04/2017

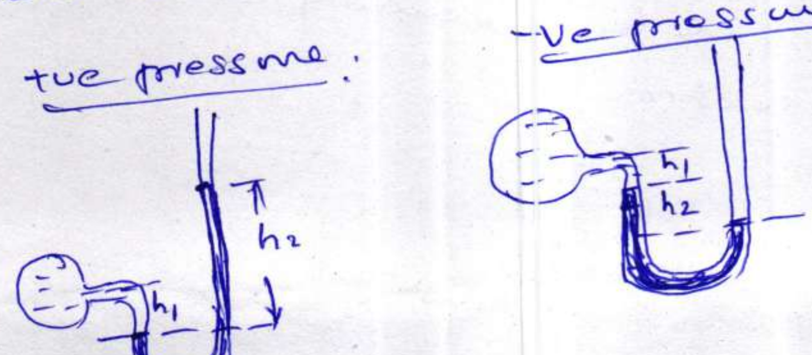
Code : A011(15)

Scoring Indicators

Version: A C

Qn. No.	Scoring Indicators	Split score	Total score
I	PART A		
1.	$p = \frac{P}{A}$ force / unit area. $p = wh$. pressure head $h = \frac{p}{w}$.	1+1	2
2.	velocity with which water reaches are below the vena contracta / the jet of water.	2	2
3.	$C_d = C_v \times C_c$.	2	2
	$\frac{\text{Actual dis.}}{\text{Theoretical Dis}} = \frac{\text{Act Velo} \times \text{Act Area}}{\text{Theo Velo.} \times \text{Th Area}} = \frac{V_A}{V_{th}} \times \frac{A_A}{A_{th}} = C_v \times C_c$.	2	2
4.	entrance $\frac{0.5V^2}{2g}$. exit $-\frac{V^2}{2g}$.	1+1	2
	5. a) Permits a -ve or suction head to be established at the runner exit - thus making possible placing of wheel & connecting machinery. b) Reduce the velocity of water discharging by turbine by gradually enlarging cross-section.		

Code : Version: A

Qn. No.	Scoring Indicators	Split score	Total score
4	PART B.		
	1. Atmosphe pressure – Due to the wt of air exerts some pressure on the surface of earth. at sea level pressure exerted by 1 m² cross-sectional area and of ht equal to that of atmosphere is 103 KN. Atmospheric pressure at sea level – 103 kN/m², 103 kPa or 10.3 m of water. Gauge pressure – pressure measured by a pressure measuring instrument	3.	
	Absolute pressure = Atmospheric pressure + Gauge pressure. If the pressure intensity less than atmospheric pressure, Difference of these two called of -ve gauge pressure or Vaccume pressure.	3	
		3+3.	6.
	(2). +ve pressure. -ve pressure. 		

(2).

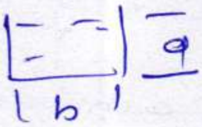
Scoring Indicators

Code : **Version:** A

Qn. No.	Scoring Indicators	Split score	Total score
	(3). Centrifugal — Reciprocating.		
	1 Simple - less parts — Complicated more parts.		
	2. wt is less for given discharge — wt is more.		
	3. Suitable for large discharge and small head — less discharge high head.		
	4. less wear & tear — more		
	5 maintainance cost less — more		
	6. can run at high speed — Cannot	6×1.	6.
	7. " handle directly — Cannot		
	8. Delivery continuous — pulsating.		
	9. No air vessels required — Air vessel required.		
	10 Need priming — Does no need		
	11. less efficient — more efficient		
	(4). $Q = \frac{8}{15} C_d \sqrt{2g} \tan \theta/2 \times H^{5/2}$.	— 2	
	① Only one reading ie (H) is required to measure discharge		
	② If $\theta = 90^\circ$ - formula simple	4	

Code :

Version:

Qn. No.	Scoring Indicators	Split score	Total score
	3. give more accurate result.		4+2
	4. Same triangular notch can measure wide range of flow accuratly.		6.
4.	Kutter formula. $C = \dfrac{23 + \frac{0.00155}{i} + \frac{1}{N}}{1 + \left[23 + \frac{0.00155}{i}\right] \times \frac{N}{\sqrt{m}}}$ 4 2 Manning formula $C = \frac{1}{N} \times m^{1/6}$	4+2	6.
6.	channel which gives maximum discharge for a given cross-section area and bed slop. Rectgular section –  $Q = A \times V$ $Q = AC\sqrt{mi}$ $= AC\sqrt{\frac{A}{P} \times i}$ $\quad \frac{dP}{dd} = 0$ $P = b + 2d = \frac{A}{d} + 2d$ Differenticite with respect to d. equal to zero. $\frac{dP}{dd} = -\frac{A}{d^2} + 2 = 0$.		

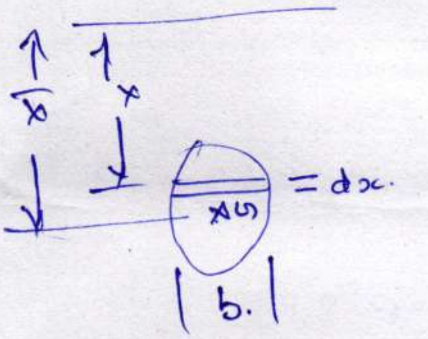
Scoring Indicators

Code : **Version:** A.

Qn. No.	Scoring Indicators	Split score	Total score
	$\frac{-A}{d^2} + 2 = 0$.		
	$A = 2d^2 \quad bd = 2d^2$		
	∴ breadth = double the depth.		
	$\underline{b = 2d}$..		
	In this case $m = \frac{A}{P} = \frac{bd}{b+2d}$		
	$= \frac{2d \times d}{2d+2d} = \frac{2d^2}{4d} = \frac{d}{2}$.		
	∴ For rectangular section		
	$\underline{b = 2d \text{ and } m = \frac{d}{2}}$.		
	PART C.		
UNIT I III(a)	a. Total pressure = Total pressure exerted by liquid on it. $P = p_1a_1 + p_2a_2 + p_3a_3 \ldots$	2	
	Centre of pressure — The point through which the resultant pressure acts.	2	

Code : **Version:** A

Qn. No.	Scoring Indicators	Split score	Total score
	(see below)	3.	7.



p = Intensity of pressure × Area

= wx × b dx.

$P = \int wx \cdot b\,dx$

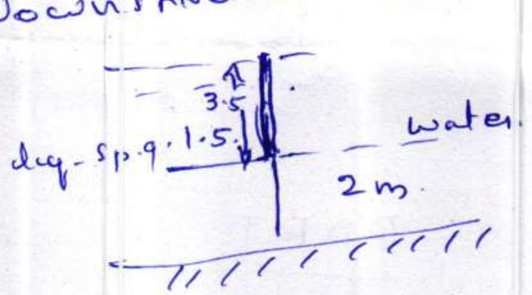
$= w\int x\, b\,dx$

$= wA\bar{x}$

III (b). width = 4 m depth of gate = 2 m. sp.g. liq = 1.5

Height of liquid above the top of gate on upstream side = 3.5 m.

Ht of water on downstream sid = 2 m.



$A = 4 \times 2 = 8\ m^2$.

upstream side →

C.G of the gate from liquid level.

$\bar{x}_1 = 3.5 + 1 = 4.5\ m$.

Downstream side

C.G. of gate from water surface.

$\bar{x}_2 = 1.0\ m$.

Pressure on upstream side $= w_1 A \bar{x}_1$

$= 1.5 \times 9.81 \times 8 \times 4.5$

$= \underline{529.7\ kN}$.

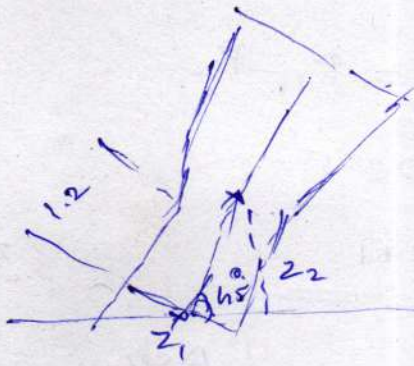
(A).

Scoring Indicators

Code : **Version:** A.

Qn. No.	Scoring Indicators	Split score	Total score
	Pressure on down stream side by water. $P_2 = w_2 A \bar{x}_2$. $= 9.81 \times 8 \times 1.0 = 78.5$ kN. Resultant pressure acting $= P_1 - P_2$ $= 529.7 - 78.5$. $= 451.2$ KN.	3.	
	Point at which Resultant pressure Acts. $\bar{h}$ - Depth of centre of Resultant pr. $I_G = \frac{bd^3}{12} = \frac{4 \times 2^3}{12} = 2.67\ m^4$. from liquid surface $\bar{h}_1 = \frac{I_G}{A\bar{x}_1} - \bar{x}_1$ $= \frac{2.67}{8 \times 4.5} + 4.5 = 4.574$ m.		3+3+2 (8)
	$\bar{h}_2 = \frac{I_G}{A\bar{x}_2} + \bar{x}_2 = \frac{2.67}{8 \times 1} + 1$ ~~= 4.574m~~ $= 1.334$ m.	3.	
	$\therefore P\bar{h} = P_1(4.574 - 3.5) - P_2 \times 1.334$. $451.2 \times \bar{h} = 529.7 \times 1.074 - (78.5 \times 1.334)$ $\bar{h} = 1.03$ m.	2.	

Code : Version:

Qn. No.	Scoring Indicators	Split score	Total score
IV a.	Bernoulli equation	5	(7)
	$Z + \frac{P_1}{\omega} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\omega} + \frac{V_2^2}{2g}$.	2.	
IV b.			
	$Z_1 = 0$ $Z_2 = 1.2 \sin 45°$. $= 0.848\,m$	2.	
	Deflection $= 0.175\,mm$. $h = 0.175\left[\frac{13.6}{1} - 1\right]$. $= 2.205\,m$.	180	
	$Q = \frac{Cd \cdot a_1 a_2 \times \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$.		
	$Cd = 0.95$. $a_1 = \pi/4 \times 0.15^2 = 0.01767$. $a_2 = \pi/4 \times 0.075^2 = 0.00441$.		
	$Q = \frac{0.95 \times 0.0176 \times 0.00441 \times \sqrt{2 \times 9.81 \times 2.205}}{\sqrt{0.0176^2 - 0.0044^2}}$.	4	
	$= \frac{0.0000737 \times 6.577}{0.0170} = 0.0285\,m/s$. $= 28.5\,lit/s$.	1	
		2+1+4+1 ~~2+1+4~~+1	8.

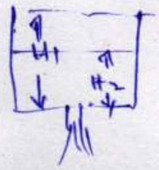
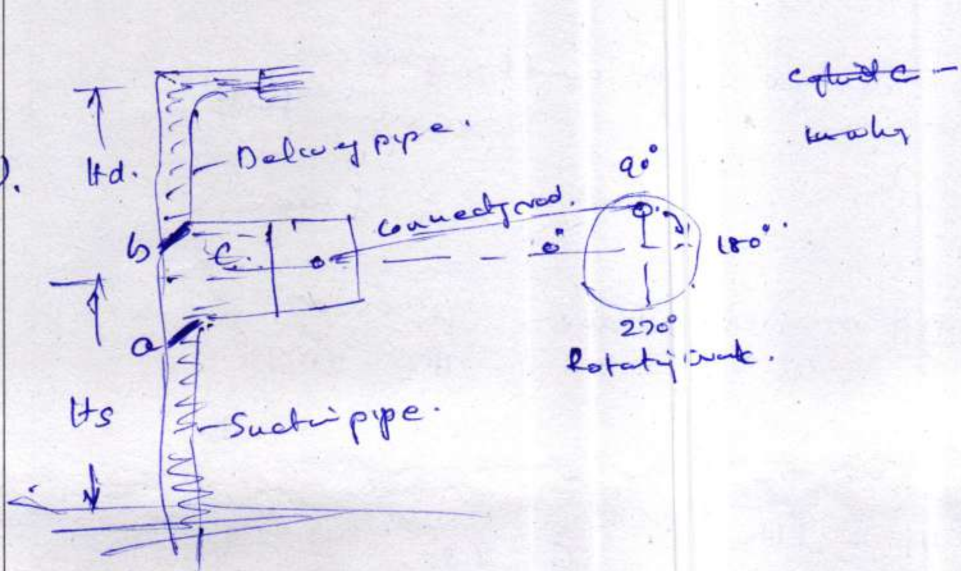
(5)

Scoring Indicators

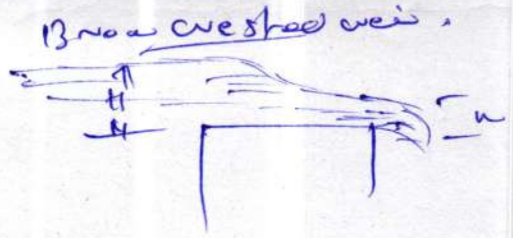
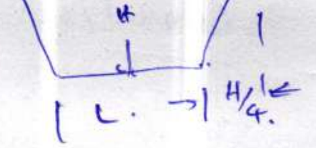
Code : **Version:**

Qn. No.	Scoring Indicators	Split score	Total score
UNIT V			
Va.	According to shape		
	Orifices – Sharp Circular Orifice		
	(opening in vessel) Rectangular any 2.	4 $3\frac{1}{2}$	
	Triangular.		
	Accord to Discharge – Fully submerged		
	Partially Submerged.		
	Mouth piece:		8
	(pipe with length more than 2 times the dia of orifice fitted to orifice is mouth pieces).		
	According to shape – Cylindrical		
	Convergent Any 2.	4 $3\frac{1}{2}$.	
	Convergent-divergent.		
	According to Discharge – Mouth piece running full and running free.		
Vb.	$D = 4m$ $H_1 = 5m$. $d = 400mm$ $H_1 = 5m$ $H_2 = 2m$.		
	$A = 12.57 m^2$	2	7
	$a = 0.1257 m^2$.		
	$T = \frac{2A(\sqrt{H_1} - \sqrt{H_2})}{Cd \cdot a \cdot \sqrt{2g}} = 61.9s$.	5	

Code : **Version:** A.

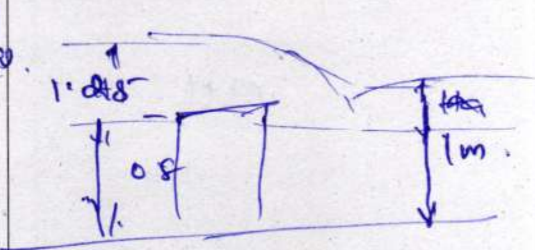
Qn. No.	Scoring Indicators	Split score	Total score
VI(a)	 $v = \sqrt{2gh}$. $dq = A \times -dh = -A\,dh$. $dq = Cd \cdot a\sqrt{2gh} \cdot dt$. $-A\,dh = Cd \cdot a\sqrt{2gh} \cdot dt$. $dt = \frac{-A\,dh}{Cd \cdot a\sqrt{2gh}}$ $= \frac{-A\,(h^{-1/2})\,dh}{Cd\;a\sqrt{2g}}$ $\therefore T = \int_{H_1}^{H_2} \frac{-A\,(h^{-1/2})\,dh}{Cd \cdot a\sqrt{2g}}$ $T = \frac{2A\,(\sqrt{H_1} - \sqrt{H_2})}{Cd \cdot a\sqrt{2g}}$	3 3 1.	3+3+1	7.
VI(b).		3	

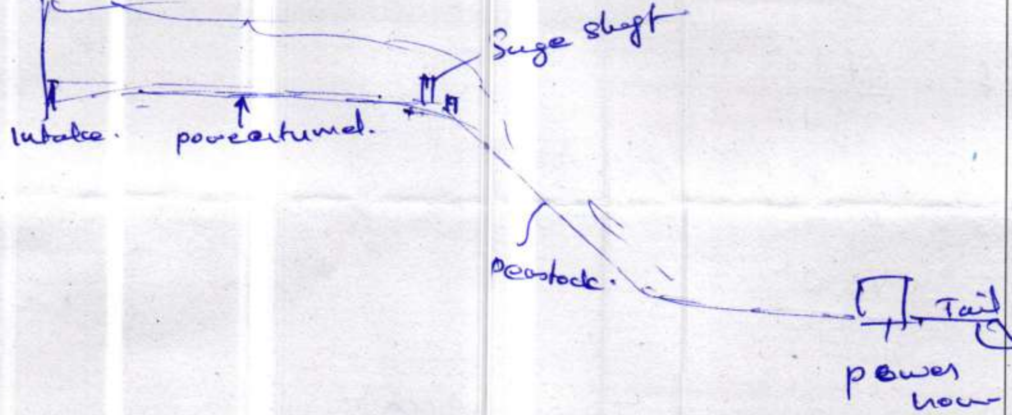
Code :   Version: A

Qn. No.	Scoring Indicators	Split score	Total score
	1 Cylinder C — where a piston P. works. 2 Suction pipe — Connecting source of water and the cylinder. 3 Delivery pipe — Discharge water. 4 Valve a — admits flow from suction pipe to cylinder 5 Valve b — admits flow from cylinder to delivery pipe.	5	5+3 8
UNIT III			
VII a.	Narrow.  Broad crested weir.  Submerged.  Cippoletti  eg. Side slope of 1 horizontal to 4 vertical	3×2+1 1. 6+1	7.

Scoring Indicators

Code : **Version:** A

Qn. No.	Scoring Indicators	Split score	Total score
VII 6.	$Q_{weir} = 1.71\ C_d\ L\ H^{3/2}$ $= 1.71 \times 0.59 \times 60 \times 0.6^{3/2}$ $= 28.4\ m^3/s$	3	
	Consi Velocity Approach. $V = \frac{Q}{A} = \frac{28.4}{45}$ $= 0.63\ m/s$ $H_a = \frac{V^2}{2g} = \frac{0.63^2}{2 \times 9.81} = 0.02\ m$	2	3+2+3
	$H_1 = H + H_a = 0.6 + 0.02$ $= 0.62\ m$		8
	max discharge $= 1.71 \times 0.59 \times 60 (0.62)^{3/2} - (0.02)^{3/2}$ $= 29.6\ m^3/s$	3	
VIII (a).	 $L = 3\ m \quad C_d = 0.6$ $H_1 = 1.25 - 0.8 = 0.45\ m$ $H_2 = 1 - 0.8 = 0.2\ m$	1	
	$Q_1 = \frac{2}{3} \times C_d \times L \sqrt{2g}\ (H_1 - H_2)^{3/2}$ $= 2/3 \times 0.6 \times 3 \sqrt{2 \times 9.81}\ (0.45 - 0.20)^{3/2}$ $= 664\ lit/s$	2+1 3	1+3+3 7
	$Q_2 = C_d \cdot L \cdot H_2 \sqrt{2g\,(H_1 - H_2)}$ $= 0.6 \times 3 \times 0.2 \sqrt{2 \times 9.81 (0.45 - 0.2)}\ m^3/s = 797\ lit/sec$ Total $Q = Q_1 + Q_2 = 664 + 797 = 1461\ lit/sec$	2+1 3	

Qn. No.	Scoring Indicators	Split score	Total score
VII(b).			
	Intake – take water from source. Screen the water.		
	Surgetank → will store extra water. Supply extra water. reduce waterhammer effect.		
	Penstock – Increase the pressure	4.	8
	powerhouse – fixing, provide, Machines & Arrangements.		
	Draft tube – create –ve, suction. reduce the pressure of discharge water by gradual increase the Dimension		
UNIT IV.			
IX. a)	Darcy's formula. $h_f = \frac{P_1}{w} - \frac{P_2}{w} = \frac{\text{Friction resistance}}{A\,w}$	2.	
	$h_f = \frac{\text{Frictional Resistance}}{\frac{\pi}{4} d^2 \times w} = \frac{f' \times \pi d l \times v^2}{\frac{\pi}{4} \times d^2 \times w}$	2.	

$= \frac{4 f' l v^2}{w d}$, $f' = \frac{f w}{2g}$.

Scoring Indicators

Code : **Version:**

Qn. No.	Scoring Indicators	Split score	Total score
	$hf = \frac{4fl v^2}{2gd}$. $Q = \frac{\pi}{4} d^2 \times v$ $v = \frac{4Q}{\pi d^2}$ $v^2 = \frac{16Q^2}{\pi^2 d^4}$. $hf = \frac{4fl}{2g} \times \frac{16 Q^2}{\pi^2 d^4} = \frac{flQ^2}{3d^5}$.	3 2+2+3	7.
4(b)	① Uniform flow - Velocity at all section are equal non uniform - " " not equal. ② Laminar flow - particle have definit path and not cross each other. Eg: Turbulent flow - not have definit path. cross each other. ③ Hydraulic gradient - pressure head (P/w). plotted as vertical ordinate on centre line of pipe. Total energy - sum of pressure head & velocity head $\left[\frac{P}{w} + \frac{v^2}{2g} \right)$.	(3×2)+1	

IX b. $l = 3\,km \quad 300\,m \qquad d = 200\,mm = 0.2\,m$

$p = 1500\,kpa. \quad f = 0.01.$

Q

Pressure head at the power station

$$H = \frac{p}{w} = \frac{1500}{9.81} = 153\,m. \quad (2)$$

For max power transmission head loss due to friction $h_f = \frac{H}{3}$. (1)

$$= \frac{153}{3} = 51\,m.$$

$$h_f = \frac{flQ^2}{3d^5} = \frac{0.01 \times 3000 \times Q^2}{3 \times 0.2^5} = 51$$

2+1+4+1 8.

$$= 312500\,Q^2$$

$$Q^2 = \frac{51}{312500} = 0.04\,m^3/s. \quad (4)$$

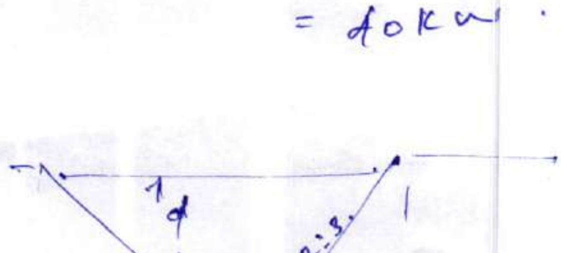
Maximum power that can be transmitted

$$= \omega Q(H - h_f)$$

$$= 9.81 \times 0.04 (153 - 51) \quad (1)$$

$$= 40\,kW.$$

X b.



Side slop = $3/2$

$Q = 20\,m^3/s.$

$i = 1/1200.$

$N = 0.01.$

2

$$\frac{b + 2nd}{2} = d\sqrt{n^2+1} = d\sqrt{1.5^2+1} = 1.8d.$$

$$A = d[0.6d + 1.5d] = 2.1d^2.$$

$$Q = A \times \frac{1}{N} m^{2/3} \ldots$$

3. 7.

$$= 2.1d^2 \times \frac{1}{0.01} \times \left(\frac{d}{2}\right)^{2/3} \times 0.0005^{1/2}.$$

$$= 2.96\,d^{8/3} \qquad d = 2.05\,m \quad b = 1.23\,m$$

2.

2+3+2.