Model Answer: Winter 2017

Subject: Hydraulics **Sub. Code: 17421**

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and Communication Skills.)
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by the candidate and those in the model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and the model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1		**Attempt any TEN of the following:**		**(20)**
	a)	**Differentiate "Solid and Fluid". (any four)**		
	Ans.	(see table below)	2	2

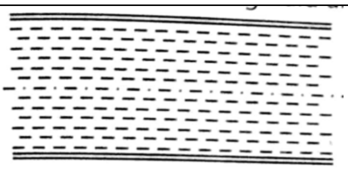
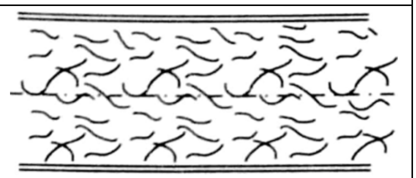
Sr. No.	Solid	Fluid
1.	Molecules are very closely spaced.	The space between molecules is large.
2.	Intermolecular cohesive force is large.	Intermolecular cohesive force is less.
3.	Solid can resist tensile compressive force.	Liquid can not resist tensile force
4.	e.g.Metal Timber, concrete	e.g. Water, petrol, kerosene.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
	(b)	**Define specific weight and give the value of specific weight for pure water.**		
	Ans.	**Specific weight:** It is defined as the weight per unit volume at standard temperature and pressure.	1	2
		Specific weight for pure water = 9.81 kN/m^3 or 9810 N/m^3	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1.	c)	**Express 7.8 m of water in N/m² and head of mercury.**		
	Ans.	Given: $h = 7.8$ m of water Find: P, h_m $P = S_w \gamma_w \ h_w$ $P = 1 \times 9.81 \times 7.8$ $\boxed{P = 76.52 \text{ kN/m}^2}$	1	2
		In terms of head of mercury, $P = S_m \gamma_w h_m$ $76.52 = 13.6 \text{ x } 9.81 \text{ x } h_m$ $\boxed{h_m = 0.57 \text{ m}}$	1	
	d)	**State Darcy Weisbach equation for frictional loss in pipe.**		
	Ans.	Darcy Weisbach equation for frictional loss in pipe is $$h_f = \frac{flv^2}{2gd}$$	1	2
		Where, h_f = Loss of head due to friction (m) f = Friction factor l = Length of pipe (m) v = Mean velocity of flow (m/sec) d = Diameter of pipe (m)	1	
	e)	**Write any two applications of hydraulics in Irrigation Engineering.**		
	Ans.	Applications of hydraulics with respect to Irrigation are as follows- 1. To measure velocity, pressure and discharge on flowing fluid. 2. To distribution of water for agriculture purpose. 3. To determine velocity of flow at a point in open channel. 4. To calculate total pressure and Centre of pressure acting on dam. 5. To design channel section, spillway etc.	1 mark each (any Two)	2
	f)	**Define "Froude's number".**		
	Ans.	Froude's number is a dimensionless number and is the ratio between inertia force to gravity force.	2	2

<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answers</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>1.</td><td>g)
Ans.</td><td>

Distinguish between Laminar flow and Turbulent flow.

<table>
<tr><th>Sr. No.</th><th>Laminar Flow</th><th>Turbulent Flow</th></tr>
<tr><td>1.</td><td>Each particle moves in a definite path and do not cross each other.</td><td>The fluid particle continuously mix and cross each other.</td></tr>
<tr><td>2.</td><td>It occurs at low velocity of flow</td><td>It occurs at high velocity of flow.</td></tr>
<tr><td>3.</td><td>This flow occurs in viscous fluids.</td><td>This flow occurs in fluid having very less viscosity.</td></tr>
<tr><td>4.</td><td>Reynolds number is less than 2000.</td><td>Reynolds number is more than 4000.</td></tr>
<tr><td>5.</td><td>Fluid particle move in layers with one layer over other.</td><td>Fluid particle moves in disorderly manner, they cross the path of each other.</td></tr>
<tr><td>6.</td><td>e.g.
a) Blood flowing through veins.
b) Oil flowing through pipes.
c) Water flowing through tap at low velocities.</td><td>e.g.
a) Water flowing through river.
b) Flood flow</td></tr>
<tr><td>7.</td><td>
Laminar Flow</td><td>
Turbulent Flow</td></tr>
</table>

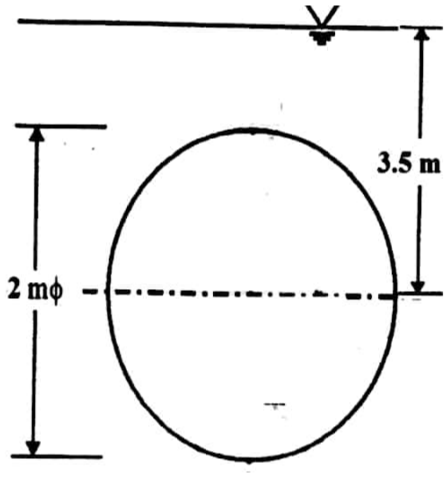
</td><td>½ mark each (any four)</td><td>2</td></tr>
<tr><td></td><td>h)
Ans.</td><td>

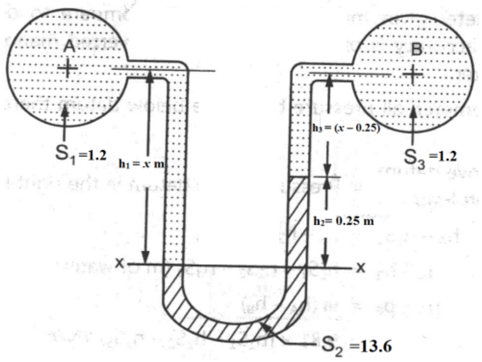
State any two uses of pitot tube.

1. Pitot tube is used to measure to velocity in channel.
2. Pitot tube is used to measure to velocity in pipe.

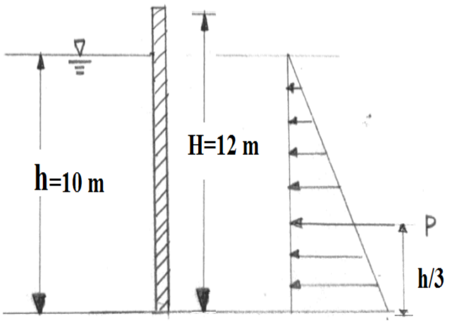
</td><td>2</td><td>2</td></tr>
</table>

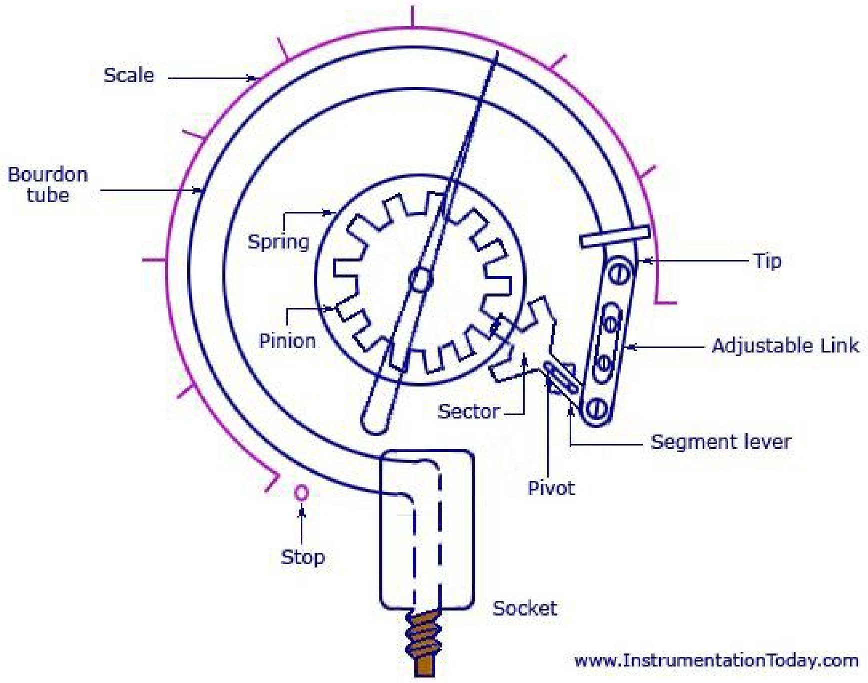
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
1.	**i)**	**State the meaning of priming and its purpose.**		
	Ans.	**Priming:-**The operation of filling the casing, impeller and suction pipe of delivery pump up to delivery valve is called priming.	**1**	**2**
		Purpose:-To remove the air from suction pipe and the pump.	**1**	
	j)	**Define discharge and state its unit.**		
	Ans.	**Discharge: -** It is defined as the quantity of fluid flowing through a section per unit time.	**1**	**2**
		Unit :– lit/sec, m^3/s	**1**	
	k)	**Define the term surface tension.**		
	Ans.	The tension of the surface film of a liquid caused by the attraction of the particles (cohesion) in the surface layer by the bulk of the liquid, which tends to minimize surface area.	**2**	**2**
	l)	**Define HGL and TEL.**		
	Ans.	**Hydraulic Gradient Line (HGL):** If a line is drawn joining the piezometer levels at various points, the line so obtained is called 'hydraulic gradient line'.	**1**	**2**
		Total Energy Line (TEL): If at different sections of the pipe , the total energy in terms of head is plotted to scale as vertical ordinate above the assumed datum and all these points are joined then a sloping straight line will be obtained , which is known as total energy line or total gradient line.	**1**	
	m)	**State two limitations of piezometer.**		
	Ans.	1. Piezometer is not suitable for measuring high pressure. 2. Piezometer is not suitable for measuring vacuum pressure.	**2**	**2**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 2		**Attempt any FOUR of the following:**		**(16)**
	(a)	**A circular plate of 2 m diameter immersed vertically in liquid having specific gravity 0.8, so that the centre of plate is 3.5 m below free surface. Determine total pressure and center of pressure.**		
	Ans.	Given: $S_L = 0.8, \quad d = 2m,$ $\bar{y} = 3.5m$ Find: P, $\bar{h}$  $A=\frac{\pi}{4}\times d^2$ $A=\frac{\pi}{4}\times 2^2$ $\boxed{A= 3.14\ m^2}$	½	
		$I_G = \frac{\pi}{64}\times d^4$ $= \frac{\pi}{64}\times 2^4$ $\boxed{I_G = 0.785\ m^4}$	½	
		$\theta = 90^0$ $P = \gamma_L A\,\bar{y}$	½	4
		$P = \gamma_W . S_L . A . \bar{y}$ $= 0.8\times 9.810\times 3.14\times 3.5$ $= 86.25\times 10^3$ kN $\boxed{P = 86.25\times 10^3\ N}$	1	
		$\bar{h} = \frac{I_G \sin^2\theta}{A\,\bar{y}} + \bar{y}$	½	
		$\bar{h} = \frac{0.785\times \sin^2 90}{3.14\times 3.5} + 3.5$ $\boxed{\bar{h} = 3.57\ m}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	**(b)**	**A 'U' tube differential mercury manometer connected two points of horizontal pipe carrying liquid of sp. gr. 1.2. Shows differential reading of 25 cm. Find pressure difference between two points in terms of N/m^2.**		
	Ans.	Given: $h_1 = x$, $S_1 = 1.2$ $h_2 = 0.25\ m$, $S_2 = 13.6$ $h_3 = (x - 0.25)\,m$ $S_3 = 1.2$ Find: $(h_A - h_B)$, $(P_A - P_B)$ 	1	
		$h_A + h_1S_1 = h_2S_2 + h_3S_3 + h_B$ $(h_A - h_B) = h_2S_2 + h_3S_3 - h_1S_1$	1	4
		$(h_A - h_B) = 0.25 \times 13.6 + (x - 0.25) \times 1.2 - (x \times 1.2)$ $\boxed{(h_A - h_B) = 3.1\ m}$	1	
		$\because \frac{P}{\gamma_L}$ $\frac{P_A}{\gamma_L} - \frac{P_B}{\gamma_L} = 3.1$ $(P_A - P_B) = 3.1 \times \gamma_L$ $(P_A - P_B) = 3.1 \times 9810$ $\boxed{(P_A - P_B) = 30411 N/m^2}$	1	
	(c)	**Define:** **(i) Specific gravity** **(ii) Specific volume** **(iii) Ideal fluid** **(iv) Real fluid**		
	Ans.	**(i) Specific gravity**: - It is the ratio of specific weight of liquid to the specific weight of pure water. **OR** It is ratio of specific mass of liquid to the specific mass of pure liquid	1	
		(ii) Specific volume: - It is the volume occupied by unit mass of liquid. **OR** It is reciprocal of specific mass.	1	4
		(iii) Real Fluid: - A fluid which possesses viscosity, is known as real fluid. All the fluids, in actual practice, are real fluids.	1	
		(iv) Ideal Fluid: - A fluid which is incompressible and is having no viscosity is known as an ideal fluid. Ideal Fluid is only an imaginary fluid.	1	

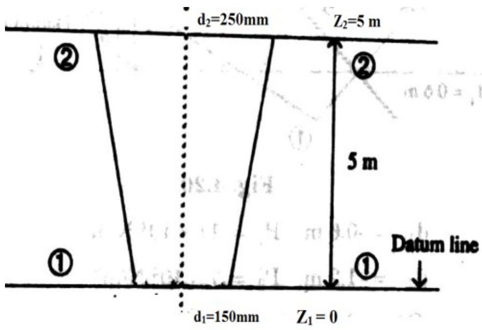
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	(d)	**Write the Bernoulli's theorem and give any two limitations of its.**		
	Ans.	**Bernoulli's theorem:** It states that in an ideal incompressible fluid, when the flow is steady and continuous the sum of pressure energy, kinetic energy and potential energy (or datum) energy is constant along a stream line.	1	
		Mathematically, $\frac{P}{\gamma_L}+\frac{V^2}{2g}+z=\text{Constant}$ Where, $\frac{P}{\gamma_L}$ = Pressure energy Or Pressure head $\frac{V^2}{2g}$ = Kinetic energy Or Velocity head z = Datum Or Potential head	1	4
		Limitations: 1)Velocity of every liquid particle, across any cross section of pipe is not uniform. 2) Bernoulli's equation is not applicable for fluid with unsteady flow. 3) Bernoulli's theorem is applicable for fluid with zero viscosity. 4) Bernoulli's equation has been derived under the assumption that there is no loss of energy of the liquid particle while flowing 5) If liquid is flowing in curved path, the energy due to centrifugal force should also be taken into account.	**1 mark each (any two)**	
	(e)	**Define dynamic viscosity and kinematic viscosity with their SI unit.**		
	Ans.	**Dynamic Viscosity: -** It is defined as shear stress (τ) required to produce unit rate of shear strain (du/dy).	1	
		Unit = N.sec/m^2	1	
		Kinematic Viscosity: - It is defined as the ratio between the dynamic viscosity (μ) and mass density of fluid (ρ).	1	4
		Unit = m^2/sec	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
2.	**(f)**	**A concrete dam 12 m deep and 2 m wide containing water to a depth of 10 m. Find total hydrostatic pressure per meter run and centre of pressure on upstream face.**		
	Ans.	Given: H =12 m h = 10 m b = 2 m 	1	
		Find: P and $\bar{h}$ Hydrostatic pressure (P) $P = \frac{1}{2} \times \gamma_W \times h^2$	1	
		$P = \frac{1}{2} \times 9.810 \times 10^2$ P = 490.5 kN per meter $\boxed{\text{P = 490.5 kN per meter length of dam}}$	1	4
		Center of pressure ($\bar{h}$) $\bar{h} = \frac{h}{3}$ from base $\bar{h} = \frac{10}{3}$ =3.33m $\boxed{\bar{h} = 3.33\text{ m from the base of dam}}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 3		**Attempt any FOUR of the following:**		**(16)**
	(a)	**Explain with neat sketch the working of Bourdon tube pressure gauge.**		
	Ans.	 Bourdon Tube Pressure Gauge	2	4
		Working: - Bourdon tube pressure gauge is used to measure high pressure. It consists of tube as shown in fig. having elliptical cross section. This tube is called as Bourdons Tube. One end of this tube is connected the point whose pressure is to be measured and other end free. When fluid enters in the tube elliptical cross section of tube becomes circular. Due to this the free end of tube shifts outward. This motion is transferred through link and pointer arrangement. The pointer moves over a calibrated scale, which directly indicates the pressure in terms of N/m^2 or m head of mercury.	2	
	(b)	**A 5 m vertical pipes tapers from 150 mm diameter at lower end to 250 mm diameter at upper end. Determine the discharge through pipe, if flow is upward and pressure gauges fitted at ends of pipe indicate same value.**		
	Ans.	*Given :* $d_1 = 150mm \quad L = 5m$ $d_2 = 250mm \quad Z_1 = 0 \quad Z_2 = 5m$ $A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(0.15)^2 = 0.0176m^2$ $A_2 = \frac{\pi}{4} d^2 = \frac{\pi}{4}(0.25)^2 = 0.0490m^2$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	**(b)**	*By* continuity Eqution,		

$Q = A_1V_1 = A_2V_2$



$$V_2 = \frac{A_1}{A_2}.V_1 = \frac{0.0176}{0.0496}V_1$$

$$\boxed{\therefore V_2 = 0.359V_1}$$ **1**

By applying Bernoulis eq^n

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

But,

$P_1 = P_2$ as given,

$$\therefore \frac{V_1^2}{2g} + 0 = \frac{V_2^2}{2g}$$

$$\frac{V_1^2}{2\times 9.81} = \frac{(0.359V_1)^2}{2\times 9.81} + 5$$

$$(1-0.1288)\frac{V_1^2}{2g} = 5$$

$$\boxed{V_1 = 10.61 \text{ m/sec}}$$ **1**

$V_2 = 0.359\ V_1$

$V_2 = 0.359\times 10.61$

$$\boxed{V_2 = 3.80 \text{ m/sec}}$$

$$\therefore Q = A_1V_1 = 0.0176\times 10.61$$

$$\boxed{\therefore Q = 0.186 \text{ m}^3\text{/sec}}$$ **1**

Total Marks: **4**

(c) **State any four minor losses with their formulas.**

Ans.

1. Loss of head at the entrance.

$$H_L = \frac{0.5V^2}{2g}$$

Where ,
H_L = Head loss
V = Velocity

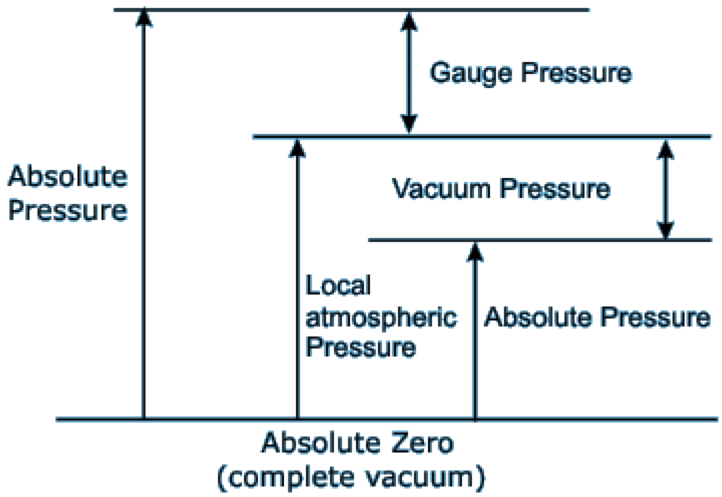
2. Loss of head due to sudden expansion.

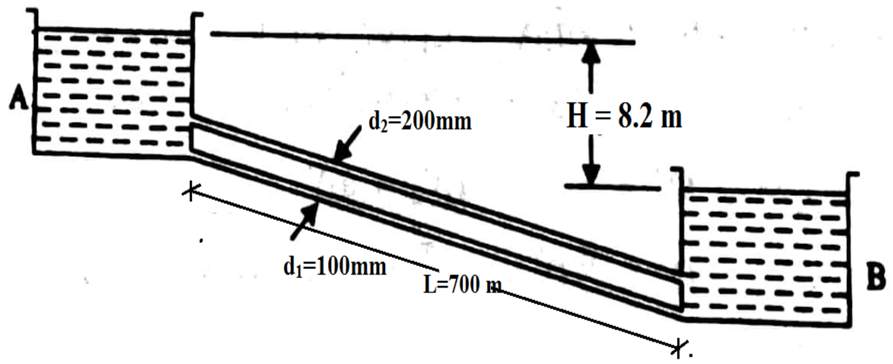
$$H_L = \frac{(V_1 - V_2)^2}{2g}$$

Marks: **1 mark each (any four)** — Total Marks: **4**

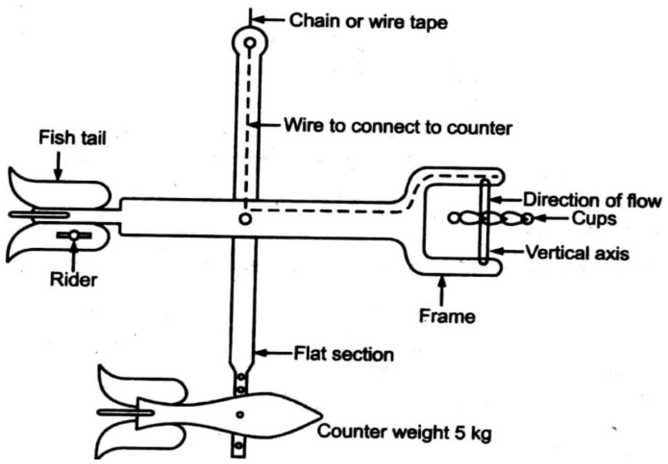
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	(c)	3. Loss of head due to sudden contraction. $H_L = \frac{0.5V^2}{2g}$ 4. Loss of head due to bend. $H_L = K\frac{V^2}{2g}$ 5. Loss of head due to exit. $H_L = \frac{V^2}{2g}$ 6. Loss of head due to obstruction. $H_L = \left[\frac{A}{C_c \times a} - 1\right]^2 \frac{V^2}{2g}$ A = c/ s Area of pipe a = c/ s Area of Opening C_C =Coefficient contraction 7. Loss of head due to pipe fitting. $H_L = K\frac{V^2}{2g}$		
	d)	**A liquid of specific gravity 0.9 is flowing through horizontal pipe of 100 mm diameter at the rate 25 lit/s. Find the total head at a point where pressure is 100 kPa. Consider datum height as a 2m.**		
	Ans.	Given: S= 0.9, d = 100mm = 0.1m P =100 kPa Z = 2m Q = 25 lit/sec = 25 $\times 10^{-3}$ m^3/sec Find: H $A = \frac{\pi}{4} \times (d)^2 = \frac{\pi}{4} \times (0.1)^2 = 7.853 \times 10^{-3} m^2$ $V = \frac{Q}{A} = \frac{25 \times 10^{-3}}{7.853 \times 10^{-3}}$ $\boxed{V = 3.183 m/sec}$	1 1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	(d)	$H=\frac{P}{\gamma}+\frac{V^2}{2g}+Z$	1	
		$=\frac{100}{9.81}+\frac{(3.183)^2}{2\times9.81}+2$		4
		$=10.193+0.516+2$		
		$=12.71m$		
		$\boxed{H=12.71m}$	1	
	(e)	**Define hydraulic jump and state its two applications.**		
	Ans.	**Hydraulic Jump: -** It is the phenomenon occurring in an open channel when rapidly flowing stream abruptly change to slowly flowing stream causing a distance rise or jump in level of liquid surface.	2	
		Applications of hydraulic jump		4
		This phenomenon is used in hydraulic structures constructed for irrigation, water supply works such as		
		1) Energy dissipation below the spillway of dam. 2) Mixing of chemicals in water treatment plants. 3) Retaining head in canal if head drops due to losses in long canals.	1 mark each (any two)	
	(f)	**Explain:** **(i) Atmospheric pressure (ii) Absolute pressure** **(iii) Gauge pressure (iv) Vacuum pressure**		
	Ans.	**(i) Atmospheric pressure :** The Atmospheric air exerts a normal pressure upon all the surfaces with which it comes in contact is called as atmospheric pressure. The atmospheric pressure varies with the altitude. It can be measured by means of a barometer.	1	
		(ii) Absolute pressure : The pressure, which is measured with references to absolute vacuum pressure or zero pressure is called as absolute pressure.	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
3.	(f)	**iii) Gauge pressure :** The pressure, which is measured above the atmospheric pressure is called as gauge pressure. It is measured with the help of pressure measuring instrument.	1	4
		iv) Vacuum pressure : The pressure which is measured below the atmospheric pressure is called as vacuum pressure or negative pressure. It is measured with the help of pressure measuring instruments.	1	
				

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 4		**Attempt any FOUR of the following.**		**(16)**
	(a)	**State causes and effect of water hammer.**		
	Ans.	**Cause :** a. If a fluid flowing in a pipe is suddenly brought to rest by closing the valve. This will cause water hammer.	**2**	
		Effects : a. Due to water hammer, the pipe can burst. b. Due to water hammer pipe joint can be leak. c. Due to water hammer a series of vibrations takes place. d. These vibrations setups noise in the pipe.	**½ mark each)**	**4**
	(b)	**Two tanks are connected by two parallel pipes of diameter 100 mm and 200 mm respectively having length of 700m. Find the discharge through each pipe if difference in water level of two tank is 8.2 m. Take f = 0.027 for both pipes.**		
	Ans.	 Given: d_1 =100mm $L_1 = L_2$ = 700m f = 0.027 d_2 =200mm H = 8.2m Find: Q for parallel pipes. ***(Note: The given problem is solved by taking f is coefficient of friction.)***		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.	**(b)**	$h_{L_1} = h_{L_2} = H$		
		$\left[\frac{4fL_1V_1^2}{2gd_1}\right] = \left[\frac{4fL_2V_2^2}{2gd_2}\right] = 8.2$	**1**	
		$\left[\frac{4\times 0.027\times 700\times V_1^2}{2\times 9.81\times 0.1}\right] = \left[\frac{4\times 0.027\times 700\times V_2^2}{2\times 9.81\times 0.2}\right] = 8.2$		
		$10V_1^2 = 5V_2^2 = 8.2$		
		$V_1^2 = \frac{5}{10}V_2^2 = 8.2$		
		$10V_1^2 = 8.2$		
		$V_1^2 = 0.82$		
		$\boxed{V_1 = 0.905 \text{ m/s}}$	**1**	
		$5V_2^2 = 8.2$		
		$V_2^2 = 1.64$		
		$\boxed{V_2 = 1.280 \text{ m/s}}$		**4**
		Total discharge,		
		$Q_1 = Q_1 + Q_2$		
		$Q_1 = A_1V_1$		
		$= \frac{\pi}{4}\times 0.1^2\times 0.905$		
		$\boxed{Q_1 = 7.10\times 10^{-3} m^3/sec}$	**1**	
		$Q_2 = A_2V_2$		
		$= \frac{\pi}{4}\times 0.2^2\times 1.280$		
		$\boxed{Q_2 = 0.040 m^3/sec}$		
		$Q = 7.10\times 10^{-3} + 0.040$		
		$\boxed{Q = 0.0473 m^3/sec}$	**1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.	**(c)**	**Explain the working principle of current meter with neat sketch**.		
	Ans.	**Principle:-** It is small reaction turbine. When placed in flow of water it rotates with speed. The velocity can be calibrated by observing revolutions per minute towing with a carriage mounted on rails, across still water at known velocities. A current meter is a mechanical device which has revolving elements such as cups which revolve when the current meter is immersed in flowing water. It is used to measure the velocity of liquid in open channels. The current meter consist of hallow hemisphere or cones mounted on spokes so as to cause rotation about a shaft perpendicular to direction of flow. The magnitude of fluid velocity is determined by the calibration curve. The calibration curve for the current meter can be prepared by plotting the rotation at speed (rpm) versus the speed of towing carriage (m/s), which will use to find the velocity of flow of water in the channel.	**2**	**4**
			**2**	

<table>
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<tr><td>4.</td><td>(d)

Ans.</td><td>
A venturimeter 30 cm diameter at entrance to 10 cm diameter at throat connected to pipe flowing water. The difference in mercury level of manometer is 6 cm. Calculate the discharge flowing through the pipe.

Given:
$d_1 = 30\,cm = 0.3\,m$
$d_2 = 10\,cm = 0.1\,m$
$x = 6\,cm = 0.06\,m$
Find: Q
Area of pipe, $a_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(0.3)^2 = 0.0707\,m^2$
Area of throat, $a_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(0.1)^2 = 7.854\times10^{-3}\,m^2$
Differential pressure head,
$h = x\left(\frac{Sm}{S} - 1\right)$
$h = 0.06\left(\frac{13.6}{1} - 1\right)$
$\boxed{h = 0.756\,m}$
Discharge through venturimeter,
$Q_{th} = \frac{a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$
$Q_{th} = \frac{7.854\times10^{-3}\times0.0707\sqrt{2\times9.81\times0.756}}{\sqrt{(0.0707)^2 - (7.854\times10^{-3})^2}}$
$Q_{th} = \frac{2.1377\times10^{-3}}{0.07026}$
$\boxed{Q_{th} = 0.0304\,m^3/sec}$
$Q_{act.} = C_d \times Q_{th}$
$Q_{act.} = C_d \times 0.0304$
$\boxed{Q = 0.0304\,C_d \text{ lit/sec}}$

(Note: Value of C_d is not given in problem. If the students assumed an appropriate value of C_d and tried to attempt the question give appropriate marks.)
</td><td>1

1

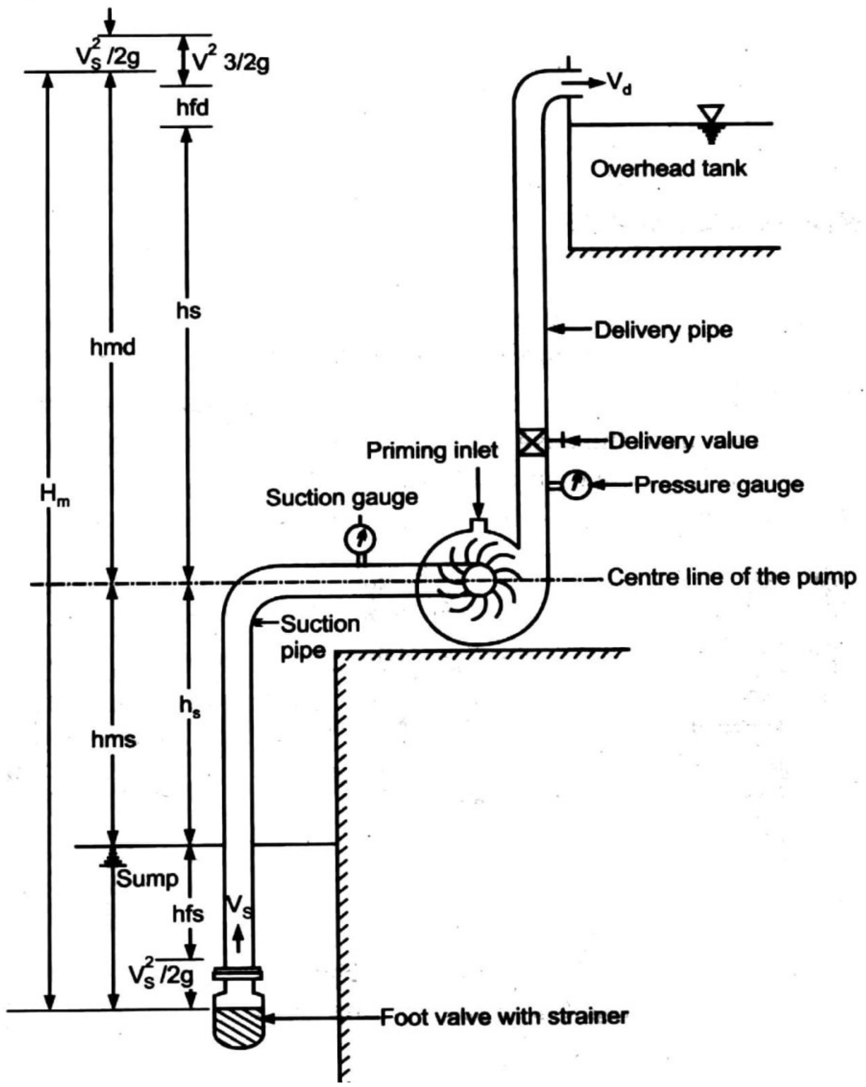
1

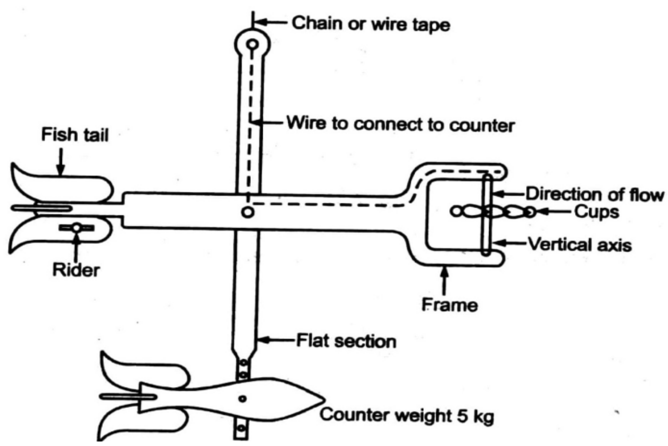
1</td><td>4</td></tr>
</table>

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
4.	(e)	**Define the frictional loss and state any four factors affecting frictional loss.**		
	Ans.	**Frictional Loss: -** The loss of head due to friction between liquid flowing through pipe and pipe surface is called as frictional loss.	2	4
		Factors affecting friction loss: - 1. Nature of surface of pipe material. 2. Pipe diameter. 3. Length of pipeline. 4. Head loss. 5. Square of the velocity of flow.	½ mark each (any four)	
	(f)	**Differentiate any four points between Notch and Weir.**		
	Ans.	(see table below)	1 mark each	4

Sr. No.	Notch	Weir
1	It is the device used for measuring the rate of flow of liquid through a small channel or a tank.	It is used for measuring the rate of flow of water in rivers or streams.
2	Notches are made of metallic plates.	Weirs are made of concrete or masonry structure.
3	Notches are of smaller sizes.	Weir is of bigger sizes.
4	e. g. Rectangular, Triangular, Trapezoidal, stepped notch.	e. g. According to shape, discharge, width of crest, nature of crest.

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5		**Attempt any FOUR of the following:**		**(16)**
	(a)	**A 80 mm diameter orifice discharges water 100 lit/sec under a constant head of 6m. The diameter of jet at vena-contracta is 7 cm. Calculate C_d, C_v, C_c.**		
	Ans.	Given:		
		$Q = 100\ \text{lit/sec} = 100\times10^{-3}\ m^3/s$		
		Head (H) $= 6\,m$		
		Diameter of orifice 80 mm $(D_o) = 0.08m$		
		Diameter of vena contracta 7 cm $(d_a) = 0.07\,m$		
		Find: C_C, C_d, C_V		
		$C_C = \dfrac{\text{Area of jet at vena contracta}}{\text{Area of orifice}}$		
		$= \dfrac{\frac{\pi}{4}\times0.07^2}{\frac{\pi}{4}\times0.08^2}$		
		$\boxed{C_C = 0.765}$	1	
		$C_d = \dfrac{Q_{actual}}{Q_{therotical}}$		
		$= \dfrac{100\times10^{-3}}{a\times\sqrt{2gh}}$	1	
		$= \dfrac{100\times10^{-3}}{\frac{\pi}{4}\times0.08^2\times\sqrt{2\times9.81\times6}}$		4
		$= \dfrac{100\times10^{-3}}{54.53\times10^{-3}}$	1	
		$\boxed{C_d = 1.83}$		
		$C_d = C_C.C_V$		
		$1.83 = 0.765\times C_v$		
		$\boxed{C_v = 2.39}$	1	
		(Note: - $Q_{act.} > Q_{th}$ there for C_d and C_v are greater than one which is not practically possible)		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.	**(b)**	**Explain with sketch working of the centrifugal pump.**		
	Ans.	**Principle-**When certain mass of liquid is made to rotate by an external force it is thrown away from the central axis of rotation and a centrifugal head is impressed which enables it to rise to higher level.	1	
		Working of centrifugal pump is in three stages. i) Priming ii) Starting iii) Stopping		
		i) **Priming-** The operation of filling the casing, impeller and suction pipe upto delivery valve is called priming. ii) **Starting-** Before starting first of all check that priming is done and return valve is not in closed condition. iii) **Stopping** - To stop the pump, delivery valve should be closed partly. Motor is switched off and then value is closed fully.	1	
		 **Centrifugal Pump**	2	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.	(c)	**Enlist various methods of measuring velocity of open channel flow. Explain any one.**		
	Ans.	**Velocity measuring methods for open channel flow.** 1) Current meter 2) Float 3) Pitot tube	1	
		1**) Current meter** A current meter is a mechanical device which has revolving elements such as cups which revolve when the current meter is immersed in flowing water. It Is used to measure the velocity of liquid in open channels. The current meter consist of hallow hemisphere or cones mounted on spokes so as to cause rotation about a shaft perpendicular to direction of flow. The magnitude of fluid velocity is determined by the calibration curve. The calibration curve for the current meter can be prepared by plotting the rotation at speed (rpm) versus the speed of towing carriage (m/s), which will use to find the velocity of flow of water in the channel.  	3	4
		2) Float A float is small object made of wood or other suitable material which is lighter than water and thus capable of floating on the water surface. It provides a simple way of measuring the velocity of the flow of water in river and channels. Different types of float are **a) Single float or surface float** **b) Subsurface float or double float** **c) Rod floats or velocity rods**	OR 3	

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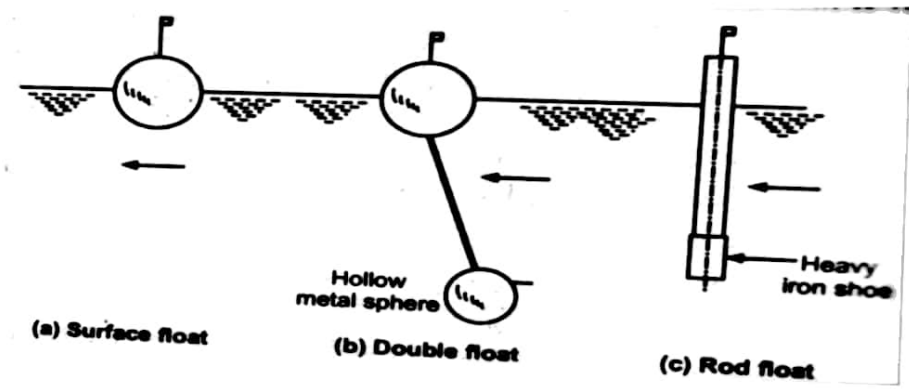
a) Single float or surface float:
It may be a piece of wood or an empty bottle. This is put on the surface of flowing water and time is noted. This float will flow with the flowing water and time is noted after travelling some distance Velocity = distance travelled / time. This gives surface velocity

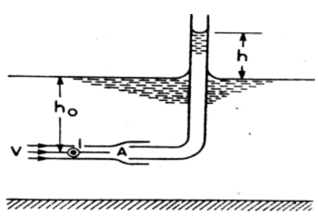
b) Subsurface float or double float:
It is used to determine the mean velocity. It consists of two floats connected by chain or rope. One float moves on the surface and other which is heavier located at 0.6 of total depth.

c) Rod floats or velocity rods:
It consists of vertical wooden rod heavier at the bottom. The depth of rod is 0.9 to 0.97 time's total depth. It gives mean velocity.



3) Pitot tube: If the velocity at particular point is reduced to zero, which is known as stagnation point, the pressure is increased due to the conversion of kinetic energy into pressure energy and by measuring the increase in pressure energy at this point, the velocity of flow mass be determined.
The velocity of flow in a closed pipe is not the same at all points of c/s for rough calculation. The velocity at center of the pipe is measured. The velocity of flow at center of the pipe is maximum. Then mean velocity is equal to 0.84 times the maximum. Then mean velocity is equal to 0.84 times the maximum velocity.

A simple pitot tube is glass tube bent at right angle. The tube is placed in the moving liquid pipe.



Pitot Tube
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Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.	**(d)**	**A rectangular channel having cross section 7 m wide and 1.8 m deep. The bed slope is 1 in 2000. Determine the velocity of channel if N=0.03 and C=42.**		
	Ans.	*Given* :		
		$b=7, \quad d=1.8, \quad S=\frac{1}{2000}$		
		$N=0.03,\ C=42$		
		Find : V		
		$A=b\times d=7\times 1.8$		
		$\boxed{A=12.6\,m^2}$	½	
		$P=b+2d=7+2\times 1.8$		
		$\boxed{P=10.6\,m}$	½	
		$R=\frac{A}{P}=\frac{12.6}{10.6}$		
		$\boxed{R=1.189\,m}$	½	
		Using Chezys formula,		
		$V=C\sqrt{RS}$	½	
		$V=42\sqrt{1.189\times\frac{1}{2000}}$		**4**
		$V=42\times 0.0243$		
		$\boxed{V=1.024\ m/s}$	½	
		Using Mannings formula,		
		$V=\frac{1}{N}\times R^{\frac{2}{3}}\times S^{\frac{1}{2}}$	½	
		$=\frac{1}{0.03}\times(1.189)^{\frac{2}{3}}\times\left(\frac{1}{2000}\right)^{\frac{1}{2}}$	½	
		$V=\frac{1}{0.03}\times 1.122\times 0.022$		
		$\boxed{V=0.836\,m/s}$	½	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.	(e)	**State and explain Dupuit's equation for equivalent pipe.**		
	Ans.	**Dupuit's equation: -** $\frac{L}{D^5} = \frac{L_1}{D_1^5} + \frac{L_2}{D_2^5} + \frac{L_3}{D_3^5} + ... + \frac{L_n}{D_n^5}$	2	
		Where, $L = Length$ of equivalent pipe (m)		4
		D = Daimeter of equivalent pipe (m) $D_1, D_2, D_3, ...D_n = Daimeters$ of compound pipe (m) $L_1, L_2, L_3 ....L_n = Length$ of compound pipe (m)	1	
		Compound pipe consisting of several pipes of different diameter and length is sometimes replaced by a single pipe of uniform diameter which is known as equivalent pipe. Total head loss in compound pipe neglecting minor losses is equal to the total head in equivalent pipe.	1	
	(f)	**Calculate power required for pump under following condition:** **(i) Water to be pumped = 4 x 10^6 lit/sec** **(ii) Pumping hours = 6 hours** **(iii) Total lift = 10 m** **(iv) All losses = 5 m** **(v) Efficiency = 75 %**		
	Ans.	$Q = 4 \times 10^6 \times 10^{-3} m^3 / \sec$	1	
		$Q = 4 \times 10^3 m^3 / \sec$ $H_m = 10 + 5 = 15m$	1	4
		$\eta = 75\ \% = 0.75$ $\text{Power required} = \frac{\gamma_w Q H_m}{\eta}$ $= \frac{9810 \times 4 \times 10^3 \times 15}{0.75}$	1	
		$= 7840800 \times 10^3 W$ $\boxed{\text{Power required } = 7840800\ kW}$	1	
		(Note: - If the above problem is solved by using water to be pumped = 4 x 10^6 lit/ day, should be considered and give appropriate marks.)		
		OR		

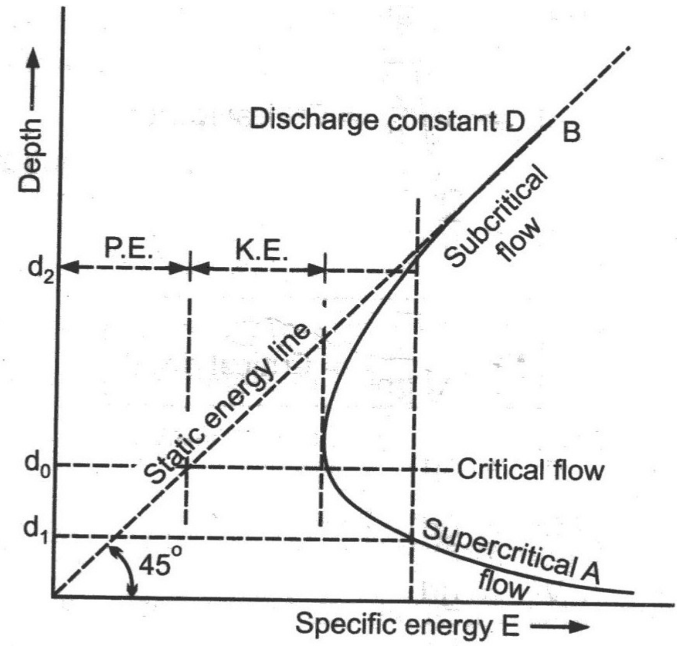
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
5.	**(f)**	Find: Power required Water to be pumped for 6 hours $Q=\frac{4\times10^{6}\times10^{-3}}{6\times60\times60}$ $Q=0.185\ m^3/s$ $H_m=10+5=15m$ $\eta=75\ \%=0.75$ $\text{Power required}=\frac{\gamma_w\,Q\,H_m}{\eta}$ $=\frac{9810\times0.185\times15}{0.75}$ $=36297\,W$ $\boxed{\text{Power required }=36.297\,kW}$	**1** **1** **1** **1**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 6		**Attempt any TWO of the following :**		**(16)**
	(a)	**A pipeline 50 m long is connected to a water tank at one end and discharges freely into atmosphere at the other end. For the first 30 m of its length from tank, the pipe line is 15 cm diameter and its diameter suddenly enlarged to 30 cm. The height of water level in the tank is 8 m above center of pipe. Considering all losses of head, determine rate of flow f = 0.16.**		
	Ans.	***(Note: The given problem is solved by taking f is a friction factor.)***		
		Given : $L = 50m,\ \ L_1 = 30m,\ d_1 = 15cm = 0.15m,$ $L_2 = (50-30) = 20m,$ $d_2 = 30cm = 0.3m,\quad H = 8m,$ $f = 0.16$ *Find* : h_L, Q Using continuity eq^n $Q_1 = Q_2$ $A_1V_1 = A_2V_2$ $\frac{\pi}{4}d_1^2V_1 = \frac{\pi}{4}d_2^2V_2$ $(0.15)^2V_1 = (0.3)^2V_2$ $\boxed{V_1 = 4V_2}$	**1**	
		All lossess = Loss at entrance + h_{f_1} + Loss due to sudden enlargement + h_{f_1} +Loss at exit *Loss* at entrance , $h_{L_{entrance}} = \frac{0.5V_1^2}{2g}$ $h_{L_{entrance}} = \frac{0.5\times(4V_2)^2}{2\times9.81}$ $\boxed{h_{L_{entrance}} = 0.4077V_2^2}$	**1**	
		Major loss in pipe $h_{f_1} = \left[\frac{f_1L_1V_1^2}{2gd_1}\right]$ $h_{f_1} = \left[\frac{0.16\times30\times(4V_2)^2}{2\times9.81\times0.15}\right]$ $\boxed{h_{f_1} = 26.0956V_2^2}$	**1**	
		Loss due to sudden enlargement, $h_{L_{enlargment}} = \frac{(V_1-V_2)^2}{2g}$ $h_{L_{enlargment}} = \frac{(4V_2-V_2)^2}{2g}$ $\boxed{h_{L_{enlargment}} = 0.458V_2^2}$	**1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6	(a)	*Major loss* in pipe $h_{f_2} = \left[\frac{fL_2V_2^2}{2gd_2}\right]$ $h_{f_2} = \left[\frac{0.16\times20\times V_2^2}{2\times9.81\times0.30}\right]$ $\boxed{h_{f_2} = 0.543V_2^2}$	1	8
		Loss at exit, $h_{L_{exit}} = \frac{V_2^2}{2g}$ $\boxed{h_{L_{exit}} = 0.051V_2^2}$	1	
		Appling Bernouli's equetion, $\frac{P_1}{\gamma_\omega}+\frac{V_1^2}{2g}+Z_1 = \frac{P_2}{\gamma_\omega}+\frac{V_2^2}{2g}+Z_2+All\ lossess$ $0+0+8 = 0+0.051V_2^2+0+0.4077V_2^2+26.0956V_2^2+0.458V_2^2+0.543V_2^2+0.051V_2^2$ $8 = 27.606V_2^2$ $V_2^2 = 0.289$ $\boxed{V_2 = 0.5376m/\sec}$	1	
		$Q = A_2V_2$ $Q = \frac{\pi}{4}\times(d_2)^2\times V_2$ $Q = \frac{\pi}{4}\times(0.3)^2\times0.5376$ $\boxed{Q = 0.038m^3/\sec}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.	**(b)**	**(i) A trapezoidal lined channel has 4 m bed width, 0.8 depth of flow, side slope 1:1 and bed slope 1 in 3000. Find the capacity of channel if C= 60 in Chezy's formula.** **(ii) Write the condition of most economical section for rectangular and trapezoidal channel.**		
		(i)		
	Ans.	*Given* : $b = 4m$ $d = 0.8m$ *Side* slope (n) 1:1 $S=\frac{1}{3000}$ $C = 60$ *Find* : Q $A = bd+nd^2$ $= 4\times0.8+1\times0.8^2$ $\boxed{A = 3.84m^2}$	1	
		$P = b + 2d\sqrt{1+n^2}$ $P = 4 + 2\times0.8\sqrt{1+1^2}$ $\boxed{P = 6.26m}$	1	
		$R = \frac{A}{P}$ $R = \frac{3.84}{6.26}$ $\boxed{R = 0.6134m}$	1	
		$Q = AC\sqrt{RS}$ $=3.84\times60\times\sqrt{0.6134\times1/3000}$ $\boxed{Q = 3.294\ m^3/s}$	1	
		(ii) Most Economical Condition		8
		Rectangular channel:		
		b = 2d	1	
		$R = \frac{d}{2}$	1	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.	**(b)**	Trapezoidal channel:		
		$\frac{(b+2nd)}{2} = d\sqrt{(n+bd)}$	1	
		$R = \frac{d}{2}$	1	
		Where, b = Width of channel (m) d = Depth of channel (m) R = Hydraulics radius Or Hydraulic mean depth (m) n = Bed channel slope		
	(c)	**(i) Find the discharge over a triangular notch of angle 60^0, when the head over the notch is 20 cm. Take C_d = 0.625.** **(ii) Define Specific energy. Explain specific energy diagram.**		
	Ans.	**(i)**		
		Given : $\theta = 60^0$, $h = 20cm$ $C_d = 0.625$ *Find* : Q		
		$Q = \frac{8}{15} \times C_d \sqrt{2g} \times \tan\left(\frac{\theta}{2}\right) \times (h)^{\frac{5}{2}}$	2	
		$Q = \frac{8}{15} \times 0.625\sqrt{2\times 9.81} \times \tan\left(\frac{60}{2}\right) \times (0.2)^{\frac{5}{2}}$		
		$\boxed{Q = 0.01525 m^3/\sec}$	2	
				8

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
6.	**(c)**	**(ii)**		
		Specific Energy: Specific energy of a flowing liquid is defined as energy per unit weight with respect to the channel bottom.	1	
		 **Specific energy diagram**	2	
		In specific energy diagram, the graph is plotted between depth (Y axis) and specific energy (X axis). The depth corresponding to minimum specific energy is called critical depth. Apart from this for every other specific energy there will be two depths Supercritical and Subcritical depth.	1	