TED (15) – 4011 Reg. No...

(REVISION — 2015) Signature ....

DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/ MANAGEMENT/COMMERCIAL PRACTICE — APRIL, 2018

HYDRAULICS

[*Time* : 3 hours

(Maximum marks : 100)

PART — A

(Maximum marks : 10)

Marks

I Answer *all* questions in one or two sentences. Each question carries 2 marks.

1. Define specific weight of liquid.
2. Define vena contracta.
3. Differentiate sharp crested and broad crested weir.
4. State the water hammer.
5. Differentiate uniform and non uniform flow. $(5\times2 = 10)$

PART — B

(Maximum marks : 30)

II Answer any *five* of the following questions. Each question carries 6 marks.

1. Discuss atmospheric pressure, gauge pressure and absolute pressure.
2. Define orifice and list the types of orifice.
3. Explain minor losses of head of water flowing through pipes.
4. Sketch a typical layout of hydro electrical power plant.
5. A circular door of 1 m diameter closes an opening in the vertical side of a bulk head, which retains sea water. If the centre of the opening is at a depth of 2m from the water level, determine the total pressure on the door. Take specific gravity of sea water as 1.03.
6. A circular water tank of 4m diameter contains 5m deep water. An orifice of 400 mm diameter is provided at its bottom. Find the time taken for water level to fall from 5m to 2m. Take Cd = 0.6.
7. During an experiment in a laboratory 280 litres of water flowing over a right angled triangular notch was collected in one minute. If the head of water over the sill is 100mm, calculate the coefficient discharge of the notch. $(5\times6 = 30)$

Marks

PART — C

(Maximum marks : 60)

(Answer *one* full question from each unit. Each full question carries 15 marks.)

UNIT — I

III (a) Explain (i) Piezometer tube (ii) Manometer 6

(b) A differential manometer connected at the two points A and B at the same level in a pipe containing an oil of specific gravity 0.8, shows a difference in mercury levels as 100 mm. Determine the difference in pressures at the two points. 9

OR

IV (a) Discuss the assumptions of Bernoulli's theorem. 6

(b) Derive the Bernoull's theorem of total energy of liquid in motion. 9

UNIT — II

V (a) State the following :

(i) Co-efficient of contraction

(ii) Co-efficient of velocity

(iii) Co-efficient of discharge 6

(b) A 60 mm diameter orifice is discharging water under a head of 9 meters. Calculate the actual discharge through the orifice in litres per second and actual velocity of the jet in meters per second at vena contracta, if Cd = 0.625 and Cv = 0.98. 9

OR

VI (a) Classify the types of mouth pieces. 6

(b) A pipe of 100 mm diameter is suddenly enlarged to 200 mm diameter. Find the loss of head, when the discharge is 60 litres/second. 9

UNIT — III

VII (a) Discuss velocity of approach. 6

(b) Determine the maximum discharge over a broad-crested weir 60 meters long having 0.6 m height of water above its crest. Take co-efficient of discharge as 0.595. Also determine the new discharge over the weir, considering the velocity of approach. The channel at the upstream side of the weir has a cross sectional area of 45 square meters. 9

OR

VIII (a) A weir 30m long is divided into 10 equal spans by vertical posts each 0.6m wide. Using Francis formula, calculate the discharge over the weir under an effective head 1 meter. 6

Marks

(b) Determine the discharge over a broad crested weir 20m long with ahead of 0.7m over the crest. Cd = 0.95. The width of approach channel is 40m and its depth below the crest of weir is 0.6m. 9

UNIT — IV

IX (a) A 2 km long water main has to carry a discharge of 0.5 m^3/sec. If the maximum allowable loss of head due to friction is 25m, find the minimum diameter required. Use Darcy's equation assume f = 0.008, neglect minor losses. 6

(b) A water flowing through a pipe 1.5 km long and 1 m diameter with a velocity of 1 m/sec. Find the head lost due to friction using Chezy's formula. Take C = 64. 9

OR

X (a) A most economical trapezoidal channel has an area of flow 3.5m^2. Find the discharge in the channel when running 1 m deep. Take C = 60 and bed slope 1 in 800. 6

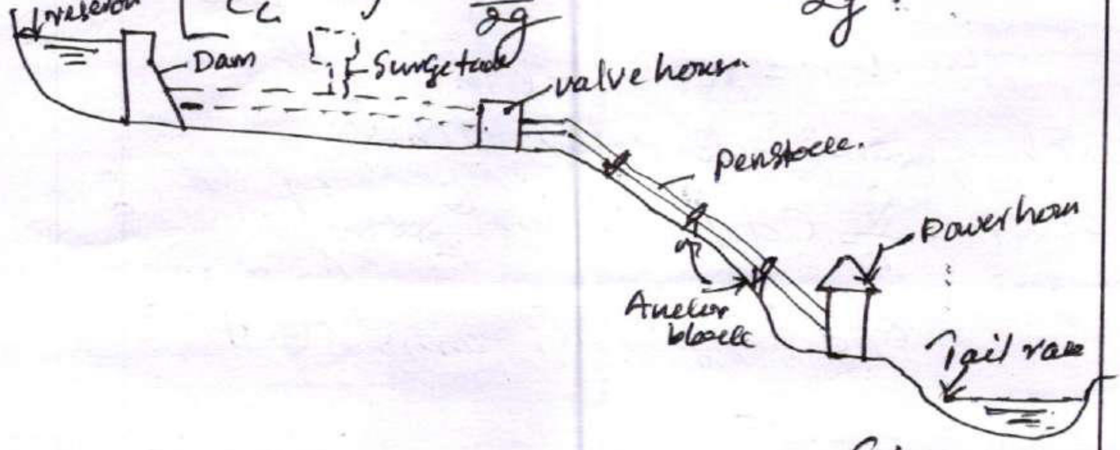
(b) Determine the dimensions of the trapezoidal channel of the most economical section to carry a discharge of 6 cumecs at a velocity of 1.6 m/sec. The side slopes of channels are ½ horizontal to 1 vertical. If the chezy's constant C = 60, what is the bed fall per km length of the channel ? 9

Revision (2015) SCHEME OF VALUATION SCORING INDICATORS

Course : Hydraulics P 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 problems, 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

Qn No	Scoring Indicator	Split up Score	Sub Total	Total
	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		

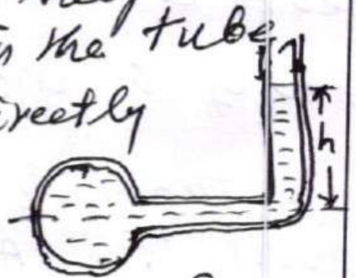
Qn No	Scoring Indicator	Split of Score	Sub Total	Total
	Loss of head due to Sudden Contraction:- $= \left(\frac{1}{C_c} - 1\right)^2 \times \frac{V_2^2}{2g}$ $C_c = \frac{0.5 V_2^2}{2g}$	1½	6	
4.	 Sketch	3		
	Components	3	6	
5.	Given : $d = 1m$, $\bar{x} = 2m$, Sp. gravity of Sea water $= 1.03$	1		
	Sp. weight of Sea water $\cdot w = 9.81 \times 1.03 = 10.1 KN/m^3$	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	

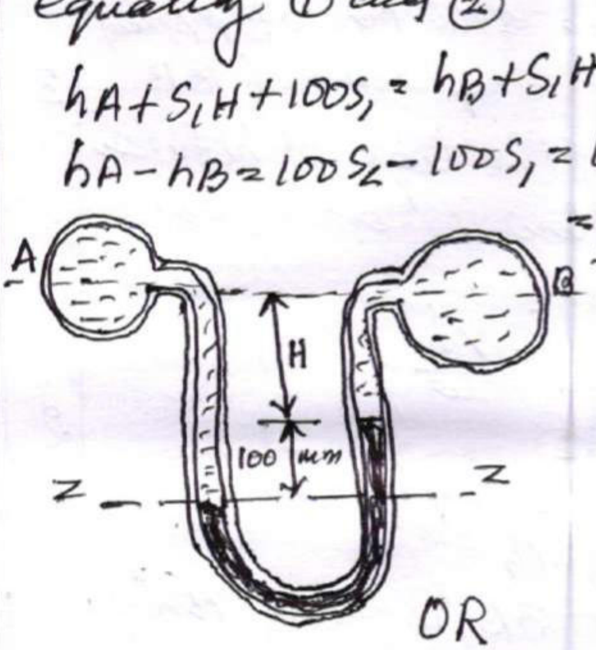
Revision : 2015

Course : hydraulics -A- Course Code : 4011

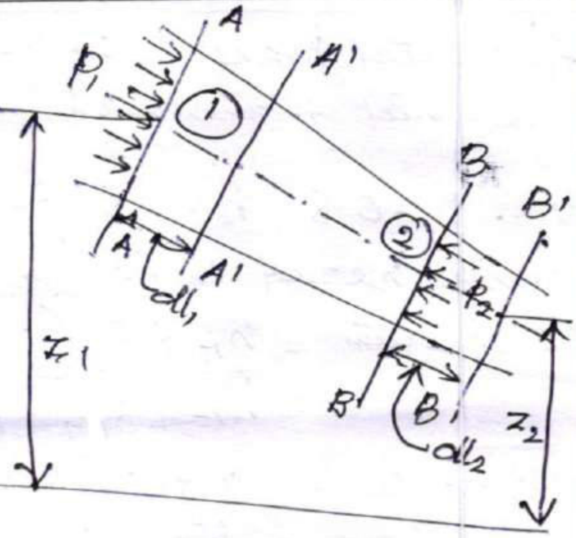
Qn. No	Scoring Indicators	Split up Score	Sub Total	Total
7	Given $Q = 280$ litres/min $= 0.28\ m^3/min$ $= 0.0047\ m^3/sec$	1		
	and $H = 100mm = 0.1m$			
	discharge over triangular notch Q			
	$0.0047 = \frac{8}{15} Cd \sqrt{2g} \tan\frac{\theta}{2} \times H^{5/2}$	2		
	$= 8/15\ Cd \sqrt{2 \times 981} \tan 45^\circ \times (0.1)^{5/2}$	2		
	$= 0.0075\ Cd$			
	$Cd = 0.007/0.0075 = 0.627$	1	6	

PART-C Module-I

Qn. No	Scoring Indicators	Split up Score	Sub Total	Total
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 without 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, Micromanometer,			

Qn NO	Scoring Indicators	Split up score	Sub Total	Total
	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			
	$= h_A + S_1 H + 100 S_1$ mm of water ①	2		
	Pressure in the right limb above Z-Z			
	$= h_B + S_1 H + S_2 \times 100$ mm of water ②	2		
	equating ① and ②			
	$h_A + S_1 H + 100 S_1 = h_B + S_1 H + 100 S_2$			
	$h_A - h_B = 100 S_2 - 100 S_1 = 100(S_2 - S_1) = 100(13.6 - 0.8)$	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	Proof	
(b)	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.

$W = w a_1 dl_1 = w a_2 dl_2$

$a_1 dl_1 = \frac{W}{w}$ — 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'

$= \text{Force} \times \text{Distance} = p_1 . a_1 . dl_1$

lly workdone by pressure at BB, in moving the liquid to B'B' $= -p_2 a_2 . dl_2$

$\therefore$ Total work done by the pressure.

$= p_1 a_1 . dl_1 - p_2 a_2 . dl_2$

$= p_1 a_1 dl_1 - p_2 . a_1 dl_1$

$= a_1 dl_1 (p_1 - p_2) = \frac{W}{w}(p_1 - p_2)$ — 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

Qn No.	Scoring Indicators	Split up Score	Sub Total	Total
	$\therefore W(z_1-z_2)+\frac{W}{w}(p_1-p_2)=\frac{W}{2g}(v_2^2-v_1^2)$			
	$(z_1-z_2)+\frac{p_1}{2}-\frac{p_2}{w}=\frac{v_2^2}{2g}-\frac{v_1^2}{2g}$			
	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	Coefficient of Contraction $C_c=\frac{\text{Area of jet at vena contracta}}{\text{Area of orifice}}$	2		
	Coefficient of Velocity $C_v=\frac{\text{Actual velocity of the jet at vena contracta}}{\text{theoretical velocity of the jet}}$	2		
	Coefficient 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 $a=\pi/4\times(d)^2=\pi/4\times(0.06)^2$ $=2.83\times10^{-3}m^2$	1		
	theoretical discharge through the orifice $Q_{th}=a\sqrt{2gh}=2.83\times10^{-3}\times\sqrt{2\times9.81\times9}$ $=37.6\times10^{-3}m^3/sec$	2		
	Actual discharge through the orifice $Q_{ac}=C_d.Q_{th}=0.625\times(37.6\times10^{-3})m^3/sec$ $=23.5\times10^{-3}m^3/s$ $=23.5$ litres/sec.	2		
	theoretical velocity of the jet at vena contracta $V_{th}=\sqrt{2gh}=\sqrt{2\times9.81\times9}=13.3m/sec$	2		
	Actual velocity of the jet at vena contracta $V_{ac}=C_v.V_{th}=0.98\times13.3$ $=13\ m/sec$	2	9	15

Qn. No	Scoring Indicators	Split up score	Sub Total	Total
VI a	OR Types of mouth piece.			
	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 $a_1 = \pi/4 \times (d_1)^2 = \pi/4 \times (0.1)^2 = 0.00785\ m^2$ lly section II $a_2 = \pi/4 \times (d_2)^2 = \pi/4 \times (0.2)^2 = 0.03142\ m^2$	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 $h_e = \frac{(V_1 - V_2)^2}{2g} = \frac{(7.64 - 1.91)^2}{2 \times 9.81} = 1.67m$	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
Course : hydraulics

Course Code : 4011

Qn NO	Scoring Indicators	Split up Score	Sub Total	Total
	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			
	$Q = 1.71\ Cd.L\ (H_1^{3/2} - H_a^{3/2})_{3/2}$			
	$= 1.71 \times 0.595 \times 60\ (0.62) - (0.02)^{2/3}$			
	$= 29.6\ m^3/sec$	3	9	15

Revision : 2015 | Course Code : 40:11
Course : Hydraulics

Qn No	Scoring Indicators	Split up Score	Sub Total	Total
VIII (a)	OR Given. Length of the weir = 30m, Effective length $L = (30 - 9\times0.6) = 24.6m$ No. of end Contractions $n = 2\times10 = 20$ Head of water $H = 1m$	2		
	Using Francis formula $Q = 1.84 (L - 0.1nH) \times H^{3/2}$	2		
	$= 1.84 (24.6 - 0.1\times20\times1) \times 1^{3/2}$ $= 41.6\ m^3/sec$	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 Channel $A = 40\times1.3 = 52m^2$	2		
	Neglecting velocity of approach. $Q_{max} = 1.705\ Cd \cdot L \cdot H^{3/2}$ $= 1.705\times0.95\times20\times(0.7)^{3/2} = 18.92\ m^3/sec$	2		
	Velocity of approach $V_a = \frac{Q_{max}}{A} = \frac{18.92}{52} = 0.364\ m/sec$ Head due to velocity of approach $h_a = \frac{V_a^2}{2g} = \frac{0.364^2}{2\times9.81} = 0.00675m$	2		
	Considering velocity of approach $Q_{max} = 1.705\times Cd\times L\left[(H+h_a)^{3/2} - (h_a)^{3/2}\right]$ $= 1.705\times0.95\times20\left[(0.7+0.00675)^{3/2} - (0.00675)^{3/2}\right]$ $= 19.17\ m^3/sec$	3	9	15

Qn No	Scoring Indicators	Split up score	Sub Total	Total
	Module - IV			
IX a	Given length $l = 2$ Km or 2000m Discharge $Q = 0.5\ m^3/sec$ $h_f = 25m$ $f = 0.008$	1		
	If 'd' is the diameter of the pipe $v = \frac{Q}{A} = \frac{Q}{\frac{\pi}{4}d^2} = \frac{4Q}{\pi d^2}$			
	$h_f = \frac{4flv^2}{2gd}$ (Darcy's Equation)	2		
	$25 = \frac{4 \times 0.008 \times 2000}{2 \times 9.81 \times d}\left(\frac{4Q}{\pi d^2}\right)^2$	1		
	$25 = \frac{4 \times 0.008 \times 2000 \times 16 \times (0.5)^2}{2 \times 9.81 \times \pi^2 \times d^5}$ $d^5 = 0.053$ $d = \underline{0.555\ m}$	2	6	
IX b	Given $l = 1.5$ KM $= 1500$ m. Chezy's Constant $C = 64$ $d = 1m$.	2		
	Hydraulic mean depth $m = \frac{d}{4} = \frac{1}{4} = 0.25$ Loss of head per unit length $i = \frac{h_f}{l} = \frac{h_f}{1500}$	3		
	Using Chezy's formula $v = C\sqrt{mi}$ $v = 1m/sec$	3		
	$1 = 64 \times \sqrt{0.25 \times \frac{h_f}{1500}}$ $0.015625 = \sqrt{\frac{0.25 \times h_f}{1500}}$ $h_f = \underline{1.46m}$	1	9	15

Revision : 2015
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Qn No.	Scoring Indicators	Split up Score	Sub Total	Total
X (a)	OR Given $A = 3.5m^2$, $d = 1m$, $C = 60$ and $i = 1/800$	2		
	most economical trapezoidal channel the hydraulic mean depth $m = \frac{d}{2} = 1/2 = 0.5m$.	2		
	discharge in the channel $Q = A \cdot C \cdot \sqrt{mi}$ $= 3.5 \times 60 \sqrt{0.5 \times \frac{1}{800}}\ m^3/s$ $= 210 \times 0.025 = 5.25\ m^3/sec$	2	6	
X b	Given Discharge $Q = 6m^3/Sec$ Velocity $v = 1.6m/Sec$ Side Slope $n = 1/2$ Chezy's Constant $= 60$	2		
	For most economical Section $\frac{(b+2nd)}{2} = d\sqrt{(0.5)^2+1}$ $b = 1.24d$	2		
	Area of flow $= (b+nd)d$ $= (1.24d + 0.5d) \times d$ $= 1.74d^2$	2		
	Discharge $Q = A \times v$ $6 = 1.74d^2 \times 1.6$ $d = 1.47m$ $b = 1.24d$ $= 1.24 \times 1.47$ $b = 1.82m$			

Qn No.	Scoring Indicators	Split up Score	Sub Total	Total
	using Chezy's equation $V = C\sqrt{mi}$			
	$1.6 = 60 \times \sqrt{\frac{1.47}{2} \times i}$ $\left(m = \frac{d}{2} = \frac{1.47}{2}\right)$			
	$i = 9.67 \times 10^{-4}$	3		
	Bed fall per Km. length of Channel = 0.97m		9	15