Model Answer: Summer - 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.

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	(A)	**Attempt any SIX:**		**(12)**
	a)	**State the importance of hydraulics with respect to environmental Engineering.**		
	Ans.	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 v) Design of sewage treatment plant vi) Estimation of available volume of water per year by discharge measurement vii) Estimation of sewage flow	**½ each (any four)**	**2**
	b)	**What is the specific volume of material with specific gravity 0.90?**		
	Ans.	Given: S = 0.90 $S = \frac{\rho_L}{\rho_W}$ $\rho_L = S \times \rho_W$ $\rho_L = 0.90 \times 1000$ $\rho_L = 900$ Specific volume $V_s = \frac{1}{\text{mass density}}$	**1**	
		$V_s = \frac{1}{\rho_L}$ $V_s = \frac{1}{900}$ $\boxed{V_s = 1.11 \times 10^{-3} m^3/kg}$	**1**	**2**

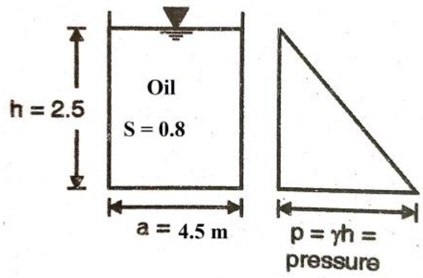
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1 (A)	c)	**State the Pascal's law and it's practical applications.**		
	Ans.	**Pascal's Law:**		
		It states that the pressure intensity or pressure at a point in a static fluid is equal in all directions.	1	
		OR		
		It states that the liquid at rest transmits its pressure with equal intensity in all direction and direction of liquid pressure is perpendicular to the surface on which it acts.		
		Applications:		
		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 two)**	2
	d)	**Explain –mercury is used as a manometric liquid.**		
	Ans.	Following are the reasons due to which mercury is used in manometers :-		
		i) Specific gravity of mercury is greater than the other liquids. ii) Mercury is immiscible with other liquids. iii) It does not stick to the surface in contact.	**1 each (any two)**	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1 (A)	e)	**List four types of minor losses.**		
	Ans.	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 pipe fitting	½ each (any four)	2
	f)	**Write down remedial measures of water hammer.**		
	Ans.	i) Valve should be closed gradually. ii) A surge tank is used near valve. iii) Use pressure relief valve. iv) The turbine gates are opened gradually. v) Air chambers are provided on the upstream of valves on long pipe lines.	½ each (any four)	2
	g)	**Enlist types of flow.**		
	Ans.	i. Gravity flow ii. Pressure flow iii. Steady flow iv. Unsteady flow v. Uniform flow vi. Non-uniform flow vii. Laminar flow viii. Turbulent flow ix. Steady uniform flow x. Unsteady non-uniform flow	½ each (any four)	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1 (A)	h)	**State the hydraulics co-efficient of an orifice and write relation between them.**		
	Ans.	**i)Coefficient of discharge (C_d)** The ratio of the actual discharge to the theoretical discharge is called as the coefficient of discharge.	½	
		ii)Coefficient of contraction (C_c) The ratio of the cross-sectional area of the jet at vena contracta to the cross-sectional area of the orifice is called coefficient of contraction.	½	
		iii)Coefficient of velocity (C_v) The ratio of actual velocity of the jet at vena contracta to the theoretical velocity of the jet is called coefficient of velocity.	½	
		Relation: $C_d = C_v \times C_c$	½	2

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	(B)	**Attempt any TWO:**		(08)
	a) Ans.	**Explain any four physical properties of fluid.** **i) Mass Density or Specific mass:** It is defined as the mass per unit volume. $\rho = \frac{\text{Mass}}{\text{Volume}} = \frac{M}{V}$ S.I. Unit: kg/m^3 **ii) Weight Density or Specific weight:** It is defined as the weight per unit volume at standard temperature and pressure **OR** It is defined as ratio of weight to volume. $\gamma = \frac{\text{Weight}}{\text{Volume}} = \frac{W}{V}$ S.I. Unit: N/m^3 **iii) Specific Volume :** It is the volume occupied by unit mass of liquid $V_s = \frac{V}{M} = \frac{1}{\rho}$ S.I. Unit : m^3/kg **iv) Specific Gravity :** It is the ratio of specific weight or specific mass of liquid to the specific weight or specific mass of pure water at 4^0C $S_L = \frac{\text{Sp. weight of liquid}}{\text{Specific weight of water at } 4^0C} = \frac{\text{Sp. mass of liquid}}{\text{Specific mass of water at } 4^0C}$ S.I. Unit : No Unit **v) Dynamic Viscosity:** It is defined as shear stress (τ) required to produce unit rate of shear strain (du/dy). It is denoted by (μ). $\mu = \frac{\tau}{\left(\frac{d_u}{d_y}\right)}$ S.I.Unit :$N.sec/m^2$	**1 each (any four)**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1		**vi)Kinematic viscosity:** It is the ratio of dynamic viscosity of a liquid to its mass density. **OR** It is ratio of absolute viscosity to its mass density. $\upsilon = \frac{\mu}{\rho}$ S.I.Unit : m^2/sec **vii) Surface Tension:** Surface tension of a liquid is the properties by which a fluid is enabled resist tensile stress. **OR** 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. S.I. Unit = N/m **viii) Capillarity:** It is defined as the phenomenon of rise or fall of liquid surface in small tube relative to the adjacent general level of liquid when the tube is held vertically in the liquid.		**4**

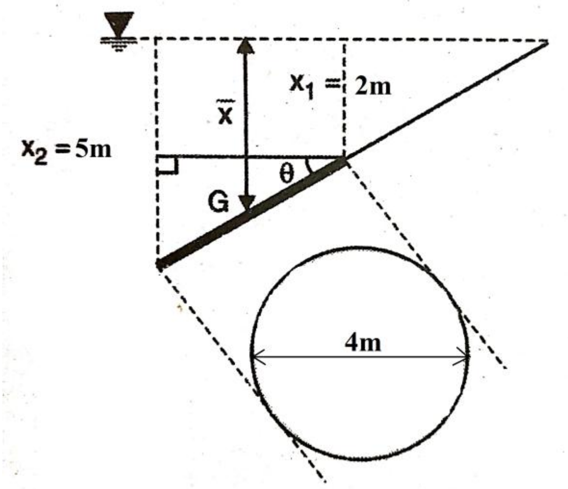
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	**(B) b)**	**A vertical tank square in plan has side width 4.5 m. It contains an oil of specific gravity 0.8 to a depth of 2.5 m. Calculate total pressure on bottom and on one side of tank.**		
	Ans.			
		Data: Side a = 4.5 m. ,Specific gravity of oil $S_{oil} = 0.8$, Depth of oil h = 2.5 a) Pressure intensity on bottom $P_{bottom} = \gamma_L \times h_L$ $P_{bottom} = 0.8 \times 9810 \times 2.5$ $\boxed{P_{bottom} = 19620\ N/m^2}$ $\boxed{P_{bottom} = 19.620 kN/m^2}$	1	
		b) Total pressure on bottom $P_1 = P_{bottom} \times Area$ $P_1 = 19.620 \times (4.5 \times 4.5)$ $\boxed{P_1 = 397.305 kN}$	1	
		c) pressure intensity on one side of tank: $P_{side} = \left(\frac{1}{2} \times \gamma_L \times h_L \times h_L\right)$ $P_{side} = \left(\frac{1}{2} \times 0.8 \times 9810 \times 2.5^2\right)$ $\boxed{P_{side} = 24525\ N/m}$ $\boxed{P_{side} = 24.525\ kN/m}$	1	
		d)Total Pressure on side of tank $P_2 = P_{side} \times$ width of liquid $P_2 = 24.525 \times 4.5$ $\boxed{P_2 = 1010.36\ kN}$	1	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.1	(B) (c) Ans.	**Differentiate between Real fluid and Ideal fluid.**		

Sr. No.	Real Fluid	Ideal Fluid
1	This is real fluid.	This is imaginary fluid.
2	This is available in nature.	No fluid is ideal in nature.
3	They possess viscosity, compressibility, surface tension.	They do not possess viscosity, compressibility and surface tension.
4	This offers resistance against fluid flow.	This offers no resistance against fluid flow.
5	Water, oil, gases are real fluids.	There are no ideal fluids.

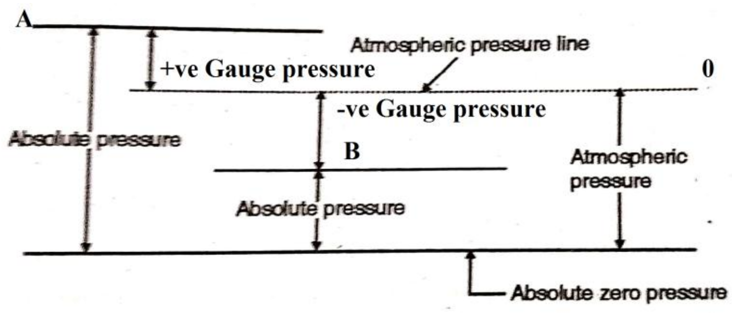
Marks: **1 each (any four)**

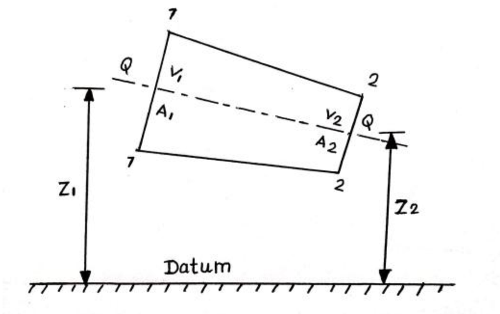
Total Marks: **4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2		**Attempt any FOUR :**		(16)
	a)	**A circular plate 4 m dia. is immersed in oil of specific gravity of 0.9 such that its greatest and least depth below the free surface of oil is 5 m and 2 m respectively.** **Calculate:** **i) The total pressure on one side or face of the plate.** **ii) The location of centre of pressure.**		
	Ans.	 		
		Step1. Depth of centroid of lamina from free surface. $\bar{x} = \frac{5+2}{2} = 3.5$ m.	½	
		Step2. Area of lamina. $\boxed{A = \frac{\pi}{4} \times (4)^2 = 12.56 m^2}$	½	
		Step3. Moment of inertia. $I_G = \frac{\pi}{64} \times D^4$ $\boxed{I_G = \frac{\pi}{64} \times 4^4 = 12.56 m^4}$	½	

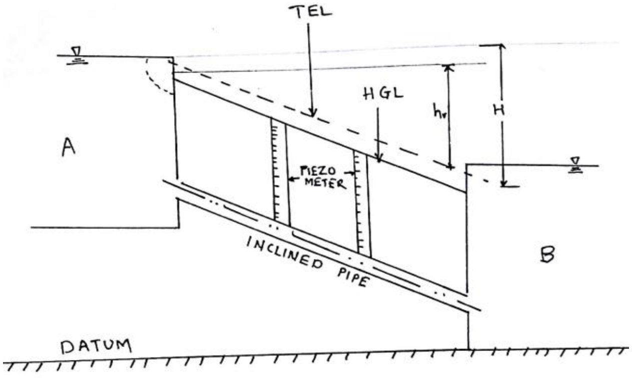
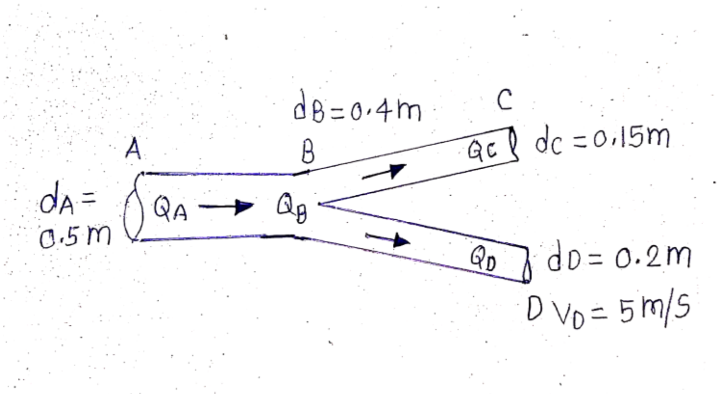
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	a)	Step4.Total pressure.		
		$P = \gamma \times A \times \bar{x}$		
		$P = 9.81 \times 12.56 \times 3.5$	½	
		$P = 431.24$ kN		
		Step5. Inclination of plate.		
		$\theta = \text{Sin}^{-1}\left(\frac{5-2}{4}\right)$		
		$\theta = 48.59^0$	½	
		Step6. Position of centre of pressure.		
		$\bar{h} = \frac{I_G \text{Sin}^2\theta}{A\bar{x}} + \bar{x}$	½	
		$\bar{h} = \frac{12.56(\sin 48.59)^2}{12.56 \times 3.5} + 3.5$		
		$\boxed{\bar{h} = 3.66\text{m}}$	**1**	**4**
	b)	**A circular plate 2.5 m dia. immersed in water vertically 2.0 m below liquid surface. Find the centre of pressure and total pressure.**		
	Ans.	Distance of centroid from free surface		
		$\bar{x} = 2 + \left(\frac{2.5}{2}\right) = 3.25\text{m}$	½	
		Total Pressure		
		$P = \gamma_w \times A \times \bar{x}$	½	
		$P = 9810 \times \frac{\pi}{4} \times 2.5^2 \times 3.25$		
		$\boxed{\begin{array}{l} P = 156.50 \times 10^3\text{N} \\ P = 156.50 \text{ kN} \end{array}}$	**1**	
		Centre of pressure		
		$\bar{h} = \frac{I_G}{A\bar{y}} + \bar{y}$	**1**	
		$\bar{h} = \frac{1.917}{4.90 \times 3.25} + 3.25$		
		$\boxed{\bar{h} = 3.37 \text{ m.}}$	**1**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	c)	**State the Pascal's law and give any two application of it.**		
	Ans.	**Pascal's Law:** It states that the pressure intensity or pressure at a point in a static fluid is equal in all directions. **OR** It states that the liquid at rest transmits its pressure with equal intensity in all direction and direction of liquid pressure is perpendicular to the surface on which it acts	2	
		Applications: i) Hydraulic Jacks ii) Hydraulic Press iii) Hydraulic Lifts iv) Hydraulic Crane v) Braking system of motor vi) Artesian well vii) Dam	1 each (any two)	4
	d)	**Explain the term :** **i. Atmospheric pressure** **ii. Absolute pressure** **iii. Gauge pressure by drawing line diagram.**		
	Ans.	**i. Atmospheric Pressure:** Pressure exerted by atmospheric air upon all the surfaces comes in contact ,is called atmospheric pressure.	1	
		ii. Absolute Pressure: The pressure which is measured with reference to absolute zero pressure or datum is called as absolute pressure.	1	
		iii. Gauge Pressure: The pressure which is measured with reference to atmospheric pressure (considering as zero) is called gauge pressure.	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	d)	 **Fig: Line diagram** Absolute pressure for A = Atmospheric pressure+ Gauge pressure Absolute pressure for B = Atmospheric pressure - Gauge pressure	1	4
	e)	**Convert pressure of 9 m of oil of specific gravity 0.92 into pressure head in ‘m’ of liquid having specific gravity 1.1.**		
	Ans.	Data: $h_o = 9m$, $S_o = 0.92$, $S_L = 1.1$, $h_L = ?$	1	
		$h_o \times S_o = h_L \times S_L$ $9 \times 0.92 = h_L \times 1.1$	1	
		$h_L = \frac{9 \times 0.92}{1.1}$ $h_L = 7.527$ m of liquid.	2	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.2	f)	**State Bernoulli's theorem and its limitations.**		
	Ans.			
		It states that in a steady, ideal flow of an incompressible fluid, the total energy at any point of the fluid is always constant. Total energy = Constant Pressure energy + Kinetic energy + Potential energy = Constant	1	
		$\boxed{\frac{P}{\gamma_L} + \frac{V^2}{2g} + Z = \text{Constant}}$	½	
		Where, $\frac{p}{\gamma} =$ Pressure head $\frac{v^2}{2g} =$ Velocity head $z =$ Datum head	½	
		Limitations: i. It is applicable to ideal fluid ii. It is applicable to incompressible fluid flow iii. It is not applicable for fluid with unsteady flow iv. It is applicable for fluid with zero viscosity	**1 each (any two)**	**4**

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 3		**Attempt any FOUR:**		(16)
	a)	**A horizontal pipe carrying water tappers from 25 cm dia at 'A' to 15 cm diameter at 'B' in a length of 2m .The pressure at A is 100 N/cm^{2}. If the discharge is 0.01 m^3/s, calculate pressure at B in N/cm^2,If the loss of head from 'A' to 'B' is 10 cm**		
	Ans.	Data: $d_1=25cm$, $d_2=0.15m$, pressure at A = $P_1=100N/cm^2=1000kN/m^2$ $Q=0.01m^3/s$, loss of head from A to B=$h_f=10cm=0.1m$ To find : pressure at 'B' in N/cm^2 $A_1=\frac{\pi}{4}(0.25)^2=0.049m^2$ $A_2=\frac{\pi}{4}(0.15)^2=0.0177m^2$	1	
		Discharge $Q=A_1V_1$ $V_1=\frac{Q}{A_1}=\frac{0.01}{0.049}=0.204$ m/s	1	
		Using Continuity Equation $A_1V_1=A_2V_2$ $V_2=\frac{A_1}{A_2}\times V_1$ $V_2=\frac{0.049}{0.0177}\times 0.204$ $V_2=0.565$ m/s	1	
		Applying Modified Bernoulli's Equation at section 1-1 & 2-2 $\frac{P_1}{\gamma_L}+\frac{V_1^2}{2g}+Z_1=\frac{P_2}{\gamma_L}+\frac{V_2^2}{2g}+Z_2+h_f$ $\frac{1000}{9.81}+\frac{(0.204)^2}{2\times9.81}+0=\frac{P_2}{9.81}+\frac{(0.565)^2}{2\times9.81}+0+0.1$ $101.939=\frac{P_2}{9.81}+0.116$ $P_2=(101.939-0.116)\times9.81$ $P_2=998.884kN/m^2$ $P_2=99.88N/cm^2$	1	4
	b)	**Explain the hydraulic gradient line and total energy line with the help of neat sketch.**		
	Ans.	**Hydraulic Gradient Line:** Due to friction the pressure head decreases gradually from section to section of the pipe in the direction of flow. If the pressure head at the different section of the pipe are plotted to the scale as vertical ordinate above the axis of the pipe and all the points are joint by the straight line, we get a straight sloping line. This line is known as "Hydraulic Gradient line" $HGL=\frac{P}{\gamma}+z$	1	
		Total Energy Line : when the total energy at the various points along the axis of the pipe is plotted and joint by the line, the line obtained is called as "Total	1	

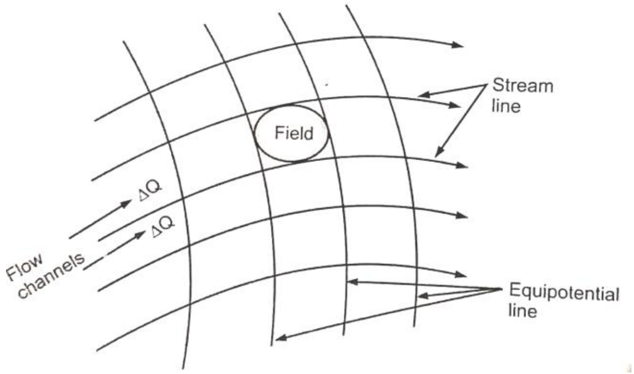
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		Energy line"(TEL) or Total energy gradient (TEG) Total energy line is the line which gives sum pressure head, datum head and kinetic head of a flowing fluid $TEL = \frac{P}{\gamma} + \frac{V^2}{2g} + z$  **Fig. HGL and TEL**	2	4
	c)	**Water flows through a pipe line which is gradually reduces from 500 mm diameter at ‘A’ to 400 mm diameter at ‘B’ and then forms ,one branch being 150 mm diameter discharge at ‘C’ and other branch 200 mm diameter discharge at ‘D’ is 5 m/s.What will be the discharge at ‘C’ and ‘D’ and the velocity at ‘B’ and ‘C’ ?**		
	Ans.	 ***(Note: Assuming Velocity at point A = 2 m/s)***		

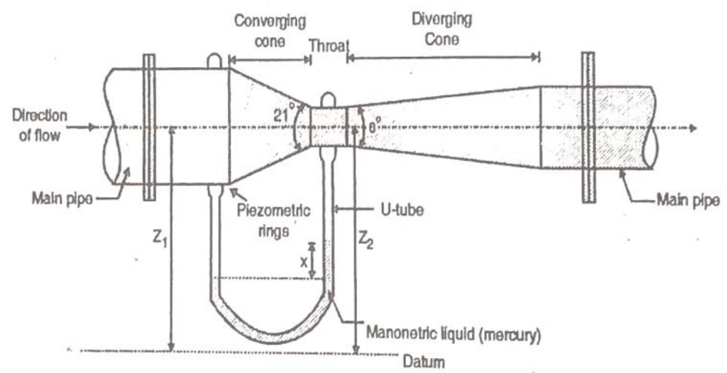
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	c)	Data: $d_A = 0.5m$, $d_B = 0.4m$, $d_c = 0.15m$, $d_A = 0.2m$, $v_D = 5m/s$. $Q_C = ?$ $Q_D = ?$ $v_B = ?$, $v_C = ?$ Assuming velocity at A $v_A = 2m/s$ Discharge at A : $Q_A = a_A \times v_A$ $Q_A = \frac{\pi}{4}(0.5)^2 \times 2$ $\boxed{Q_A = 0.393\ m^3/s}$ Discharge at D : $Q_D = a_D \times v_D$ $Q_D = \frac{\pi}{4}(0.2)^2 \times 5$ $\boxed{Q_D = 0.157\ m^3/s}$	1	
		$Q_A = Q_B = Q_C + Q_D$ $Q_A = Q_C + Q_D$ $0.393 = Q_C + 0.157$ $\boxed{Q_C = 0.236\ m^3/s}$	1	
		$v_B = \frac{Q_B}{a_B}$ $v_B = \frac{0.393}{\frac{\pi}{4} \times (0.4)^2}$ $\boxed{v_B = 3.127 m/s}$	1	
		$v_C = \frac{Q_C}{a_C}$ $v_C = \frac{0.236}{\frac{\pi}{4} \times (0.15)^2}$ $\boxed{v_C = 13.355 m/s}$	1	4
		(Note: Velocity of flow is not given in question if suitable value of velocity is assumed and try to attempt should be considered and give appropriate marks.)		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	d) Ans.	**Three pipes having same length and same friction factor having different diameter as 300 mm, 150 mm, 50 mm respectively. When three pipes are connected parallel, gives a total discharge of 0.90 m^3/s. Find out discharge in each pipe.** **Data:** Data: $f_1 = f_2 = f_3$ and $l_1 = l_2 = l_3$ d_1 = 300 mm, d_2 = 150 mm, d_3 = 50 mm. Q = 0.9 m^3/s. To find: Q_1 = ? Q_2 = ? Q_3 = ? Solution: for pipes connected in parallel head loss is equal $\therefore \frac{f_1 l_1 v_1^2}{2gd_1} = \frac{f_2 l_2 v_2^2}{2gd_2} = \frac{f_3 l_3 v_3^2}{2gd_3}$ But $f_1 = f_2 = f_3$ and $l_1 = l_2 = l_3$..........given $\therefore$ above equation reduces to $\frac{v_1^2}{d_1} = \frac{v_2^2}{d_2} = \frac{v_3^2}{d_3}$ equating $\frac{v_1^2}{d_1} = \frac{v_2^2}{d_2}$ $\therefore v_1^2 = \frac{0.3}{0.15} v_2^2$ $\therefore v_1 = 1.414\ v_2$ ------------1. equating $\frac{v_3^2}{d_3} = \frac{v_2^2}{d_2}$ $\therefore v_3^2 = \frac{0.05}{0.15} v_2^2$ $\therefore v_3 = 0.577\ v_2$ ------------2. $Q_1 = A_1 v_1 = 0.071 \times 1.414\ v_2 = 0.100\ v_2$ $Q_2 = A_2 v_2 = 0.018\ v_2$ $Q_3 = A_3 v_3 = 1.963 \times 10^{-3} \times 0.577\ v_2 = 1.133 \times 10^{-3} v_2$ For pipes in parallel $Q = Q_1 + Q_2 + Q_3$ $0.9 = 0.100\ v_2 + 0.018\ v_2 + 1.133 \times 10^{-3} v_2$ $0.9 = 0.119\ v_2$ $v_2 = 7.563$m/s.	 ½ ½ ½	

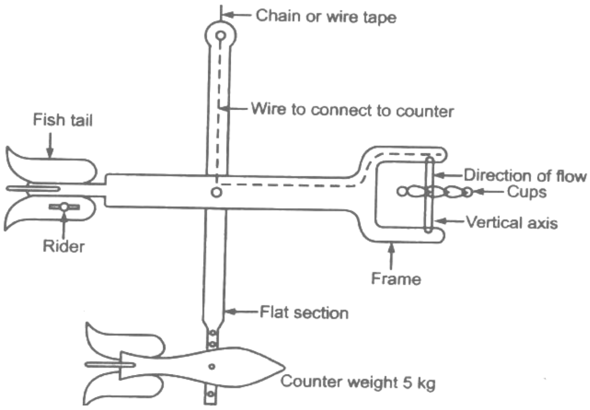
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3		$v_1=1.414\times7.563 = 10.694$ m/s	½	
		$v_3=0.577\times7.563=4.364$ m/s	½	
		$Q_1=A_1v_1= 0.071\times10.694 = 0.756\ m^3/s$	½	
		$Q_2=A_2v_2= 0.018\times7.563 = 0.136\ m^3/s$	½	
		$Q_3=A_3v_3= 1.963\times10^{-3}\times4.364 = 8.567\times10^{-3}\ m^3/s$	½	4
	e)	**Define following:** **i) Wetted perimeter ii) Wetted area ii)Hydraulic mean depth iii)Most economical channel**		
	Ans.	**i) wetted perimeter-** It is length of channel boundary which is wetted.	1	
		ii) wetted area- it is cross sectional area which is covered by water	1	
		iii) Hydraulic mean depth: The depth of flow in a channel above bed surface is called as hydraulic depth (d).	1	
		iv) Most economical section:- A channel section is said to be most economical when it gives maximum discharge for a given cross section area, bed slope and coefficient of resistance.	1	4
	f)	**Explain Moody's diagram and state its applications.**		
	Ans.	**i.** Moody's diagram is graph plotted in the form of frictional factor (f) verses Reynold's number (R_e) for various values of relative roughness (e/D)		
		ii. R_e is taken on X –axis and f on Y-axis .The curve on this graph are plotted from the results of experiments.	½ each	
		iii. In case of laminar flow, the friction factor is computed from the formula. $$f = \frac{64}{R_e}$$		
		iv. In case of turbulent flow, the influences of the roughness of the pipe wall become dominant. The roughness size is expressed in terms of pipe diameter.		

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.3	f)	$\varepsilon = \frac{e}{D}$ Where ε is called the relative roughness. **Applications of moody's diagram:** i. It is used to find relative roughness ii. It is used to find friction factor iii. It can be used for finding pressure drop or flow rate down such a pipe. iv. It is in the selection of a diameter for a pipe for some Purpose	½ each	4

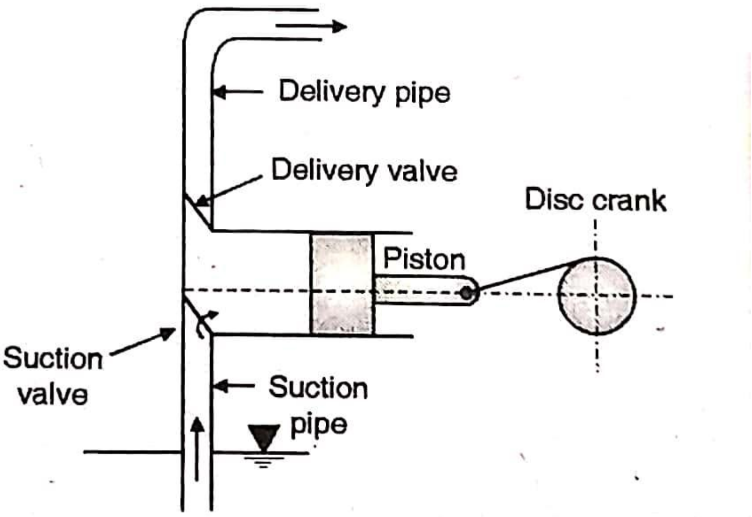
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4		**Attempt any FOUR:**		(16)
	a)	**Draw neat sketch of flow net showing streamlines and equipotential lines and state its uses.**		
	Ans.	 **Fig. Flow Net**	2	
		Uses of Flow Net: i. To check the problems of flow under hydrostatic structure like dams etc. ii. for determination of seepage pressure iii. To find exit gradient iv. A flow net analysis assists in the design of an efficient boundary shapes	½ each	4
	b)	**Define Hydraulic jump and state its two applications.**		
	Ans.	**Hydraulic jump-** It is the phenomenon in which supercritical flow is converted to subcritical flow. **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	2	
		It's applications are- **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	1 each (any two)	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q. 4	**c)**	**Explain critical ,sub critical and supercritical flow with reference to Froude's Number.**		
	Ans.	Froude Number $F_r = \frac{v}{\sqrt{gh}}$	1	
		Critical Flow- The flow at which specific energy is minimum is called as critical flow. At critical flow Froude's number is 1.	1	
		Subcritical flow- when the depth of flow in a channel is greater than the critical depth, the flow is said to be sub critical. For this flow, Froude's number is less than 1.	1	
		Super critical flow: When the depth of flow in a channel is less than the critical depth ,the flow is said to be supercritical flow . For this flow, Froude's number is greater than 1.	1	4
	d)	**What is most economical channel section ? Write condition for rectangular channel section to be economical.**		
	Ans.	**Most Economical Channel Section:** - A channel which gives max. discharge for a given c/s area & bed slope and coefficient of roughness is called as Most Economical Channel Section.	2	
		Condition for rectangular channel: - i) b = 2d ii) R = d/2	2	4
	e)	**Explain working of venturimeter with neat sketch.**		
	Ans.	Venturimeter is a device used to measure the discharge of a fluid flowing through pipe. It consists of three parts- 1. A short converging part 2. Throat 3. Diverging part	1	
		 **Fig. Venturimeter**	1	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.4	**e)**	Venturimeter works on the principle of Bernoulli's theorem. Generally the diameter at throat is half of pipe diameter. The pressure at the inlet of convergent cone and throat is measured. It is used to find the discharge through pipe.	**1**	
		Discharge is calculated by formula. $Q_{actual} = \frac{C_d a_1 a_2 \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$	**1**	**4**
		a_1= area of inlet of convergent cone a_2= area at throat section h = difference of pressure		
	f)	**A triangular notch of an angle 120^0 used to measure the discharge of pump .Determine the head over the notch , If discharge is 1000 lit/minute. Assume C_d = 0.6**		
	Ans.	Data: $\theta=120^0, C_d=0.6$, Q =1000lit/min = $\frac{1000\times10^{-3}}{60}$ = $0.017 m^3/s$		
		$\therefore Q = \frac{8}{15} C_d \tan\frac{\theta}{2}\sqrt{2g}\times H^{\frac{5}{2}}$	**1**	
		$0.0166 = \frac{8}{15}\times0.6\times\tan\frac{120}{2}\sqrt{2\times9.81}\times H^{\frac{5}{2}}$	**2**	
		$H^{\frac{5}{2}} = 6.788\times10^{-3}$ $H = 0.1357$ m	**1**	**4**

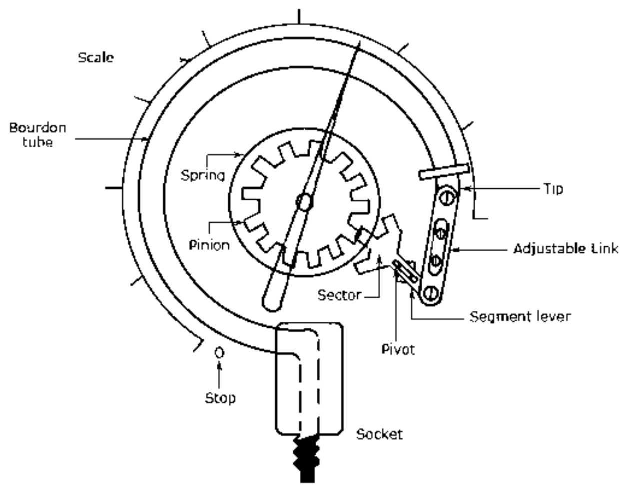
Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5		**Attempt any FOUR:**		**(16)**
	a)	**List the velocity measuring devices for channel and explain any one.**		
	Ans.	**Velocity measuring devices for channel:** i. Pitot Tube ii. Cup type current meter, iii. Single float iv. Double float v. Rod float vi. Screw type current meter or propeller type	**½ each (any four)**	
		Current Meter:  **Fig. Current Meter**		
		Working: i. 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. ii. Current meter is used to find out velocity of water. Current meter consist of a wheel containing blades on cups. iii. These cups are vertically immersed in stream of water. The thrust exerted by water on the cups. iv. The number of revolutions of the wheel per unit time is proportional to the velocity of flow. v. The revolution counter operated by dry cell. The counter is calibrated or a calibration curve is provided to read velocity. ***(Note: Any one device listed above should be considered.)***	**2**	

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	b)	**Determine discharge through 60^0 triangular notch in LPS under the head of 0.20m. Take C_d = 0.6**		
	Ans.	Data: $\theta=60^0, C_d=0.6$, H=0.2m Q =?	½	
		$\therefore Q = \frac{8}{15} C_d \tan\frac{\theta}{2}\sqrt{2g}\times H^{\frac{5}{2}}$	2	
		$Q = \frac{8}{15}\times 0.6\times\tan\frac{60}{2}\sqrt{2\times 9.81}\times 0.2^{\frac{5}{2}}$	½	
		$Q=0.0146 m^3/s$		
		Q=14.6 lps	1	4
	c)	**List any four components of centrifugal pump with their functions.**		
	Ans.	The following are the main component parts of centrifugal pump. i. Impeller ii. Casing iii. Suction pipe iv. Deliver pipe v. Foot valve with strainer		
		i. Impeller: The rotating part of the centrifugal pump is called impeller. It consists of series of backward curved vanes. The impeller is mounted on a shaft which is connected to the shaft of an electric motor. **ii. Casing:** It is as air tight passage surrounding the impeller and is designed in such a way that the kinetic energy of water discharged at the outlet of the impeller is converted into pressure energy before the casing and enters the delivery pipe. **iii. Suction pipe with a foot valve and a strainer**: A foot valve which is a non- return valve or one any type of valve is fitted at the lower end of the suction pipe. The foot valve opens only in the upward direction. A strainer is also fitted at the lower end of the suction pipe. **iv. Delivery pipe:** A pipe whose one end is connected to the outlet of the pump and other delivers the water at the required height is known as delivery pipe. **v. Foot valve with strainer:** It is fitted at lower end of suction pipe and it is submerged under water up to 45 to 60 cm depth because when surface in the well is lowered ,the foot valve may suck the air and depriming of the pump takes place.	1 each (any four)	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	d)	**Explain the working of reciprocating pump with neat sketch.**		
	Ans.	 **Fig. Reciprocating Pump**	1	
		Working: i. When piston moves back in the cylinder, water is sucked in the cylinder this is called suction stroke. ii. When piston moves forward, water pushed through the delivery valve by piston this is called delivery stroke. in single acting pump, there is a discharge only in the alternate stroke. iii. In double acting reciprocating pump , there is suction and delivery in each stroke therefore discharge is continues	3	4

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.5	e)	**Water flows over rectangular weir 6 m long under head of 1.5 m calculate the discharge over the weir if C_d = 0.6**		
	Ans.	Data: L = 6m, C_d = 0.6, H = 1.5 m, Q = ?		
		$\therefore Q = \frac{2}{3} C_d \times L \times \sqrt{2g} \times H^{\frac{3}{2}}$	2	
		$Q = \frac{2}{3} \times 0.6 \times 6 \sqrt{2 \times 9.81} \times 1.5^{\frac{3}{2}}$	1	
		$Q = 19.53\ m^3/s$	1	4
	f)	**Compare centrifugal pump and reciprocating pump on any four points.**		
	Ans.	(see table below)	1 each (any four)	4

Sr. No.	Centrifugal Pump	Reciprocating Pump
1	For Centrifugal pump discharge is continuous.	For Reciprocating pump discharge is fluctuating.
2	Suitable for large discharge and small heads.	Suitable for less discharge and higher heads.
3	Simple in construction due to less number of parts.	Complicated in construction because of more number of parts.
4	It has rotating elements so there is less wear and tear.	It has reciprocating element, there is more wear and tear.
5	It can run at high speed.	It cannot run at high speed.
6	Air vessels are not required.	Air vessels are required.
7	Starting torque is more.	Starting torque is less.
8	It has less efficiency.	It has more efficiency.
9	It can handle dirty water.	It can not handle dirty water.
10	Requires less floor area and simple foundation.	Requires more floor area and heavy foundation.

Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6		**Attempt any TWO:**		**(16)**
	a)	**Explain with reason triangular notches are preferred than rectangular notches. Find the discharge over triangular notches of an angle 60^0 when head over the notch is 15 cm. Take C_d= 0.62**		
		Triangular notches are preferred than rectangular notches because : i. Only one reading i.e head (H) is required to be taken for measurement of rate of flow in a given triangular notch. ii. If in triangular notch the angle of the notch is 90º, the formula become very simple to remember. iii. A triangular notch gives more accurate result for low rate of flow than a rectangular notch. iv. The same triangular notch can measure a wide range of flows accurately.	4	
		Data:$\theta=60^0, C_d=0.62$, H = 0.15m, Q = ? $\therefore Q = \frac{8}{15} C_d \tan\frac{\theta}{2}\sqrt{2g}\times H^{\frac{5}{2}}$	2	
		$Q = \frac{8}{15}\times 0.62\times \tan\frac{60}{2}\sqrt{2\times 9.81}\times 0.15^{\frac{5}{2}}$ $Q = 7.368\times 10^{-3} m^3/s$	2	8
	b)	**Explain construction and working of Bourdon's pressure gauge with the help of neat sketch and write two advantages of it.**		
	Ans.	 Bourdon Tube Pressure Gauge *(Note: 3 Marks for sketch and 1 mark for labeling.)*	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.6</td><td></td><td>

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.
As the pressure in the case containing the bourdon tube is usually atmospheric, the pointer indicates gauge pressure.

</td><td>2</td><td rowspan="2">8</td></tr>
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Advantages:
i. Bourdon tube are simple in construction
ii. It can be used for high pressure measurement.
iii. Accuracy is high especially at high pressure.
iv. It is safe for high pressure measurement.
v. Cost is low
vi. Easy to handle
vii. No calculations are required for measurement of pressure because it gives direct reading.

</td><td>1 each any two)</td></tr>
<tr><td></td><td>c)</td><td>

The diameter of horizontal pipe suddenly changes from 30 cm to 35 cm. The discharge from the pipe is 300 lps. Calculate head loss when
i. Water flows from smaller dia. to large dia. pipe.
ii. Flow is reversed with same discharge.

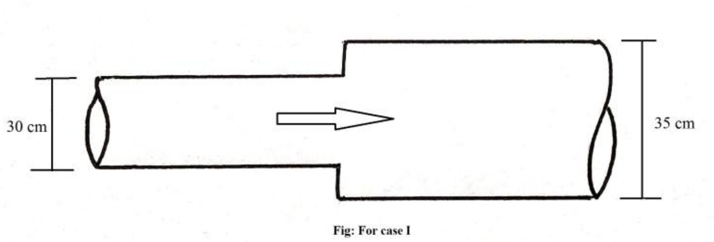

Fig: For case I

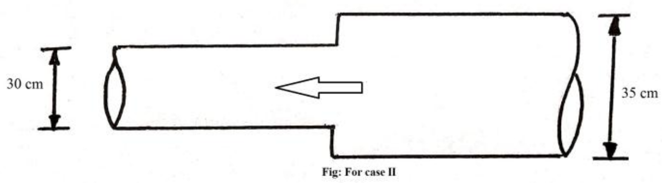

Fig: For case II

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Que. No.	Sub. Que.	Model Answer	Marks	Total Marks
Q.6	**c)** **Ans.**	Data: $Q=0.3m^3/s$, $d_1=30cm$, $d_2=35cm$		
		$Q = a_1 v_1$		
		$0.3=\frac{\pi}{4}(0.3)^2 \times v_1$		
		$v_1=4.24m/s$	**1**	
		$Q = a_2 v_2$		
		$0.3=\frac{\pi}{4}(0.35)^2 \times v_2$		
		$v_2=3.12m/s$	**1**	
		Case 1. Water flows from smaller dia. to large dia. pipe		
		Head loss due to sudden enlargement		
		$H_L = \frac{(v_1 - v_1)^2}{2g}$		
		$H_L = \frac{(4.24-3.12)^2}{2\times 9.81}$		
		$H_L = 0.064m$	**3**	
		Case 2. flow is reversed with same discharge.		
		loss of head due to sudden contraction		
		$H_L = \frac{0.5(v_1)^2}{2g}$		
		$H_L = \frac{0.5(4.24)^2}{2\times 9.81}$		
		$H_L=0.458$ m	**3**	**8**