Model Answer: Summer 2018

Subject: Hydraulics **Sub. Code: 17421**

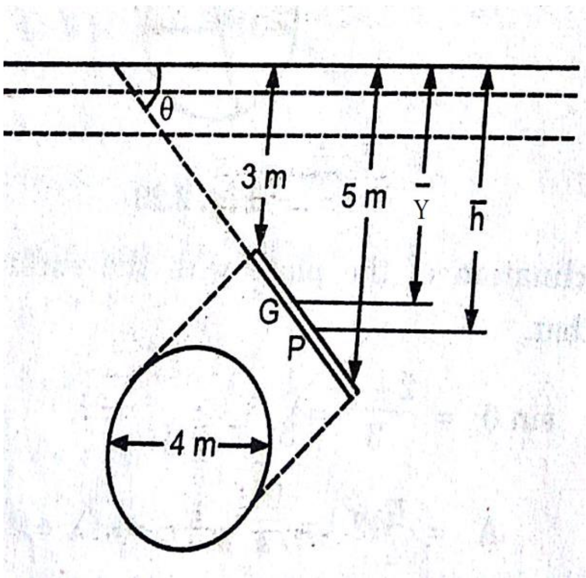
Important Instructions to examiners:

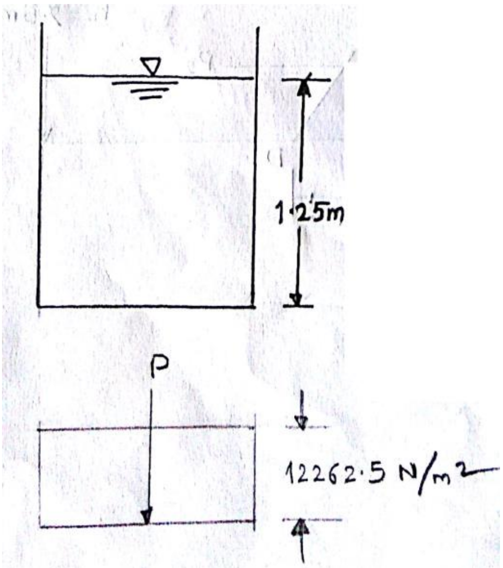
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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 Answers	Marks	Total Marks
Q. 1	**(A)**	**Attempt any SIX of the following:**		**12**
	(a)	**Define surface tension and state its unit.**		
	Ans.	Surface tension of a liquid is the properties by which a fluid is enabled resist tensile stress. **OR** The tension of the surface film of a liquid caused by the attraction of the particles (cohesion) in the surface layer by the bulk of the liquid, which tends to minimize surface area.	1	
		SI unit = N/m	1	2
	(b)	**A pressure of 1.2 Pascal applied to 650 liters of a liquid caused a volume reduction by 1.5 liters respectively. Calculate the bulk modulus of elasticity for liquid.**		
	Ans.	P =1.2 Pascal = 1.2 N/m^2 $V = 650 lit. = 650\times10^{-3} m^3$ $dV = 1.5\ lit. = 1.5\times10^{-3} m^3$ *Bulk* modulus (K), $K=\frac{dP}{\left(\frac{dV}{V}\right)}=\frac{1.2}{\left(\frac{1.5\times10^{-3}}{650\times10^{-3}}\right)}$	1	
		$\boxed{K=520\ N/m^2}$	1	2

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1.	(c)	**What is the principle of Manometer?**		
	Ans.	Manometer measure the pressure at a point in fluid by balancing the column of fluid by same or another column of fluid.	2	2
	(d)	**Convert pressure head of 50 m of oil of sp. Gravity 0.8 into corresponding head of water.**		
	Ans.	$h_{Oil} = 50m,\ S_{Oil} = 0.8$ $S_{Water} = 1$ $P = \gamma_{Oil} \times h_{Oil} = \gamma_{Water} \times h_{Water}$ $P = S_{Oil} \times \gamma_{Water} \times h_{Oil} = S_{Water} \times \gamma_{Water} \times h_{Water}$	1	
		$0.8 \times 9810 \times 50 = 1 \times 9810 \times h_{Water}$ $\boxed{h_{Water} = 40m}$	1	2
	(e)	**Write modified Darcy's Weisbach equation.**		
	Ans.	Modified Darcy-Weisbach equation is as following :- $h_f = \dfrac{f\ L\ Q^2}{12.1\ D^5}$ Where, h_f = Head loss due to friction. L = Length of pipe. D = Diameter of pipe. f = Friction factor. Q = Discharge through pipe.	2	2
	(f)	**Define hydraulic gradient line and total energy line.**		
	Ans.	**Hydraulic Gradient Line (HGL)** is defined as the line which gives the sum of pressure head and datum head of a flowing fluid in a pipe with respect to some reference line.	1	
		Total Energy Line (TEL) is defined as the line which gives the sum of pressure head, datum head and velocity head of a flowing fluid in a pipe with respect to some reference line.	1	2
	(g)	**Enlist any four velocity measuring devices for canal.**		
	Ans.	Velocity measuring devices for canal: a) Pitot Tube b) Cup type current meter, c) Single float d) Double float e) Rod float f) Screw type current meter or propeller type	½ each (any four)	2
	(h)	**Write the principle on which venturemeter works.**		
	Ans.	**Principle of venturimeter:** It is based on Bernoulli's equation that is the velocity increases in an accelerated flow by reducing the cross section area of the flow passage due to which the pressure head is reducing at that section. A pressure difference is created which enables to the determination of discharge through the pipe.	2	2

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1	**(B)**	**Attempt any TWO of the following:**		**8**
	(a)	**If Specific gravity of oil is 0.80. What is the specific weight in N/m³?**		
	Ans.	$S_{Oil} = 0.8$ $S_{Oil} = \frac{\gamma_{Oil}}{\gamma_{water}}$ $0.8 = \frac{\gamma_{Oil}}{9810}$	**2**	
		$\boxed{\gamma_{Oil} = 7848 N/m^3}$	**2**	**4**
	(b)	**A shaft of 150 mm diameter rotates at 75 rpm in a 500 mm long bearing taking that two surfaces are uniformly separated by a distance of 1 mm and considering linear velocity distribution having viscosity of 0.005 N-s/m². Find the power absorbed in the bearing.**		
	Ans.	Diameter of shaft (D) = 150 mm = 0.150 m Length of bearing (L) = 500 mm = 0.5 m $t = 1 \text{ mm} = 1 \times 10^{-3}$ m $\mu = 0.005$ N-s/m² N = 75 rpm Power absorbed in the bearing $P = \frac{\mu \pi^3 D^3 N^2 L}{60 X 60 X t}$	**2**	
		$P = \frac{0.005 \times \pi^3 \times (0.150)^3 \times (75)^2 \times 0.5}{60 \times 60 \times 1 \times 10^{-3}}$ $\boxed{P = 0.408 \text{ Watt}}$	**2**	**4**
	(c)	**State Pascal's law of fluid pressure. Enlist any four application of it.**		
	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**	
		Applications of Pascal law: It is applied in the construction of machines used for multiplying forces e.g. i. Hydraulic Jacks ii. Hydraulic Press iii. Hydraulic Lifts iv. Hydraulic Crane v. Braking system of motor vi. Artesian well	**½ each any four**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2		**Attempt any FOUR of the following :**		**16**
	(a)	**A circular plate of 4m diameter is immersed in water such that its greatest and least depth below the free surface of water are 5m and 3m respectively, calculate i)Total pressure on one face of plate ii) The position of center of pressure.**		
	Ans.			
		$A=\frac{\pi}{4}\times 4^2$ $A=4\times\pi$ $\boxed{A=12.566\ m^2}$	½	
		$\bar{y}=\frac{5+3}{2}$ $\boxed{\bar{y}=4m}$	½	
		$\sin\theta=\frac{2}{4}$ $\theta=\sin^{-1}(\frac{1}{2})$ $\boxed{\theta=30^0}$	½	
		$I_G=\frac{\pi}{64}\times D^4$ $I_G=\frac{\pi}{64}\times 4^4$ $\boxed{I_G=12.57\ m^4}$	½	
		$P=\gamma_w\times A\times\bar{y}$ $P=9.81\times 12.566\times 4$ $\boxed{P=493.10\,kN/m^2}$	1	
		$\bar{h}=\frac{I_G\sin^2\theta}{A\bar{y}}+\bar{y}$ $\bar{h}=\frac{12.57\times\sin^2 30^0}{12.566\times 4}+\bar{y}$ $\boxed{\bar{h}=4.0625m}$	1	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	**(b)**	**Find the intensity of pressure in N/m^2 on the base of container when (i) Water stands to a height of 1.25 m in it. (ii) When oil for 0.625 m height stands on water of 1 m height. Draw pressure diagrams in all cases.**		
	Ans.	**Case i) Water stands to a height of 1.25m:** $P =$ Pressure intensity at bottom $P = \gamma_w \times h$ $P = 9.81 \times 1.25$ $P = 12.2625\, kN/m^2$ $P = 12262.5\, N/m^2$	1	
		 Case (i)	1	
		Case ii) When oil for 0.625m height stands on a water of 1m height: *for* Water, $P =$ Pressure intensity at bottom $P = w_w \times h$ $P_1 = 9.81 \times 1$ $P_1 = 9.81 kN/m^2$ $P_1 = 9810\ N/m^2$	½	
		for Oil, $P_2 =$ Pressure intensity at bottom $P_2 = w_{oil} \times h$ $P_2 = S_{oil} \times w_{water} \times 0.625$ $P_2 = 6.13125 \times\ S_{oil}\ kN/m^2$	½	

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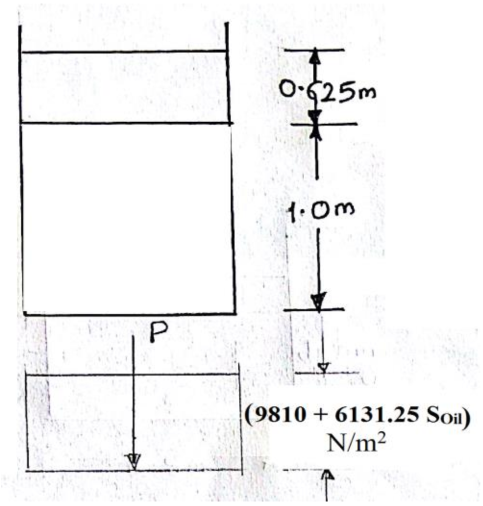
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>2.</td><td>(b)</td><td>

$\boxed{P_2 = 6131.25 \times S_{oil}\ N/m^2}$

$P = P_1 + P_2$

$\boxed{P = (9810 + 6131.25 \times S_{oil})N/m^2}$

Note: If Sp. Gr. of oil is assumed then appropriate marks should be given



Case (ii)

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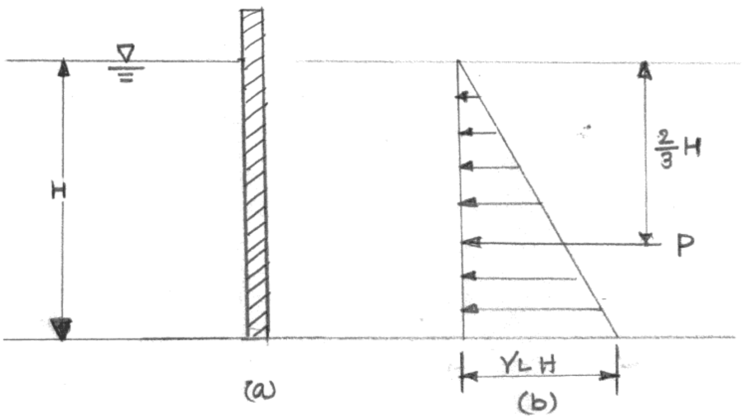
<tr><td></td><td>(c)

Ans.</td><td>

Explain the concept of pressure diagram with neat sketches and explain the use of pressure diagram.

Pressure diagram is defined as "It gives the variation of pressure on the surface with depth". The total pressure per unit length is the area of pressure diagram. The position of center of the pressure is the position of center of gravity of the pressure diagram.



Use of pressure diagram:

i. To calculate pressure due to liquid on the side of surface.

ii. To calculate pressure due to liquid on both the side of surface.

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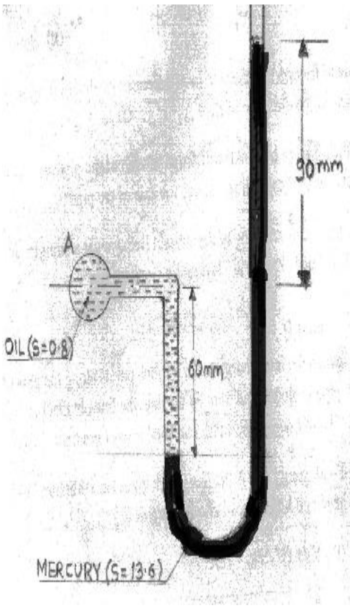
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.		iii. To calculate pressure on vertical and inclined faces of dam. iv. To calculate pressure on sluice gate, side and bottom of water tank.	**2**	**4**
	(d)	**An oil of specific gravity 0.8 is flowing through a pipe. A simple manometer is connected to the pipe containing mercury. The deflection of mercury level in left limb from center of pipe is 60 mm, where as in right limb (from center of pipe) it is 90 mm. Calculate the pressure in kPa.**		
	Ans.	 $h_1 = 60mm = 0.06m,$ $h_2 = 90 + 60 = 150mm = 0.15m,$ $S_1 = 0.80, \quad S_2 = 13.6,$	**1**	
		$h_A + S_1 h_1 = S_2 h_2$ $h_A = S_2 h_2 - S_1 h_1$ $h_A = 13.6 \times 0.15 - 0.8 \times 0.06$	**½**	
		$\boxed{h_A = 1.99m\ of\ \ water}$	**1**	
		$P_A = \gamma_w h$ $P_A = \gamma_{Std} \times S_w \times h$ $P_A = 9.81 \times 1 \times 1.99$	**½**	
		$\boxed{P_A = 19.81 kN/m^2}$ $\boxed{P_A = 19.81 kPa}$	**1**	**4**
	(e)	**Define: 1) Reynold's Number ii) Pressure head iii) Velocity head iv) Datum head.**		
	Ans.	**Reynold's Number:** The Reynolds Number is defined as the ratio of inertia force to viscous force. $$\text{Re} = \frac{\text{inertial force}}{\text{viscous force}} = \frac{F_i}{F_v}$$ $$\text{Re} = \frac{\rho\ V\ d}{\mu}$$	**1**	
		Pressure head: Pressure head is the head possessed by fluid due to having some pressure force by the flowing fluid**.** $$h = \frac{P}{\gamma}$$	**1**	
		Velocity head: Velocity head is the head possessed by fluid due to having some velocity of the flow. $$\text{Velocity Head} = \frac{V^2}{2g}$$	**1**	
		Datum head: The energy possessed by fluid particle by virtue of its position is called as potential energy. Potential energy per unit weight is called datum head.	**1**	**4**

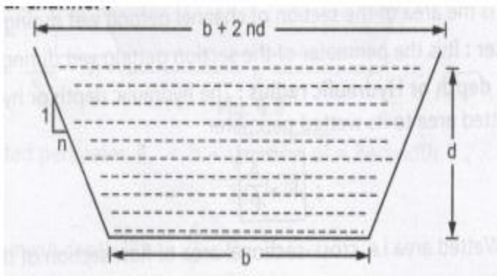
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	**(f)** **Ans.**	**State the Bernoulli's theorem. State any two application of it.** **Bernoulli's Theorem:** It states that in an incompressible frictionless fluid, when the flow is steady and continuous the energy of each particle of the fluid is the same. OR **Bernoulli's Theorem:** It states that in an incompressible fluid, when the flow is steady and continuous the sum of total energy of each particle of the fluid is the same.(provided that no energy enters or leaves the system at any point). Mathematically, $\frac{P}{\gamma}+\frac{V^2}{2g}+z=\text{Constant}$ **Where,** $\frac{P}{\gamma}$ = Pressure energy $\frac{V^2}{2g}=$ Kinetic energy $z=$ Datum head **Applications:** 1) To find the total energy at any section. 2) To find the head loss in the system. 3) To find the pressure difference at any given two points. 4) Practical applications of the following measuring devices. a) Venturimeter b) Orifice meter c) Pitot tube	**2** **1 each (any two)**	 **4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3		**Attempt any FOUR of the following:**		**16**
	(a)	**A pipe line carrying oil of specific gravity 0.8 changes in diameter from 300mm at position 1 to 600 mm diameter at position 2 which is at 5 m at higher level. If the pressure at position 1 and 2 are 100 kN/m^2 and 60 kN/m^2 respectively and the discharge is 300 lit/sec. Determine the loss of head.**		
	Ans.	$d_1 = 300mm$ = 0.3 m, $Z_1 = 0$, $P_1 = 100 kN/m^2$ $d_2 = 600mm$ = 0.6 m, $Z_2 = 5m$, $P_2 = 60kN/m^2$ $Q = 300 lit/\sec = 300\times10^{-3} m^3/\sec$, $A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(0.3)^2 = 0.0706 m^2$		
		$A_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(0.6)^2 = 0.2827 m^2$	½	
		By continuity Eqution,	½	
		$Q = A_1V_1 = A_2V_2$ $Q = A_1V_1$ $300\times10^{-3} = 0.0706\times V_1$ $\boxed{V_1 = 4.2492 m/\sec}$		
		$Q = A_2V_2$ $300\times10^{-3} = 0.2827\times V_2$ $\boxed{V_2 = 1.061 m/\sec}$	½	
		By applying Bernoulli's eq^n		
		$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2 + h_L$	½	
		$\frac{100\times10^3}{9810\times0.8} + \frac{4.2492^2}{2\times9.81} + 0 = \frac{60\times10^3}{9810\times0.8} + \frac{1.061^2}{2\times9.81} + 5 + h_L$	1	
		$\boxed{h_L = 0.9574 m}$	1	4
		Flow is flowing from Position 1 to Position 2		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	(b)	**A pipe line changes in size from 30 cm diameter at A to 60 cm at B. It is used to carry oil of specific gravity 0.80. Point A is 5 m lower than point B and the pressure are 80 kN/m^2 and 60 kN/m^2 respectively. If the discharge is 200 LPS. Find the loss of head and direction of flow**.		
	Ans.	$d_1 = 30cm = 0.3$ m, $Z_1 = 0$, $P_1 = 80kN/m^2$ $d_2 = 60mm = 0.6$ m, $Z_2 = 5m$, $P_2 = 60kN/m^2$ $Q = 200\ lps = 200\times10^{-3} m^3/\text{sec}$, $A_1 = \frac{\pi}{4}d_1^2 = \frac{\pi}{4}(0.3)^2 = 0.0706m^2$ $A_2 = \frac{\pi}{4}d_2^2 = \frac{\pi}{4}(0.6)^2 = 0.287m^2$	½	
		By continuity Eqution, $Q = A_1V_1 = A_2V_2$ $Q = A_AV_A$ $200\times10^{-3} = 0.0706\times V_A$ $\boxed{V_A = 2.8294m/\text{sec}}$	½	
		$Q = A_BV_B$ $200\times10^{-3} = 0.287\times V_B$ $\boxed{V_B = 0.707m/\text{sec}}$	½	
		By applying Bernoulli's eq^n $\frac{P_A}{\gamma} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\gamma} + \frac{V_B^2}{2g} + Z_B + h_F$	½	
		$\frac{800\times10^3}{9810\times0.8} + \frac{2.8294^2}{2\times9.81} + 0 = \frac{60\times10^3}{9810\times0.8} + \frac{0.707^2}{2\times9.81} + 5 + h_F$	1	
		$\boxed{h_F = -2.069m}$	½	
		Flow is flowing from point B to point A	½	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	**(c)**	**What are major and minor loss of head in flow through pipes? Write any two equations of minor loss.**		
	Ans.	**Major loss:** The major loss of head is caused due to friction when fluid flow through a pipe.	**1**	
		Minor loss: The minor loss of head is caused due to change in velocity of flowing fluid either in magnitude or direction.	**1**	
		1. Loss of head at the entrance. $H_L = \frac{0.5V^2}{2g}$ Where , H_L = Head loss, V = Velocity 2. Loss of head due to sudden expansion. $H_L = \frac{(V_1 - V_2)^2}{2g}$ 1. Loss of head due to sudden contraction. $H_L = \frac{0.5V^2}{2g}$ 2. Loss of head due to bend. $H_L = K\frac{V^2}{2g}$ 3. Loss of head due to exit. $H_L = \frac{V^2}{2g}$ 4. Loss of head due to obstruction. $H_L = \left[\frac{A}{C_c \times a} - 1\right]^2 \frac{V^2}{2g}$ A = c/ s Area of pipe a = c/ s Area of Opening C_C =Coefficient contraction 7. Loss of head due to pipe fitting. $H_L = K\frac{V^2}{2g}$	**1 each (any two)**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	**(d)**	**An oil of specific gravity 0.9 and viscosity of 0.06 poise is flowing through a pipe of diameter 200 mm at rate of 60 litres/sec. Find the head lost due to friction for 500 m length of pipe. Take f= 0.02.**		
	Ans.	$S_{oil} = 0.9$, $\mu = 0.06$ Poise, d = 200 mm = 0.2 m, L= 500 m, f = 0.02 Q = 60 lit/sec, $Q = 60 \times 10^{-3} m^3/sec$ $V = \frac{Q}{a} = \frac{60 \times 10^{-3}}{\frac{\pi}{4} \times 0.2^2} = 1.9098$	2	
		$h_f = \frac{f L V^2}{2gd}$ $h_f = \frac{0.02 \times 500 \times (1.9098)^2}{2 \times 9.81 \times 0.2}$	2 **Or**	
		$\boxed{h_f = 9.2949m}$ Or $h_f = \frac{f L Q^2}{12.1 d^5}$	2	
		$h_f = \frac{0.02 \times 500 \times (60 \times 10^{-3})^2}{12.1 \times 0.2^5}$ $\boxed{h_f = 9.2975m}$	2	4
	(e)	**What do you mean by water hammer? State its causes (any three).**		
	Ans.	**Water Hammer:** When the water flowing in a long pipe is suddenly brought to rest by closing the valve, there will be a sudden rise in pressure due to the momentum of the moving water being destroyed. This causes a wave of high pressure to be transmitted along the pipe which creates noise known as water hammer.	1	
		Causes : i. Sudden increasing velocity of flow ii. Sudden closure of valve with high speed. iii. Sudden increase in pressure in pipe	1 each	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	**(f)**	**Define with a neat sketch for a trapezoidal channel (1) Hydraulic depth (2) Hydraulic Radius.**		
	Ans.	**1) Hydraulic depth (D):** The depth of flow in a channel above bed surface is called as hydraulic depth (D).	**1**	
		Or		
		It is ratio of wetted area to top width		
		$D = \frac{\text{Wetted area}}{\text{Top width}} = \frac{A}{T}$	½	
		$T = b + 2nd$		
		$A = bd + nd^2$		
		$D = \frac{bd + nd^2}{b + 2nd}$		
		2) Hydraulic Radius (R): It is the ratio of the wetted area to wetted perimeter. It is also called as Hydraulic mean depth.	**1**	
			**1**	
		Fig. Trapezoidal channel		
		$R = \frac{\text{Wetted area}}{\text{Wetted perimeter}} = \frac{A}{P}$	½	**4**
		For Trapezoidal Channel.		
		$A = bd + nd^2$		
		$P = b + 2d\sqrt{n^2 + 1}$		
		$R = \frac{A}{P} = \frac{bd + nd^2}{b + 2d\sqrt{n^2+1}}$		
		Where, R = Hydraulic radius. b = width of the channel at bottom d= Hydraulic depth of the flow P = Wetted perimeter The side slope is given as 1 vertical to n horizontal		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		**Attempt any FOUR of the following:**		**16**
	(a)	**Define steady, unsteady, uniform and non-uniform flow in open channel.**		
	Ans.	**Steady flow:** If the depth of flow, the discharge and mean velocity of the flow at any section does not change with respect to time, the flow is called as steady flow.	**1**	
		Unsteady flow: If the depth of flow, the discharge and mean velocity of the flow at any section changes with respect to time, the flow is called as unsteady flow.	**1**	
		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**	
		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**	**4**
	(b)	**What is meant by most economical channel section and write condition for most economical rectangular and trapezoidal channel section.**		
	Ans.	**Most economical channel section:** A channel section is said to be most economical when it gives maximum discharge for a given cross section area, bed slope and coefficient of resistance.	**2**	
		Most economical condition:		
		Rectangular channel:		
		$b = 2d$	½	
		$R = \frac{d}{2}$	½	
		Trapezoidal channel:		
		$\frac{(b+2nd)}{2} = d\sqrt{(1+n^2)}$	½	
		$R = \frac{d}{2}$	½	**4**

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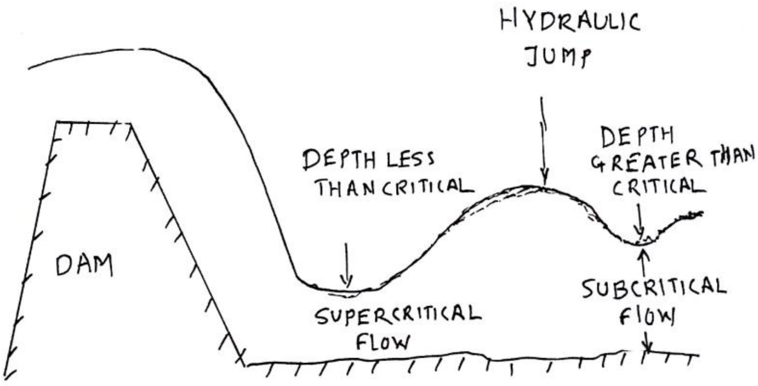
<tr><td>4.</td><td>(c)

Ans.</td><td>What do you mean by Hydraulic jump? Explain with sketch.

Hydraulic jump: It is the phenomenon in which supercritical flow is converted to subcritical flow.



Fig→ HYDRAULIC JUMP.

1) It is the phenomenon occurring in an open channel when rapidly flowing stream abruptly change to slowly flowing stream causing a distance rise or jump in level of liquid surface.

2) Hydraulic jump formed on a horizontal floor of canal and at the downstream side of spillway, at the downstream side of sluice gate, or at the downstream side of canal fall.</td><td>1

1

2</td><td>4</td></tr>
<tr><td></td><td>(d)

Ans.</td><td>What flows through a rectangular open channel having width of 2m with flow depth of 0.6m with discharge of 4 m³/sec. Find Fraud’s number.

$b = 2m,\ d = 0.6m$
$Q = 4m^3/sec$
Find froude's no.
$A = b \times d$
$A = 2 \times 0.6$
$\boxed{A = 1.2\ m^2}$
$Q = A\,V$
$V = \frac{Q}{A} = \frac{4}{1.2}$
$\boxed{V = 3.333\ m/sec}$
$R = \frac{A}{P} = \frac{1.2}{3.2} = 0.375$</td><td>1

1</td><td></td></tr>
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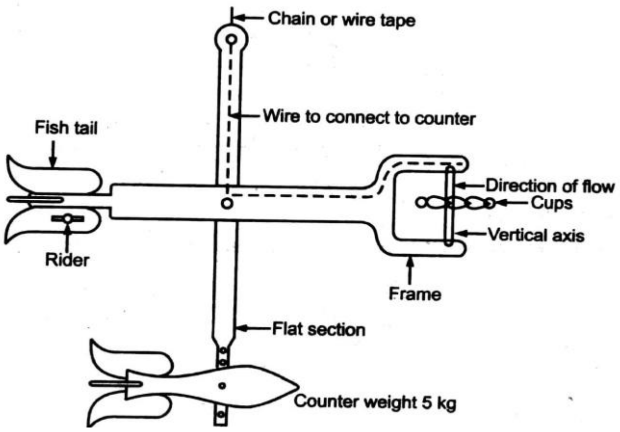
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.		$F_r = \frac{V}{\sqrt{gR}}$ $F_r = \frac{3.333}{\sqrt{9.81 \times 0.375}}$ $\boxed{F_r = 1.7377}$ F_r is greater than 1 flow is super critical flow	1 1	 4
	(e)	**Define hydraulic coefficients. State the relationship among the hydraulics coefficient for an orifice.**		
	Ans.	1. **Coefficient of discharge (C_d):** The ratio of the actual discharge to the theoretical discharge is called as the coefficient of discharge. 2. **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. 3. **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. **Relation:** $C_d = C_v \times C_c$	1 1 1 1	 4
	(f)	**A 30 × 15 cm venturimeter is provided in a vertical pipe line carrying oil of specific gravity 0.90 the flow being upward. The difference in elevations of the throat section and entrance section of the venturimeter is 50 cm. The differential U-tube mercury manometer shows a gauge deflection of 30 cm. Calculate discharge of oil. (cd = 0.98)**		
	Ans.	Inlet area, $A_1 = \frac{\pi}{4} \times 0.3^2 = 0.0706\ m^2$ Throat area, $A_2 = \frac{\pi}{4} \times 0.15^2 = 0.0176\ m^2$ Gauge deflection interms of oil $h = 30cm$ of Hg = 0.30 m	 ½ ½	

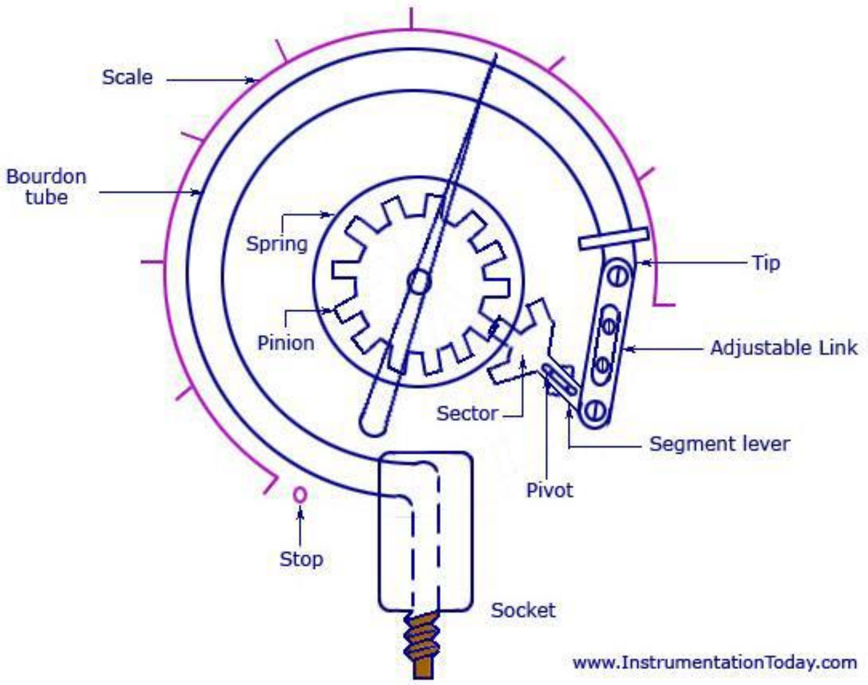
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.	**(f)**	$h = x\left(\frac{S_m}{S_{oil}} - 1\right)$	**1**	
		$h = 0.30 \times \left(\frac{13.6}{0.9} - 1\right)$		
		$\boxed{h = 4.233\ m \text{ of oil}}$		
		$Q = \frac{C_d \times a_1 \times a_2 \times \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$	**1**	
		$Q = \frac{0.98 \times 0.0706 \times 0.0176 \times \sqrt{2 \times 9.81 \times 4.233}}{\sqrt{0.0706^2 - 0.0176^2}}$		
		$\boxed{Q = 0.1622\ m^3/s}$	**1**	**4**

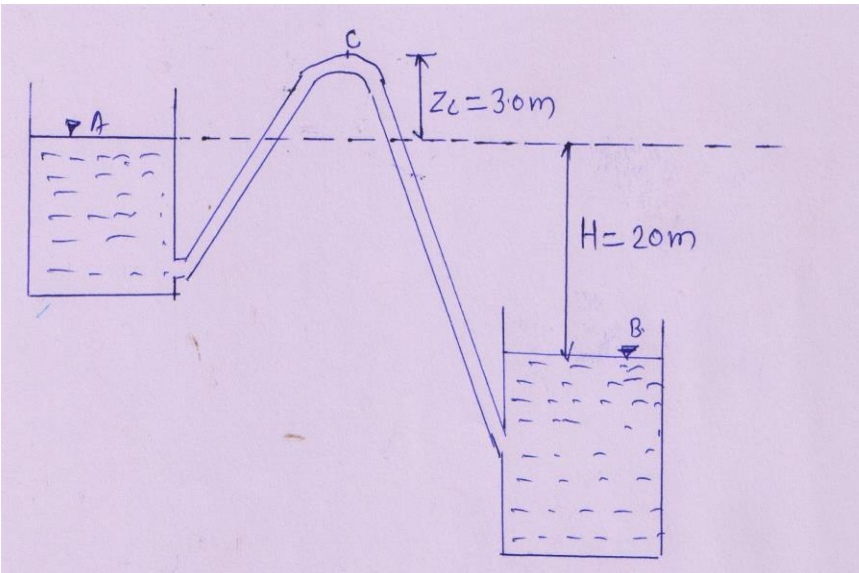
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5		**Attempt any FOUR of the following :**		**16**
	(a)	**Draw a neat sketch of cup type current meter and explain its working.**		
	Ans.	 *(Note: 1 mark for sketch and 1 mark for labeling.)*	2	
		Working: 1. In a cup type current meter the wheel 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. 2. Current meter is used to find out velocity of water. Current meter consist of a wheel containing blades on cups. 3. These cups are vertically immersed in stream of water. The thrust exerted by water on the cups. 4. The number of revolutions of the wheel per unit time is proportional to the velocity of flow. 5. The revolution counter operated by dry cell. The counter is calibrated or a calibration curve is provided to read velocity.	2	4
	(b)	**Determine the discharge through 60^0 triangular notch in lit/sec. when the head is 0.20 m. take cd = 0.6.**		
	Ans.	$\theta = 60^0$, H = 20 cm = 0.20 m $C_d = 0.6$ $Q = \frac{8}{15} C_d \cdot \sqrt{2g} \tan\frac{\theta}{2} \times H^{5/2}$	2	
		$Q = \frac{8}{15} \times 0.6 \times \sqrt{2 \times 9.81} \times \tan\left(\frac{60}{2}\right) \times (0.20)^{5/2}$ $\boxed{Q = 0.0146 \text{ m}^3/\text{sec}}$ $\boxed{Q = 14.6 \text{ lit/sec}}$	2	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5	**(c)**	**A rectangular notch 2.5 m wide has a constant head of 40 cm. Find discharge over it if cd = 0.62.**		
	Ans.	L = 2.5m, h = 40 cm = 0.40m,		
		$C_d = 0.62$		
		$Q = \frac{2}{3} \times C_d \times L \times \sqrt{(2g)} \times (h)^{\frac{3}{2}}$	**2**	
		$= \frac{2}{3} \times 0.62 \times 2.5 \times \sqrt{(2 \times 9.81)} \times (0.40)^{\frac{3}{2}}$		
		$\boxed{Q = 1.157\ m^3/s}$	**2**	**4**
	(d)	**Define (i) Static head (ii) Manometric head of pump.**		
	Ans.	**i) Static head:** The sum of suction head and delivery head is known as static head.	**1**	
		$hs = h_s + h_d$	**1**	
		ii) Manometric head: It is sum of suction head, delivery head, major loss in suction and delivery pipes and minor losses in the system.	**1**	
		$h_m = h_s + h_d + h_{fs} + h_{fd} +$ Minor losses	**1**	**4**
	(e)	**Differentiate between centrifugal and reciprocating pump.**		
	Ans	(see table below)	**1 each (any four)**	**4**

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

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.	**(f)**	**A centrifugal pump delivers water at 30 lit/sec. to a height of 18m through a pipe of 90m long and 100 mm in diameter if overall efficiency of pump is 75%. Find power required to drive the pump take f= 0.012.**		
	Ans.	$Q = 30 lit/\sec = 30\times10^{-3} m^3/\sec$ $\eta = 75\%$, f = 0.012, L = 90 m, D = 0.1 m Velocity at section, $V = \frac{Q}{A} = \frac{30\times10^{-3}}{\frac{\pi}{4}\times(0.1)^2}$	1	
		V =3.819 m/sec Now, Loss of head due to friction, $h_f = \frac{f L V^2}{2gD}$	1	
		$h_f = \frac{0.012 \times 90 \times 3.819^2}{2\times9.81\times0.1}$ $\boxed{h_f = 8.028}$ Total manometric head, $H_m = 18 + 8.028$ $\boxed{H_m = 26.028 \text{ m}}$	1	
		$P = \frac{\gamma_W Q H_m}{\eta}$ $P = \frac{9810\times30\times10^{-3}\times26.028}{0.75}$ $\boxed{P = 10213.39 \text{ Watt}}$ $\boxed{P = 10.213 \text{ kW}}$	1	4
		OR	**OR**	**OR**
		if suction head is considered, $h = \frac{V^2}{2g} = \frac{3.819^2}{2\times9.81} = 0.743m$	1	
		Total manometric head, $H_m = 18 + 8.028 + 0.743$ $\boxed{H_m = 26.771 \text{ m}}$	1	
		$P = \frac{9810\times30\times10^{-3}\times26.771}{0.75} = \boxed{P = 10504.94 \text{ Watt}}$	1	
		$\boxed{P = 10.504 \text{ kW}}$	1	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		**Attempt any TWO of the following:**		**16**
	(a)	**Explain with a neat sketch the working of Bourdon's pressure gauge.**		
	Ans.	 Bourdon Tube Pressure Gauge *(Note: 2 marks for sketch and 2 marks for labeling.)*	4	
		Working: Bourdon tube pressure gauge is used to measure high pressure. It consists of tube as shown in fig. having elliptical cross section. This tube is called as Bourdons Tube. One end of this tube is connected the point whose pressure is to be measured and other end free. When fluid enters in the tube elliptical cross section of tube becomes circular. Due to this the free end of tube shifts outward. This motion is transferred through link and pointer arrangement. The pointer moves over a calibrated scale, which directly indicates the pressure in terms of N/m^2 or m head of mercury. As the pressure in the case containing the bourdon tube is usually atmospheric, the pointer indicates gauge pressure.	4	8

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.	**(b)**	**A Syphon of diameter 20 cm connects two reservoirs having a difference in elevation 20 m. Total length of pipe is 500 m and summits is 3 m above the water level in the upper reservoir. The length of the pipe from upper reservoir to summit is 100 m. Determine the discharge through the Siphon and also pressure at summit. Neglect minor losses. Take coefficient of friction f = 0.005.**		
	Ans.	D = 0.2 m, H = 20m, L = 500m, Z_c = 3 m L (Upper reservoir to summit) = 100m, Coefficient of friction = f = 0.005 Q =? P =? **Diagram-**		
				
		$h_f = \frac{(4f)\, L\, V^2}{2gd}$	1	
		$20 = \frac{(4 \times 0.005)\, 500\, V^2}{2 \times 9.81 \times 0.2}$ $20 = 0.637 \times 4V^2$ $V^2 = 7.848$		
		V = 2.801 m/s	1	
		Discharge $Q = a\,V$	1	
		$Q = \frac{\pi}{4} \times 0.2^2 \times 2.8014$	1	
		Q = 0.0879 m^3/s		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
		Pressure at summit: Applying Bernoulli's equation between A and C $\frac{P_A}{\gamma_c}+\frac{V_A^2}{2g}+Z_A=\frac{P_C}{\gamma_C}+\frac{V_C^2}{2g}+Z_C+Losses$	2	
		$0=\frac{P_C}{\gamma_C}+\frac{2.801^2}{2\times 9.81}+3+(\frac{4\times 0..005\times 100\times 2.801^2}{2\times 9.81\times 0.2})$ $0=\frac{P_C}{\gamma_C}+3.39+4$ $0=\frac{P_C}{9810}+7.39$	1	
		P_C = -72.49 KN/m^2 **P_C = 72.49 kN/m^2 (Vacuum)**	1	8
	(c)	**A trapezoidal channel of most economical section has side slopes 1.5 horizontal to 1 vertical. It is required to discharge 16 m^3/sec with a bed slope of 0.5 meter in 3.2 km. Design the section using Manning's formula. Take N= 0.015.**		
	Ans.	$Q = 16\ m^3/sec$		
		$\text{Bed slope}(S)=\frac{0.5}{3200}=\frac{1}{6400}$	½	
		$n=\frac{1.5}{1}=1.5$	½	
		Manning's constant $(N)=0.015$ Most economical condition for trapezoidal section having following condition		
		i) $R=\frac{d}{2}$	½	
		ii) $\frac{(b+2nd)}{2}=d\sqrt{(1+n^2)}$	½	
		$\frac{(b+2nd)}{2}=d\times\sqrt{(1+n^2)}$ $b+(2\times 1.5\times d)=2\times d\sqrt{(1+1.5^2)}$ $b+3d=3.606\ d$		
		$\boxed{b=0.606d}$	½	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.	(c)	$A = bd + nd^2$	½	
		$= (0.606d) \times d + 1.5d^2$		
		$\boxed{A = 2.106\ d^2}$	½	
		Manning formula,		
		$Q = \frac{A}{N} \times (R)^{\frac{2}{3}} \times (S)^{\frac{1}{2}}$	1	
		$16 = \frac{(2.106\ d^2)}{0.015} \times \left(\frac{d}{2}\right)^{\frac{2}{3}} \times \left(\frac{1}{6400}\right)^{\frac{1}{2}}$	1	
		$16 = 140.4 \times d^2 \times 0.6299 \times d^{\frac{2}{3}} \times 0.0125$		
		$(d)^{\frac{8}{3}} = 14.47$		
		$\boxed{d = 2.72\ m}$	½	
		$\boxed{b = 1.648\ m}$	1	
		$\boxed{A = 15.581\ m^2}$		
		$\boxed{R = 1.36 m}$	1	8