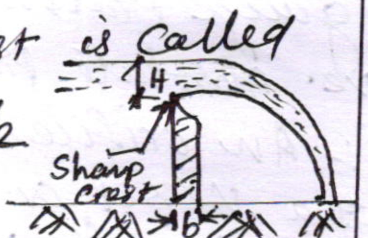
Revision (2015) — SCHEME OF VALUATION / SCORING INDICATORS — P

Course : Hydraulics — COURSE CODE 4011

Qst No	Scoring indicator	Split up Score	Sub Total	Total
	PART – A			
I				
1.	Sp. weight of a fluid is the weight of the liquid per unit volume	2	2	
2.	When water flows through an orifice the jet of water contracts from the mouth of orifice up to a distance of about 1½ times the diameter of the orifice. This section of the jet beyond which no further contraction takes place and the stream lines first become parallel is known as vena contracta	2	2	
3.	A weir having a sharp crest is called sharp crested weir $b < H/2$ 	1		
	A weir having a broad crest is called broad crested weir. If the crest width (B) is greater than ½ the height of water above the crest (0.5H) it is called broad crested weir	1	2	
4	Water, while flowing in a pipe, possesses some momentum on account of its motion. If the flowing water is suddenly brought to rest by closing the valve its momentum is destroyed which causes a very high pressure on the valve and walls on pipes is called water hammer	2	2	
6	~~In order to overcome water hammer problem, a storage reservoir is fitted at some opening made on the pipeline (or penstock) for control the pressure variations. and to regulate the flow of water retarding head of water~~	~~2~~	~~2~~	~~10~~
5	Uniform flow:- A flow in which the velocities of liquid particles at all section of a pipe or a channel are equal	1		
	Non uniform Channel:- A flow in which the velocities of liquid particles at all section of a pipe or channel are not equal.	1	2	10

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	PART- B			
II 1.	Atmospheric Pressure:- The ~~air~~ & atmospheric air exerts normal pressure upon all surfaces which is in contact and it is known as atmospheric pressure	2		
	gauge pressure:- when the pressure is measured either above or below atmospheric pressure it is called gauge pressure. pressure is measured by instruments called gauges	2		
	Absolute Pressure:- It is the algebraic sum of the gauge pressure and atmospheric pressure. Absolute pressure = gauge pr. + atmospheric pr.	2	6	
2.	orifice:- An orifice is an opening in the side of a vessel or a tank through which the liquid will flow out, in such a way that the liquid surface is always above the top edge of the opening. The opening may be in the side or in the bottom of the vessel. It is used to measure the rate of flow of the liquid	2		
	Types of orifices 1. According to size — Small orifice, Large orifice 2. According to shape - Circular, Rectangular, Triangular 3. According to shape of edge — Sharp edged, Square edged, Bell mouthed 4. According to nature of the discharge } - Fully submerged, partially submerged	4	6	
3.	Minor losses 1. Loss of head at entrance in a pipe $= \frac{0.5V^2}{2g}$ where V is the velocity of the liquid in the pipe	1½		
	2. Loss of head at exit of a pipe $= \frac{V^2}{2g}$	1½		
	3. Loss of head due to sudden enlargement $\frac{(V_1-V_2)^2}{2g}$ where V_1 = Velocity of section smaller section, V_2 = velocity of section larger section	1½		

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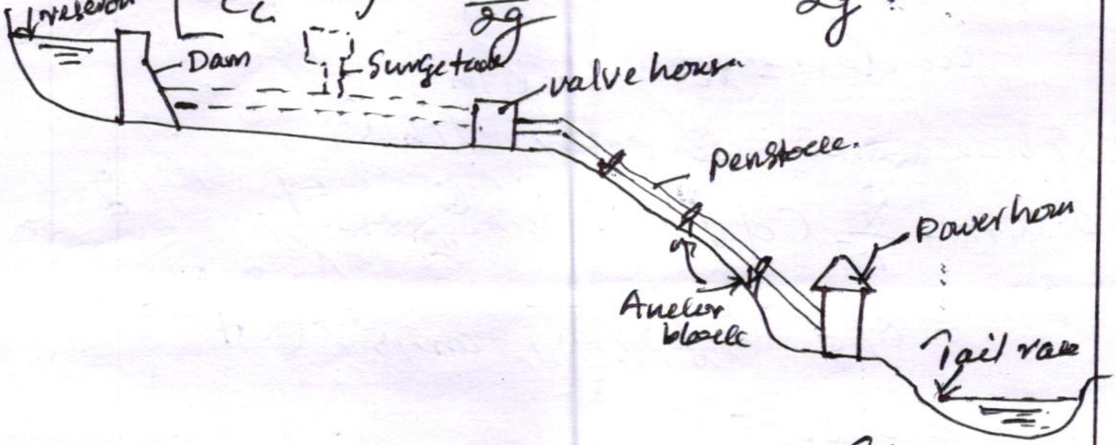
	Loss of head due to Sudden Contraction:- $= \left(\frac{1}{C_c} - 1\right)^2 \times \frac{V_2^2}{2g}$ $\quad C_c = \frac{0.5 V_2^2}{2g}$	1½	6	
4.				
	Sketch	3		
	Components	3	6	
5.	Given : $d = 1m$, $\bar{x} = 2m$, Sp. gravity of Sea water $= 1.03$	1		
	Sp. weight of Sea water $w = 9.81 \times 1.03 = 10.1\,kN/m^3$	1		
	Area of the Circular door $A = \pi/4\, d^2 = \pi/4\, 1^2 = 0.7854\,m^2$	2		
	Total pressure on the door $P = wA\bar{x} = 10.1 \times 0.7854 = 15.91\,kN$	2	6	
6	Given : diameter of the tank $D = 4m$, $H_1 = 5m$, diameter of the orifice $d = 400mm = 0.4m$, $H_2 = 2m$ and $Cd = 0.6$	1		
	Area of Circular tank $\pi/4\,(D^2) = \pi/4 \times 4^2 = 12.57\,m^2$	1		
	Area of the orifice $a = \pi/4 \times d^2 = \pi/4 \times 0.4^2 = 0.1257\,mm^2$	1		
	∴ Time taken to fall the Water level $T = \frac{2A(\sqrt{H_1} - \sqrt{H_2})}{Cd \cdot a \cdot \sqrt{2g}}$	1		
	$= \frac{2 \times 12.57 \times \sqrt{5} - \sqrt{2}}{0.6 \times 0.1257 \times \sqrt{2 \times 9.81}} = 61.9$ Seconds.	1	6	

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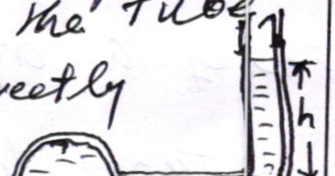
7	Given $Q = 280$ litres/min $= 0.28\ m^3/min$ $= 0.0047\ m^3/sec$	1		
	and $H = 100mm = 0.1m$			
	discharge over triangular notch Q			
	$0.0047 = \frac{8}{15} Cd \sqrt{2g} \tan\frac{\theta}{2} \times H^{5/2}$	2		
	$= 8/15\ Cd \sqrt{2 \times 981} \tan 45^\circ \times (0.1)^{5/2}$	2		
	$= 0.0075\ Cd$			
	$Cd = 0.007/0.0075 = 0.627$	1	6	
	PART-C Module-I			
III (a)	(i) Piezometer tube :- A Piezometer tube is the Simplest form of instrument, used for measuring moderate pressures. It consists of a tube, one end of which is connected to the pipeline in which the pressure is required to be found out. The other end is open to the atmosphere, in which the liquid can rise freely with out overflow. The height to which the liquid rises up in the tube gives the pressure head directly 	3		
	(ii) Manometer			
	Manometer is an improved form of a piezometer tube. used for measuring high pressures and negative pressures also			
	types :- Simple Manometer, Micro manometer,			

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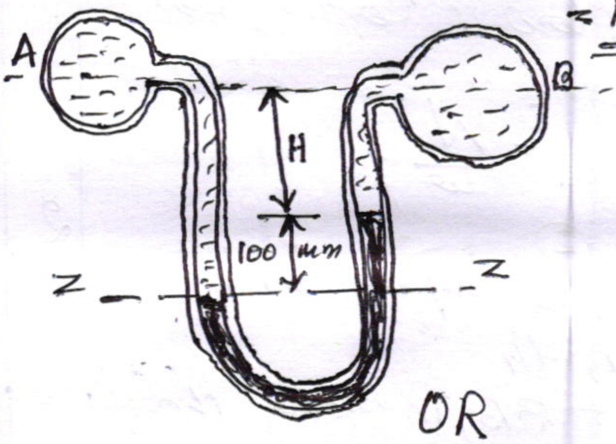
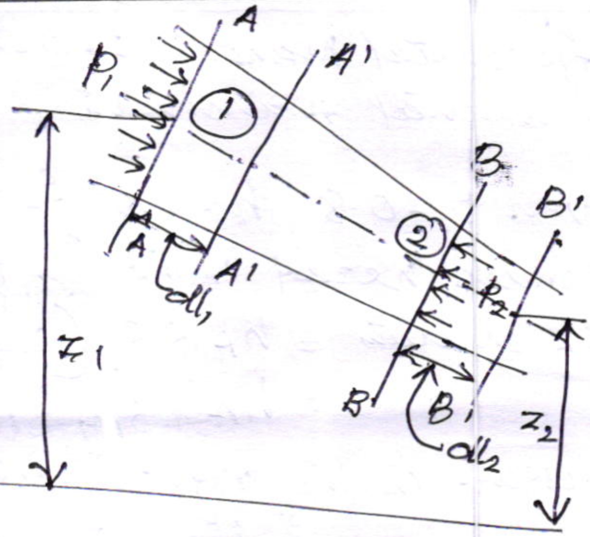
	Differential manometer, and inverted differential manometer	3	6	
III b	Given $S_1 = 0.8$ $h = 100$ $S_2 = 13.6$			
	Pressure head in the left limb above			
	z-z datum $= h_A + S_1(H+100)$ mm of water			
	$= h_A + S_1H + 100S_1$ mm of water —(1)	2		
	Pressure in the right limb above z-z			
	$= h_B + S_1H + S_2 \times 100$ mm of water —(2)	2		
	equating (1) and (2)			
	$h_A + S_1H + 100S_1 = h_B + S_1H + 100S_2$			
	$h_A - h_B = 100S_2 - 100S_1 = 100(S_2 - S_1) = 100(13.6 - 0.8)$	3		
	$= 1.28$ m of water			
	 fig.	2	9	15
	OR			
IV (a)	Assumptions and limitations of Bernoulli's theorem			
	1. The fluid is ideal and incompressible			
	2. The flow is steady and continuous			
	3. The flow is along a streamline ie it is one dimensional			
	4. The velocity is uniform over the section and is equal to mean velocity			
	5. No external force except the gravitational force is acting on the liquid			
	any 4 x 1½	6		

Qn No	Scoring Indicators	
IV (b)	Proof Consider a perfect incompressible fluid, flowing through a non-uniform pipe. Let z_1 = Height of AA above datum p_1 = Pressure at AA V_1 = Velocity of liquid at AA a_1 = Cross Sectional area of the pipe at AA and z_2, p_2, V_2, a_2 = Corresponding values of BB	3
	Let W be the weight of the liquid between AA and A'A' Since the flow is Continuous. $W = wa_1 dl_1 = wa_2 dl_2$ $a_1 dl_1 = \frac{W}{w}$ — (1) lly $a_2 dl_2 = \frac{W}{w}$ $\therefore a_1 dl_1 = a_2 dl_2$ — (2)	2
	Pressure at AA, in moving the liquid to A'A' = Force × Distance = $p_1 \cdot a_1 \cdot dl_1$ lly workdone by pressure at BB, in moving the liquid to B'B' = $-p_2 a_2 \cdot dl_2$ $\therefore$ Total work done by the pressure. $= p_1 a_1 \cdot dl_1 - p_2 a_2 \cdot dl_2$ $= p_1 a_1 dl_1 - p_2 \cdot a_1 dl_1$ $= a_1 dl_1 (p_1 - p_2) = \frac{W}{w}(p_1 - p_2)$	2
	Loss of potential energy $= W(z_1 - z_2)$ and gain in Kinetic energy $= W\left(\frac{V_2^2}{2g} - \frac{V_1^2}{2g}\right) = \frac{W}{2g}(V_2^2 - V_1^2)$ loss of potential energy + workdone by pressure = Gain in Kinetic energy	2



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	$\therefore W(z_1 - z_2) + \frac{W}{w}(p_1 - p_2) = \frac{W}{2g}(v_2^2 - v_1^2)$			
	$(z_1 - z_2) + \frac{p_1}{w} - \frac{p_2}{w} = \frac{v_2^2}{2g} - \frac{v_1^2}{2g}$			
	or $z_1 + \frac{v_1^2}{2g} + \frac{p_1}{w} = z_2 + \frac{v_2^2}{2g} + \frac{p_2}{w}$			
	$\therefore$ Potential energy + Pressure energy + Kinetic energy = Constant	2	9	15
	Module II			
V a	Co efficient of Contraction $C_c = \frac{\text{Area of jet at vena contracta}}{\text{Area of orifice}}$	2		
	Co efficient of Velocity $C_v = \frac{\text{Actual velocity of the jet at vena contracta}}{\text{theoretical velocity of the jet}}$	2		
	Co efficient of discharge $C_d = \frac{\text{Actual Velocity}}{\text{theoretical discharge}}$	2	6	
V (b)	Given $d = 60mm = 0.06m$, $H = 9m$, $Cd = 0.625$, and $C_v = 0.98$			
	area of the orifice $a = \pi/4 \times (d)^2 = \pi/4 \times (0.06)^2$ $= 2.83 \times 10^{-3} m^2$	1		
	theoretical discharge through the orifice $Q_{th} = a\sqrt{2gh} = 2.83 \times 10^{-3} \times \sqrt{2 \times 9.81 \times 9}$ $= 37.6 \times 10^{-3} m^3/sec$	2		
	Actual discharge through the orifice $Q_{ac} = Cd \cdot Q_{th} = 0.625 \times (37.6 \times 10^{-3}) m^3/sec$ $= 23.5 \times 10^{-3} m^3/s$ $= 23.5$ litres/sec	2		
	theoretical velocity of the jet at vena contracta $V_{th} = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 9} = 13.3 m/sec$	2		
	Actual velocity of the jet at vena contracta $V_{ac} = C_v \cdot V_{th} = 0.98 \times 13.3$ $= 13 m/sec$	2	9	15

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	OR			
VI a.	Types of mouth pieces.			
	1. According to the Position of the mouth piece. (a) Internal mouth piece (b) External mouth piece	2		
	2. According to the Shape of the mouth piece. (a) Cylindrical mouth piece (b) Convergent mouth piece (c) Convergent-divergent mouth piece	2		
	3. According to the nature of discharge (a) Mouthpiece running full (b) Mouth piece running free	2	6	
VI b.	Given $d_1 = 100mm = 0.1m$, $d_2 = 200mm = 0.2m$, and $Q = 60$ litres/sec. $= 0.06\ m^3/sec$	2		
	area of pipe section I $a_1 = \frac{\pi}{4}(d_1)^2 = \frac{\pi}{4}\times(0.1)^2 = 0.00785\ m^2$			
	lly section II $a_2 = \frac{\pi}{4}(d_2)^2 = \frac{\pi}{4}\times(0.2)^2 = 0.03142\ m^2$	2		
	∴ The velocity of water at section I $V_1 = \frac{Q}{a_1} = \frac{0.06}{0.00785} = 7.64$ m/sec			
	lly section II $V_2 = \frac{Q}{a_2} = \frac{0.06}{0.03142} = 1.91$ m/sec	2		
	loss of head due to sudden enlargement $h_e = \frac{(V_1-V_2)^2}{2g} = \frac{(7.64-1.91)^2}{2\times9.81} = 1.67m$	3	9	15
	Module III			
VII a.	Sometimes, a weir is provided in a stream or a river to measure the flow of water. In such a case, the water approaching the weir, has got			

Revision : 2015
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Course Code : 4011

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	Some velocity, Known as velocity of approach	3		
	Let A = Cross-sectional area of the channel on the upstream side of the weir; Q = Discharge over the weir; ∴ Velocity of approach $V = \frac{Q}{A}$	3	6	
VII b	Given L = 60m, H = 0.6m, Cd = 0.595 and A = 45 m^2	1		
	Maximum discharge over the weir without considering the velocity of approach $Q_{max} = 1.71\,Cd.L \times H^{3/2} = 1.71 \times 0.595 \times 60 \times 0.6^{3/2}$ $= 28.4\ m^3/sec$	2		
	Maximum discharge over the weir considering the velocity of approach $V = \frac{Q}{A} = \frac{28.4}{45} = 0.63\ m/sec$	1		
	The head due to velocity of approach $H_a = \frac{V^2}{2g} = \frac{(0.63)^2}{2 \times 9.81} = 0.02\ m$	2		
	total head $H_1 = H + H_a = 0.6 + 0.02 = 0.62\ m$. Max. discharge over the weir $Q = 1.71\,Cd.L\left(H_1^{3/2} - H_a^{3/2}\right)_{3/2}$ $= 1.71 \times 0.595 \times 60\,(0.62) - (0.02)^{2/3}$ $= 29.6\ m^3/sec$	3	9	15

Revision : 2015

Course : Hydraulics

Course Code : 40:11

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VIII @	OR			
	Given:			
	Length of the weir = 30m, Effective length			
	$L = (30 - 9 \times 0.6) = 24.6m$			
	No. of end contractions $n = 2 \times 10 = 20$			
	Head of water $H = 1m$	2		
	using Francis formula			
	$Q = 1.84\,(L - 0.1nH) \times H^{3/2}$	2		
	$= 1.84\,(24.6 - 0.1 \times 20 \times 1) \times 1^{3/2}$			
	$= 41.6\ m^3/sec$	2	6	
VIII b	Given Length of the weir = 20m.			
	$H = 0.7m$			
	Crest height = 0.6m			
	Total depth of water in the Channel = 1.3m			
	Cross sectional area of flow in the	2		
	Channel $A = 40 \times 1.3 = 52m^2$			
	Neglecting velocity of approach.			
	$Q_{max} = 1.705\ Cd \cdot L \cdot H^{3/2}$			
	$= 1.705 \times 0.95 \times 20 \times (0.7)^{3/2} = 18.92\ m^3/sec$	2		
	Velocity of approach $V_a = \frac{Q_{max}}{A} = \frac{18.92}{52} = 0.364\ m/sec$			
	Head due to velocity of approach			
	$h_a = \frac{V_a^2}{2g} = \frac{0.364^2}{2 \times 9.81} = 0.00675m$	2		
	Considering velocity of approach			
	$Q_{max} = 1.705 \times Cd \times L \left[(H + h_a)^{3/2} - (h_a)^{3/2}\right]$			
	$= 1.705 \times 0.95 \times 20 \left[(0.7 + 0.00675)^{3/2} - (0.00675)^{3/2}\right]$			
	$= 19.17\ m^3/sec$	3	9	15