio of these quantities for the boundary layer described by the velocity distribution $\frac{u}{U} = \left(\frac{y}{\delta}\right)^{1/7}$. [1+2+3]

c) A jet of the water. 50 mm in diameter, is striking normally with velocity of 50m/sec at the center of the plate which is hinged at its top edge and a horizontal external force is applied at the bottom edge to keep it vertical. What should be amount of the applied force? If the force is removed what will be the angle of inclination of the plate with vertical for equilibrium condition? [3+3]

5. a) What is the expression for the drag on a sphere, when Re of the flow is 0.2? Prove that the coefficient of drag for sphere for this range of the Reynolds number is given by $C_D = 24/Re$, where Re is the Reynolds number. [2+4]

b) 1:400 model is constructed to study tides. What length of time in the model corresponds to a day in the prototype? Suppose the model could be transported to the moon and tested there. What then would be the time relationship between the model and prototype? Given, 'g' of earth = 6 times 'g' of moon. [6]

c) Sphere of diameter d and density $\rho_s$ settles at a terminal velocity V in a liquid of density $\rho_l$ and dynamic viscosity $\mu$. Determine an expression of velocity in which velocity also depends on acceleration due to gravity g. Use Rayleigh's Method. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
2078 Bhadra

| 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 All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
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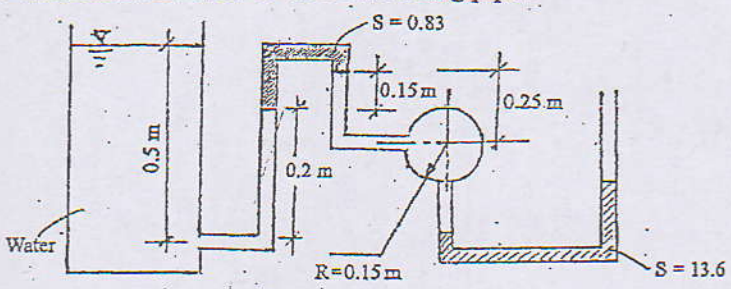
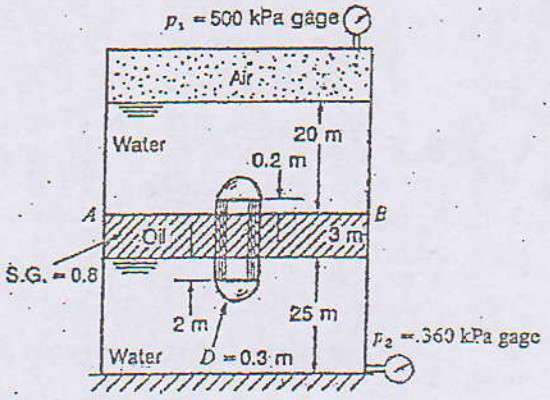
1. a) The space between two large flat and parallel walls 25 mm apart is filled with a liquid of dynamic viscosity 0.7 Pa.s. Within this space a thin flat plate 250 mm × 250 mm is towed at a velocity of 150 mm/s at a distance of 6 mm from one wall, the plate and its movement being parallel to the walls. Assuming linear variations of velocity between the plate and the walls, determine the force exerted by the liquid on the plate. [8]

   b) An inverted manometer is connected to the pipe and tank as shown in figure. What will be the differential level on U-tube connecting pipe? [8]




2. a) A tank is hermetically sealed into two compartments by plate AB. A cylinder of diameter 0.3 m with two hemispherical end is protrudes above and below the seal AB and is welded to the seal AB. what is the vertical force in the cylinder? [8]

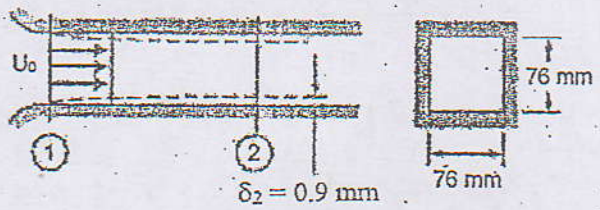



   b) A buoy, floating in sea-water of density 1025 kg/m$^3$ is conical in shape with a diameter across the top of 1.2 m and a vertex angle of 60°, its mass is 300 kg and its centre of gravity is 750 mm from the vertex. A flashing guiding light is to be fitted to the top of the buoy. If this unit is of mass 55 kg, what is the maximum height of its centre of gravity above the top of the buoy if the whole assembly is not be unstable? (The centroid of a cone of height h is at 3h/4 from the vertex.) [8]

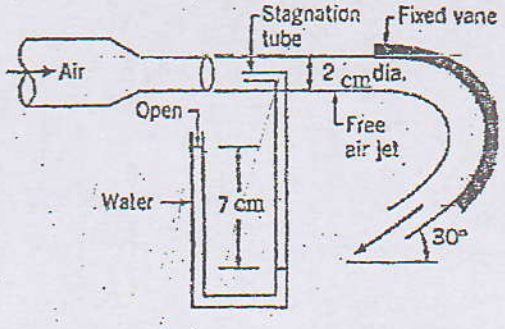
3. a) A pressurised 2 m diameter tank of water has a 10 cm dia orifice at the bottom, where water discharges to the atmosphere. The water level initially is 3m above the outlet. The tank air pressure above water level is maintained at 450 kPa absolute and the atmospheric pressure is 100 kPa. Neglecting the frictional effects, determine (i) how long it will take for half of the water in the tank to discharge and (ii) the water level in the tank after 10 sec. [6+2]

b) The x component of velocity in a two-dimensional, incompressible flow field is given by $u = Axy$; the coordinates are measured in meters and $A = 2m^{-1}s^{-1}$. There is no velocity component or variation in the z direction. Calculate the acceleration of a fluid particle at point (x, y) = (2, 1). Estimate the radius of curvature of the streamline passing through this point. Plot the streamline and show both the velocity vector and the acceleration vector on the plot. [8]

4. a) Air flows in the entrance region of a square duct, as shown. The velocity is uniform, $U_0 = 30$ m/s, and the duct is 76 mm square. At a section 0.3 m downstream from the entrance, the displacement thickness on each wall measures 0.9 mm. Determine pressure change between section 1 and 2. [6]




b) A stream of air at standard condition from 2 cm dia. nozzle strikes a curved vane as shown. A stagnation pitot tube connected to water-filled U-tube manometer is located in the nozzle exit plane. Calculate the speed of the air leaving the nozzle. Estimate the horizontal component of force exerted on the vane by the jet. [6]




c) What is laminar Sub-layer? Differentiate between the characteristics of laminar and turbulent boundary layer. [2+2]

5. a) In Buckingham – Pi method, describe the following:

(i) Guiding rule for selection of repeating variables. (ii) Rules for grouping the Pi-terms oil of kinematic viscosity $4.645 \times 10^{-5}$ $m^2/s$ is to be used in a prototype in which both viscous and gravity force dominate. A model scale of 1:5 is also desired. What viscosity of model liquid is necessary to make both the Froude number and the Reynold number same in model and prototype? [2+2+4]

b) An aeroplane is designed according to the following specifications:

Weight = 13.5 kN, wing Area = 30 $m^2$, Take off speed = 30 m/s

Model tests show that the lift and drag coefficient vary with the angle of attack of the wing according to following approximate relations:

$C_D = 0.008\ (1 + \alpha)$ $\quad$ $C_L = 0.35\ (1 + 0.2\alpha)$

For small $\alpha$, where $\alpha$ is the angle of attack measured in degree. The atmospheric density is 1.29 $Kg/m^3$. Find the angle of attack that ensures take-off at the design speed and power required for take off. [6+2]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
2078 Bhadra

| 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 All questions.*
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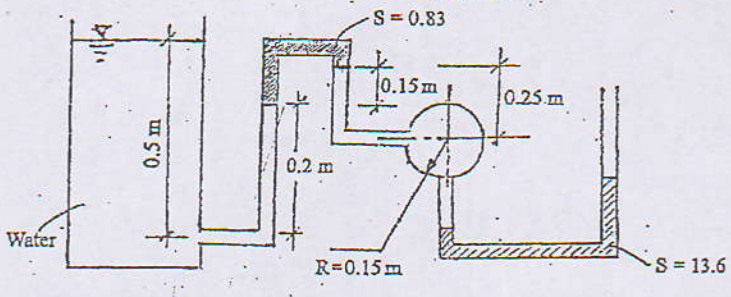
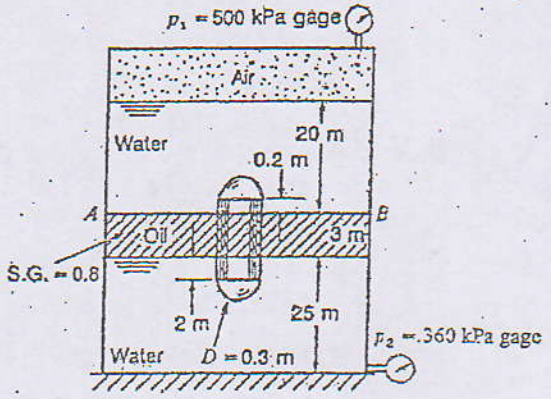
1. a) The space between two large flat and parallel walls 25 mm apart is filled with a liquid of dynamic viscosity 0.7 Pa.s. Within this space a thin flat plate 250 mm × 250 mm is towed at a velocity of 150 mm/s at a distance of 6 mm from one wall, the plate and its movement being parallel to the walls. Assuming linear variations of velocity between the plate and the walls, determine the force exerted by the liquid on the plate. [8]

   b) An inverted manometer is connected to the pipe and tank as shown in figure. What will be the differential level on U-tube connecting pipe? [8]




2. a) A tank is hermetically sealed into two compartments by plate AB. A cylinder of diameter 0.3 m with two hemispherical end is protrudes above and below the seal AB and is welded to the seal AB. what is the vertical force in the cylinder? [8]




   b) A buoy, floating in sea-water of density 1025 kg/m$^3$ is conical in shape with a diameter across the top of 1.2 m and a vertex angle of 60°, its mass is 300 kg and its centre of gravity is 750 mm from the vertex. A flashing guiding light is to be fitted to the top of the buoy. If this unit is of mass 55 kg, what is the maximum height of its centre of gravity above the top of the buoy if the whole assembly is not be unstable? (The centroid of a cone of height h is at 3h/4 from the vertex.) [8]

3. a) A pressurised 2 m diameter tank of water has a 10 cm dia orifice at the bottom, where water discharges to the atmosphere. The water level initially is 3m above the outlet. The tank air pressure above water level is maintained at 450 kPa absolute and the atmospheric pressure is 100 kPa. Neglecting the frictional effects, determine (i) how long it will take for half of the water in the tank to discharge and (ii) the water level in the tank after 10 sec. [6+2]

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2078 Kartik**

| 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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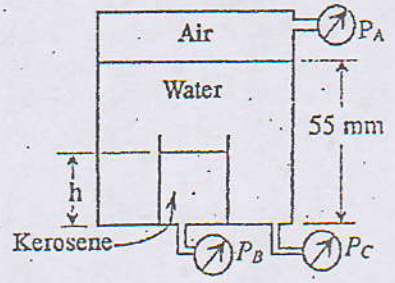
1. a) The viscosity of one of the liquid in laboratory is determined by measurements of shear stress $\tau$ and rate of shearing strain $\frac{du}{dy}$ tested in suitable viscometer. Based on following observations, determine if the given liquid is Newtonian or Non-Newtonian fluid. Explain how you arrive at your answer. [4]

| $\tau$ (N/m$^2$) | 0.04 | 0.06 | 0.12 | 0.18 | 0.3 | 0.52 | 1.12 | 2.1 |
|---|---|---|---|---|---|---|---|---|
| $\frac{du}{dy}$ ($s^{-1}$) | 2.25 | 4.5 | 11.25 | 22.5 | 45 | 90 | 225 | 450 |

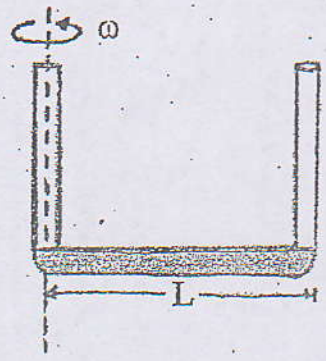
b) Under what condition inverted U-tube manometer and single column inclined manometer are used to measure pressure. [3]

c) A cylindrical tank contains water at a height of 55 mm as shown in figure below. Inside a smaller open cylinder tank containing cleaning fluid (S = 0.8) at a height h. If $P_B$ = 13.4 Kpa and $P_C$ = 13.42 KPa gauge, what are gauge pressure $P_A$ and height h of cleaning fluid? Assume that the cleaning fluid the kerosene is prevented from moving to the top of the tank. [5]

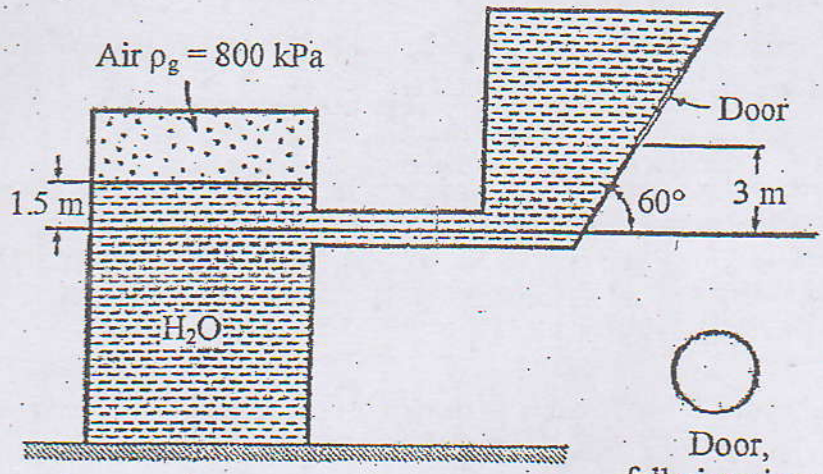



d) Write the Navier-Stokes and Bernoulli's equation (derivation not required). Explain each terms in the equations with physical meaning. [4]

2. a) The figure shows U-tube of base length L in which a liquid of density 0.85 is filled such that it completely fills the base length only. If the tube is now rotated at angular speed of 10 rad/sec as shown, find the level rise of liquid in outer arm of tube. [6]



b) Determine the force and its position from fluids acting on the door as shown in figure. [10]




3. a) Consider the flow described by the velocity field $\vec{v} = Bx(1 + At)\vec{i} + Cy\vec{j}$, with $A = 0.5\ s^{-1}$, and $B = C = 1\ s^{-1}$. Coordinates are measured in meter. Plot the streak lines traced out by the particle that passes through the point (1, 1) during the interval from $t = 0$ to $t = 3$ s. Compare with streamlines plotted through the same point at the instants $t = 0$, 1 and 2 s. (no need of graph paper, plot in answer copy in precision as far as possible) [4+4]

b) Derive an expression for flow through partially and fully submerged orifice. [2+2]

c) Show that the slope of Cipolletti weir is 1:4. How can you account for velocity of approach while computing the discharge over weirs? [3+1]

4. a) The diameter of a pipe-bend is 300 mm at inlet and 150 mm at outlet and the flow is turned through 120° in a vertical plane. The axis at inlet is horizontal and the center of outlet section is 1.4 m below the center of inlet section. The total volume of fluid contained in the bend is 0.085 $m^3$. Neglecting friction, calculate the magnitude and direction of the net force exerted on the bend by water flowing through it at 0.23 $m^3/s$ when the inlet gauge pressure is 140 kPa. Take head loss in the bend as 0.25 $V^2/2g$, where V = velocity at inlet pipe. [9]

b) Explain the development of boundary layer along a thin flat plate held parallel to uniform flow. Also point out the salient features. [7]

5. a) A pressure drop $\Delta P$ provides a measure of the frictional losses of a fluid as it flows through a pipe. Determine how $\Delta P$ is related to the variables that influence it, namely, pipe dia. D, its length L, fluid density $\rho$, viscosity $\mu$, velocity V and the relative roughness factor $\frac{\epsilon}{D}$, which is ratio of average size of surface irregularities to the pipe diameter. Use Buckingham-$\pi$ method. [8]

b) Describe with the help of a sketch, the variation of drag coefficient for a cylinder over a wide range of Reynolds number. [8]

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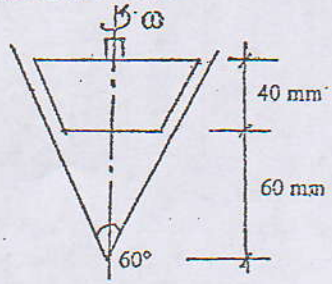
1. a) A pressure gauge consists of U tube with equal enlarged ends and is filled with water on one side and oil of specific gravity 0.97 on the other, the surface of separation being in the tube below the enlarged ends. Calculate the diameter of each enlarged end if the tube diameter is 5 mm and the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

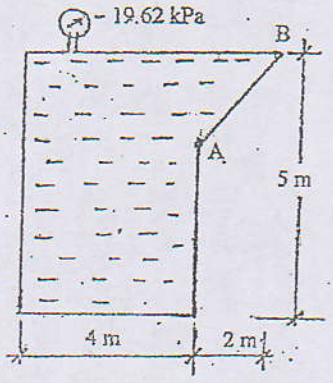
   b) Oil of viscosity $\mu = 2$ poise fills the small gap of thickness 0.2 mm. Determine the torque required to rotate the truncated cone at constant speed of 100 rpm. Neglect fluid stress exerted on the circular bottom. [6]




   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

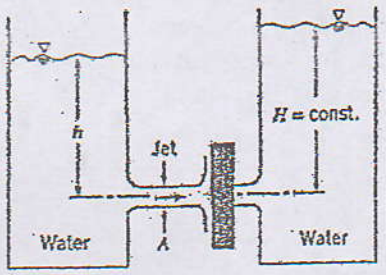
(i) sketch streamlines $\psi = 0$ and $\psi = 8m^2/s$

(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]

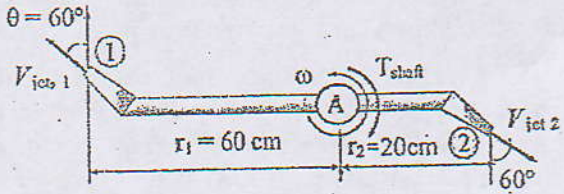
b) Prove that in Cippoletti weir the sides have a slope of 1:4. A sharp-edged notch is in the form of a symmetrical trapezium. The horizontal base is 100 mm wide, the top is 500 mm wide and the depth is 300 mm. Develop from first principles a formula relating the discharge to the upstream water level, 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]



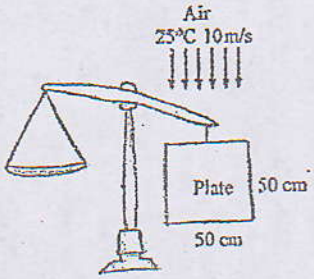

b) Flow takes place over a flat plate exposed parallel to free stream. Mention characteristics of flow and draw a neat sketch of the boundary layer development showing, (i) Laminar boundary layer, (ii) Turbulent boundary layer, (iii) Transition zone, (iv) Laminar sub layer. What is displacement thickness? [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**
2076 Ashwin

| Exam. | Back | | |
|---|---|---|---|
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*Subject:* - Fluid Mechanics *(CE 505)*

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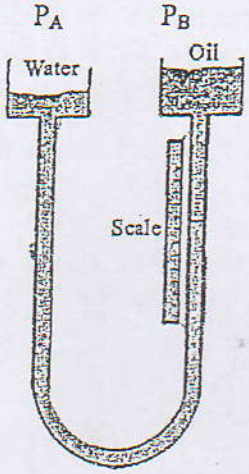
1. a) A manometer consists of a U-tube, 7 mm internal diameter, with vertical limbs each with an enlarged upper end 44 mm diameter. The left hand limb and the bottom of the tube is filled with water and the top of the right-hand limb is filled with oil of specific gravity 0.83. The free surfaces of the 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]

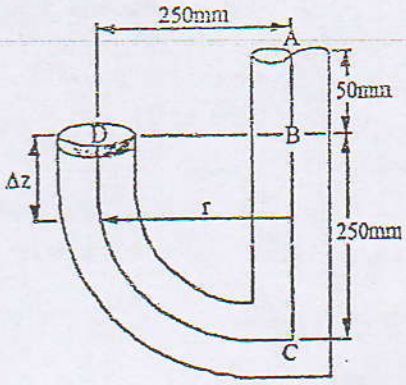



b) Explain Capillarity phenomenon. [1]

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]

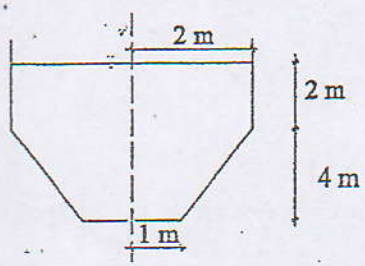
b) A tube ABCD has the end A open to atmosphere and the end D closed as shown in figure below. The portion ABC is vertical while the portion CD is a quadrant of radius 250 mm with its centre is B, the whole being arranged to rotate about its vertical axis ABC. If the tube is completely filled with water 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 25$m^2$. 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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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.*
- ✓ *Assume suitable data if necessary.*

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.

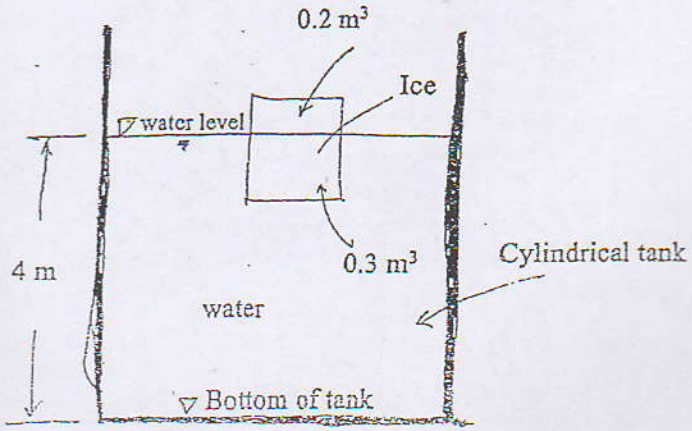
   When the right-hand side is connected to a cylinder of gas the surface of separation is observed to fall by 25mm, but the surface of oil remains in the enlarged end. Calculate the gauge pressure in the cylinder. Assume that the specific gravity of the water is 1.0 and that of the oil 0.9. [8]

   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]



3. a) Velocity field $\vec{v} = Bx(1+At)\vec{i} + cy\vec{j}$ with A=0.5$s^{-1}$, B=C=1$s^{-1}$. 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 3.2$m^2$ has two orifices each 8.8$mm^2$ 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 ($\mu$), density of fluid ($\rho$) 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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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
**Examination Control Division**
**2075 Ashwin**

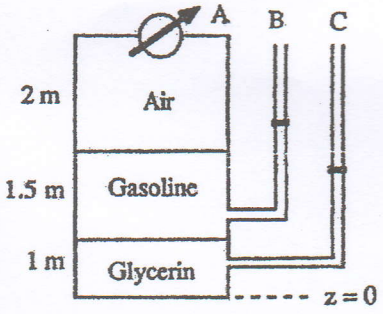
| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BCE, B.Agri. | Pass Marks | 32 |
| Year / Part | II / I | Time | 3 hrs. |

***Subject:*** - Fluid Mechanics *(CE505)*

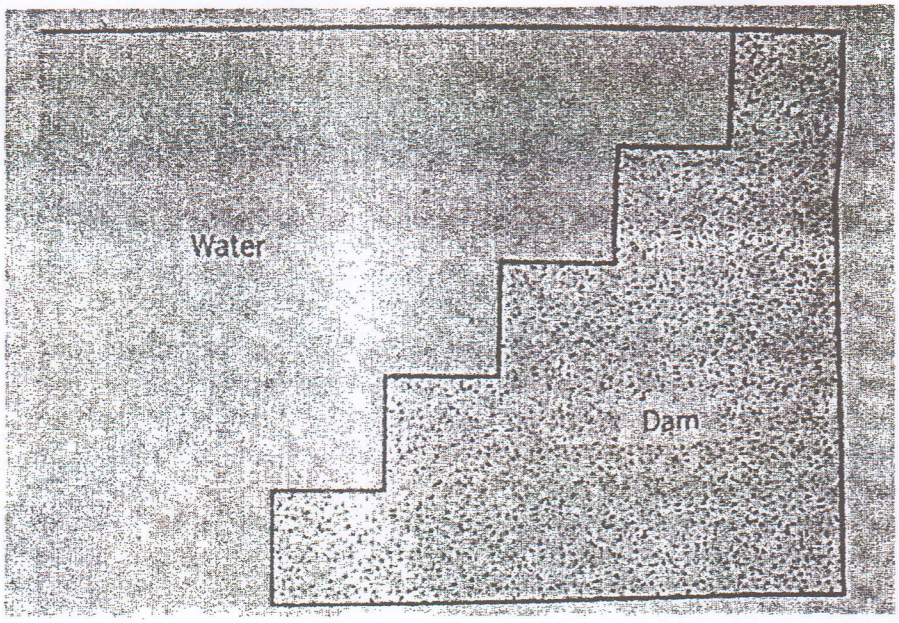
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Assume suitable data if necessary.***

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]

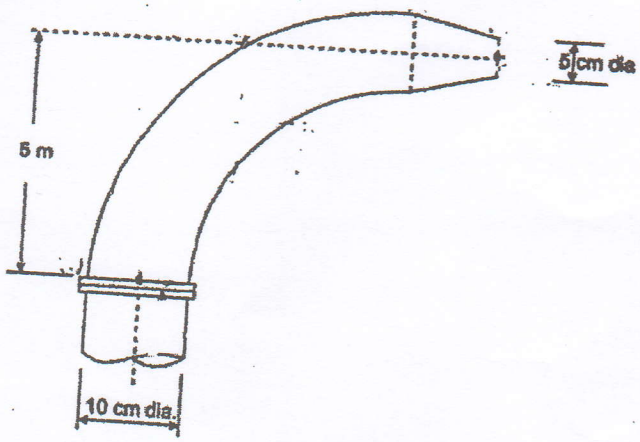


b) A thin-walled, open-topped tank in the form of a cube of 500 mm side is initially full of oil of relative density 0.88. It is accelerated uniformly at 5 m/s2 up a long straight slope at arctan (1/4) to the horizontal, the base of the tank remaining parallel to the slope, and the two side faces remaining 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 $\tau_w$ in a boundary layer is assumed to be a function of stream velocity U, boundary layer thickness $\delta$, local turbulence velocity u', density $\rho$, and local pressure gradient dp/dx. Using ($\rho$, U,$\delta$) 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**

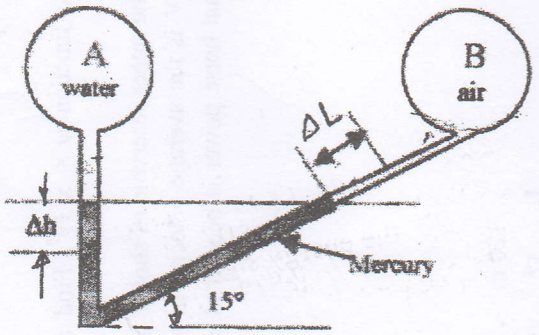
| Exam. | Back | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BCE, B. Agri. | Pass Marks | 32 |
| Year / Part | II / I | Time | 3 hrs. |

## *Subject:* - Fluid Mechanics *(CE505)*

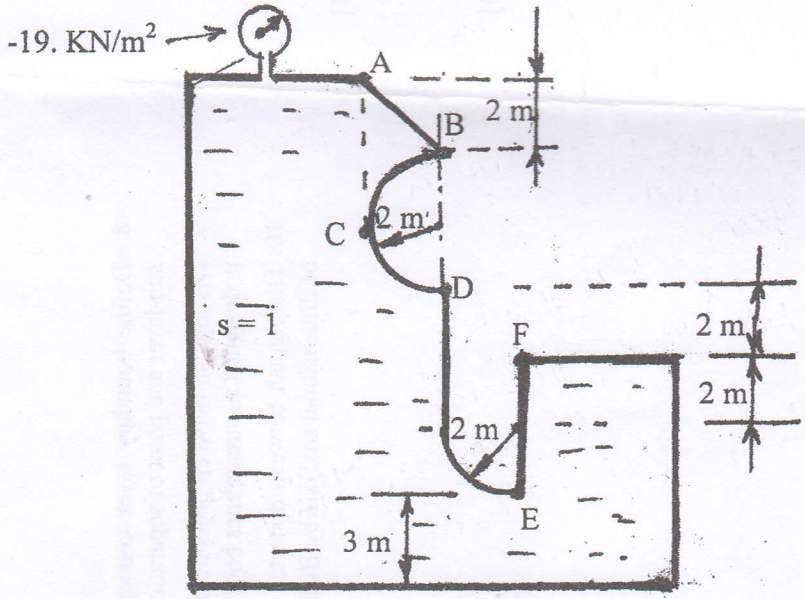
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

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]

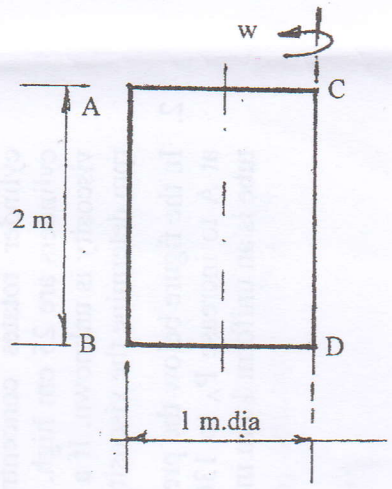



3. a) Find the resultant pressure force due to water on a curved surface BCDEF of 10 m length as shown in figure below. [8]



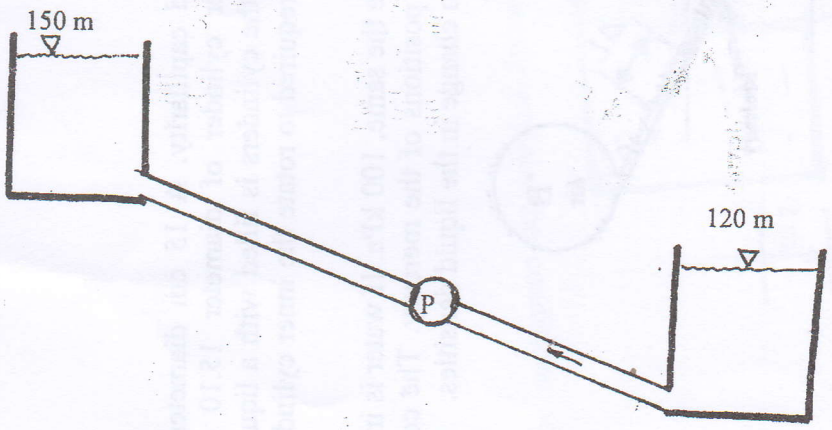

b) Explain the use of hydrometer and shortly explain the conditions of stability of floating bodies. [6]

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]

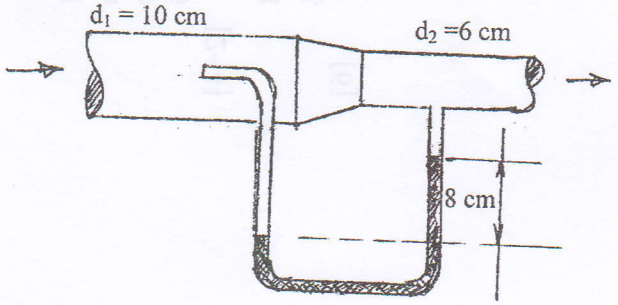



4. Sketch the streamlines represented by the stream function $\psi = x^2+y^2$. Find also the velocity and its direction at point (3,4). [3+3]

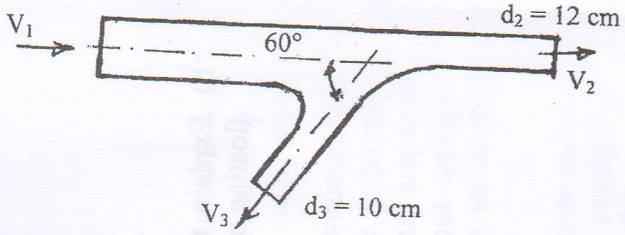
5. Water is pumped at $0.12 m^3/s$ from the lower to the upper reservoir as shown in figure below. Pipe friction losses $h_f = 27v^2/2g$, where V is the average velocity in the pipe (diameter = 15 cm). If pump is 75% efficient, what horse power is needed to drive it? Draw TEL and HGL. [5+3]




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**

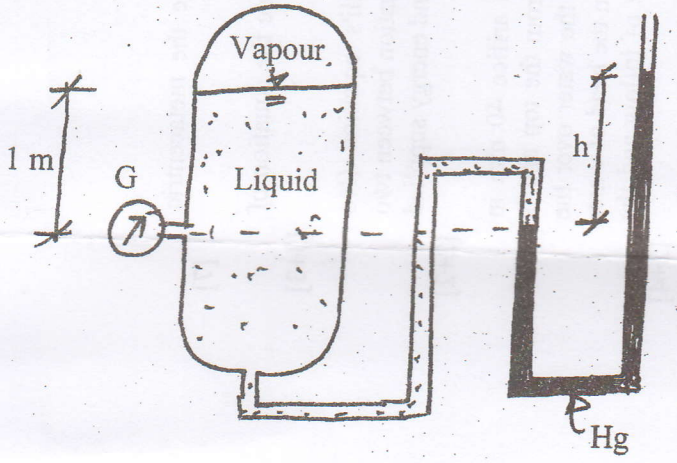
| Exam. | New Back (2066 & Later Batch) | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BCE, B. Agri. | Pass Marks | 32 |
| Year / Part | II / I | Time | 3 hrs. |

***Subject:*** - Fluid Mechanics *(CE505)*

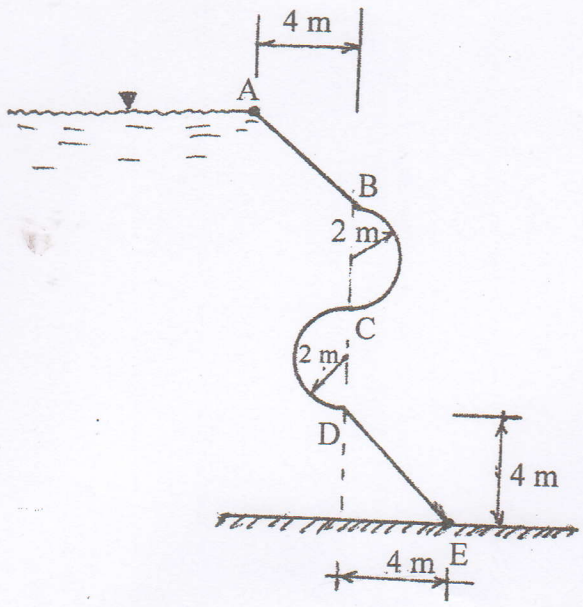
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

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]

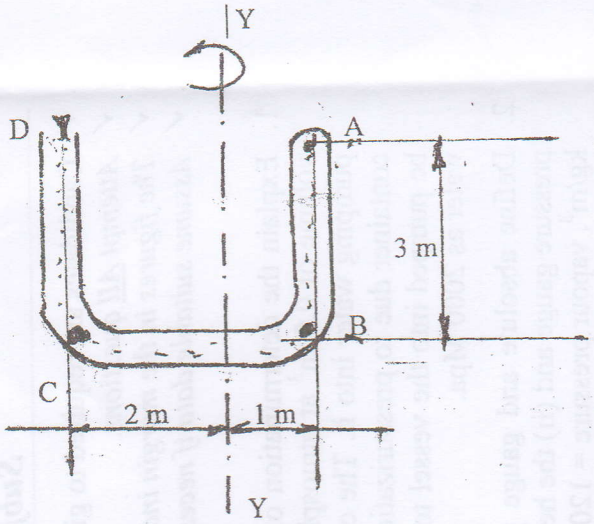
2. Define absolute and gauge pressure. Determine (i) the gauge pressure reading on the pressure gauge and (ii) the height h, of the mercury monometer. Take liquid density = 800 $kg/m^3$, vapour pressure = 120 Kpa (abs) and atmospheric pressure = 101 kpa (abs). [2+5]




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 $\psi$ and $\phi$. [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**

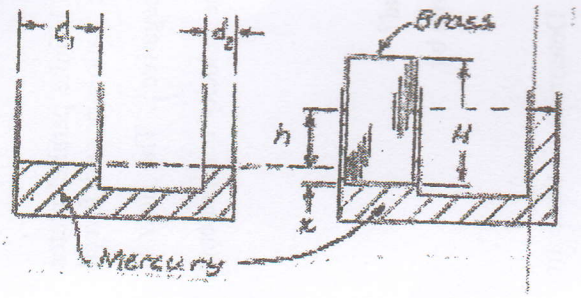
| Exam. | Regular | | |
|---|---|---|---|
| Level | BE | Full Marks | 80 |
| Programme | BCE, B. Agri. | Pass Marks | 32 |
| Year / Part | II / I | Time | 3 hrs. |

## *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.*

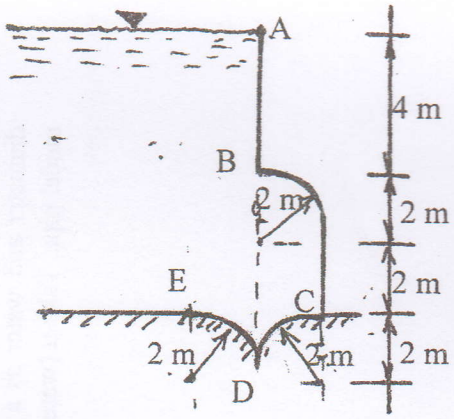
1. Explain the determination of viscosity by viscometer. A U-tube is made up of two capillaries of bores 1.5 mm and 2mm respectively. The U tube is held vertical and partially filled with liquid whose surface tension $\sigma$ = 0.075 N/m. Find out the mass density of the liquid if the difference in two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

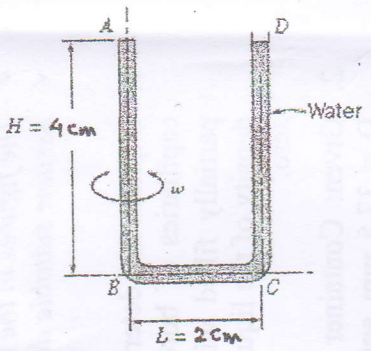



Find: (a) Pressure on bottom of cylinder
(b) New equilibrium level; h, of mercury

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 $\mu$ is fluid's viscosity. Is this flow rotational or irrotational?

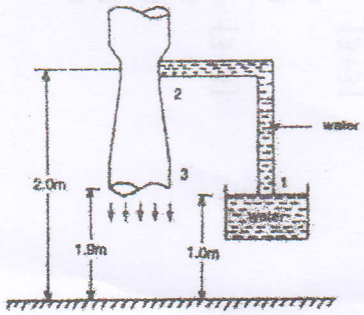
b) A steady, incompressible, two dimensional velocity field is given by [3]

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

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 $\mu$ (water) = 0.01 poise. [5]

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