MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC - 27001 - 2013 Certified)

Model Answer: Winter- 2019

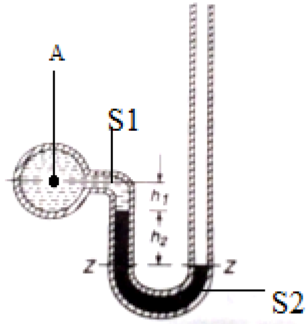
Subject: Hydraulics

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.

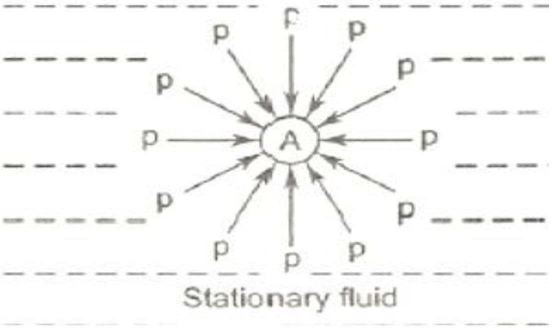
<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answer</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.1</td><td>(A)</td><td>Solve any SIX of the following:</td><td></td><td>(12)</td></tr>
<tr><td></td><td>(a)</td><td>Differentiate real and ideal fluid.</td><td></td><td></td></tr>
<tr><td></td><td>Ans.</td><td>
<table>
<tr><th>Sr. No.</th><th>Real fluid</th><th>Ideal fluid</th></tr>
<tr><td>1</td><td>Real fluid possess properties like viscosity, surface tension</td><td>Ideal fluid has no viscosity and no surface tension.</td></tr>
<tr><td>2</td><td>Real fluids are compressible</td><td>Ideal fluids are incompressible</td></tr>
<tr><td>3</td><td>Real fluids are practical fluid</td><td>Ideal fluid are an imaginary fluid</td></tr>
</table>
</td><td>1 each (any two)</td><td>2</td></tr>
</table>

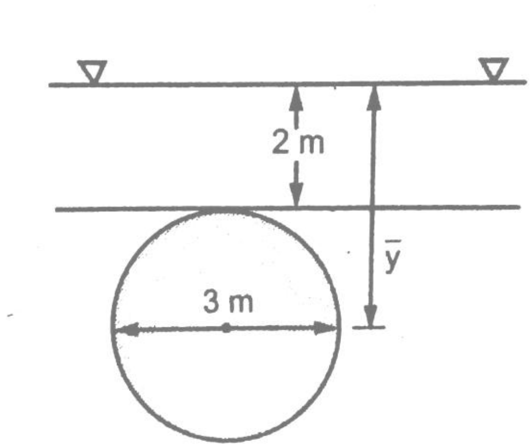
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	(b)	**State Newton's law of viscosity and state unit of dynamic viscosity.**		
	Ans.	It states that "The shear stress between adjacent fluid layers is proportional to velocity gradient between the two layers''. **OR** The shear stress on a layer of a fluid is directly proportional to the Velocity gradient.	1	
		Unit of dynamic viscosity is N-S/m^2	1	2
	(c)	**Express 8.5m of mercury in N/mm^2.**		
	Ans.	$P = \gamma H$ $P = S_m \gamma_w H$	½	
		$P = 13.6\times9.81\times8.5$ $P = 1134.04 kN/m^2$	½	
		$P = \frac{1134.04\times1000}{(1000)^2} = 1.134 N/mm^2$	1	2
	(d)	**How will you measure negative pressure?** By using U Tube manometer: it is an instrument that measure negative pressure.		
			1	
		Pressure head on lift limb = pressure head on right limb above z-z datum $h_A + h_1 s_1 + h_2 s_2 = 0$ $h_A = -(h_1 s_1 + h_2 s_2)$ h_A= pressure head at A	1	2

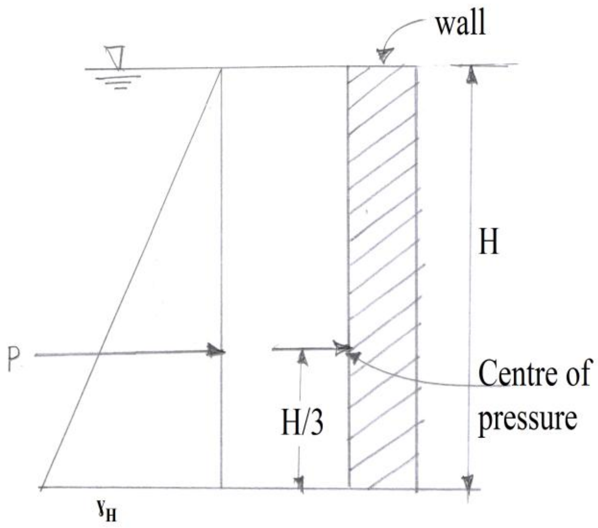
<table>
<tr><th>Que. No.</th><th>Sub. Que.</th><th>Model Answer</th><th>Marks</th><th>Total Marks</th></tr>
<tr><td>Q.1</td><td>(e)
Ans.</td><td>State Darcy Weisbatch equation for frictional loss.
It is an empirical equation which relates the head loss due to friction along a given length of pipe to the average velocity of the fluid flow for an incompressible fluid.
$h_f = \frac{fLV^2}{2gD}$
Where,f = Darcy's coeficient of friction
L = Length of pipe
V = Velocity of flow through pipe
g = acceleration due to gravity
D = Diameter of pipe</td><td>1
1</td><td>2</td></tr>
<tr><td></td><td>(f)
Ans.</td><td>List four types of minor losses.
i. Loss of head at the entrance
ii. Loss of head due to sudden expansion
iii. Loss of head due to sudden contraction
iv. Loss of head due to bend
v. Loss of head due to exit
vi. Loss of head due to gradual contraction & expansion
vii. Loss of head due to obstruction
viii. Loss of head due to bends
ix. Loss of head due to pipe fitting</td><td>½ each (any four)</td><td>2</td></tr>
<tr><td></td><td>(g)
Ans.</td><td>What is the difference between a notch and weir?
<table>
<tr><th>Sr. No.</th><th>Notch</th><th>Weir</th></tr>
<tr><td>1</td><td>It is an opening provided on one side of the tank or reservoir with free surface of liquid below the top edge of the opening.</td><td>It is a structure which obstructs the flow in an open channel.</td></tr>
<tr><td>2</td><td>It is a device used for measuring the rate of flow of liquid through a small channel or a tank</td><td>It is used for measuring the rate of flow of water in rivers or streams.</td></tr>
<tr><td>3</td><td>Notches are made of metallic plates</td><td>Weirs are made of concrete or masonry structure</td></tr>
<tr><td>4</td><td>Notch is of small sizes.</td><td>Weir is of bigger sizes.</td></tr>
<tr><td>5</td><td>e. g. Rectangular, Triangular, Trapezoidal, stepped notch.</td><td>e. g. According to shape, discharge, width of crest, nature of crest.</td></tr>
</table></td><td>½ each (any four)</td><td>2</td></tr>
</table>

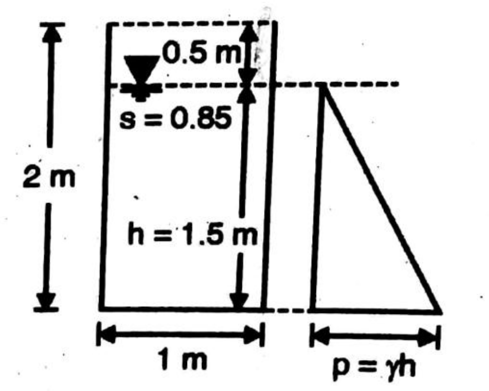
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	**(h)** **Ans.**	**State the significance of C_d and C_v in flow through orifice.** C_d is used to find the actual discharge from theoretical discharge which is calculated by formula $Q_{th} = a\sqrt{2gh}$ $Q_{act} = C_d \times a\sqrt{2gh}$ Once we find C_d or C_v for particular orifice we can find actual discharge and actual velocity of any flow with the help of that orifice $V_{th} = \sqrt{2gh}$ $V_{act} = C_v\sqrt{2gh}$	**2**	**2**

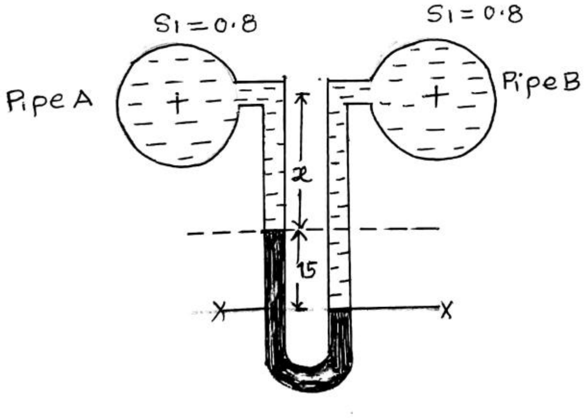
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	**(B)**	**Solve any TWO of the following:**		**(8)**
	(a)	**Write a note on application of hydraulics in Irrigation and Environmental Engineering.**		
	Ans.	**Application of hydraulics in irrigation engineering:** i. To determine the total pressure acting on the dam ii. To design the canal iii. To determine the discharge flowing through the canal or river.	**1 each (any two)**	
		Application of hydraulics in environmental engineering: i. To design the pipe line system for water supply and drainage. ii. To find the pressure acting on the side and bottom of the tank iii. To determine the discharge through the pipe iv. To determine the power of the pump required	**1 each (any two)**	**4**
	(b)	**Calculate the kinematic viscosity of oil whose Sp. gravity is 0.9 and viscosity is 0.1 N-S/m^2.**		
	Ans.	Given: Sp.gravity = 0.9 , Dynamic viscosity $\mu = 0.1 N\text{-}S/m^2$ Solution:		
		Sp.gravity = $\frac{\text{Mass density of liquid}}{\text{Mass density of water}}$	**1**	
		$0.9 = \frac{\rho}{1000}$		
		$\rho = 0.9\times1000 = 900\ kg/m^3$	**1**	
		Kinematic viscosity = $\frac{\text{Dynamic viscosity}}{\text{Mass density of liquid}}$	**1**	
		Kinematic viscosity = $\frac{0.1}{900} = 1.11\times10^{-4} m^2/sec$	**1**	**4**

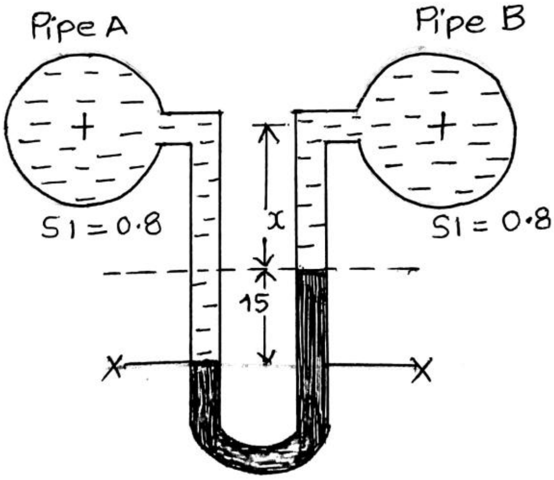
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1 (B)	(c) Ans.	**State Pascal's law and its practical applications.** **Pascal's Law:** It states that the pressure intensity or pressure at a point in a static fluid is equal in all directions.	1	
			1	
		Applications: Pascal's Law is applied in the construction of machines and used for multiple purposes. i. Hydraulic Jacks ii. Hydraulic Press iii. Hydraulic Lifts iv. Hydraulic Crane v. Braking system of motor vi. Artesian well vii. Dam	½ each (any four)	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2		**Solve any FOUR of the following:**		**(16)**
	(a)	**A circular plate 3.0 m diameter immersed in water vertically 2.0 m below free liquid surface. Find centre of pressure and total pressure.**		
	Ans.		**1**	
		Given:		
		Diameter of plate (D)= 3m		
		Solution:		
		$\bar{y}$ =2+1.5 = 3.5m		
		$A=\frac{\pi}{4}\times D^2=\frac{\pi}{4}\times 3^2=7.068m^2$	½	
		$I_g=\frac{\pi}{64}\times D^4=\frac{\pi}{64}\times 3^4=3.976m^4$	½	
		Total Pressure (P) = $\gamma A\bar{y}$		
		P = 9810×7.068×3.5		
		P = 242679.78 N		
		Centre of pressure $(\bar{h})=\frac{I_g}{A\bar{y}}+\bar{y}$	**1**	
		$\bar{h}=\frac{3.976}{7.068\times 3.5}+3.5$		
		$\bar{h}$ =3.66m	**1**	**4**

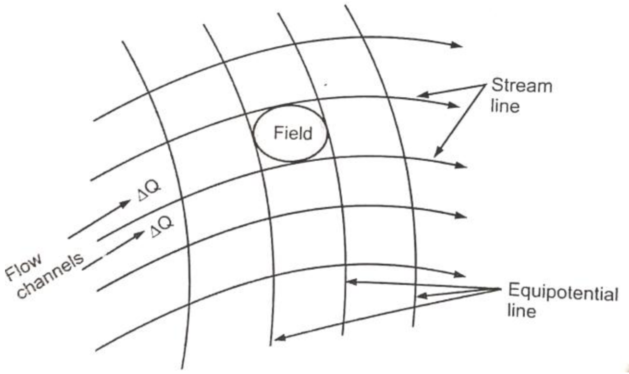
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	(b) Ans.	**Define total hydrostatic pressure and centre of pressure. Draw diagram to describe it.**		
		Total hydrostatic pressure: It is the force exerted by a static fluid on a surface plane or curved. This force is always perpendicular to the surface.	1	
		Centre of pressure: It is the point at which total pressure acts on the surface.	1	
		Diagram-  	1	
		Total pressure P = $\frac{1}{2}\gamma H^2$ N/m		
		Centre of pressure = H/3 from bottom Pressure intensity at top of wall = zero Pressure intensity at bottom of wall = γH N/m^2	1	4

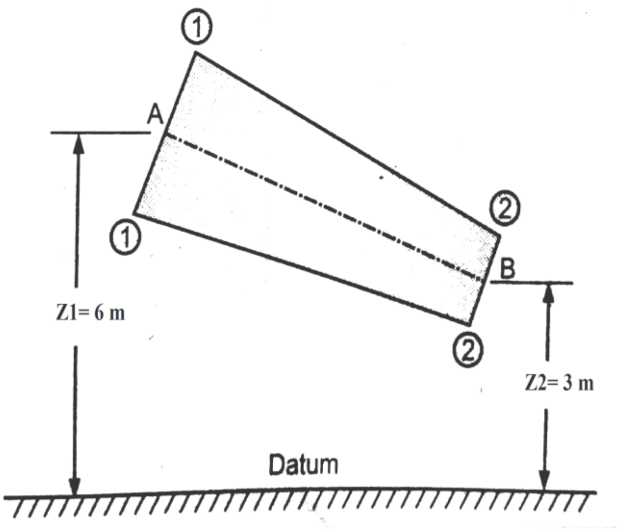
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	(c) Ans.	**A square tank 1m x 1m in plan and 2m deep contain oil of Sp. gravity 0.85.The free liquid surface of oil is 50 cm below top of tank. Find total pressure and position of centre of pressure on side and bottom of tank.**  Area of plan A = 1×1=1m^2 Depth of oil = 2.0.5 = 1.5m Sp.gravity of oil = 0.85 Pressure at bottom of tank $P= \gamma_L AH$ $P= S_L \gamma_w AH$ $P= 0.85\times9810\times1\times1\times1.5$ P=12507.75N=12.5kN Pressure at the side of the tank $P=\frac{1}{2}\gamma H^2$length $P=\frac{1}{2}S_L\gamma_w H^2$length $P=\frac{1}{2}\times0.85\times9810\times1.5^2\times1$ P=9380.81N=9.38kN Position of centre of pressure from free surface=$\frac{2}{3}\times1.5$=1m from bottom=$\frac{1}{3}\times1.5$=0.5m	½ ½ ½ ½ **2**	**4**

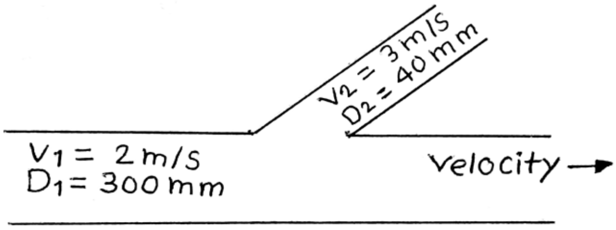
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	(d)	**A differential manometer connected at the two points A and B on a horizontal pipe. Calculate difference in pressure at point in M of oil and N/m^2, if pipe carries oil of Sp. gravity 0.8 and it shows difference in mercury levels as 15cm.**		
	Ans.		1	
		$h_A + h_1s_1 = h_2s_2 + h_3s_3 + h_B$	1	
		$h_A - h_B = h_2s_2 + h_3s_3 - h_1s_1$		
		$h_A - h_B = (0.15\times13.6) + (x-0.15)0.8 - x\times0.8$		
		$h_A - h_B = 2.04+0.8x-0.12-0.8x$		
		$h_A - h_B = 1.92$		
		$\frac{P_A}{\gamma_L} - \frac{P_B}{\gamma_L} = h_A - h_B$		
		$P_A - P_B = \gamma_L (h_A - h_B)$		
		$P_A - P_B = 9810\times1.92$	1	
		$P_A - P_B = 18835.2N/m^2$		
		$h = \frac{P_B - P_A}{\gamma}$		
		$h = \frac{18835.2}{0.8\times9810} = 2.4m$	1	4

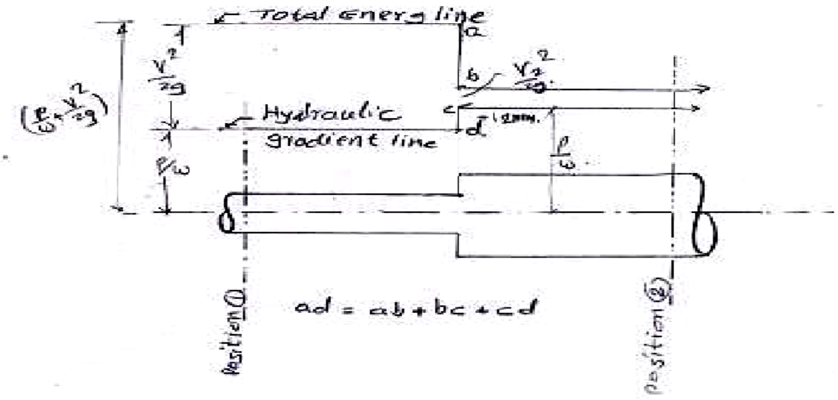
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	**(d)**	**OR**		
		 	**1**	
		$h_A + x \times 0.8 + 0.15 \times 0.8 = 0.15 \times 13.6 + x \times 0.8 + h_B$ $h_A + 0.12 = 2.04 + h_B$ $h_A - h_B = 2.04 - 0.12$	**1**	
		$h_A - h_B = 1.92$m of water	**1**	
		$P = \gamma_L \times h_L$ $\gamma_w h_w = \gamma_{oil} h_{oil}$ $9810 \times 1.92 = h_{oil}$ $h_{oil} = 2.4$m	**1**	**4**

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

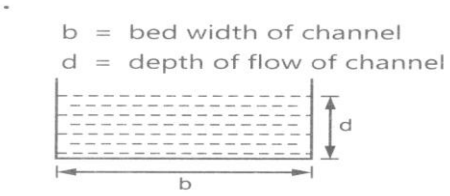
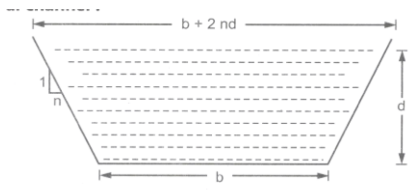
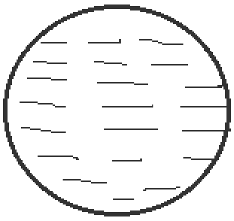
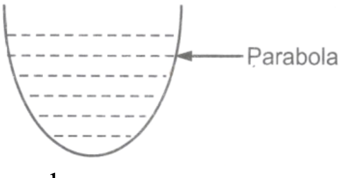
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	(f) Ans.	**Define and draw flow net. State properties and application of flow net.** It is a graphical representation of stream lines & equipotential lines. **OR** A set of stream lines and equipotential lines constitutes flow net.	1	
		 **Fig. Flow Net**	1	
		Properties of flow net- i. The stream lines and equipotential lines are mutually perpendicular to each other ii. The rate of flow is same between each successive pair of stream line iii. Stream lines in flow net shows the direction of flow iv. The equipotential line joins the points the equal velocity potential	½ **each (any two)**	
		Application of flow net - i. To check the problems of flow under hydrostatic structure like dams etc. ii. To determine of seepage pressure. iii. To find exit gradient. iv. A flow net analysis assists in the design of an efficient boundary shapes.	½ **each (any two)**	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		**Solve any FOUR of the following:**		**(16)**
	(a)	**A pipeline gradually varies from 15cm diameter at 'A' to 7.5 cm diameter at 'B'. The point 'A' is 6 above, while point 'B' is 3 m above datum.** **The velocity at 'A' is 3.6 m/sec. Determine pressure at 'B' if pressure at 'A' is 9.81 N/cm^2**		
	Ans.			
		$Given: \ d_A = 15\ cm,\ \ Z_A = \ 6\ m\ ,\ V_A = 3.6\ m/s\ ,\ P_A = 9.81\ N/cm^2$ $d_B = 7.5\ cm,\ Z_B = \ 3\ m$ $Calculate: P_B$ $A_AV_A = A_BV_B$	1	
		$V_B = \frac{A_AV_A}{A_B} = \frac{\frac{\pi}{4}(d_A)^2 \times V_A}{\frac{\pi}{4}(d_B)^2} = \frac{(d_A)^2 \times V_A}{(d_B)^2} = \frac{(0.15)^2 \times 3.6}{(0.075)^2} = 14.40\ m/s$ $\boxed{V_B = 14.40\ m/s}$	1	
		Using Bernoullie's Equation $Z_A + \frac{(V_A)^2}{2g} + \frac{P_A}{\gamma_L} = Z_B + \frac{(V_B)^2}{2g} + \frac{P_B}{\gamma_L}$	1	
		$6 + \frac{(3.6)^2}{2 \times 9.81} + \frac{98100}{9810} = 3 + \frac{(14.40)^2}{2 \times 9.81} + \frac{P_B}{9810}$ $\boxed{P_B = 30324.60\ N/m^2}$	1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	(b)	**Velocity of flow of water in pipe line of 300 mm diameter is 2 m/s from which 40 mm diameter pipe branches out. Velocity measured in the branch pipe is 3 m/s. What is the velocity of water in main pipe beyond the branch line?**		
	Ans.		½	
		$Given:\ d = d_1 = 300\ mm,\ d_2 = 40\ mm,\ V = 2\ m/s\ ,V_2 = 3\ m/s$ $Calculate:\ V_1$	½	
		$a = a_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4} \times (0.3)^2 = 0.071\ m^2$	½	
		$a_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4} \times (0.04)^2 = 1.256 \times 10^{-3}\ m^2$	½	
		$av = a_1 v_1 + a_2 v_2$	1	
		$0.071 \times 2 = 0.071 \times V_1 + 1.26 \times 10^{-3} \times 3$ $V_1 = 1.947\ m/s$	1	4
	(c)	**What do you mean by water hammer? State its causes.**		
	Ans.	**Water Hammer:** When the water flowing in a long pipe is suddenly brought to rest by closing the valve, there will be a sudden rise in pressure due to the momentum of the moving water being destroyed. This causes a wave of high pressure to be transmitted along the pipe which creates noise known as water hammer.	2	
		Causes : i. Sudden increasing velocity of flow ii. Sudden closure of valve with high speed. iii. Sudden increase in pressure in pipe	2	4

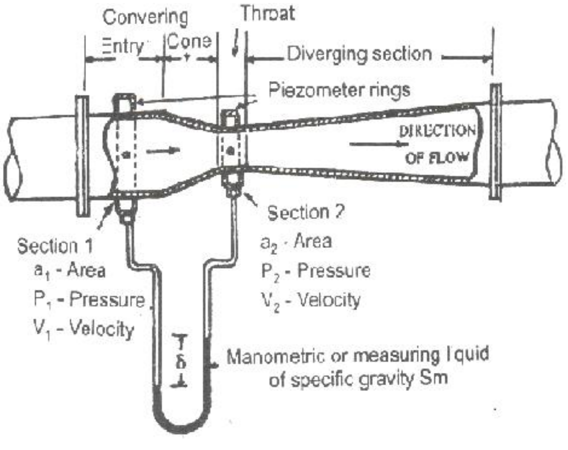
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	**(d)**	**At a sudden enlargement of water line a 250 mm diameter to 500 mm diameter pipe, the hydraulic gradient rises by 12 mm. Calculate the discharge through pipe.**		
	Ans.	 		
		Let, v_1=velocity of water at section 1, v_2=velocity of water at section 2, From the equation of continuity		
		$a_1v_1=a_2v_2$	½	
		$\frac{\pi}{4}\times(250)^2\times V_1=\frac{\pi}{4}\times(500)^2\times V_2$	½	
		$\therefore V_1=4V_2$ Now from the geometry of figure above Ad=ab+bc+cd $(v_1)^2/2g=(v_1-v_2)^2/2g + (v_2)^2/2g + 12$ mm $(4v_2)^2/2g=(4v_2-v_2)^2/2g + (v_2)^2/2g + 12$ mm $(16(v_2)^2)/2g=(9(v_2)^2)/2g +(v_2)^2/2g + 12$ mm		
		$(v_2)^2$ =(12 x 9.81 x 1000)/ 3	**1**	
		(v_2)= 198.09 mm/Sec Therefore $Q=a_2 \times v_2$		
		$=\frac{\pi}{4}\times(500)^2\times198.09$	**1**	
		=38894880.55 mm^3 /Sec $=\frac{38894880.55}{10^6}$		
		= 38.895 lit/Sec	**1**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	(e) Ans.	**Explain the terms i) Pipes in parallel, ii) Equivalent pipe.** **Pipes in parallel:** When a pipeline divides into two or more parallel pipes which again join together at downstream then that pipe is said to be in parallel. The discharge in the main pipe is equal to sum of the discharge in each of the parallel pipes. Loss of head in each parallel pipes is same. **Equivalent pipe :** A compound pipe which is consist of several pipes of different lengths and diameters to be replaced by a pipe of uniform diameter and same length as that of the compound pipe, is called as equivalent pipe. **OR** Equivalent pipe is a pipe of uniform diameter whose discharge and loss of head are same as that of the compound pipe.	2 2	4

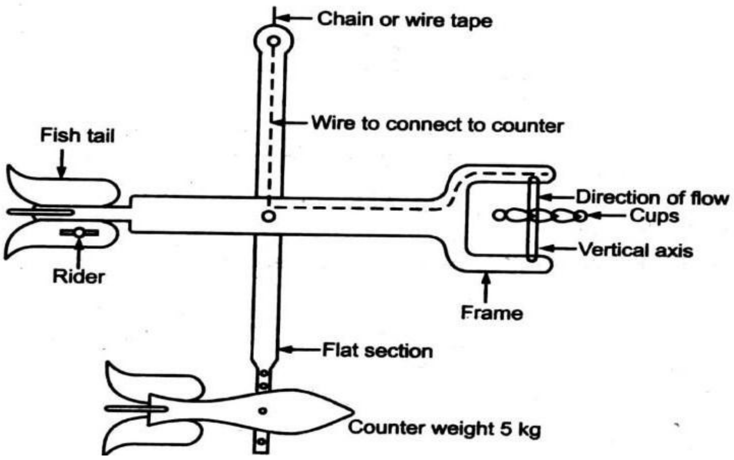
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	**(f)** **Ans.**	**Explain with neat sketch different types of open channel.** 1. **Rectangular channel:** This is used in case of hard rock strata.  b= width of the channel, d= depth of the flow R= hydraulic mean depth Area= b x d Perimeter = b + 2d The condition of most economical section is that for a given area the perimeter should be minimum b = 2d, R= d/2 2. **Trapezoidal channel:** this is most commonly used shape because of stability.  b = width of the channel at bottom , d= depth of the flow the side slope is given as 1 vertical to n horizontal most economical conditions are- half of top width= sloping side 3. **Circular section:**  d= depth of the flow R= radius of channel Though it is closed the pressure on water surface is atmospheric 4. **V shaped channel:**  d= depth of the flow , θ = angle The pressure on water surface is atmospheric.	**2 each (any two)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		**Solve any FOUR of the following:**		**(16)**
	(a)	**Define Hydraulic jump and state its applications.**		
	Ans.	**Hydraulic jump-** It is the phenomenon in which supercritical flow is converted to subcritical flow.	**2**	
		OR		
		It is a phenomenon occurring in an open channel when rapidly flowing stream abruptly changes to slowly flowing stream causing a distinct rise or jump in level of liquid surface		
		Applications: i. To minimize the energy of flowing water ii. To mix the chemicals in the flow of water iii. To increase the depth of water	**2**	**4**
	(b)	**Define steady, unsteady, uniform and non-uniform flow in open channel.**		
	Ans.	**Steady flow:** If the depth of flow, the discharge and mean velocity of the flow at any section does not change with respect to time, the flow is called as steady flow.	**1**	
		Unsteady flow: If the depth of flow, the discharge and mean velocity of the flow at any section changes with respect to time, the flow is called as unsteady flow.	**1**	
		Uniform flow: If the depth of flow, the discharge and mean velocity flow at a given instant do not change along the length of channel, the flow is called as Uniform flow.	**1**	
		Non-uniform flow: If the depth of flow, the discharge and mean velocity flow at a given instant changes along the length of channel, the flow is called as Non-uniform flow.	**1**	**4**

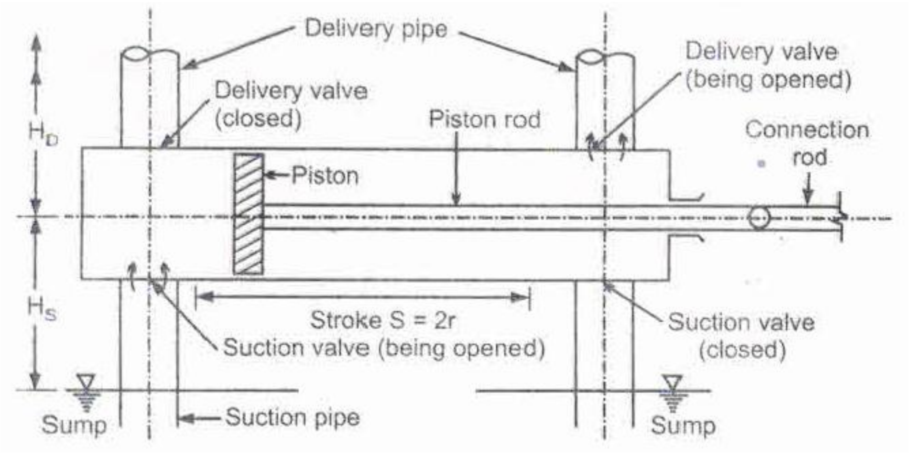
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	(c)	**State condition for most economical rectangular and trapezoidal channel section.**		
	Ans.	For rectangular section- b = 2d and R = d/2	2	
		For trapezoidal section- Half of top width = sloping side $\frac{b+2nd}{2}=d\sqrt{1+n^2}$ R = d/2 b = width at bottom of channel d = depth of flow 1: n = side slope R= hydraulic mean depth	2	4
	(d)	**Water is flowing through a rectangular channel of width 8 m and slope 1 in 1000. Depth of flowing channel is 5 m. Find the discharge through the channel. Take Chezy's constant C = 50.**		
	Ans.	A=(8 x 5) =40 m^2 Q=(a x v) Using chezy formula, V=C$\sqrt{RS}$ R=hydraulic mean depth = A/p	1	
		S= bed slope =1 in 1000 =0.001, C= chezy's constant =50 P=(b+2d)=(8+2 x 5)=18 m	1	
		R=hydraulic mean depth = A/p=(40/18)=2.22 Q=(a x c$\sqrt{RS}$)=(40 x 50 x$\sqrt{(2.22\times0.001)}$)	1	
		Q =94.2337 m^3/Sec Q=94233.7 lit /Sec	1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	(e)	**Explain the working of venturimeter with neat sketch.**		
	Ans.	Venturimeter is practical application of Bernoulli's theorem. It is an instrument used to measure discharge in a pipeline, generally permanently fixed in pipe line. It consists of three parts a) Convergent Cone b) Throat c) Divergent Cone $Q = \frac{C_d a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$ a_1= area of inlet of convergent cone a_2= area at throat section h = difference of pressure	1	
		Working : i. The Venturimeter consist of a short converging tube leading to a cylindrical portion called throat. ii. The angle of convergent cone is 21° and the angle of divergent cone is from 7° to 15°. iii. The angle of divergent cone is smaller because when water is passing through throat, its velocity is more, since area of throat is less. iv. As this water passing through diversion cone there is chance of separation of fluid flow from boundary of diversion cone causing cavitation. v. The pressure difference from section 1 and section 2 is measured by U-tube manometer. vi. The axis of Venturimeter may be horizontal or vertical or inclined.	2	
		 **Fig. Venturimeter**	1	4

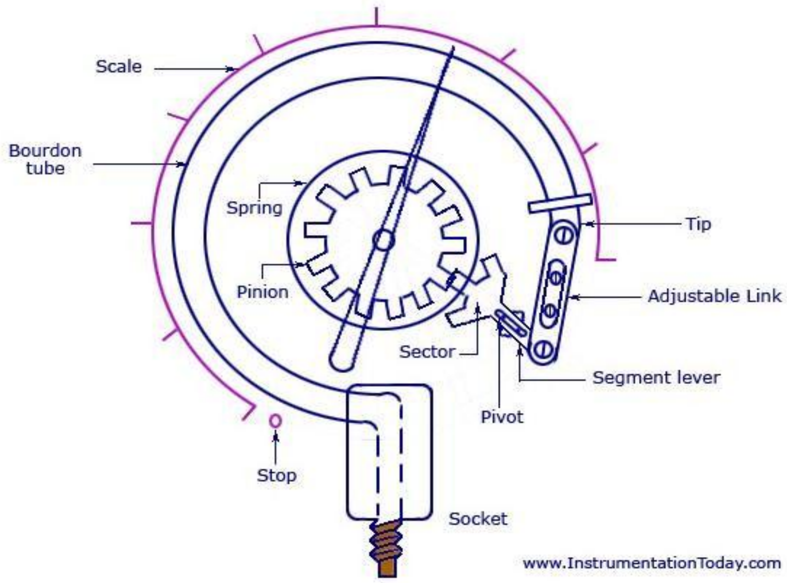
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	**(f)** **Ans.**	**A 100mm diameter orifice discharge 40 lit/ sec liquid under constant head of 2m. the diameter of jet at vena- contracta is 90mm. Calculate C_d, C_v , C_c.** Given, Discharge= 40 lit/sec $\text{Discharge}= \frac{40}{1000}\ \text{m}^3/\text{sec}$ $\text{Discharge}= 0.040\ \text{m}^3/\text{sec}$ $Head = H = 2m$ $Diameter = D = 100mm = 0.1m$ $\text{diameter of vena- contracta} = 90mm = 0.09m$ $\text{therotical velocity= } \text{V}_{\text{th}} = \sqrt{2gH}$ $\text{V}_{\text{th}} = \sqrt{2\times 9.81\times 2}$ $\text{V}_{\text{th}} = 6.26m/\sec$ $\text{therotical discharge= } \text{Q}_{\text{th}} = \text{V}_{\text{th}} \times \text{Area of orifice}$ $\text{Q}_{\text{th}} = 6.26\times \frac{\Pi}{4}\times 0.1^2$ $\text{Q}_{\text{th}} = 0.049\ m^3/\sec$ $C_d = \frac{\text{actual discharge}}{\text{theoretical discharge}}$ $C_d = \frac{0.04}{0.04914}$ $C_d = 0.81$ $C_c = \frac{\text{area at vena-c ontracta}}{\text{area of orifice}}$ $C_c = \frac{\frac{\pi}{4}\times 0.09^2}{\frac{\pi}{4}\times 0.1^2}$ $C_c = 0.81$ $C_d = C_c \times C_v$ $C_v = \frac{C_d}{C_c}$ $C_v = \frac{0.81}{0.81} = 1$	½ ½ 1 1 1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	**(a)** **Ans.**	**Solve any FOUR of the following:** **Explain working principle of current meter with sketch.** **Working:** 1. In a cup type current meter the wheel or revolving element has the form of a series of conical cups, mounted on a spindle. Spindle is held vertical at right angle to the direction of flow. 2. Current meter is used to find out velocity of water. Current meter consist of a wheel containing blades on cups. 3. These cups are vertically immersed in stream of water. The thrust exerted by water on the cups. 4. The number of revolutions of the wheel per unit time is proportional to the velocity of flow. 5. The revolution counter operated by dry cell. The counter is calibrated or a calibration curve is provided to read velocity.  **Fig. Current Meter**	2 2	**(16)** **4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	**(b)**	**Determine the discharge through 60^0 triangular notch in lps under the head of 0.16 m. If $C_d = 0.6$.**		
	Ans.	Ans. $\Theta = 60^0$ $H = 0.16$ $C_d = 0.6$ $Q = \frac{8}{15} c_d \sqrt{2g} \tan\frac{\Theta}{2} H^{5/2}$	**1**	
		$Q = \frac{8}{15} \times 0.6 \times \sqrt{2 \times 9.81} \times \tan\frac{60}{2} \times 0.16^{5/2}$	**1**	
		Q = 8.380x 10^{-3} m^3/sec OR Q=8.380 lit/sec	**2**	**4**
	(c)	**A reservoir has a catchment area of 30 $km^{2.}$ The maximum rainfall over the area is 2.5 cm/hr. ,45 % of which flows to reservoir a weir, find the length of the weir. The head over weir is 80 cm.**		
	Ans.	Area = 30 km^2=30 x10^6 m^2	**1**	
		Discharge =(30 x 10^6 x 2.5) / (100x60x60) =208.335 m^3/s		
		Discharge over weir 40%= 45/100 x 208.335 = 93.75 m^3/s	**1**	
		We know $Q = 1.84 \times (L - 0.1\, n\, H) H^{\frac{3}{2}}$	**1**	
		93.75 = 1.84 x (L-0.1x2x0.8)x $0.8^{3/2}$ 93.75 = 1.84(L- 0.16) x 0.715 71.02=(L- 0.16)		
		L = 71.18m.	**1**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	(d)	**Draw neat sketch of reciprocating pump. (double acting reciprocating pump)**  **Fig. Double Acting Reciprocating Pump** ***(Note: 2 marks for neat diagram and 2 marks for labeling.)***	4	4
	(e) Ans.	**What is priming? Why is it necessary?**		
		Priming: Priming is the process of filling the suction pipe, casing of the pump and portion of delivery pipe up to delivery valve with liquid which is to be pumped.	2	
		Necessity: Priming is necessary to remove the air from the pump. Even a presence of small air pocket in any portion of the pump results in no delivery from the pump.	2	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	(f) Ans.	**A centrifugal pump is required to pump 10lit/second against a head of 40m. find the power required by the pump taking overall efficiency as 70 %.** Given: Discharge(Q)=10lit/sec=10×10^{-3}m^3/sec, Head(H)=40m Efficiency(η)=70%=0.70, ω = 9810N/m^3 $P=\frac{\omega QH}{\eta}$ $P=\frac{9810\times10\times10^{-3}\times40}{0.70}$ P=5605.71 watt P=5.605 kW	1 2 1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**Solve any TWO of the following:**		**(16)**
	a)	**Explain construction and working of Bourdon's pressure gauge with sketch and write two advantages of it.**		
	Ans.	 **Fig. Bourdon's pressure Gauge** ***(Note: 2 marks for neat diagram and 2 marks for labeling.)***	**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**	
		Advantages: i) It is suitable for measuring vertical pressure as well as vacuum pressure. ii) It is suitable where tube gauges are not suitable.	**2**	**8**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	b)	**A siphon of diameter 20 cm connects two reservoirs having a difference in elevation of 20m.The length of the siphon is 500m and the summit is 3.0m above the water level in the upper reservoir. The length of the pipe from upper reservoir to the summit is 100m. Determine the discharge through the siphon and also pressure at summit. Neglect minor losses. Take coefficient of friction f= 0.005.**		
	Ans.	Given: d = 0.2m, H = 20m, L= 500m, Z_c = 3m L = 100m		
		as the coeficient of friction is given use f = 0.005		
		$h_f = \frac{(4f)LV^2}{2gd}$	2	
		$20 = \frac{(4\times0.005)500\ V^2}{2\times9.81\times0.2}$		
		$20=0.637\times4\times V^2$		
		$V^2=7.848$		
		$V\ =2.801m/s$	2	
		$Q=av$		
		$Q=\frac{\pi}{4}(0.2)^2\times8.801$		
		$Q=0.0879\ m^3/sec$	1	
		Pressure at summit (P_c)		
		Applying Bernoulli's Equation between A and C		
		$\frac{P_A}{\omega_c}+\frac{{V_A}^2}{2g}+Z_A=\frac{P_c}{\omega_c}+\frac{Vc^2}{2g}+Z_c+\text{ losses}$	2	
		$0=\frac{P_c}{\omega_c}+\frac{2.801^2}{2\times9.81}+3+\left[\frac{4\times0.005\times100\times2.801^2}{2\times9.81\times0.2}\right]$		
		$0=\frac{P_c}{9810}+2.39+4$		
		$P_c=-72.49kN/m^2$		
		$P_c=72.49kN/m^2$ (Vaccume)	1	8

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	**c)**	**A trapezoidal channel section has side slope 2 vertical 3 horizontal. It is discharging water at a rate of 20 cumecs with bed slope 1 in 2000. Design the channel for its best form. Take Manning's constant N= 0.01.**		
	Ans.			
		Given:		
		side slope $\frac{1}{n}=\frac{2}{3}$		
		$n=\frac{3}{2}=1.5$, Discharge,$Q = 20m^3/sec$		
		Bedslope,$S = \frac{1}{2000} = 0.0005$,Manning'sconstant, $N = 0.01$		
		Let,b = breadth at bottom, d = depth of flow		
		for most economical trapezoidal section		
		half of the top side = sloping side		
		$\left(\frac{b+2nd}{2}\right)=d\sqrt{n^2+1}$	**1**	
		$\left(\frac{b+2\times1.5d}{2}\right)=d\sqrt{1.5^2+1}$		
		$b+3d=2d\times1.8$		
		$b=0.6d$	**1**	
		$AreaA=d\left(b+nd\right)$		
		$AreaA=d\left(0.6d+1.5d\right)$		
		$A=2.1d^2$		
		$HydraulicmeandepthR=\frac{d}{2}$	**1**	
		$Q=AV$	**1**	
		$Q=A\frac{1}{N}R^{2/3}S^{1/2}$	**1**	
		$20=2.1d^2\times\frac{1}{0.01}\left(\frac{d}{2}\right)^{2/3}0.0005^{1/2}$	**1**	
		$20=2.958d^{8/3}$		
		$d^{8/3}=6.76$	**1**	
		$d=2.05m$		
		$b=1.23m$		
			1	**8**