

**DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/
MANAGEMENT/COMMERCIAL PRACTICE — APRIL, 2019**

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 gravity and specific weight.
2. Distinguish between simple manometer and differential manometer.
3. Name the types of energy of a liquid in motion. Write their relation.
4. Define End contraction.
5. List the main components of hydro electric power plant.

(5×2 = 10)

PART — B

(Maximum marks : 30)

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

1. An isosceles triangular plate of base 3 metres and altitude 3 metre is immersed vertically in an oil of specific gravity 0.8. Determine the total pressure and centre of pressure of the plate.
2. Derive an expression for finding discharge through a venturimeter.
3. A swimming pool 10 metres long and 6 metres wide holds water to a depth of 1.80 metres. If the water is discharged through an opening at the bottom of the pool of an area 0.15 square metre, find the time taken to empty the pool.
4. With the help of a neat sketch, describe the working of jet pump.
5. Discuss the advantages of triangular notch over rectangular notch.
6. Explain the term end contraction, discuss the effect of it over discharge.
7. Explain about water hammer and its effects.

(5×6 = 30)

PART — C

(Maximum marks : 60)

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

UNIT — I

- III (a) Explain the types of flow of fluid. 6
- (b) An inverted U-tube manometer is connected with two pipes which carries an oil of specific gravity 1.2 and 0.8 respectively. The fluid in the manometer is an oil of specific gravity 0.7. Find the pressure difference between pipes. 9

OR

- IV (a) Derive an equation for total pressure and centre of pressure of an inclined Plane surface submerged in liquid. 9
- (b) A sub-marine moves horizontally in sea and has its axis 15m below the surface of water. A pitot tube properly placed just in front of the sub-marine and along its axis is connected to the two limbs of a U-tube containing mercury. The difference of mercury level is found to be 170mm. Find the speed of sub-Marine knowing the sp.gr. of mercury is 13.6 and that of sea water is 1.026. 6

UNIT — II

- V (a) Differentiate between Impulse turbine and Reaction turbine. 7
- (b) An external cylindrical mouth piece of diameter 150mm is discharging water under a constant head of 6m. Determine the discharge and absolute pressure head of water at vena-contracta. Take $C_d = 0.855$ and C_c for vena-contracta = 0.6 Atmospheric pressure head is 10.3m of water. 8

OR

- VI (a) Explain with neat sketch the function of draft tube. What are the main classifications ? 7
- (b) A 3m high tank standing on the ground is kept full of water. There is a small orifice in its vertical side with its centre at depth h metres below the free surface of liquid in the tank. Find the value of h so that the liquid strikes the ground at the maximum distance from the tank. Assume $C_v = 0.97$, also calculate maximum value of horizontal distance. 8

UNIT — III

- VII (a) Draw the hydroelectric installation layout and explain. 7
- (b) A trapezoidal notch 120cm wide at the top and 45cm at the bottom is 30cm high. Find the discharge through the notch, if the head of water is 22.5cm. Take coefficient of discharge as 0.6. 8

OR

- VIII (a) Discuss the difference between notch and weir. 8
- (b) A 24m long weir is divided into 8 equal bays by vertical posts each 0.2m wide. If the head over the weir is 900mm and velocity of approach 2.2m/s, determine the discharge over the weir using (1) Francis formula and (2) Bazin's formula. 7

UNIT — IV

- IX (a) Derive an expression for loss of head due to friction in pipes. 7
- (b) A trapezoidal earthen channel has side slope 2 vertical to 3 horizontal and discharging water at the rate of $15\text{m}^3/\text{s}$ at a velocity 3m/s so that the concrete lining for the bed and sides is minimum. Calculate the area of lining required for 100m length of canal. 8

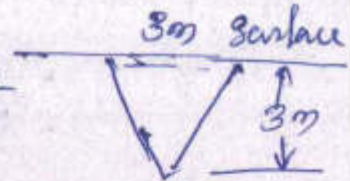
OR

- X (a) Explain about most economical section of channel. 7
- (b) A pipeline 40m long is connected to a water tank at one end, and discharges freely into the atmosphere at the other end. For the first 25m of its length from the tank, the pipe is 15cm dia. And its diameter is suddenly enlarged to 30cm. The height of water level in the tank is 8m above the centre of the pipe. Considering all losses of head which occur, determine the rate of flow. Assume pipe friction coefficient $f = 0.04$. 8
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Qn. No.	Scoring Indicators	Split score	Total score
I	PART. A		
1.	Ratio of specific weight of liquid to that of standard substance at a standard temperature. $Sp. gr = \frac{\text{Specific weight of liquid}}{\text{Specific weight of pure water}}$	1+1 = 2	
2.	Specific weight may be defined as the weight per unit volume. one end of simple manometer is attached to the gauge point and the other is open to the atmosphere. It is used for measuring high as well as negative pressure. In differential manometer, whose two ends are connected to the points whose difference of pressures is required to be found out.	1+1 = 2	
3.	Potential energy, kinetic energy, Pressure energy. $\text{Total energy} = \text{Potential energy} + \text{Kinetic energy} + \text{Pressure energy}.$ $E = Z + \frac{V^2}{2g} + \frac{P}{\rho g}$	1+1 = 2	
4.	The length of the stream of liquid, while flowing over a weir, gets contracted at the end	2	
5.	storage reservoir, Dam, Waterways and Penstock, Surge tank, Power house, well-	2	10

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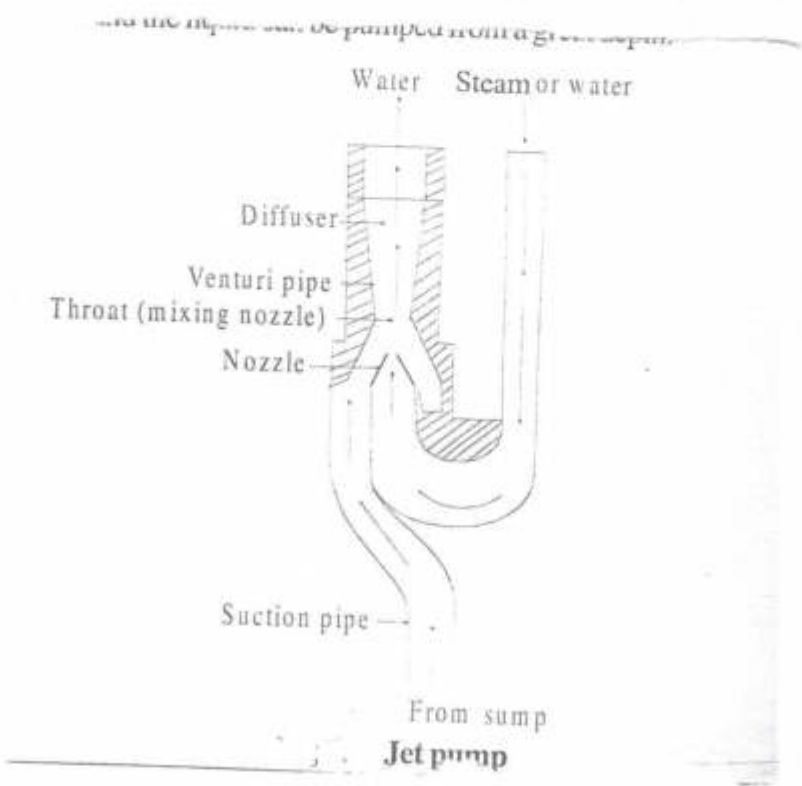
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Qn. No.	Scoring Indicators	Split score	Total score
<p><u>II</u></p> <p>1,</p> <p>2,</p>	<p>turbine, Tail race.</p> <p style="text-align: center;"><u>PART. B</u></p> <div style="display: flex; align-items: center;"> <div style="flex: 1;"> <p>Area (A) = $\frac{1}{2} \times 3 \times 3 = \underline{4.5 \text{ m}^2}$</p> <p>$P = \rho A \bar{v} =$</p> <p>$\rho = 9.81 \times 0.8 = 7.848 \text{ kW/m}^3$</p> <p>$\therefore P = 7.848 \times 4.5 \times \frac{3}{3} = \underline{35.316 \text{ kW}}$</p> <p>$\bar{h} = \frac{IG}{A \bar{v}} + \bar{x} ; I_G = \frac{bh^3}{36} = \frac{3 \times 3^3}{36}$</p> <p>$= \underline{2.25 \text{ m}^4}$</p> <p>$\Rightarrow \frac{2.25}{4.5 \times 1} + 1 = \underline{1.5 \text{ m}}$</p> </div> <div style="flex: 1; text-align: center;">  </div> </div> <p>Applying Bernoulli's equation at Section 1 and 2</p> $Z_1 + \frac{V_1^2}{2g} + \frac{P_1}{\rho} = Z_2 + \frac{V_2^2}{2g} + \frac{P_2}{\rho} \quad \text{--- (1)}$ <p>Diameteric pass through the axis of the Venturimeter</p> <p>$\therefore Z_1 = 0, Z_2 = 0$</p> $\frac{P_1}{\rho} - \frac{P_2}{\rho} = \frac{V_2^2}{2g} - \frac{V_1^2}{2g}$ <p>$a_1 V_1 = a_2 V_2$</p> <p>$V_1 = \frac{a_2 V_2}{a_1}$</p>	<p>3+3</p> <p>2</p> <p>2</p>	<p>6</p>

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Qn. No.	Scoring Indicators	Split score	Total score
	$\frac{P_1}{\rho} - \frac{P_2}{\rho} = \frac{V_2^2}{2g} \left[1 - \frac{a_2^2}{a_1^2} \right]$ $h = \frac{V_2^2}{2g} \left[\frac{a_1^2 - a_2^2}{a_1^2} \right]$ $V_2 = \sqrt{2gh} \left(\frac{a_1}{\sqrt{a_1^2 - a_2^2}} \right)$ <p>Discharge = $Q = C \cdot a_2 V_2$</p> $= C \cdot \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \sqrt{2gh}$	2	6
3.	<p>length of the pool = 10m.</p> <p>width of the pool = 3m.</p> $T = \frac{2A\sqrt{H_1}}{Cd \cdot a \cdot \sqrt{2g}}$ $= \frac{2 \times 60 \times \sqrt{1.25}}{0.62 \times 0.23 \times \sqrt{2 \times 9.81}}$ $= \underline{\underline{21.2 \text{ sec}}} \text{ or}$ $\underline{\underline{3 \text{ min } 32 \text{ sec}}}$	2 2	6
4.			

Qn. No.	Scoring Indicators	Split score	Total score
4.	<p>The major advantage is that it requires no prime mover. It is a pumping device works under the principle of Bernoulli's theorem. It is used for feeding water to boilers against boiler pressure. In this device steam or water under high pressure is passed through a pipe containing a nozzle at its end. The nozzle is placed in a Venturi pipe.</p> 	3	6

Qn. No.	Scoring Indicators	Split score	Total score
5	<p>1. In a right angled V-notch expressions for the computation of discharge is very simple to remember i.e. $Q = 1.417 H^{5/2}$</p> <p>2. For measuring more accurate results for low discharge, triangular notch is preferred than rectangular notch.</p> <p>3. In case of triangular notch 'H' is only required for the computation of discharge.</p> <p>4. No need for Ventilation.</p> <p>5. Same notch can measure wide range of floods.</p> <p>6. The length of the stream of liquid, while flowing over a weir gets contracted at the ends of the sill. This end contraction of the stream of liquid is known as lateral contraction or side contraction. Francis also found that the amount of end contraction depends upon the conditions of sides of the channel and top of the sill, as well as velocity of liquid. Approximate value of end contraction at each end is $\frac{1}{10}$ of the height of liquid above the sill of the weir. Thus for two end contractions.</p>	<p>$1 \times 6 = 6$</p> <p>6</p> <p>3</p>	6

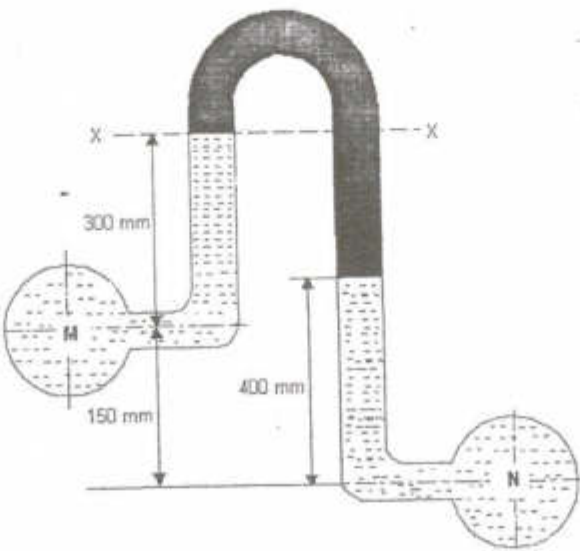
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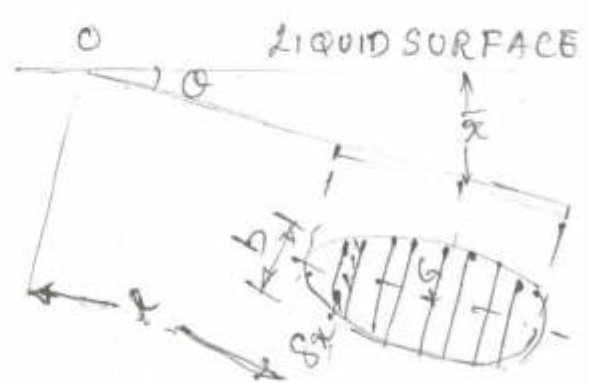
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Qn. No.	Scoring Indicators	Split score	Total score
	<p>Effective length of weir is $L - 0.2H$ \therefore The equation for discharge becomes.</p> $Q = \frac{2}{3} C_d (L - 0.2H) \sqrt{2g} H^{3/2}$ <p>In general $Q = \frac{2}{3} C_d (L - 0.1nH) \sqrt{2g} H^{3/2}$ n = number of end contractions.</p>	3	6
7.	<p>When the valve of a pipeline carrying the water from dam and supplying to a prime-mover of a hydraulic power plant suddenly closed, the momentum of the flowing water is destroyed and because of that very high pressure wave is generated upward the pipe and its velocity is equal to sound wave. This creates very high noise known as knocking. This high pressure wave generated may damage the pipe or even the dam. The intensity of pressure rise due to above phenomena is known as water hammer. It depends</p> <ol style="list-style-type: none"> 1, velocity of water flow 2, length of pipe 3, Time taken to close the valve 4, elastic property of pipe materials. 	3	6

Code :

Version:

Qn. No.	Scoring Indicators	Split score	Total score
<p>III</p> <p>a,</p> <p>b</p>	<p style="text-align: center;">PART C</p> <p>uniform flow :- Velocities of liquid particles at all sections of the pipe and channel are equal.</p> <p>Non-uniform :- velocities of liquid particles at all sections are not equal.</p> <p>Stream line flow - each liquid particle has a definite path.</p> <p>Turbulent flow :- each liquid particle does not have definite path.</p> <p>Steady flow :- Quantity of liquid flowing per second is constant.</p> <p>Unsteady flow :- Quantity of liquid flowing per second is not constant. etc.</p> 	<p>2x3</p> <p>3</p>	<p>6</p>

Qn. No.	Scoring Indicators	Split score	Total score
	<p>Pressure in the left limb below $x-x$:</p> $P_M - 1200 \times 9.81 \times 0.3 = P_D - 3531.6$ <p>Pressure in the right limb below $x-x$.</p> $= P_N - 800 \times 9.81 \times 0.4 - 700 \times 9.81 \times 0.05$ $= P_N - 3139.2 - 343.35$ $= P_N - 3482.55$ <p>Equating two pressures.</p> $P_M - 3531.6 = P_N - 3482.5$ $P_M - P_N = 3531.6 - 3482.55 = 49.05 \text{ N/m}^2$ $= \underline{\underline{0.0491 \text{ kN/m}^2}}$	3	3x = 6
<p><u>IV</u> a.</p>	 <p>The intensity of pressure on the strip</p> $= \rho h \sin \alpha$ <p>Pressure on the strip = Intensity of Pressure \times area</p> $= \rho h \sin \alpha \times b \delta x$	3	

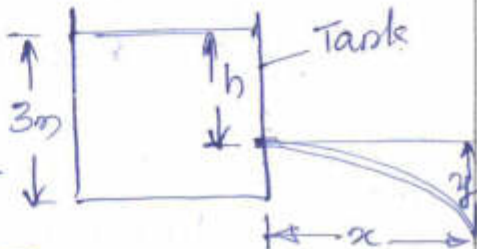
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Version: 2022

Qn. No.	Scoring Indicators	Split score	Total score
	<p align="center"><u>Reaction turbine</u></p> <ol style="list-style-type: none"> 1, Only the portion of Hydraulic energy is converted into kinetic energy before the water enters the turbine runner. 2, The water passes over the moving vanes with potential or pressure energy. 3, Pressure of water is not uniform 4, The wheel is always run full of water 5. The water is guided to the moving vanes at a proper angle by the guide vanes. <p>b,</p> $d = 150\text{mm} = 0.15\text{m}$ $\text{Area} = a = \frac{\pi \times 0.15^2}{4} = \underline{\underline{0.01767\text{m}^2}}$ $H = 6\text{m}$ $C_d = 0.855$ $C_c \text{ at Vena contracta} = 0.62$ $\text{Atmospheric pressure } H_a = 10.3\text{m}$ $\therefore \text{Discharge} = C_d \cdot a \times \sqrt{2gH}$ $= 0.855 \times 0.01767 \times \sqrt{2 \times 9.81 \times 6}$ $= \underline{\underline{0.1639\text{m}^3/\text{s}}}$	<p align="center">1x7</p>	<p align="center">7</p>
		<p align="center">4</p>	

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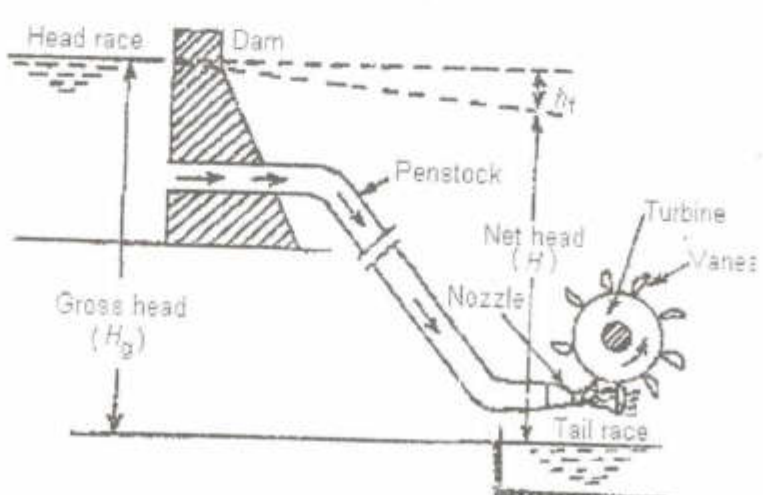
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Qn. No.	Scoring Indicators	Split score	Total score
	<p>Pressure head at Vena Contracta = $10.3 - 0.89 \times 6 = \underline{4.96\text{m}}$ (Absolute)</p>	A	
VI	<p>a. The draft tube is a pipe of gradually increasing area which connects the outlet of the runner to the tail race. It is used for discharging water from the exit of the turbine to the tail race. This pipe of gradually increasing area is called draft tube.</p>	3	4+4 8-
	<p>Type of draft tube: 1, Conical draft tube 2, Simple elbow tubes 3, Moody spreading tubes 4, Elbow draft tubes with circular inlets and rectangular outlet. (fig)</p>	4	7
	<p>b. Let the maximum value of horizontal distance = x</p> $x^2 = \frac{2V^2 y}{g}$ <p>Substituting $V = C_v \sqrt{2gh}$ $y = H - h$</p> 	2	

Scoring Indicators

Code :

Version:

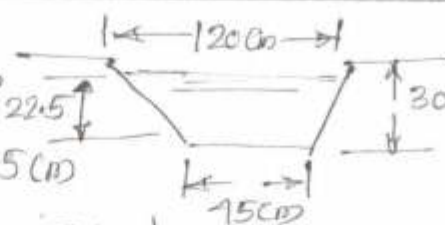
Qn. No.	Scoring Indicators	Split score
	<p>we get $x^2 = \frac{2 \times C_v^2 \times 2gh(H-h)}{g}$</p> $x = 2C_v \sqrt{h(H-h)}$ <p>Horizontal distance maximum</p> $\frac{d}{dh}(h(H-h)) = 0 \text{ or } \frac{d}{dh}(hH - h^2) = 0$ $H - 2h = 0, \quad h = \frac{H}{2} = \frac{3}{2} = \underline{1.5 \text{ m}}$ <p>$\therefore h = \underline{1.5 \text{ m}}$</p> $x_{\text{max}} = 2 \times 0.97 \times \sqrt{1.5(3-1.5)} = \underline{2.91 \text{ m}}$	3 3
VII a.	 <p style="text-align: center;">Layout of a hydroelectric power plant</p>	3 4

explain each component

Scoring Indicators

Code :

Version:

Qn. No.	Scoring Indicators	Split score
b.	<p>Base width $b = 45\text{cm}$</p> <p>Head of water $H = 22.5\text{cm}$</p> <p>Coefficient of discharge $C_d = 0.6$</p>  <p>From the geometry of the notch</p> $\tan \frac{\theta}{2} = \frac{(120 - 45) \times \frac{1}{2}}{30} = \underline{\underline{1.25}}$ <p>Using the relation</p> $Q = \frac{2}{3} C_d b \sqrt{2g} H^{3/2} + \frac{8}{15} C_d \sqrt{2g} \tan \frac{\theta}{2} H^{5/2}$ $= \frac{2}{3} \times 0.6 \times 45 \times \sqrt{2 \times 9.81} \times 22.5^{3/2} + \frac{8}{15} \times 0.6 \times \sqrt{2 \times 9.81} \times 1.25 \times 22.5^{5/2}$ $= \underline{\underline{127.6 \text{ lit/Sec}}}$	<p>2</p> <p>2</p> <p>2</p>
VIII a.	<ol style="list-style-type: none"> Notch is a large opening in the side of a tank or dam over which the fluid flows. The upstream water level is below the upper edge of the notch. The sheet of water flowing over a notch is termed as nappe or vein. Head of water over the sill of notch is small. 	<p>4</p>

Qn. No.	Scoring Indicators	Split score	Total score
	<p>A weir may be defined as an opening provided in the side of a tank or vessel any regular obstruction in an open stream over which the flow takes place. It is made of masonry or concrete.</p> <p>b. Length of weir, $L = 24 \text{ m}$ Number of bays = 8 Width of each post = 0.2 m Velocity of approach = 2.2 m/s. Effective length $L = 24 - 7 \times 0.2 = \underline{22.6 \text{ m}}$ Number of end contractions = $n = 2 \times 8 = 16$ Additional head $(h_a) = \frac{V a^2}{2g} = \frac{2.2^2}{2 \times 9.81} = \underline{0.24669 \text{ m of water}}$</p> <p>Total height of water above the weir or notch $H_1 = H + h_a = 0.9 + 0.24669 = \underline{1.14669 \text{ m of water}}$</p> <p>Francis formula</p> $Q = 1.84 (L - 0.1 n H_1) \left[H_1^{3/2} - H_2^{3/2} \right]$ $= 1.84 \left[22.6 - 0.1 \times 16 \times 1.14669 \right] \left[1.14669^{3/2} - 0.24669^{3/2} \right]$	4	8

Qn. No.	Scoring Indicators	Split score	Total score
	$= \underline{42.23495 \text{ m}^3/\text{sec}}$ <p>b. Bazin's formula</p> $Q = m \times L \sqrt{2g} \times H_1^{3/2}$ $= \quad \quad \quad m = 0.405 + \frac{0.003}{1.14669}$ $= 0.4076$ $Q = 0.4076 \times 22.6 \sqrt{2 \times 9.81} \times (1.14669)^{3/2}$ $= \underline{50.102 \text{ m}^3/\text{sec}}$ <p style="text-align: center;"><u>UNIT IV</u></p>	3	7
IX a,	<p>head loss due to friction $h_f =$</p> $= \frac{4fL V^2}{2gd}$ <p>[Derivation fall. with fig.]</p>	3+1	7
b.	<p>Side slope, $n = 3$ horizontal to 2 vertical</p> $\frac{\text{Horizontal}}{\text{Vertical}} = \frac{3}{2} = 1.5$ <p>Discharge $Q = 15 \text{ m}^3/\text{sec}$</p>		

Qn. No.	Scoring Indicators	Split score	Total score
	<p>velocity = $v = 3 \text{ m/sec}$</p> $\frac{b + 2nd}{2} = d\sqrt{n^2 + 1}$ $\frac{b + 2 \times 1.5d}{2} = d\sqrt{1.5^2 + 1}$ $\frac{b + 3d}{2} = \underline{1.8027d}$ $b = 2 \times 1.8027d - 3d$ $= 3.6054d - 3d = \underline{0.6054d} \quad 2$ <p>Area of trapezoidal Section, $= A = d(b + nd)$</p> $5 = d(0.6054d + 1.5d)$ $5 = \underline{2.1054d^2}$ $d = \sqrt{5/2.1054}$ $= \underline{1.541 \text{ m}} \quad 2$ <p>Substituting the value of 'd' in equation</p> $b = 0.6054d \text{ we get}$ $b = 0.6054 \times 1.541 = \underline{0.9329 \text{ m}} \quad 2$ <p>Correct Perimeter =</p> $0.9329 + 2 \times 1.541 \sqrt{1.5^2 + 1}$ <p>Area of lens = $6.489 \times 100 = \underline{648.9 \text{ m}^2} \quad 2$</p>		
			$2 \times 4 = 8$

Qn. No.	Scoring Indicators	Split score	Total score
$\frac{y}{a}$ a.	<p>A channel which gives maximum discharge for a given cross sectional area and bed slope is called a channel of most economical section.</p> <p>For rectangular sections whose $b = 2d$ and hydraulic mean depth $m = \frac{A}{P} = \frac{bd}{b+2d}$</p> $= \frac{2d^2}{4d} = \frac{d}{2}$ <p>is an economical section.</p> <p>b. Since the discharge is continuous</p> $Q_1 V_1 = Q_2 V_2$ $V_1 = \frac{Q_2 V_2}{Q_1} = \frac{\frac{\pi \times 3^2}{4} \times V_2}{\frac{\pi \times 0.15^2}{4}}$ <p>Loss of head at entrance</p> $= \frac{0.5 V_1^2}{2g} = \frac{0.5 [4 V_2]^2}{2g} = \frac{8 V_2^2}{2g} \text{--- (1)} = \underline{\underline{\frac{4 V_2^2}{g}}}$ <p>Loss of head due to friction in pipe 1</p> $h = \frac{4 f L V_1^2}{2g d}$ $= \frac{4 \times 0.04 \times 15 \times V_1^2}{2g \times 0.3}$ $= \frac{4 \times 0.04 \times 25 \times (4 V_2)^2}{2g \times 0.3} = \frac{8 V_2^2}{g} \text{--- (2)}$ $\dots \frac{426.7}{2g} \text{--- (2)}$	<p>2+5</p> <p>2</p> <p>2</p>	<p>7</p>

Qn. No.	Scoring Indicators	Split score	Total score
loss of head due to sudden enlargement.	$\frac{(V_1 - V_2)^2}{2g} = \frac{(4V_2 - V_2)^2}{2g} = \frac{9V_2^2}{2g} \quad (3)$	2	
loss of head due to friction in pipe 2.	$h_{f_2} = \frac{4f_2 l_2 V_2^2}{2g} = \frac{4 \times 0.04 \times 15 \times V_2^2}{2 \times 9.8}$ $= \frac{8V_2^2}{2g} \quad \text{--- 4}$		
loss of head at exit = $\frac{V_2^2}{2g}$	$8 = \frac{8V_2^2}{2g} + \frac{426.7V_2^2}{2g} + \frac{9V_2^2}{2g} + \frac{8V_2^2}{2g} +$	2	
	$\frac{V_2^2}{2g} = \frac{452.7V_2^2}{2g}$		
	$V_2 = 0.59 \text{ m/sec.}$		
	$Q = A_2 V_2 = \frac{\pi \times 0.3^2}{4} \times 0.59$ $= \underline{\underline{0.042 \text{ m}^3/\text{sec}}}$		$2 \times 4 = 8$