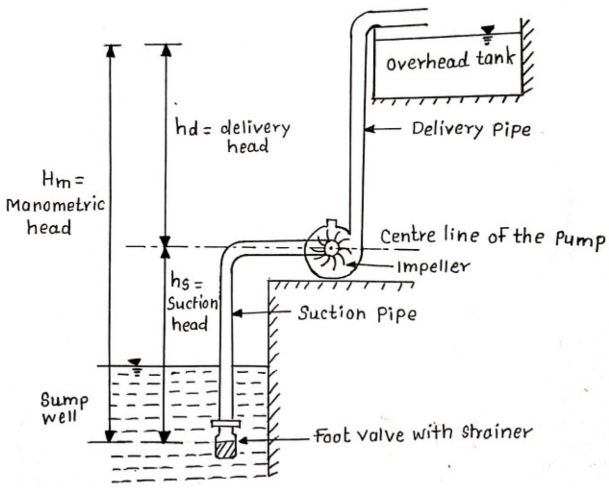
Model Answer: Summer - 2019

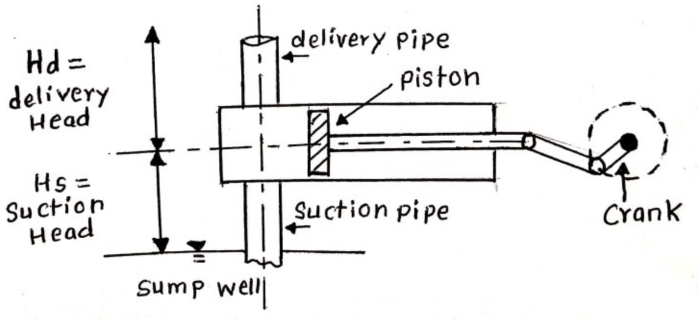
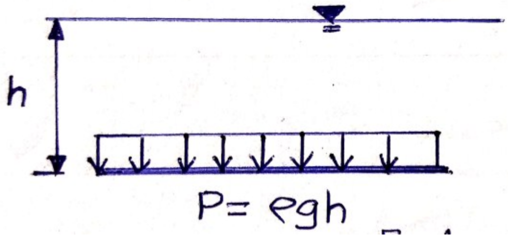
Subject: Hydraulics **Sub. Code: 22401**

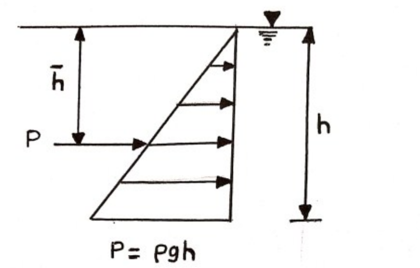
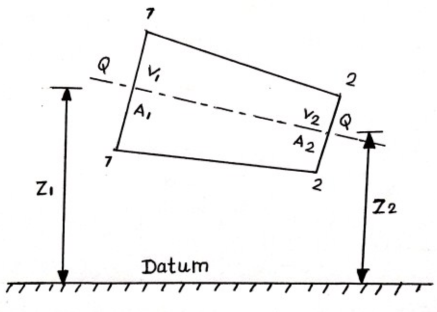
Important Instructions to Examiners

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by the candidate and those in the model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

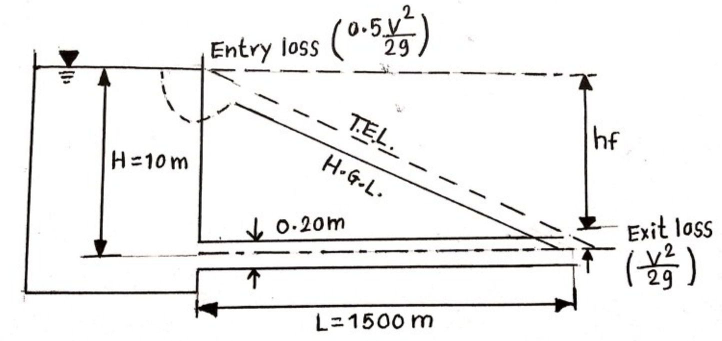
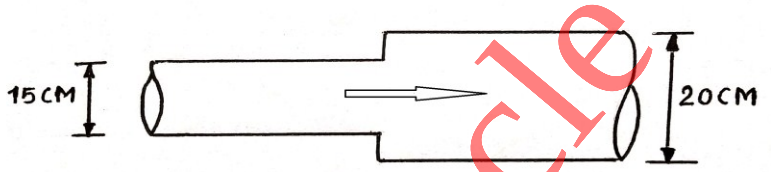
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1		**Attempt any FIVE of the following:**		(10)
	a) Ans.	**Define weight density and relative density and give its unit.** i. **Weight Density:** It is the weight per unit volume. **OR** It is the ratio of weight to the volume **Unit:** N/m^3 or kN/m^3	½ ½	
		ii. **Relative Density:** It is the ratio of specific weight of liquid to the specific weight of pure water at 4^0 C. **OR** It is the ratio of density of liquid to the density of pure water at 4^0 C. **Unit:** No unit.	½ ½	2
	b) Ans.	**Define total pressure and centre of pressure with its unit.** i) **Total Pressure:** The force exerted by the static fluid on the surface in contact with the fluid is called as total pressure. **Unit :** kN or N i) **Centre of pressure:** The point at which the total pressure is suppose to be act is called as centre of pressure. **Unit:** Meter (m)	½ ½ ½ ½	2

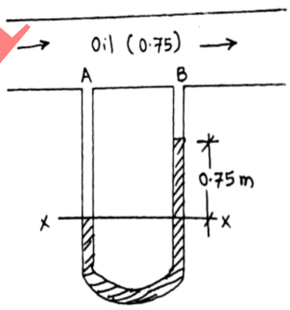
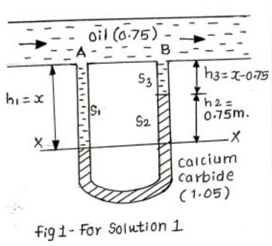
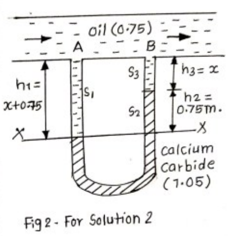
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	c) Ans.	**Define datum head and pressure head and give its unit.**		
		i. **Datum head:** It is the head possessed by fluid due to height above the datum	½	
		Unit: meter (m)	½	
		ii. **Pressure head:** It is the head possessed by fluid due to pressure force by the flowing fluid.	½	
		Unit: meter (m)	½	2
	d) Ans.	**Enlist any two factors on which friction coefficient 'F' depends.** i. Diameter of pipe ii. Velocity of flow iii. Reynold's number of the flow iv. Roughness condition of the pipe surface	1 each (any two)	2
	e) Ans.	**State the formula for specific energy with components names.** E = Potential head + Kinetic head		
		$$E = y + \frac{v^2}{2g}$$	1	
		Where, y = Depth of liquid flow v = Velocity of liquid	1	2
	f) Ans.	**Define suction head and delivery head with diagram.**		
		i. **Suction head:** It is defined as vertical distance between lowest water level in sump well and centre-line of pump.	½	
		ii **Delivery head:** It is defined as the vertical distance between centre-line of the pump and highest level in the overhead tank up to which water is lifted.	½	
		 **Fig: Centrifugal Pump**	1	2
		OR		

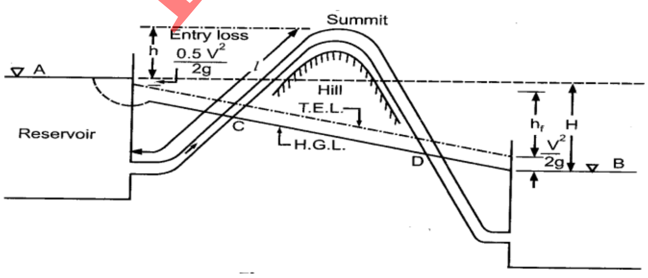
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1		 **Fig: Single Acting Reciprocating Pump**	1	
	g) Ans.	**Define uniform flow and non-uniform flow and give practical example for each** i. **Uniform flow:** The flow in which velocity at a given time does not change both in magnitude and direction from point to point in the flowing liquid is called uniform flow	½	
		Examples: a. Flow of liquid under pressure through long pipe lines of constant diameter b. Flow through a channel having uniform cross sectional area	½	
		ii. **Non Uniform flow:** The flow in which velocity at a given time changes from point to point in flowing fluid. is called non-uniform flow.	½	
		Examples: a. Flow of liquid under pressure through long pipe lines of varying diameter b. Flow in river where cross sectional area changes.	½	2
Q.2		**Attempt any <u>THREE</u> of the following:**		**(12)**
	a) Ans.	**Explain with neat sketch variation of pressure in horizontal and vertical direction in static liquid.** **a) Pressure diagram for horizontal surface**  	1	

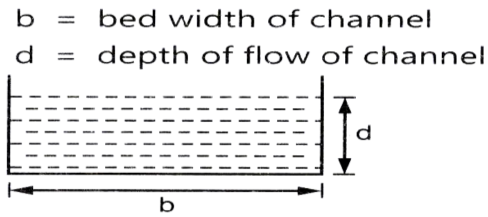
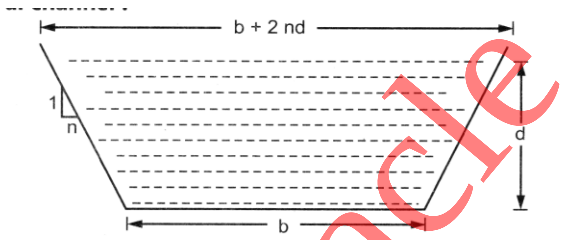
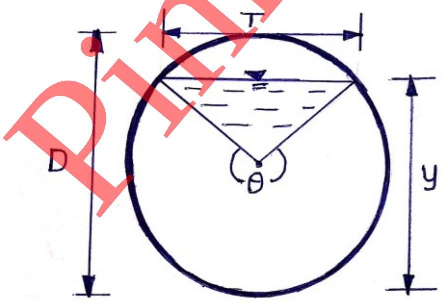
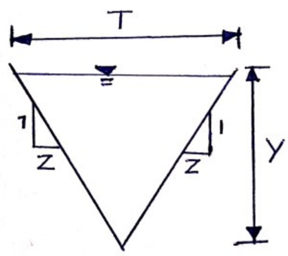
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	a)	Pressure intensity at bottom $P = \rho gh$ $P = \gamma h$ Total pressure on bottom = pressure intensity x Area of bottom surface **b)Pressure diagram for vertical surface**  Pressure diagram for vertical Surface Pressure intensity at base $P = \rho gh$ $P = \gamma h$ Total pressure per meter = $\frac{1}{2}\gamma h \times h$ $= \frac{1}{2}\gamma h^2$ $\bar{h}$ will be at $\frac{2}{3}h$ from free surface and $\frac{1}{3}h$ from base	1 1 1	4
	b)	**State and explain Bernoullis theorem with any two practical application of it.**		
	Ans.	 It states that in a steady ,ideal flow of an incompressible fluid, the total energy at any point of the fluid is always constant . Total energy = Constant Pressure energy + Kinetic energy + Potential energy = Constant $\frac{P}{\gamma_L} + \frac{V^2}{2g} + Z = \text{Constant}$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	b)	Where, $\frac{p}{\gamma}$ = Pressure head $\frac{v^2}{2g}$ = Velocity head z = Datum head	1	
		Practical Application of Bernoullis is as follows i. Venturimeter ii. Orifice meter iii. Pitot tube	1 each (any two)	4
	c)	**Find the discharge through the pipeline 20cm in diameter and 1500 m long. The drop in water level is 10 m. Assume F = 0.02. Also draw TEL.**		
	Ans.	Data: H= 10 m, D= 0.2 m, L= 1500 m, F= 0.02		
		Considering Minor losses $H = \frac{v^2}{2g}\left(1.5+\frac{f\,L}{D}\right)$ $10 = \frac{v^2}{2\times 9.81}\left(1.5+\frac{0.02\times 1500}{0.2}\right)$	1	
		$v = 1.138$ m/s $Q = A\times V$	1	
		$Q = \frac{\pi}{4}\times(0.2)^2\times 1.138$ $\boxed{Q = 0.035\ m^3/s}$	1	
		OR	**OR**	
		Neglecting minor losses $H = \frac{flv^2}{2gd}$ $10 = \frac{0.02\times 1500\times v^2}{2\times 9.81\times 0.2}$	1	
		$10 = \frac{30\times v^2}{3.924}$ $v = 1.143$ m/s	1	
		$Q = A\times V$ $Q = \frac{\pi}{4}\times(0.2)^2\times 1.143$ $\boxed{Q = 0.0359\ m^3/s}$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	c)		1	4
	d)	**A 15 cm diameter pipe suddenly enlarge to 20 cm diameter. Calculate discharge through pipe if loss of head due to sudden enlargement is 30 cm of water.**		
	Ans.			
		By using continuity equation		
		$a_1 V_1 = a_2 V_2$		
		$\frac{\pi}{4}(0.15)^2 \times V_1 = \frac{\pi}{4}(0.20)^2 \times V_2$		
		$0.0176 V_1 = 0.0314 V_2$		
		$V_1 = 1.78 V_2$	1	
		Head loss due to sudden enlargement		
		$h_L = \frac{(V_1 - V_2)^2}{2g}$	1	
		$0.3 = \frac{(1.78V_2 - V_2)^2}{2g}$		
		$V_2 = 3.11$ m/s	1	
		$Q = A_2 \times V_2$		
		$Q = \frac{\pi}{4} \times (0.2)^2 \times 3.11$		
		$Q = 0.0976 \text{ m}^3/\text{s}$	1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		**Attempt any <u>THREE</u> of the following**		(12)
	a)	**Explain the procedure for measurement of density of an oil in laboratory.**		
	Ans.	Procedure: i. Weigh the empty mass of measuring cylinder by using electronic weighing balance. Record the mass in kg (W_1)	1	
		ii. Pour 100 ml oil in measuring cylinder. Use a dropper to add or remove small amounts of oil and convert 100 ml of oil into m^3 iii. Weight the measuring cylinder with the oil in it .Record the mass in kg (W_2)	1	
		iv. Find the mass of only oil by subtracting the mass of the empty measuring cylinder i.e. (W_2-W_1).	1	
		v. Use mass and volume of the oil to calculate density of an oil. vi. Use following relation to calculate density of an oil $$\text{Density} = \rho = \frac{m}{v} \text{ in kg/m}^3$$ Where, m = mass of liquid in kg. v = volume of liquid in m^3.	1	4
	b)	**A differential manometer connected to two pipes A and B in a pipeline containing an oil of specific gravity 0.75. A manometer reading is 0.75 m of calcium carbide of specific gravity 1.05. Find the pressure difference in kPa. If points A and B are at the same level and oil flows A to B as shown in Fig.No.1**		
	Ans.	 **Fig. No. 1**  		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	b)	for solution 1		
		$S_1 = S_3 = 0.75$ Specific gravity of an oil		
		$S_2 = 1.05$ Specific gravity of manometric liquid	1	
		$h_A + h_1S_1 = h_B + h_2S_2 + h_3S_3$		
		$h_A - h_B = h_2S_2 + h_3S_3 - h_1S_1$		
		$= (1.05\times0.75) + (0.75\times(x-0.75)) - (0.75\times x)$	1	
		$= 0.788 + 0.75\times x - 0.563 - 0.75\times x$		
		$h_A - h_B = 0.225\ m$	1	
		$\therefore\ P_A - P_B = (h_A - h_B)\times\gamma_w$		
		$= 0.225\times9.81$		
		$= 2.207\ \text{kN/m}^3$	1	4
		OR	OR	OR
		for solution 2		
		$\frac{P_A}{\gamma_w} + (x+0.75)\times0.75 = \frac{P_B}{\gamma_w} + 0.75\times x + 0.75\times1.05$	1	
		$\frac{P_A}{\gamma_w} - \frac{P_B}{\gamma_w} = 0.75\times x + 0.7875 - 0.75\times x - 0.5625$	1	
		$\frac{(P_A - P_B)}{\gamma_w} = 0.225\ m$	1	
		$P_A - P_B = 0.225\times\gamma_w$		
		$= 0.225\times9.81$		
		$= 2.207\ \text{kN/m}^3$	1	4
	c)	**Explain with sketch working of syphon pipe.**		
	Ans.	 **Fig. Working of Syphon Pipe**	1	
		i. Syphon is long bent pipe which is used to transfer the liquid from reservoir at a higher level to another reservoir at a lower level , When two reservoirs are separated by a hill or high level ground as shown in figure.		
		ii. The syphonic action is the process of rising of water from inlet upto summit and beyond summit water flows under action of gravity.		
		iii. The highest point of syphon is called summit.	3	4
		iv. As shown in Fig. above the portion of syphon between C and D is above hydraulic grade line having pressure below atmospheric pressure i.e. negative pressure.		
		v. It is essential that pressure at summit is less than atmospheric pressure or negative pressure to rise the liquid or water in the inlet limb.		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	d)	**State with sketch different shapes of Artificial channels. Give the formula for wetted area, wetted perimeter for any two.**		
	Ans.	**1. Rectangular channel:** 	½	
		2. Trapezoidal channel: 	½	
		3. Circular section: 	½	
		4.Triangular section: 	½	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	d)			

Sr.No.	Shape	Area (A)	Perimeter (P)
1	Rectangular	A= bxd	P = b+2d
2	Trapezoidal	$A= bd+ nd^2$	$P=b+2d\sqrt{n^2+1}$
3	Circular	$A= \frac{1}{8}(\theta-\sin\theta)D^2$	$P= \frac{1}{2}\theta\times D$
4	Triangular	$A = Zy^2$	$P = 2y\sqrt{Z^2}+1$

Marks: 1 each (any two) — Total Marks: 4

Q.4 Attempts any **THREE** of the following: (12)

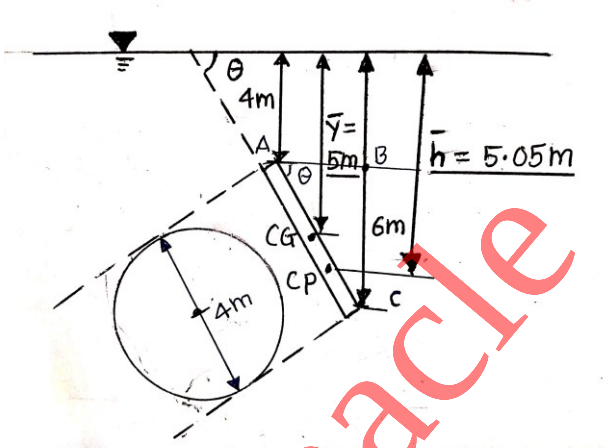
a) **Differentiate Reciprocating pump with centrifugal pump.**

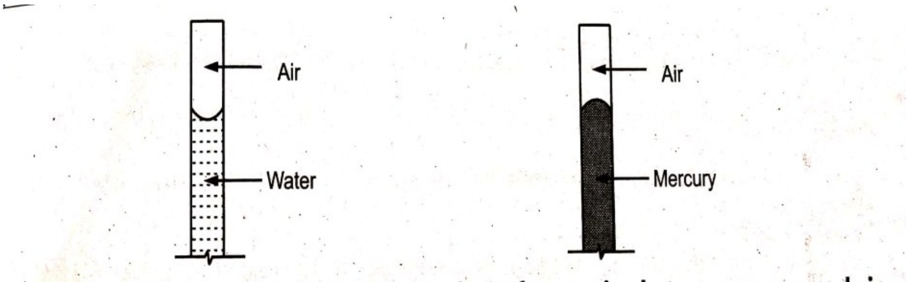
Ans.

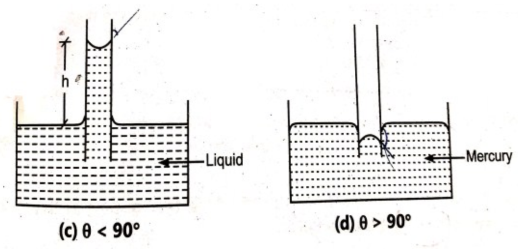
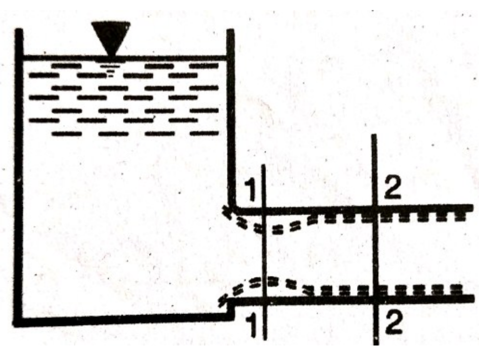
Sr. No.	Reciprocating Pump	Centrifugal Pump
1	For Reciprocating pump discharge is fluctuating.	For Centrifugal pump discharge is continuous.
2	Suitable for less discharge and higher heads.	Suitable for large discharge and small heads.
3	Complicated in construction because of more number of parts.	Simple in construction due to less number of parts.
4	It has reciprocating element, there is more wear and tear.	It has rotating elements so there is less wear and tear.
5	It cannot run at high speed.	It can run at high speed.
6	Air vessels are required.	Air vessels are not required.
7	Starting torque is less.	Starting torque is more.
8	It has more efficiency.	It has less efficiency.
9	It can not handle dirty water.	It can handle dirty water.
10	Requires more floor area and requires heavy foundation.	Requires less floor area and simple foundation.

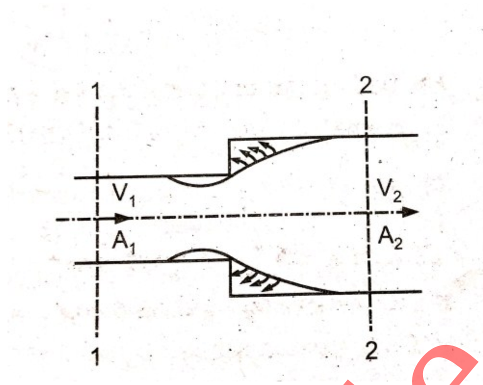
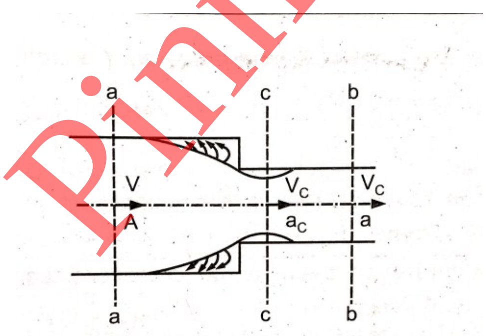
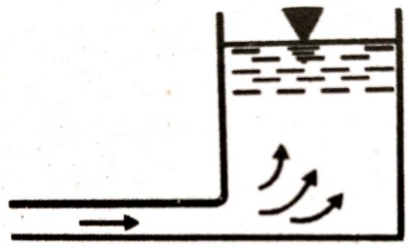
Marks: 1 each (any four) — Total Marks: 4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	b) Ans.	**i.Explain Dupuit's equation for equivalent pipes.**		
		$\frac{l}{d^5} = \frac{l}{d_1^5} + \frac{l}{d_2^5} + \frac{l}{d_3^5}$	1	
		l = length of equivalent pipe = $l_1 + l_2 + l_3$ d = diameter of equivalent pipe d_1, d_2, d_3 = diameter of pipes in series l_1, l_2, l_3 = length of pipes in series	1	
		ii.Define Moddy's diagra m diagram with its use.		
		Moody's diagram: It is the graphical representation of Friction factor verses Reynold's number (R_e) Curves for various values of relative roughness (ε)	1	
		Uses: Moody's chart is used to find friction factor of a commercial pipe.	1	4
	c) Ans.	**i) Define Reynold's number and give any two applications of it.**		
		Reynold's Number: It is the ratio of inertia force to viscous force.	1	
		Applications: i) Predicting whether the flow is laminar. ii) Predicting whether the flow is turbulent. iii) Finding out coefficient of friction in order to determine Frictional loss very accurately.	½ each (any two)	
		ii)Find the discharge flowing through a pipe of 10 cm dia and velocity is 1 m/sec.		
		Data: d = 0.1m, V = 1m/s, $Q = A \times V$	1	
		$Q = \frac{\pi}{4} \times (0.1)^2 \times 1$		4
		$\boxed{Q = 0.00785\ m^3/s}$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	d)	**A circular plate of 4 m diameter is immersed in water such that its greatest and least depth below the free surface of water are 6m and 4m respectively. Calculate:** **i) Total pressure on one face of the plate.** **ii) The position of centre of pressure.**		
	Ans.			
		Data: Diameter of plate (d) = 4 m Here, $\text{Sin}\theta = \frac{2}{4}$ $\theta = \text{Sin}^{-1}(0.5)$ $\theta = 30^0$ from fig. $\text{Sin}\theta = \frac{BC}{AB}$ $BC = \text{Sin}\theta \times AB$ $= \text{Sin}30^0 \times 2$ $= 1\ m$ $\therefore\ \bar{y} = 4 + 1$ $\bar{y} = 5\ m$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	d)	i) Total pressure on one face of plate (P)		
		$P = \gamma_L A \bar{y}$	1	
		$P = 9.81 \times \frac{\pi}{4}(4)^2 \times 5$		
		$P = 616.380$ kN		
		ii) Position of centre of pressure ($\bar{h}$)		
		$\bar{h} = \frac{I_G \sin^2\theta}{A\bar{y}} + \bar{y}$	1	
		$I_G = \frac{\pi}{64}(4)^4$		
		$I_G = 12.566\ m^4$		
		$\bar{h} = \frac{12.566 \times \sin^2 30}{\frac{\pi}{4} \times (4)^2 \times 5} + 5$		
		$\bar{h} = 5.05$ m.	1	4
	e)	**Define surface tension and capillarity with sketch. Give practical example of each.**		
	Ans.	**Surface tension:** The property of liquid which enables it to resist tensile stress is called surface tension .In the following figure we can see the surface tension between water and air also between mercury and air.	½	
		 (a) Surface tension between air and water (b) Surface tension between mercury and air	½	
		Practical Example: i) Due to surface tension shape of liquid drop is not spherical. ii) Capillary rise or fall of liquid in a smaller diameter tube.	1 each (any one)	

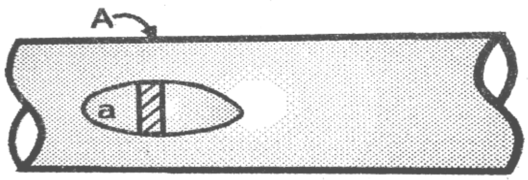
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	e)	**Capillarity:** It is defined as the phenomenon of rise or fall of liquid surface in small tube relative to the adjacent general level of liquid when the tube is held vertically in the liquid. Following figure shows capillary rise and fall.	½	
			½	
		Practical Example: i) Rise of ground water in the bushes. ii) Water moving up a straw when deep in water glass.	1 each (any one)	4
Q.5		**Attempt any TWO of the following:**		(12)
	a)	**State the classification of losses in pipe with suitable sketches and equations for each.**		
	Ans.	**Major loss:** The major loss of head is caused due to friction when fluid flow through a pipe. $h_f = \frac{f L V^2}{2gd}$	½	
		Minor loss: The minor loss of head is caused due to change in velocity of flowing fluid either in magnitude or direction **1. Loss of head at the entrance.** 	½	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
	.	$H_L = \frac{0.5V^2}{2g}$	½	
		2. Loss of head due to sudden expansion.		
			½	
		$H_L = \frac{(V_1 - V_2)^2}{2g}$	½	
		3. Loss of head due to sudden contraction.		
			½	
		$H_L = \frac{0.5V^2}{2g}$	½	
		4. Loss of head at exit.		
			½	
		$H_L = \frac{V^2}{2g}$	½	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks

Q.5 **a)**

5. Loss of head due to obstruction.



½

$$H_L = \left[\frac{A}{C_c \times a} - 1\right]^2 \frac{V^2}{2g}$$

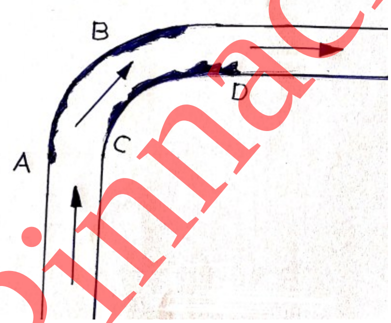
½

A = c/ s Area of pipe

a = c/ s Area of Opening

C_C =Coefficient contraction

6. Loss of head due to pipe fitting.



½

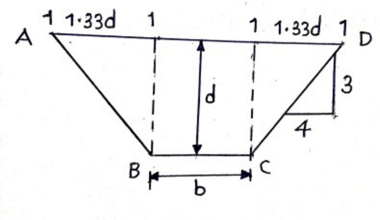
$$H_L = K\frac{V^2}{2g}$$

Total Marks: 6

(Note: Figure of any one of the pipe fitting should be considered)

b) **Determine the most economical section of a trapezoidal channel for carrying discharge 15 m³/sec with bed slope of 1:4500.The side slopes are 4H:3V.Take Manning's constant 0.015.**

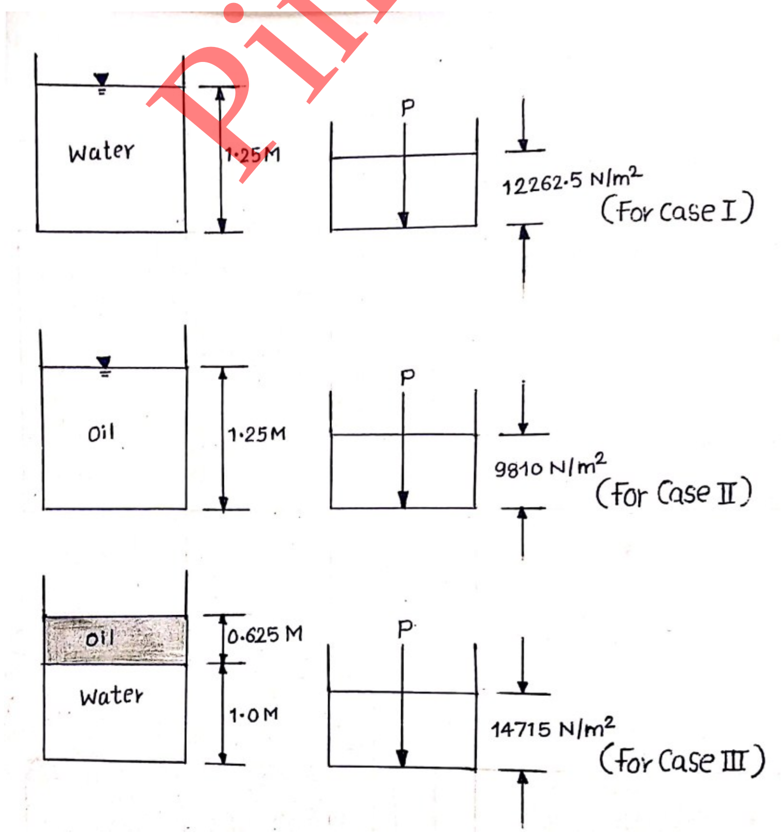
Ans. Data: Q= 15 m^3/s, S= 1/4500, n= $\frac{4}{3}$, N= 0.015

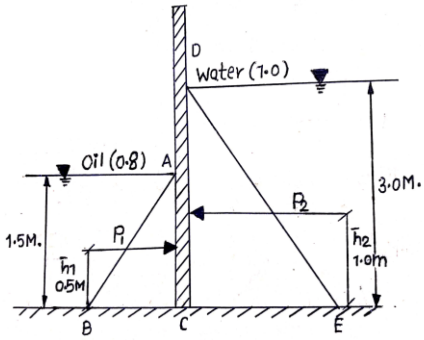


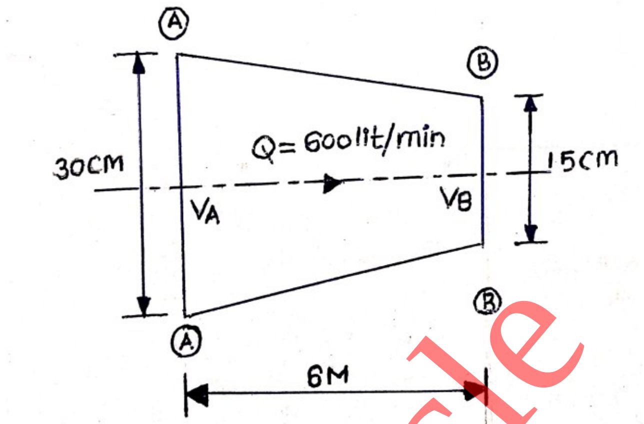
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	b)	For most economical channel section conditions are		
		$R=\frac{d}{2}$, Sloping side $=\frac{1}{2}\times$Top width	1	
		$\frac{b+2nd}{2}=d\sqrt{1+n^2}$		
		$\frac{b+2\times\left(\frac{4}{3}\right)d}{2}=d\sqrt{1+\left(\frac{4}{3}\right)^2}$		
		$b+\left(\frac{8}{3}\right)d=2d\sqrt{1+\left(\frac{4}{3}\right)^2}$		
		$b=0.67d$		
		$\boxed{A=bd+nd^2}$	1	
		$A=(0.67d)\ d+\frac{4}{3}(d^2)$		
		$A=2d^2$		
		Using Manning's equation		
		$\boxed{Q=A\times\frac{1}{N}\times R^{\frac{2}{3}}\times S^{\frac{1}{2}}}$	1	
		$15=2d^2\times\frac{1}{0.015}\times\left(\frac{d}{2}\right)^{\frac{2}{3}}\times\left(\frac{1}{4500}\right)^{\frac{1}{2}}$	1	
		$11.979=d^{\frac{8}{3}}$		
		$d=(11.979)^{\frac{3}{8}}$		
		$\boxed{d=2.54m}$	1	
		$b=0.67d$		
		$b=0.67\times2.54$		
		$\boxed{b=1.7\ m}$	1	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	c)	**Calculate the power of the pump from following data:** **i) Total Static lift = 25 m** **ii) Diameter of suction pipe = 12 cm** **iii) Diameter of delivery pipe = 10 cm** **iv) Length of suction pipe = 5 m** **v) Length of delivery pipe = 50 m** **vi) F= 0.03 for both pipes** **vii) Q= 30 lit/sec** **viii) Efficiency = 85%**		
	Ans.	Velocity at suction pipe $(V_s) = \frac{Q}{A_s}$ $V_s = \frac{30\times10^{-3}}{\frac{\pi}{4}\times(0.12)^2}$ $V_s = 2.65$ m/s	½	
		Velocity at delivery pipe $(V_d) = \frac{Q}{A_d}$ $V_d = \frac{30\times10^{-3}}{\frac{\pi}{4}\times(0.1)^2}$ $V_d = 3.82$ m/s	½	
		By neglecting minor losses Head loss due to friction in suction pipe (h_s) $h_s = \frac{flv_s^2}{2gd_s}$ $h_s = \frac{0.03\times5\times2.65^2}{2\times9.81\times0.12}$ $h_s = 0.447$ m.	1	
		Head loss due to friction in delivery pipe (h_d) $h_d = \frac{flv_d^2}{2gd_d}$ $h_d = \frac{0.03\times50\times3.82^2}{2\times9.81\times0.1}$ $h_d = 11.156$ m.	1	
		$\boxed{\text{Total head}(H_m) = 25 + h_s + h_d}$ $H_m = 25 + 0.447 + 11.156$ $H_m = 36.60$ m.	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
		$P = \frac{\gamma_w \times Q \times H_m}{\eta}$	1	
		$P = \frac{9810 \times 30 \times 10^{-3} \times 36.60}{0.85} = 12672.21w$		6
		$\boxed{P=12.67\ kw}$	1	
		OR		
		If minor loss is considered 10% of frictional loss then total head H_m = Static head+head loss due to friction+head loss due to minor loss	OR	
		H_m = Static head$+(h_s+h_d)+10\%(h_s+h_d)$		
		$H_m = 25 + 11.603 + \frac{10}{100}(11.603)$		
		$H_m = 37.76$ m.		
		$\boxed{P = \frac{\gamma_w \times Q \times H_m}{\eta}}$	1	
		$P = \frac{9810 \times 30 \times 10^{-3} \times 37.76}{0.85} = 13073.84\ w$		
		$\boxed{P=13.073\ kw}$	1	
Q.6	a)	**Attempt any TWO of the following**		(12)
		Find the intensity of pressure in N/m² on the base of the container When, **i) Water stands to height of 1.25m in it.** **ii) Only oil stands for 1.25 m. The specific gravity of oil is 0.80.** **iii) When oil Height is 0.625 m stands on water of 1 m height .** **Draw the pressure diagram for all cases.**		
	Ans.	**Case I) Water stands to height of 1.25m**		
		$P = \gamma_w \times h$		
		$P = 9810 \times 1.25$		
		$\boxed{P = 12262.5\ N/m^2}$	1	

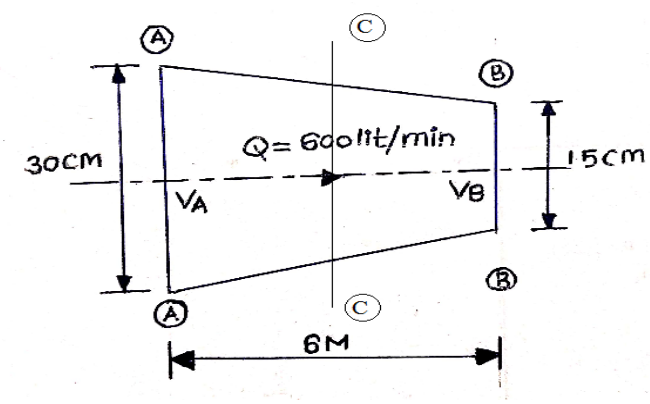
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**Case II) When oil stands for 1.25m** $P = \gamma_{oil} \times h$ $P = 0.8 \times 9810 \times 1.25$ $\boxed{P = 9810\ N/m^2}$	1	
		Case III) When oil of specific gravity 0.8 stand at height of 0.625 over 1 meter water. For water. $P_1 = \gamma_w \times h$ $P_1 = 9810 \times 1$ $P_1 = 9810\ N/m^2$ For oil $P_2 = \gamma_{oil} \times h$ $P_2 = 9810 \times 0.8 \times 0.625$ $P_2 = 4905\ N/m^2$ $P = P_1 + P_2$ $P = 9810+4905$ $\boxed{P = 14715\ N/m^2}$	1	
			3	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	b)	**Find the resultant pressure and its position for a tank wall containing liquid of specific gravity 0.8 to a depth of 1.5m on one side, while on other side there is water to a depth of 3.0 m.**		
	Ans,		1	
		1) Pressure of liquid of specific gravity 0.8 $P_1 = \frac{1}{2} \times \gamma_w \times h_1^2$ $P_1 = \frac{1}{2} \times (9810 \times 0.8) \times 1.5^2$ $P_1 = 8829 \text{ N/m}^2$ $\boxed{P_1 = 8.829 \text{ kN/m}^2}$	1	
		2) Pressure due to water $P_2 = \frac{1}{2} \times \gamma_w \times h_2^2$ $P_2 = \frac{1}{2} \times (9810 \times 1) \times 3^2$ $P_2 = 44145 \text{ N/m}^2$ $\boxed{P_2 = 44.145 \text{ kN/m}^2}$	1	
		3) Resultant pressure $P = P_2 - P_1$ $P = 44.145 - 8.829$ $\boxed{P = 35.316 \text{ kN/m}^2}$	1	
		4) Position of centre of pressure from base $P\bar{h} = P_2\bar{h}_2 - P_1\bar{h}_1$ $35.316\bar{h} = (44.145 \times \frac{1}{3} \times 3) - (8.829 \times \frac{1}{3} \times 1.5)$	1	
		$\bar{h} = \frac{39.730}{35.316}$ $\boxed{\bar{h} = 1.125 \text{ m}}$	1	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	c)	**A horizontal pipe carrying water tapers from 30 cm dia. at A to 15 cm dia. at B in a length of 6 m. The pressure at A is 100 N/cm^2. If the discharge is 600 lit/min. Calculate pressure at B in N/cm^2. If the loss of head is 10 cm of water. Also calculate pressure in pipe at it mid length.**		
	Ans.		½	
		Data: $P_A = 100 N/cm^2$, Head loss = 10 cm, Q = 600 lit/min $P_A = 100 N/cm^2$ $P_A = \frac{100N}{(0.01)^2}$ $P_A = 1000 \times 10^3 N/m^2$ Q = 600 lit/min $Q = \frac{600}{1000 \times 60} = 0.01 \ m^3/sec$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		by using continuity equation		
		$Q = A_A \times V_A$		
		$0.01 = \frac{\pi}{4}\times(0.3)^2 \times V_A$		
		$V_A = 0.141$ m/s	**1**	
		$Q = A_B \times V_B$		
		$0.01 = \frac{\pi}{4}\times(0.15)^2 \times V_B$		
		$V_B = 0.565$ m/s	**1**	
		Applying Bernoulli's theorem: Assuming flow from A to B		
		$\frac{P_A}{\gamma} + \frac{V_A{}^2}{2g} + Z_A = \frac{P_B}{\gamma} + \frac{V_B{}^2}{2g} + Z_B + h_L$	**1**	
		$\frac{1000\times10^3}{9810} + \frac{0.141^2}{2\times9.81} + 0 = \frac{P_B}{9810} + \frac{0.565^2}{2\times9.81} + 0 + 0.10$		
		$101.936 + 1.013\times10^{-3} + 0 = \frac{P_B}{9810} + 0.0162 + 0 + 0.10$		
		$101.82 = \frac{P_B}{9810}$		
		$P_B = 998.86\times10^3$ N/m^2		
		$\boxed{P_B = 99.88 \text{N/cm}^2}$	**1**	
		(Note: If the flow is from B to A is taken and attempted should be considered.)		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks



by using continuity equation

$Q = A_C \times V_C$

$$0.01 = \frac{\pi}{4} \times (0.225)^2 \times V_A$$

$V_C = 0.251$ m/s

Mid length = 6/2 =3m.

Considering 50 % of total head loss at mid length

h_L = 0.10/2= 0.05 m

Applying Bernoulli's theorem: Assuming flow from A to C

$$\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + Z_A = \frac{P_C}{\gamma} + \frac{V_C^2}{2g} + Z_C + h_L$$

$$\frac{1000 \times 10^3}{9810} + \frac{0.141^2}{2 \times 9.81} + 0 = \frac{P_C}{9810} + \frac{0.251^2}{2 \times 9.81} + 0 + 0.05$$

$$101.936 + 1.013 \times 10^{-3} + 0 = \frac{P_C}{9810} + 0.0532$$

$$101.883 = \frac{P_C}{9810}$$ ½

$$P_B = 999.48 \times 10^3 \, N/m^2$$

$$\boxed{P_B = 99.94 N/cm^2}$$

Total Marks: 6