(21)

April-24
Pageno-12

Scoring Indicators

COURSE NAME:HYDRAULICS

COURSE CODE :4011

QID :2

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			**10**
I.1	**Specific gravity :** Ratio of weight density of a fluid to the weight density of a standard fluid **Viscosity :** Defined as the resistance offered by a layer of fluid over the other layer	1 1	2	
I.2.	Orifice: An orifice is a small, typically circular opening or hole in a surface, barrier, or device that allows fluids (liquids or gases) to pass through. Orifices are commonly used in engineering and fluid dynamics to control the flow of fluids or to measure the rate of flow	2	2	
I.3	The velocity of approach in a weir refers to the velocity of the approaching flow (water) just upstream of the weir crest. The velocity of approach affects the flow characteristics over the weir, including the flow rate or discharge measurement accuracy. A high velocity of approach can disrupt the flow over the weir, leading to inaccuracies in flow rate measurements. To minimize the impact of velocity of approach, engineers often use certain guidelines and design features	2	2	
I.4	The hydraulic mean depth is defined as the ratio of the cross-sectional area of flow (A) to the wetted perimeter (P). Hydraulic Mean Depth (HMD) = A / P Where: • A - the cross-sectional area of the flow (the area of the water surface). • P - the wetted perimeter, which is the length of the channel bottom and sides that is in contact with the flowing liquid.	2		
I.5	Uniform and Non-Uniform Flow: Uniform Flow: Uniform flow occurs when the fluid properties (e.g., velocity and pressure) are the same at all points within a particular cross-section of the flow. In other words, the flow does not vary along the direction of flow.	2		

	PART B			30
II.1	Bernoullis theorem: This theorem is a form of the well known principle of *conservation of energy.* The theorem is stated as follows. "In a steady continuous flow of frictionless incompressible fluid, the sum of the potential head, pressure head and kinetic head is the same at all points".Hence it is mathematically represented as $\frac{p}{\rho g}+\frac{v^2}{2g}+z=\text{Constant}.$	2		
	The following are the assumptions made in the Bernoullis equation (i) The fluid is ideal i.e., viscosity is zero. (ii) The flow is steady (iii) The flow is incompressible (iv) The flow is irrotational, and (v) The flow is one dimensional.	2	6	
	Limitations 1. In Bernoullis theorem, it is assumed that the velocity of every liquid particle at any cross-section is uniform. But actually, the velocity of liquid particle at the centre of the pipe is maximum and gradually decreases towards the walls of the pipe due to friction. Thus, while using Bernaullis equation, we take only mean velocity 2. In Bernoullis theorem , it is also assumed that no external force except the gravity force is acting on the liquid. But actually, there are some external forces like pipe friction is acting on the liquid, which may effect the flow of liquid. 3. In Bernoullis theorem , it is assumed that there is no loss of energy while flowing. But actually, it is not true. For example, in turbulant flow, some of the kinetic energy is converted into heat energy and in a viscous flow, some energy is lost due to shear forces. 4. If the fluid is flowing in a curved path, the energy due to centrifugal force should also be taken into account. But normally we neglect the energy due to centrifugal force.	2		
II.2.	Larger diameter of tapered pipe, d_1 = 200 mm = 0.2 m Smaller diameter of tapered pipe, d_2 = 100 mm = 0.1m Velocity of flow at larger end, v_1 = 4.5 m/sec	2		
	Larger cross sectional area, $a_1=\frac{\pi}{4}d_1^2=\frac{\pi}{4}\times(0.2)^2=0.0314\ \text{m}^2$ Smaller cross sectional area, $a_2=\frac{\pi}{4}d_2^2=\frac{\pi}{4}\times(0.1)^2=0.00785\ \text{m}^2$ Discharge through the pipe, $Q=a_1v_1=0.0314\times4.5=\mathbf{0.1413\ m^3/s}$	2	6	
	Using continuity equation, *i.e.,* $a_1v_1=a_2v_2$ $\therefore$ Velocity at the smaller end of the pipe, $v_2=\frac{a_1v_1}{a_2}=\frac{0.1413}{0.00785}=\mathbf{18\ m/s}$	2		

II.3.

Impulse turbine	Reaction Turbine
The entire available energy of the water is first converted into kinetic energy.	The available energy of the water is not converted from one form to another.
The water flows through the nozzles and impings on the buckets, which are fixed to the outer periphery of the wheel.	The water is guided by the glide blades to flow over the moving vane.
The water impings on the buckets with KE	The water glides over the moving vanes with PE.
The pressure of the flowing water remains unchanged and is equal to the atmospheric pressure.	The pressure of the flowing water is reduced after gliding over the vane.
It is not essential that the wheel should run full.	It is essential that the wheel should always run full and kept full of water.
It is possible to regulate the flow without loss.	It is not possible to regulate the flow without loss.
Impulse Turbine has more hydraulic efficiency.	Reaction Turbine has relatively less efficiency.
Impulse Turbine operates at high water heads.	Reaction turbine operates at low and medium heads.
Example of Impulse turbine is Pelton wheel.	Examples of Reaction Turbine are Francis turbine, Kaplan and Propeller Turbine, Deriaz Turbine, Tubuler Turbine, etc.

any 6 points

6

II.4

Centrifugal Pumps	Reciprocating Pumps
1. Steady and even flow	1. Intermittent and pulsating flow
2. For large discharge, small heads	2. For small discharge, high heads.
3. Can be used for viscous fluids e.g. oils, muddy water.	3. Can handle pure water or less viscous liquids only otherwise valves give frequent trouble.
4. Low initial cost	4. High initial cost.
5. Can run at high speed. Can be coupled directly to electric motor.	5. Low speed. Belt drive necessary.
6. Low maintenance cost. Periodic check up sufficient.	6. High maintenance cost. Frequent replacement of parts.
7. Compact less floors required.	7. Needs 6-7 times area than for centrifugal pumps.
8. Low head pumps have high efficiency	8. Efficiency of low head pumps as low as 40 per cent due to the energy losses.
9. Uniform torque	9. Torque not uniform.
10. Simple constructions. Less number of spare parts needed	10. Complicated construction. More number of spare parts needed.

any 6 points

II.5

A triangular notch is prefered to a rectangular notch due to the following advantanges ver a rectangular notch.

1. In a right angled V- notch the expression for the computation of discharge is very simple to remember (i.e., $Q = 1.417$)
2. For measuring more accurate results for low discharge, triangular notch is preferred than rectangular notch
3. In case of triangular notch, only one reading i.e., head (H) is required to be taken for the computation of discharge.
4. No need for ventilation of triangular notch.
5. The same triangular notch can measure a wide range of flows accurately.
6. The head over the crest of triangular notch is independent of wetted edge. In case of rectangular notch the width or length of notch crest is constant for all heads with which the results are effected.

any 6 points

II.6

The expression for discharge over a rectangular notch or weir is the same.

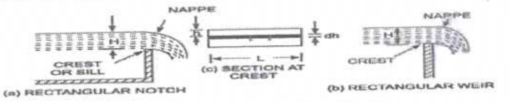


Fig. 8.1 *Rectangular notch and weir.*

Consider a rectangular notch or weir provided in a channel carrying water as shown in Fig. 8.1.

Let H = Head of water over the crest

L = Length of the notch or weir

For finding the discharge of water flowing over the weir or notch, consider an elementary horizontal strip of water of thickness dh and length L at a depth h from the free surface of water as shown in Fig. 8.1(c).

The area of strip $= L \times dh$

and theoretical velocity of water flowing through strip $= \sqrt{2gh}$

The discharge dQ, through strip is

$$dQ = C_d \times \text{Area of strip} \times \text{Theoretical velocity}$$

$$= C_d \times L \times dh \times \sqrt{2gh} \quad \ldots(i)$$

where C_d = Co-efficient of discharge.

The total discharge, Q, for the whole notch or weir is determined by integrating equation (i) between the limits 0 and H.

$$\therefore \quad Q = \int_0^H C_d \cdot L \cdot \sqrt{2gh} \cdot dh = C_d \times L \times \sqrt{2g} \int_0^H h^{1/2}\, dh$$

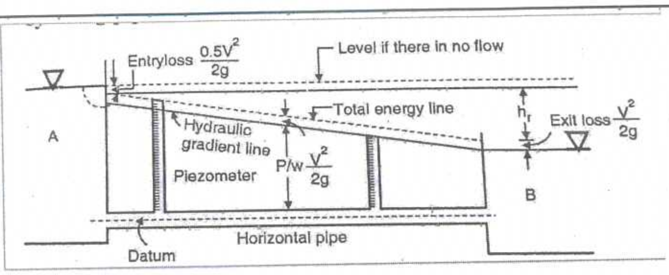
$$= C_d \times L \times \sqrt{2g} \left[\frac{h^{1/2+1}}{\frac{1}{2}+1}\right]_0^H = C_d \times L \times \sqrt{2g} \left[\frac{h^{3/2}}{3/2}\right]_0^H$$

$$= \frac{2}{3} C_d \times L \times \sqrt{2g}\, [H]^{3/2}. \quad \ldots(8.1)$$

3

3

II.7



2

Each point 1mark (4x1 =4)

The total energy line (TEL) is a graphical or mathematical representation used to represent the total energy of a fluid at various points along a flow path within a system. It shows the different forms of energy that a fluid possesses in a pipeline or open channel.

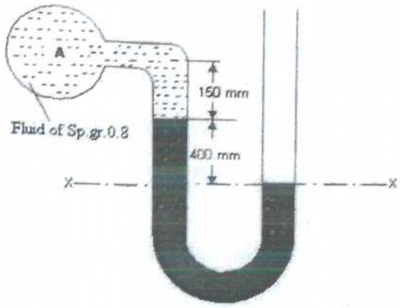
Total Energy (TE) = Kinetic Energy (KE) + Potential Energy (PE) + Pressure Energy (PE)

Hydraulic Gradient Line (HGL): The hydraulic gradient line (HGL) represents the variation of piezometric head or pressure head along the flow direction in a fluid system. It shows the energy available to drive the flow. The HGL consists of the sum of the elevation head and pressure head at any point along the flow path.

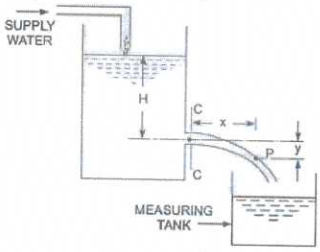
6

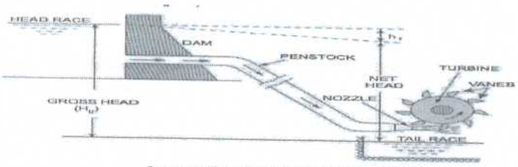
	PART C			42
III.a.	A manometer and a differential manometer are both devices used to ~sure the pressure of a fluid, but they serve different purposes and have distinct characteristics:		6	6

	Manometer: A manometer is a device used to measure the pressure of a single fluid, such as a gas or a liquid, with respect to the atmospheric pressure or a reference point. A simple manometer consists of a U-shaped tube partially filled with a liquid (usually mercury or a less dense liquid). One end of the tube is open to the fluid whose pressure you want to measure, and the other end is open to the atmosphere or a reference pressure source. The difference in height of the liquid columns in the two arms of the U-tube is directly proportional to the pressure difference between the fluid and the reference point. 1. **Applications**: Manometers are commonly used in applications like measuring gas pressure in laboratory experiments, checking tire pressure, and assessing the draft in a chimney.	3		
	Differential Manometer: A differential manometer is specifically designed to measure the pressure difference between two points in a fluid system. It is used to compare the pressures at two different locations within the same system. 1. **Working**: A differential manometer typically consists of a U-tube, similar to a regular manometer. However, it has two separate arms, each connected to a different point in the fluid system. By comparing the heights of the liquid columns in the two arms, the pressure difference between the two points in the system can be determined 2. **Applications**: Differential manometers are widely used in fluid mechanics and engineering to measure pressure drops across various components like valves, filters, and orifices. They are valuable for assessing the performance and efficiency of fluid systems.	3		

III.b.	Specific gravity of fluid in the pipe, $S_1 = 0.8$ $\therefore$ Density of the fluid, $\rho_1 = S_1 \times 1000 = 0.8 \times 1000$  **Fig.1.2.11** Specific gravity of mercury, $S_2 = 13.6$ $\therefore$ Density of mercur $= S_2 \times 1000 = 13.6 \times 1000$ Height of liquid in the left limb $h_1 = 150 \text{ mm} = 0.15 \text{ m}$ Difference of mercury level, $h_2 = 400 \text{ mm} = 0.4 \text{ m}$ Let p be the intensity pressure of fluid flowing in the pipe Equating pressure at the left and right limb above datum line X-X, we $p + \rho_1 g h_1 + \rho_2 g h_2 = 0$ Or, $p = -(\rho_1 g h_1 + \rho_2 g h_2) = -(800 \times 9.81 \times 0.15 + 13600 \times$ $= -(1177.2 + 53366.4) =$ **- 54543. 6 N / m²** $=$ **- 54.54 kN / m²** or **kPa**	3 6	9	9
IV. a.	Venturi Meter: • A Venturi meter is a flow measurement device used to determine the flow rate of a fluid (liquid or gas) in a pipeline. • It operates on the principle of Bernoulli's equation, which relates the velocity of fluid to its pressure. • The Venturi meter consists of a converging inlet, a throat where the tube is narrowest, and a diverging outlet. The fluid flows through this tapering tube. Pitot Tube: • A Pitot tube, named after Henri Pitot, is a device used to measure the fluid velocity at a specific point in a flow, such as in pipes, aircraft, or wind tunnels. • It relies on the difference in pressure between the dynamic pressure (pressure due to fluid motion) and static pressure (pressure at rest).	(2each x 3 = 6)	6	6

IV. b.	Diameter of pipe, $d = 200\text{mm} = 0.2\text{ m}$ Discharge, $Q = 2500 \text{ litres/min} = \frac{2500}{1000} \text{m}^3/\text{min} = \frac{2500}{60 \times 1000} \text{m}^3/\text{s}$ $= 0.04167 \text{ m}^3/\text{s}$ Intensity of pressure, $p = 20 \text{ kN/m}^2 = 20 \times 10^3 \text{ N/m}^2$ Datum head, $z = 5\text{m}$ Area of pipe, $a = \frac{\pi}{4}d^2 = \frac{\pi}{4}\times(0.2)^2 = 0.0314 \text{ m}^2$ We know that, discharge, $Q = av$ $\therefore$ Velocity of water, $v = \frac{Q}{a} = \frac{0.04167}{0.0314} = 1.3271 \text{ m/s}$ Kinetic head, $\frac{v^2}{2g} = \frac{(1.3271)^2}{2\times9.81} = 0.08976 \text{ m}$ Pressure head, $\frac{p}{\rho g} = \frac{20\times10^3}{1000\times9.81} = 2.0387 \text{ m}$ Total head $= \frac{p}{\rho g} + \frac{v^2}{2g} + z = 2.0387 + 0.08976 + 5$ $= 7.1285$ **metres of oil** *(Ans)*	4.5 4.5	9	
V.a.	Dia. of orifice, $d = 20 \text{ mm} = 0.02 \text{ m}$ $\therefore$ Area, $a = \frac{\pi}{4}(0.02)^2 = 0.000314 \text{ m}^2$ Head, $H = 1 \text{ m}$ Actual discharge, $Q = 0.85 \text{ litre/s} = 0.00085 \text{ m}^3/\text{s}$ Theoretical velocity, $V_{th} = \sqrt{2gH} = \sqrt{2\times9.81\times1} = 4.429 \text{ m/s}$ $\therefore$ Theoretical discharge, $Q_{th} = V_{th} \times$ Area of orifice $= 4.429 \times 0.000314 = 0.00139 \text{ m}^3/\text{s}$ $\therefore$ Co-efficient of discharge $= \frac{\text{Actual discharge}}{\text{Theoretical discharge}} = \frac{0.00085}{0.00139} =$ **0.61. Ans.**	1 1 1 1 2 1	7	
V.b.	Mouthpieces are fluid flow control devices that are typically used to discharge or control the flow of fluids, especially liquids, from one location to another. **CLASSIFICATION OF MOUTHPIECES** 1. The mouthpieces are classified as (*i*) External mouthpiece or (*ii*) Internal mouthpiece depending upon their position with respect to the tank or vessel to which they are fitted. 2. The mouthpiece are classified as (*i*) Cylindrical mouthpiece or (*ii*) Convergent mouthpiece or (*iii*) Convergent-divergent mouthpiece depending upon their shapes. 3. The mouthpieces are classified as (*i*) Mouthpieces running full or (*ii*) Mouthpieces running free depending upon the nature of discharge at the outlet of the mouthpiece. This classification is only for internal mouthpieces which are known Borda's or Re-entrant mouthpieces. A mouthpiece is said to be running free if the jet of liquid after contraction does not touch the sides of the mouthpiece. But if the jet after contraction expands and fills the whole mouthpiece it is known as running full.	3 5	8	

VI.a.	**EXPERIMENTAL DETERMINATION OF HYDRAULIC CO-EFFICIENTS** **Determination of Co-efficient of Discharge (C_d).** The water is allowed to flow through an orifice fitted to a tank under a constant head, H as shown in Fig. . The water is collected in a measuring tank for a known time, t. The height of water in the measuring tank is noted down. Then actual discharge through orifice, $Q = \frac{\text{Area of measuring tank} \times \text{Height of water in measuring tank}}{\text{Time } (t)}$ and theoretical discharge = area of orifice $\times \sqrt{2gH}$  Fig. *Value of C_d.* $\therefore \quad C_d = \frac{Q}{a \times \sqrt{2gH}}$	3	7	
	Determination of Co-efficient of Velocity (C_v). Let C-C represents the vena-contracta of a jet of water coming out from an orifice under constant head H as shown in Fig. . Consider a liquid particle which is at vena-contracta at any time and takes the position at P along the jet in time 't'. Let x = horizontal distance travelled by the particle in time 't' y = vertical distance between P and C-C V = actual velocity of jet at vena-contracta. Then horizontal distance, $x = V \times t$ ...(*i*) and vertical distance, $y = \frac{1}{2} gt^2$ ...(*ii*) From equation (*i*), $t = \frac{x}{V}$ Substituting this value of 't' in (*ii*), we get $y = \frac{1}{2} g \times \frac{x^2}{V^2}$ $V^2 = \frac{gx^2}{2y}$ $\therefore \quad V = \sqrt{\frac{gx^2}{2y}}$ But theoretical velocity, $V_{th} = \sqrt{2gH}$ $\therefore$ Co-efficient of velocity, $C_v = \frac{V}{V_{th}} = \sqrt{\frac{gx^2}{2y}} \times \frac{1}{\sqrt{2gH}} = \sqrt{\frac{x^2}{4yH}}$ $= \frac{x}{\sqrt{4yH}}$.	4		
	Determination of Co-efficient of Contraction (C_c). The co-efficient of contraction is determined from the equation (7.4) as $C_d = C_v \times C_c$ $\therefore \quad C_c = \frac{C_d}{C_v}$			
VI.b.	A draft tube is a key component in the design of hydraulic turbines, typically used in hydroelectric power plants. Its purpose is to improve the efficiency and performance of the turbine by allowing the water to exit the turbine at a lower velocity and with less turbulence. Here's its main purpose and how it works:	2	8	
	Purpose of a Draft Tube: 1. Energy Recovery: The primary purpose of a draft tube is to recover the kinetic energy of water leaving the turbine. When water exits the turbine, it often has a high velocity, which contains significant kinetic energy. The draft ube helps convert this kinetic energy into potential energy, which can be harnessed for additional power generation.	3		
	2. Reduced Turbulence: Water leaving the turbine without a draft tube can create turbulence and vortices, which can reduce the turbine's	3		

	efficiency and cause wear and tear on the equipment. The draft tube helps guide the water smoothly out of the turbine, minimizing turbulence.			
VII.a	 *Layout of a hydroelectric power plant.* Penstock:A penstock is a long, large-diameter pipe or conduit used in hydroelectric power plants and other hydraulic engineering applications to transport water from a reservoir or water source to a turbine or waterwheel. Gross Head: Gross head, refers to the total available energy or potential energy of the water in a reservoir or water source that can be converted into mechanical or electrical energy. It is the vertical distance between the water surface at the reservoir's highest level and the water outlet where it is used to drive a turbine. Tailrace: The tailrace is the channel or conduit that carries water away from a hydropower turbine or waterwheel after it has passed through the turbine and done the mechanical work of generating electricity.	7	7	
VII. b	Discharge over the notch, $Q = 233$ litres/s $= 0.233$ m³/s	1	8	
	Head over the notch, $H = \frac{1}{3}L$	1		
	Coefficient of discharge, $C_d = 0.62$.	1		
	Using the equation for discharge, i.e., $Q = \frac{2}{3} C_d \cdot L \cdot \sqrt{2g} \cdot H^{\frac{3}{2}}$	2		
	Substituting $0.233 = \frac{2}{3} \times 0.62 \times L \times \sqrt{2 \times 9.81} \times \left(\frac{L}{3}\right)^{\frac{3}{2}} = 0.352 \times L^{\frac{5}{2}}$	2		
	$\therefore$ Length of the notch, $L = \left(\frac{0.233}{0.352}\right)^{\frac{2}{5}}$ $= \mathbf{0.85\ m}$	1		

VIII a.	Head over the notch, $H = 900\text{mm} = 0.9\text{m}$ Discharge over the notch, $Q = 300 \text{ litres/s} = 0.3 \text{ m}^3/\text{s}$ Coefficient of discharge, $C_d = 0.62$ Using the equation for discharge over a rectangular notch, i.e., $Q = \frac{2}{3} C_d \cdot L \cdot \sqrt{2g} \cdot H^{\frac{3}{2}}$ or, Length of the notch, $L = \frac{3Q}{2C_d\sqrt{2g} \cdot H^{\frac{3}{2}}} = \frac{3\times0.3}{2\times0.62\times\sqrt{2\times9.81}\times(0.9)^{\frac{3}{2}}}$ $= 0.1919 \text{ m} = 192 \text{ mm}$ *(Ans)*	1 1 1 2 2	7	
VIII b.	A **notch** is a device used for measuring the rate of flow of a liquid through a small channel or a tank. It may be defined as an opening in the side of a tank or a small channel in such a way that the liquid surface in the tank or channel is below the top edge of the opening. A **weir** is a concrete or masonary structure, placed in an open channel over which the flow occurs. It is generally in the form of vertical wall, with a sharp edge at the top, running all the way across the open channel. The notch is of small size while the weir is of a bigger size. The notch is generally made of metallic plate while weir is made of concrete or masonary structure. 1. **Nappe or Vein.** The sheet of water flowing through a notch or over a weir is called Nappe or Vein. 2. **Crest or Sill.** The bottom edge of a notch or a top of a weir over which the water flows, is known as the sill or crest. **CLASSIFICATION OF NOTCHES AND WEIRS** The notches are classified as : 1. According to the shape of the opening : (*a*) Rectangular notch, (*b*) Triangular notch, (*c*) Trapezoidal notch, and (*d*) Stepped notch. 2. According to the effect of the sides on the nappe : (*a*) Notch with end contraction. (*b*) Notch without end contraction or suppressed notch. Weirs are classified according to the shape of the opening, the shape of the crest, the effect of the sides on the nappe and nature of discharge. The following are important classifications. (*a*) According to the shape of the opening : (*i*) Rectangular weir, (*ii*) Triangular weir, and (*iii*) Trapezoidal weir (Cipolletti weir) (*b*) According to the shape of the crest : (*i*) Sharp-crested weir, (*ii*) Broad-crested weir, (*iii*) Narrow-crested weir, and (*iv*) Ogee-shaped weir.	4 4	8	
IX a.	Water Hammer : Water flowing though a long pipe line is brought to rest by suddenly closing the valve provided on the pipe line. The sudden closure of valve, there will be a sudden rise in pressure due to the momentum of water being destroyed. A pressure	5	7	

	wave is transmitted along the pipe due to closing the valve create noise in the pipe known as knocking. The sudden rise in pressure has the effect of hammering action on the walls of the pipe and hence this phenomenon is known as water hammer or hammer blow. Effects of Water hammer are, Pressure Surges: Noise: Vibration: Fatigue and Wear: Valve and Pump Damage: Reduced System Efficiency: Water Contamination: Safety Concerns			
IX b.	Diameter of pipe, d $= 250\text{ mm} = 0.25\text{m}$ Length of pipe, l $= 100\text{m}$ Velocity of flow, v $= 2.5\text{ m/s}$ Coefficient of pipe friction, f $= 0.005$ Chezy's constant, C $= 55$ Using Darcy's formula Head loss due to friction, $h_f = \frac{4flv^2}{2gd} = \frac{4\times0.005\times100\times(2.5)^2}{2\times9.81\times0.25}$ $= 2.548$ **m of water** *(Ans)* Hydraulic mean depth, $m = \frac{d}{4} = \frac{0.25}{4} = 0.0625\text{ m}$ Loss of head per unit length, $i = \frac{h_f}{l} = \frac{h_f}{100}$ Using Chezy's formula for velocity of flow, $v = C\sqrt{mi}$ Substituting $2.5 = 55\times\sqrt{0.0625\times\frac{h_f}{100}}$ $\therefore\quad h_f = \left(\frac{2.5}{55}\right)^2\times\frac{100}{0.0625}$ $= 3.306$ **m of water** *(Ans)*	2 4 2	8	
X.a.	When a fluid is flowing through a pipe, the fluid experiences some resistance due to which some of the energy of fluid is lost. This loss of energy is classified as : **Energy Losses** 1. Major Energy Losses This is due to friction and it is calculated by the following formulae : (*a*) Darcy-Weisbach Formula (*b*) Chezy's Formula 2. Minor Energy Losses This is due to (*a*) Sudden expansion of pipe (*b*) Sudden contraction of pipe (*c*) Bend in pipe (*d*) Pipe fittings etc. (*e*) An obstruction in pipe.	2 2 3	7	

X.b.	**Solution.** Given : Width of rectangular channel, $b = 6$ m Depth of channel, $d = 3$ m ∴ Area, $A = 6 \times 3 = 18\ m^2$ Bed slope, $i = 1 \text{ in } 2000 = \frac{1}{2000}$ Chezy's constant, $C = 55$ Perimeter, $P = b + 2d = 6 + 2 \times 3 = 12$ m ∴ Hydraulic mean depth, $m = \frac{A}{P} = \frac{18}{12} = 1.5$ m Velocity of flow is given by equation (16.4) as, $V = C\sqrt{mi} = 55\sqrt{1.5 \times \frac{1}{2000}} = $ **1.506 m/s. Ans.**	2 4 2	8	