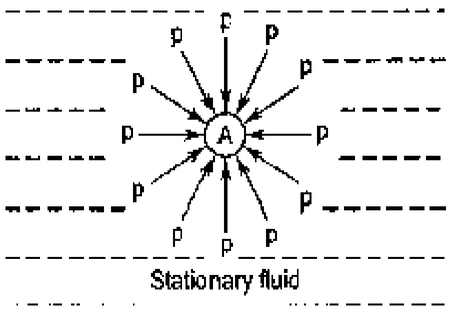
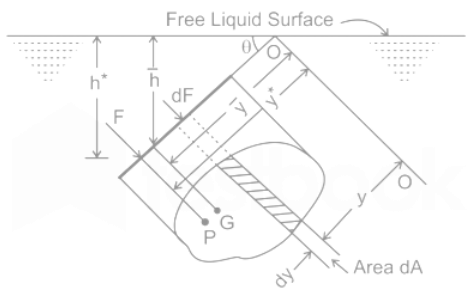
Model Answer: Summer - 2022

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 candidate and 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 model answer.
6) In case of some questions credit may be given by judgement 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.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1		**Attempt any FIVE of the following:**		(10)
	a)	**State Pascal's law of fluid pressure.**		
	Ans.	**Pascal's Law:** It states that the pressure intensity or pressure at a point in a static fluid is equal in all directions. 	2	2
	b)	**Draw pressure diagram for inclined immersed surface.**		
	Ans.	 Inclined immersed surface	2	2

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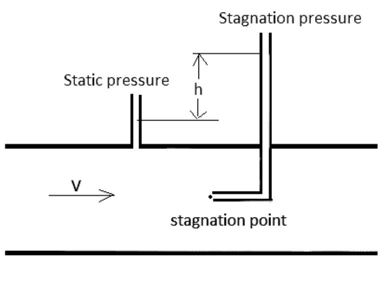
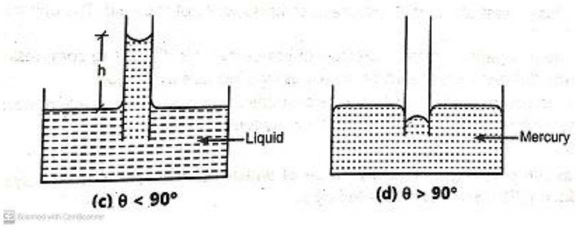
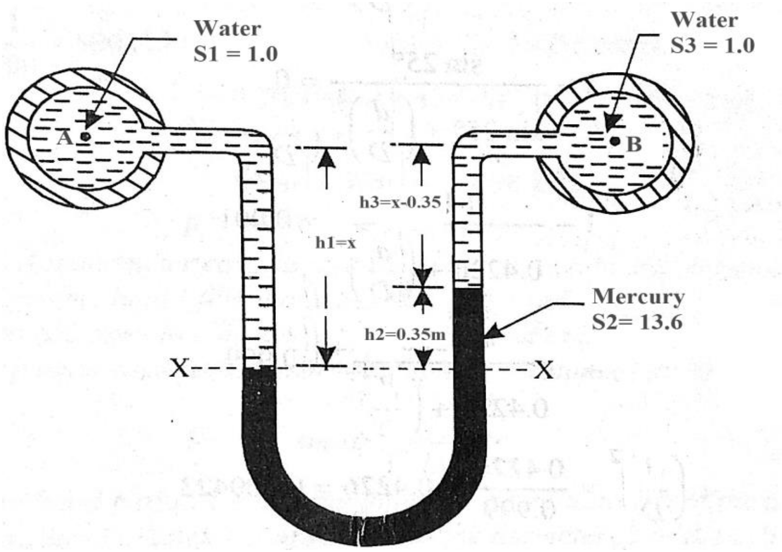
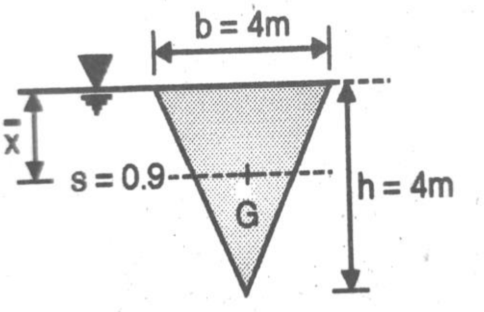
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	c)	**Define uniform flow and non-uniform flow.**		
	Ans.	**i) Uniform flow:** If the depth of flow, the discharge and mean velocity flow at a given instant do not change along the length of channel, the flow is called as Uniform flow.	1	2
		ii) Non-uniform flow: If the depth of flow, the discharge and mean velocity flow at a given instant changes along the length of channel, the flow is called as Non-uniform flow.	1	
	d)	**Write the use of Moody's Diagram.**		
	Ans.	i) It is used to find relative roughness. ii) It is used to find friction factor. iii) It can be used for finding pressure drop or flow rate down such a pipe. iv) It is in the selection of a diameter for a pipe for some purpose.	**1 each (any two)**	2
	e)	**Define hydraulic coefficients of orifice.**		
	Ans.	**i) Coefficient of discharge (C_d):** The ratio of the actual discharge to the theoretical discharge is called as the coefficient of discharge. **ii) Coefficient of contraction (C_c):** The ratio of the cross-sectional area of the jet at vena contracta to the cross-sectional area of the orifice is called coefficient of contraction. **iii) Coefficient of velocity (C_v):** The ratio of actual velocity of the jet at vena contracta to the theoretical velocity of the jet is called coefficient of velocity.	**1 each (any two)**	2
	f)	**State the principle of working of Pitot tube.**		
	Ans.	**Principle:** If the velocity of flow at a point become zero, the pressure is increased due to conversion of kinetic energy into pressure energy. 	2	2

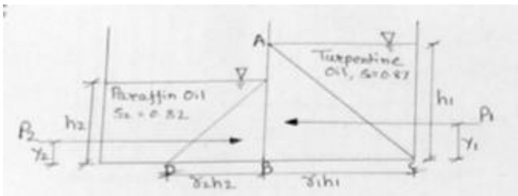
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	g)	**Define static head and manometric head of centrifugal pump.**		
	Ans.	**Static Head:** It is the sum of suction head and delivery head, it represent the vertical distance between the top surface level of sump to discharge level in delivery tank. Static head = Suction head + Delivery head	1	2
		Manometric head: The manometric head is defined as the minimum amount of head against which the pump has to work to deliver the required discharge. Manometric Head = Suction Head + Delivery Head + Major losses and minor losses in the system.	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2		**Attempt any <u>THREE</u> of the following:**		**(12)**
	a)	**Define capillarity. Derive an expression for capillary rise.**		
	Ans.	**Capillarity:** The phenomenon of rise or fall of liquid level in the capillary tube is called capillarity. The rise of liquid surface is known as capillary rise relative to the adjacent general level of liquid when the tube is held vertically in the liquid. The rise of liquid surface is known as capillary rise.	1	
				
		Let h be the capillary rise or fall in a tube of diameter'd' centre surface tension force in upward direction.	1	4
		$P = \pi\, d\, \sigma \cos\theta$ Weight of liquid column = V.γ $=(\frac{\pi}{4}d^2\times h)\gamma$ Where γ = specific weight of liquid under equilibrium , the weight of liquid column will be balanced by surface tension force 'σ' Weight of liquid = Surface tension force $\frac{\pi}{4}d^2h\gamma = \pi d\sigma\cos\theta$ $\boxed{h = \frac{4\sigma\cos\theta}{\gamma d}}$	2	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	**b)**	**U tube differential mercury manometer is connected to horizontal pipe carrying water at two points A and B. The difference in levels of mercury in the two limbs is 0.35 m. Calculate pressure difference at A and B in kN/m².**		
	Ans.		1	
		$h_A + h_1S_1 = h_2S_2 + h_3S_3 + h_B$ $h_A - h_B = h_2S_2 + h_3S_3 - h_1S_1$ $h_A - h_B = (0.35\times13.6) + (X-0.35)\times1 - (X\times1.0)$ $h_A - h_B = 4.76 + X - 0.35 - X$ $\boxed{h_A - h_B = 4.41m}$	½ 1	4
		$\frac{P_A}{\gamma_L} - \frac{P_B}{\gamma_L} = h_A - h_B$ $P_A - P_B = (h_A - h_B)\times\gamma_L$ $P_A - P_B = 4.41\times9.81$ $\boxed{P_A - P_B = 43.26kN/m^2}$	½ 1	
	c)	**An isosceles triangular plate of base 4m and height 4m is immersed vertically in an oil of specific gravity 0.9. The base of triangular plate is touching the surface and the plate is immersed with apex in downward position. Find the total pressure and centre of pressure on the plate.**		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	**c)** **Ans.**	 Given data: Base width (b) = 4m Height (h) = 4m Specific gravity of oil (S)= 0.9 Solution: i) Weight density of oil $\gamma_{oil} = S_{oil} \times \gamma_{water}$ $\gamma_{oil} = 0.9 \times 9.81$ $\gamma_{oil} = 8.829\ kN/m^3$ ii) Depth of centroid from free surface $\bar{x} = \frac{h}{3} = \frac{4}{3} = 1.33m$ iii) Area of plate A= $\frac{1}{2} \times b \times h$ $= \frac{1}{2} \times 4 \times 4 = 8m^2$ iv) Moment of inertia I = $\frac{bh^3}{36} = \frac{4 \times 4^3}{36} = 7.11m^4$ v) Total Pressure $P = \gamma_{oil} \times A \times \bar{x}$ $P = 8.829 \times 8 \times 1.33$ $\boxed{P = 93.94kN}$ vi) Centre of Pressure $\bar{h} = \bar{x} + \frac{I}{A\bar{x}}$ $\bar{h} = 1.33 + \frac{7.11}{(8 \times 1.33)}$ $\boxed{\bar{h} = 2m}$	 ½ ½ ½ ½ 1 1	 4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	d)	**Define total hydrostatic pressure and centre of pressure. Mention two application of it.**		
	Ans.	**Total hydrostatic pressure:** It is the force exerted by a static fluid on a surface plane or curved. This force is always perpendicular to the surface.	1	
		OR		
		When Static mass of Fluid is at rest, the force exerted by the fluid on a surface in contact with fluid may be plane or curved is called total hydrostatic pressure. This force is always perpendicular to the surface.	1	
		Centre of pressure: It is the point at which total pressure acts on the surface.		4
		Application: i) To determine intensity of pressure at any point on the wall or surface. ii) To determine location of total pressure. iii) To calculate resultant pressure acting due to one, two or three liquids filled in a tank. iv) To calculate total pressure due to liquid and its direction.	**1 each (any two)**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		**Attempt any <u>THREE</u> of the following:**		**(12)**
	a)	**A partition wall 2m long divides a storage tank. On one side there is turpentine of specific gravity 0.87 upto a depth of 3m. On the other side there is paraffin oil of specific gravity 0.82 stored to a depth of 2m. Determine the resultant pressure on partition wall and the position of it.**		
	Ans.		1	

Pressure due to turpentine $=P_1=$ Area of triangle ABC × L

$$P_1=\frac{1}{2}\times b\times h\times L$$

$$P_1=\frac{1}{2}\times\gamma\times h_1\times h_1\times L$$

$$P_1=\frac{1}{2}\times\gamma\times h^2{}_1\times L$$

$$P_1=\frac{1}{2}\times(0.87\times9.81\times3^2)\times2$$ **1**

$$\boxed{P_1=76.812kN}$$

Pressure due to paraffin oil $=P_2=$ Area of triangle ABD × L **4**

$$P_2=\frac{1}{2}\times b\times h\times L$$

$$P_2=\frac{1}{2}\times\gamma\times h_2\times h_2\times L$$

$$P_2=\frac{1}{2}\times\gamma\times h^2{}_2\times L$$

$$P_2=\frac{1}{2}\times(0.82\times9.81\times2^2)\times2$$

$$\boxed{P_2=32.177kN}$$ **1**

Pressure $P=P_1-P_2=76.812-32.177$

$$\boxed{P=44.635kN}$$

Position of P_1 from base $=y_1=\frac{1}{3}\times3=1m$

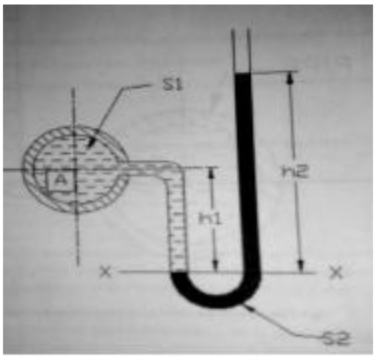
Position of P_2 from base $=y_2=\frac{1}{3}\times2=0.667m$

Position of resultant Pressure y

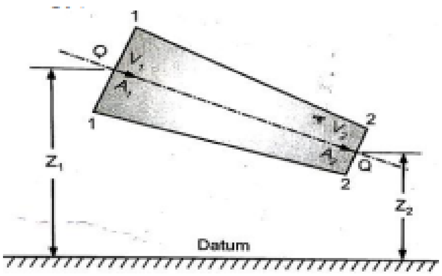
$$P\times y=(P_1\times y_1)-(P_2\times y_2)$$

$$44.635\times y=(76.812\times1)-(32.177\times0.667)$$

$$\boxed{y=1.242m}$$ **1**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	b)	**Explain simple U tube manometer with a neat sketch.**		
	Ans.		2	4
		Simple U tube manometer: It is the simplest form of manometer. It consists of thin glass tube of uniform diameter bent into U-shape. It's one end is connected to a point whose pressure is to be measured and other end open to atmosphere. The U-tube manometer contains the manometric liquid whose specific gravity should be greater than the specific gravity of liquid to whose pressure is to be measured. $h = h_2S_2 - h_1S_1$ (m of water) $P = \gamma h$	2	
	c)	**Calculate the specific weight, density, specific volume and specific gravity of 1.5 liters of fluid which weighs 6N.**		
	Ans.	Given data: Weight = 6N , Volume = $1.5\times10^{-3}m^3$		
		i) Specific Weight $\gamma = \frac{W}{V} = \frac{6}{1.5\times10^{-3}} = 4000 N/m^3$	1	4
		ii) Specific Gravity $S = \frac{\gamma_L}{\gamma_w} = \frac{4000}{9810} = 0.408$	1	
		iii) Density $\rho_L = S\times\rho_w = 0.408\times1000 = 408 kg/m^3$	1	
		iv) Specific volume $V_s = \frac{1}{\rho_L} = \frac{1}{408} = 2.451\times10^{-3} m^3/kg$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	d)	**Water flows with velocity 2 m/s through a pipeline which gradually reduces from 450mm diameter at A to 300mm diameter at B and then from B branches into 2 pipes. One branch being150 mm diameter discharging at C and the other branch 225 mm diameter discharging at D. If the velocity at D is 4m/s. What will be the discharge at C and D?**		
	Ans.	Given data : $V_A = 2m/s$, $V_D = 4m/s$		
		$d_A = 0.45m \quad A_A = \frac{\pi}{4}\times0.45^2 = 0.159m^2$		
		$d_B = 0.30m \quad A_B = \frac{\pi}{4}\times0.30^2 = 0.071m^2$		
		$d_C = 0.15m \quad A_C = \frac{\pi}{4}\times0.15^2 = 0.017m^2$	1	
		$d_D = 0.22m \quad A_D = \frac{\pi}{4}\times0.22^2 = 0.039m^2$		
		By using continuity equation between A and B		
		$A_A V_A = A_B V_B$		
		$V_B = \frac{A_A}{A_B} V_A = \frac{0.159}{0.071}\times2$	1	
		$\boxed{V_B = 4.479m/s}$		
		Dischrage at B = $Q_B = A_B V_B$		4
		$Q_B = 0.071\times4.479$		
		$\boxed{Q_B = 0.318m^3/s}$		
		Dischrage at D = $Q_D = A_D V_D$	1	
		$Q_D = 0.039\times4$		
		$\boxed{Q_D = 0.156m^3/s}$		
		Dischrage at C = $Q_C = Q_B - Q_D$		
		$Q_C = 0.318-0.156$		
		$\boxed{Q_C = 0.160m^3/s}$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		**Attempt any THREE of the following:**		(12)
	a)	**State Bernoulli's theorem .Write the limitation of Bernoulli's theorem.**		
	Ans.	**Bernoulli's theorem:** It states that in an ideal incompressible fluid when the flow is steady and continuous, the total energy of each particle of the fluid is the same. (Provided that no external energy enters or leaves the system at any point).	2	
		 $\frac{P_1}{\gamma_L}+\frac{V_1^2}{2g}+Z_1=\frac{P_2}{\gamma_L}+\frac{V_2^2}{2g}+Z_2$ Where, $\frac{P_1}{\gamma_L}$ and $\frac{P_2}{\gamma_L}$ = Pressure head or Pressure Energy per unit weight at section 1-1 and 2-2 $\frac{V_1^2}{2g}$ and $\frac{V_2^2}{2g}$ = Velocity head or kinetic energy per unit weight at section 1-1 and 2-2 Z_1 and Z_2 = Datum head or Potential Energy per unit weight at section 1-1 and 2-2		4
		Limitations of Bernoulli's theorem: i) Velocity of every liquid particle, across any cross section of pipe is not uniform. ii) Bernoulli's equation is not applicable for fluid with unsteady flow. iii) Bernoulli's theorem is applicable for fluid with zero viscosity. iv) Bernoulli's equation has been derived under the assumption that there is no loss of energy of the liquid particle while flowing v) If liquid is flowing in curved path, the energy due to centrifugal force should also be taken into account.	½ each (any four)	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	b)	**Determine the diameter of uniform pipe to replace a compound pipeline having 50 cm diameter pipe for 1500 m length. 40 cm diameter pipe for 1000 m length and 35 cm diameter pipe for 1200m length. The total length of uniform pipe should remain the same.**		
	Ans.	Given data : $d_1 = 0.50m \quad L_1 = 1500m$ $d_2 = 0.40m \quad L_2 = 1000m$ $d_3 = 0.35m \quad L_3 = 1200m$	1	
		Total length of uniform pipe $L = L_1 + L_2 + L_3$ $L = 1500 + 1000 + 1200 = 3700m$	1	4
		Using Dupit's Equation $\frac{L}{D^5} = \frac{L_1}{d^5_1} + \frac{L_2}{d^5_2} + \frac{L_3}{d^5_3}$ $\frac{3700}{D^5} = \frac{1500}{0.5^5} + \frac{1000}{0.4^5} + \frac{1200}{0.35^5}$	1	
		$D^5 = \frac{3700}{374132.48}$ $\boxed{D = 0.3972m}$	1	
	c)	**Differentiate between triangular notch and rectangular notch.**		
	Ans.	(see table below)	1 each (any four)	4

Sr. No.	Triangular Notch	Rectangular Notch
i.	Triangular notch gives more accurate results for low discharge.	Rectangular notch does not gives more accurate results for low discharge.
ii.	Ventilation of triangular notch is not necessary.	Ventilation of rectangular notch is necessary.
iii.	In triangular notch only height is measured.	In rectangular notch width and height is measured.
iv.	In most of the cases of flow over triangular notch velocity of approach may be neglected.	In most of the cases of flow over rectangular notch velocity of approach required to be considered

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answer</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.4</td><td>c)</td><td>

v.	$Q=\frac{8}{15}C_d\sqrt{2g}\tan\frac{\theta}{2}H^{\frac{5}{2}}$	$Q=\frac{2}{3}C_d L\sqrt{2g}H^{\frac{3}{2}}$

</td><td></td><td></td></tr>
<tr><td></td><td>d)</td><td>A rectangular channel carries water at the rate of 500 litres/sec when bed slope is 1 in 3000. Find the most economical dimension of the channel if C = 60.</td><td></td><td></td></tr>
<tr><td></td><td>Ans.</td><td>Given data:
$Q = 500lps = 500\times10^{-3} = 0.5 m^3/s$
$S = 1 in 3000 = \frac{1}{3000}$
C = 60
For most economical rectangular section conditions are
i) b=2d
ii) R=d/2
Area= A=b×d=2d×d
$A=2d^2$
by using Chezy's equation
$V= C\sqrt{RS}$
$V= 60\sqrt{d/2\times(1/3000)}$
$V= 0.775\times d^2$
Q=AV
$0.5=2d^2\times0.775d^{1/2}$
$0.5=1.55d^{5/2}$
$\boxed{d = 0.636m}$
b = 2×0.636
$\boxed{b =1.272m}$</td><td>1

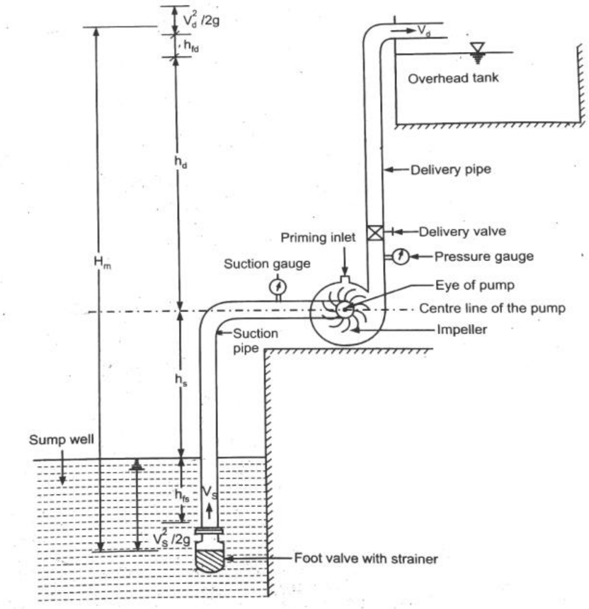
1

1

1</td><td>4</td></tr>
</table>

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	**e)**	**Calculate the power required for the pump with following data.** **Static lift=20m** **Length of delivery pipe = 50m** **Head lost in suction pipe =1m** **Diameter of delivery pipe=10cm** **f for delivery pipe = 0.04.** **Q = 20 lit/sec.** **η = 70%**		
	Ans.	Given data: Static lift = H_s=20m Length of delivery pipe = 50m Diameter of delivery pipe = 0.10m Head loss in suction pipe = 1m f for delivery pipe = 0.04 Discharge = Q= 20 lit/sec = $0.02m^3/s$ Efficiency = η=0.7 Solution : Head lost in delivery pipe $hf_d = \frac{flQ^2}{12.1d^5}$	1	
		$hf_d = \frac{0.04\times50\times0.02^2}{12.1\times0.1^5}$ $\boxed{hf_d = 6.612m}$ $h_{major} = hf_s + hf_d$ $\boxed{h_{major} = 1+6.612 = 7.612m}$	1	
		$h_{minor} = 10\% h_{major}$ $\boxed{h_{minor} = \frac{10}{100}\times7.612 = 0.761m}$ $H_L = h_{major} + h_{minor}$ $H_L = 7.612+0.761$ $\boxed{H_L = 8.373m}$		4
		Manometric head $H_m = H_S + H_L$ $H_m = 20+8.373$ $\boxed{H_m = 28.373m}$	1	

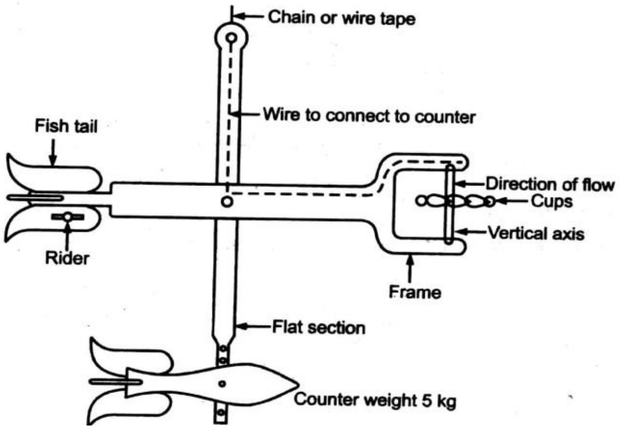
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	**e)** **Ans.**	Power $P = \frac{\gamma Q H_m}{\eta}$ $P = \frac{9.81 \times 0.02 \times 28.373}{0.7}$ $\boxed{P = 7.94 kW}$	 **1**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5		**Attempt any TWO of the following:**		**(12)**
	a)	**Explain the main component part of centrifugal pump with neat sketch.**		
	Ans.	 ***Centrifugal Pump*** ***(Note: 1 mark for sketch and 1 mark for labeling.)***	**2**	**6**
		Parts of Centrifugal Pump: **i. Impeller:** It is wheel or rotor which is provided with series of backward curved blades or vanes. It is mounted on shaft which is coupled to an electric motor which rotates the impeller. It is classified as closed, semi open and open impeller. **ii. Casing:** It is an air tight chamber which surrounds the impeller. **iii. Suction Pipe:** It is the pipe which is connected at its upper end to the inlet of the pump or to the centre of the impeller i.e eye. The lower end of the suction pipe dips into liquid in a suction tank. **iv. Delivery Pipe:** It is a pipe which is connected at its lower end to the outlet of the pump and it delivers the liquid to the required height. On delivery pipe delivery valve is provided to control the flow from the pump into delivery pipe.	**1 each (any four)**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	a)	v. **Foot Valve:** It is fitted at the lower end of suction pipe and it is submerged under water up to 45 to 60 cm depth because when water surface in the well is lowered, the foot valve may suck the air and de-priming of the pump takes place.		
	b)	**A horizontal pipeline 50m long starts from reservoir. The head above inlet is 8 m. The pipeline discharges freely at other end. The diameter of first 25m length is 15 cm. and for remaining length is 30cm . Calculate the discharge through pipeline taking F= 0.04 for both the lengths of the pipe.**		
	Ans.	Given, L=50m , H= 8m ,f= 0.04 L_1 =25m , d_1=0.15m L_2 =25m , d_2=0.30m Assuming $P_A = P_B = 0$ By using contunity equation $A_1V_1=A_2V_2$ $\frac{\pi}{4}(d_1)^2 \times V_1 = \frac{\pi}{4}(d_2)^2 \times V_2$ $(0.15)^2 \times V_1 = (0.3)^2 \times V_2$ $V_1 = 4 \times V_2$ $H_L = \frac{0.5\ (4V_2)^2}{2\times 9.81} + \frac{(0.04\times 25\times (4V_2)^2}{2\times 9.81\times 0.15} + \frac{(4V_2 - V_2)^2}{2\times 9.81} + \frac{0.04\times 25\times (V_2)^2}{2\times 9.81\times 0.3} + \frac{(V_2)^2}{2\times 9.81}$ $8 = 0.407(V_2)^2 + 5.436(V_2)^2 + 0.458(V_2)^2 + 0.17(V_2)^2 + 0.05(V_2)^2$ $\boxed{V_2 = 1.105 m/s}$ Q=AV $Q = \frac{\pi}{4}(0.3)^2 \times 1.105$ $\boxed{Q = 0.078 m^3/sec}$	1 1 1 1 1 1	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	c)	**A sloping pipe line has diameter of 1 m at higher end and 50 cm at lower end . It carries liquid at specific gravity 0.75 at 4800 lpm. The length of pipe is 350 m and it is laid on slope of 1 in 100. The pressure at lower end is 1200 kN/m².Determine pressure at higher end.**		
	Ans.	Given data:		
		$d_1=1m,\ d_2=0.5m,\ Z_1=\frac{1}{100}\times 350 = 3.5m$		
		$Q = 4800lpm = \frac{4800\times 10^{-3}}{60} = 0.08m^3/sec.$		
		$P_1 = 1200\ kN/m^2 = 1.2\times 10^6 N/m^2$		
		P_2 =Find		
		By using continuity equation	1	
		$Q = A_1V_1 = A_2V_2$		
		$0.08 = \frac{\pi}{4}(1)^2 \times V_1$		
		$\boxed{V_1 = 0.102m/s}$	1	
		$0.08 = \frac{\pi}{4}(0.5)^2 \times V_2$	1	6
		$\boxed{V_2 = 0.408m/s}$		
		$\frac{P_1}{\gamma_L} + \frac{(V_1)^2}{2g} + Z_1 = \frac{P_2}{\gamma_L} + \frac{(V_2)^2}{2g} + Z_2$	1	
		$\frac{P_1}{\gamma_L} + \frac{(V_1)^2}{2g} + Z_1 = \frac{P_2}{\gamma_L} + \frac{(V_2)^2}{2g} + Z_2$	1	
		$\frac{P_1}{0.75\times 9810} + \frac{(0.102)^2}{2\times 9.81} + 3.5 = \frac{1.2\times 10^6}{0.75\times 9810} + \frac{(0.408)^2}{2\times 9.81} + 0$		
		$\boxed{P_1 = 1.1\ x\ 10^6 kN/m^2}$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**Attempt any <u>TWO</u> of the following:**		**(12)**
	a)	**Water discharges at the rate of 0.0982 m^3/sec. through a 12cm diameter vertical sharp edges orifice placed under a constant head of 10m . A point on the jet measured from vena contracta of the jet has co-ordinate 4.5 m horizontal and 0.54 m vertical .Find the coefficients C_c , C_d ,C_v of the orifice.**		
	Ans.	Given:		
		$Q_a = 0.0982 m^3/s$		
		d = 12cm = 0.12m		
		h = 10 m		
		x = 4.5m		
		y = 0.54m		
		$A = \frac{\pi}{4} \times d^2$		
		$= \frac{\pi}{4} \times (0.12)^2$		
		$\boxed{A = 11.30 \times 10^{-3} m^2}$		
		$C_d = \frac{Q_a}{Q_t}$	1	
		$= \frac{0.0982}{A \times \sqrt{(2gh)}}$		
		$= \frac{0.0982}{\left(11.3 \times 10^{-3} \times \sqrt{(2 \times 9.81 \times 10)}\right)}$		6
		$\boxed{C_d = 0.62}$	1	
		$C_v = \frac{x}{\sqrt{(4hy)}}$	1	
		$= \frac{4.5}{\sqrt{(4 \times 10 \times 0.54)}}$		
		$\boxed{C_v = 0.968}$	1	
		$C_d = C_c \times C_v$	1	
		$C_c = \frac{C_d}{C_v} = \frac{0.62}{0.968}$		
		$\boxed{C_c = 0.640}$	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	b)	**Explain working of cup type of current meter with a neat sketch.**		
			2	
		Cup Type Current Meter		6
		(Note: 1 mark for sketch and 1 mark for labeling.)		
		Working: i. **I**n a cup type current meter the wheel or revolving element has the form of a series of conical cups, mounted on a spindle. Spindle is held vertical at right angle to the direction of flow. ii. Current meter is used to find out velocity of water. Current meter consist of a wheel containing blades on cups. iii. These cups are vertically immersed in stream of water. The thrust exerted by water on the cups. iv. The number of revolutions of the wheel per unit time is proportional to the velocity of flow. v. The revolution counter operated by dry cell. The counter is calibrated or a calibration curve is provided to read velocity.	4	
	c)	**Design a section of an unlined channel to carry a discharge of 6 m^3/sec. with a bed slope of 1 in 3600 and side slope 1.5 H to 1V. The average velocity of flow is not to exceed 0.667 m/s. take manning's N = 0.025.**		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	c) Ans.	**Given:** $Q = 6\ m^3/sec$ $V = 0.667\ m/s$ $N = 1.5/1$ We know $Q = A.V$ $6 = A \times 0.667$ $A = 9\ m^2$ Area of trapezoidal $A = bd + nd^2$ $9 = d(b + nd)$ ……………………….(1) Manning's equation is, $V = \frac{1}{N} R^{\frac{2}{3}} S^{\frac{1}{2}}$ $0.667 = \frac{1}{0.025} \times R^{\frac{2}{3}} \times (\frac{1}{3600})^{\frac{1}{2}}$ $R^{\frac{2}{3}} = 1$ R = 1 But, $R = \frac{A}{P}$ $1 = \frac{9}{P}$ P = 9 But, $P = b + 2d\sqrt{1 + n^2}$ $9 = b + 2d\sqrt{1 + 1.5^2}$ $9 = b + 3.6d$ $b = 9 - 3.6d$………………………………….(2) Putting value of b from equation 2 in equation 1 $d(9 - 3.6d + 1.5d) = 9$ $d(9 - 2.1d) = 9$ $9d - 2.1d^2 = 9$ $2.1d^2 - 9d + 9 = 0$ $d = \frac{9 \pm \sqrt{9^2 - 4 \times 2.1 \times 9}}{2 \times 2.1}$ d =2.68 m or d = 1.595 But if we put d = 2.68 in equation 2 becomes negative d=1.595 m b = 1.8 x 1.595 = 3.25m	1 1 1 1 1 1	6

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	c) Ans.	OR Given data: $Q = 6m^3/sec$ $V=0.667m/s$ $n=\frac{1.5}{1}=1.5, N=0.025$ $N=0.025$ For economical trapezoidal section $R = \frac{d}{2}$ Sloping side = half the top width $d\sqrt{n^2+1} = \frac{b+2nd}{2}$ $d\sqrt{1.5^2+1} = \frac{b+2\times1.5d}{2}$ $2d(1.8) = b+3d$ $\boxed{b = 0.6d}$ Area for trapezoidal section is $A= bd+nd^2$ but, $Q = AV$ $6 = A\times0.667$ $\boxed{A = 9m^2}$ $9 = 0.6d\times d+1.5d^2$ $\boxed{d = 2.06m}$ $b = 0.6d$ $\boxed{b = 1.24m}$ ***(Note: Base width to depth ratio is not given in numerical, therefore students may solve the problem by considering most economical channel section. Considering this give appropriate marks.)***	1 1 1 1 1 1	6