
SUMMER – 2015 EXAMINATION

MODEL ANSWER

Important Instructions to examiners:

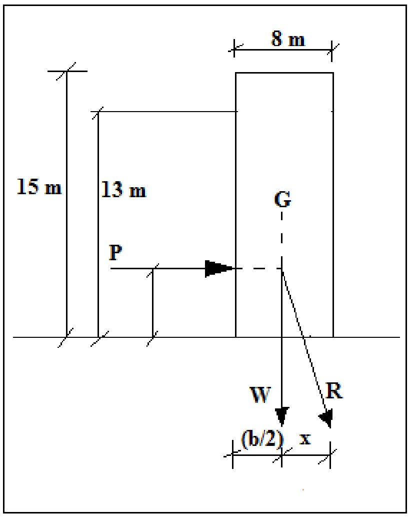
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

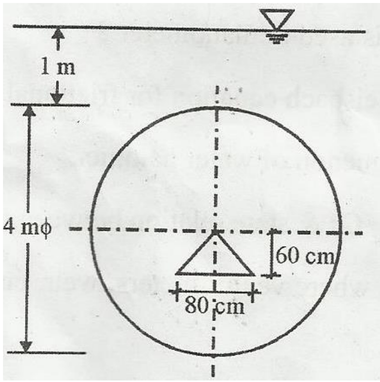
Model Answer

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 1	**(A)**	**Attempt any SIX**		
	(a)	**Differentiate real and Ideal fluid.**		
	Ans.	Real Fluid :- A fluid which possesses viscosity, is known as real fluid. All the fluids, in actual practice, are real fluids.	**01**	
		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.	**01**	**02**
	(b)	**Define kinematic and dynamic viscosity. Give units of them.**		
	Ans.	Kinematic Viscosity :- It is defined as the ratio between the dynamic viscosity (μ) and mass density of fluid (ρ). It is denoted by (γ). $\gamma = \frac{\mu}{\rho}$ Unit = m^2/sec	**01**	
		Dynamic Viscosity :- It is defined as shear stress (τ) required to produce unit rate of shear strain(du/dy). It is denoted by (μ). $\mu = \frac{\tau}{(du/dy)}$ Unit = N.sec/m^2	**01**	**02**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	(c) Ans.	**Define atmospheric and vacuum pressure.** Atmospheric Pressure :- At the earth surface, the pressure due to the weight of air above the earth surface is called as atmospheric pressure. Vacuum Pressure :- The pressure below the atmospheric pressure is known as vacuum pressure.	01 01	02
	(d) Ans.	**Why mercury is used in manometer?** 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.	02 (any two)	02
	(e) Ans.	**State Darcy Weisbach equation for frictional loss in pipe.** Darcy Weisbach equation for frictional loss in pipe is – $h_f = \frac{flv^2}{2gd}$ Where, hf = Loss of head due to friction f = Friction factor l = Length of pipe v = Mean velocity of flow d = Diameter of pipe.	01 01 for terms used	02
	(f) Ans.	**Explain phenomenon of water hammer.** Water hammer :- When a long pipe is connected to tank on one end and another end is having a valve to regulate the flow of water. . When a valve is completely open, the water is flowing with a velocity V in the pipe. If now the valve is suddenly closed the momentum of flowing water will be destroyed and at the same time a wave of high pressure will be set up. This wave of high pressure will travel along the pipe with a velocity equal to the velocity of sound wave and create a noise called knocking. Also this wave of high pressure has the effect of hammering action on pipe walls and hence it is known as water hammer.	02	02
	(g) Ans.	**Define Cd, Cv, Cc and state relation between them.** Coefficient of Discharge (Cd) :- It is defined as ratio of actual discharge from an orifice to the theoretical discharge from the orifice. Coefficient of Velocity (Cv) :- It is defined as ratio of actual velocity of a jet of a liquid at vena-contracta to the theoretical velocity of jet. Coefficient of Contraction (Cc) :- It is defined as ratio of area of jet at vena-contracta to the area of orifice. Relation between Cd, Cv, Cc is – Cd = Cv X Cc	½ ½ ½ ½	02
	(h) Ans.	**State the situation where venturimeters, weir, current meter and flumes are used.** At following situations venturimeters, weir, current meter and flumes are used –		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	**(h)**	(1) Venurimeter – To measure rate of flow / discharge of a liquid flowing through a pipe.	**1/2**	
		(2) Weir – To measure rate of flow / discharge of a liquid flowing through rivers or streams.	**1/2**	
		(3) Current meter – To determine velocity of flow at a required point in a flowing stream.	**1/2**	
		(4) Flumes - To measure rate of flow / discharge of a liquid flowing through an open channel.	**1/2**	**02**
	(B)	**Attempt any TWO.**		
	(a)	**A shaft of 150 mm diameter rotates at 75 rpm in a 500 mm long bearing. Taking that two surfaces are uniformly separated by a distance of 1 mm and considering linear velocity distribution having viscosity of 0.005 N-s/m^2. Find the power absorbed in the bearing.**		
	Ans.	Givens :- Diameter of shaft (D) = 150 mm = 0.150 m Length of bearing (L) = 500 mm = 0.5 m t = 1 mm = 1 X 10^{-3} m μ = 0.005 Ns/m^2 N = 75 rpm Solution :- Power absorbed in the bearing		
		$P = \frac{\mu \pi^3 D^3 N^2 L}{60 X 60 X t}$	**02**	
		$= \frac{0.005 \times \pi^3 \times (0.150)^3 \times (75)^2 \times 0.5}{60 \times 60 \times 1 \times 10^{-3}}$	**01**	**04**
		P = 0.408 W	**01**	
	(b)	**Define compressibility. How it is related to bulk modulus of elasticity? Name some hydraulic problems where compressibility of water is taken into account.**		
	Ans.	Compressibility :- It is defined as the ratio of compressive stress to volumetric strain.	**02**	
		Relation of compressibility with bulk modulus of elasticity:- It is a reciprocal of the bulk modulus of elasticity.	**01**	**04**
		Hydraulic problems where compressibility of water is taken into account:- In case of water hammer, where the change of pressure is very large, it is necessary to consider compressibility.	**01**	
	(c)	**A concrete dam of rectangular section 15 m deep and 8 m wide containing water upto 13 m. Find** **(i) Total pressure of water on 1 m length** **(ii) Depth of centre of pressure above base** **(iii) The point at which resultant cuts the base**		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.1	Ans.	Givens :- Height of dam = 15 m Depth of water = 13 m Width of dam = 8 m Assuming weight of masonry = 25 KN/m^3 Solution :- 	01	
		(1) Total pressure on 1 m length of dam (P) $P = (½)\ \gamma_w\ H^2$ $= (1/2) X 9.81 X 13^2$ = 828.945 KN per m length of dam	01	
		(2) Depth of centre of pressure above base The pressure will act at H/3 from the base. = 13 / 3 = 4.333 m from the base	01	
		(3) The point at which the resultant cuts the base Let x be the horizontal distance from midpoint of the base of the dam. The resultant cuts the base at a distance x from the midpoint. The weight of masonry per unit length of the dam W = Volume of wall of unit length X Specific weight of masonry = (15 X 8 X 1) X 25 = 3000 KN We know, x = (P/W) X (H/3) = (828.945 / 3000) X 4.333 = 1.197 m The resultant cuts the base at a distance of 1.197 m from the midpoint of the base of the dam.	01	04
Q.2		**Attempt any FOUR.**		
	(a)	**A circular plate of 4 m diameter is immersed vertically in water so that its upper edge is 1 m below the water. The plate is having a triangular hole which has a base of 80 cm and height of 60 cm in**		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	**(a)**	**such a position that its vertex coincides with the centre of plate as shown in Fig. Find total pressure acting on the plate and its centre of pressure.**		
	Ans.	Givens :- Dia. of circular plate = 4 m Base of triangle = 80 cm Height of triangle = 60 cm Solution :-  		
		(1) Total Pressure on the circular plate $P_1 = \gamma . \bar{x} . A$ $= 9810 \times (1+2) \times (\pi/4)(4^2)$ $= 369.828 \times 10^3$ N $= 369.828$ KN	**01**	
		(2) Total Pressure on the triangular hole $P_2 = \gamma . \bar{x} . A$ $= 9810 \times (1+2+((2/3)\times 0.60)) \times (1/2 \times 0.80 \times 0.60)$ $= 8.00 \times 10^3$ N $= 8.00$ KN	**01**	
		(3) Total pressure on one side of the plate $P = P_1 - P_2$ $= 369.828 - 8.00$ $= 361.828$ KN	**01**	
		(4) Position of centre of pressure $\bar{h}_1 = \frac{I_g \sin^2\theta}{A\bar{x}} + \bar{x}$ $= \frac{[(\pi/64) \times (4^4)]}{\{[(\pi/4) \times (4^2)] \times (1+2)\}} + (1+2)$ $= 3.333$ m $\bar{h}_2 = \frac{I_g \sin^2\theta}{A\bar{x}} + \bar{x}$ $= \frac{[(0.8) \times (0.6)^3/36]}{[(1/2) \times 0.8 \times 0.60) \times [1+2+((2/3) \times 0.60)]} + [1+2+((2/3) \times 0.60)]$ $= 3.406$ m $\bar{h} = \frac{P_1\bar{h}_1 - P_2\bar{h}_2}{P}$ $= \frac{(369.828 \times 3.333) - (8.00 \times 3.406)}{361.828}$ $= 3.331$ m from free liquid surface	**01**	**04**

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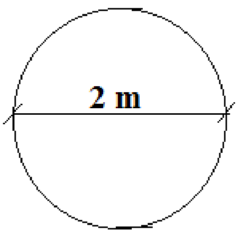
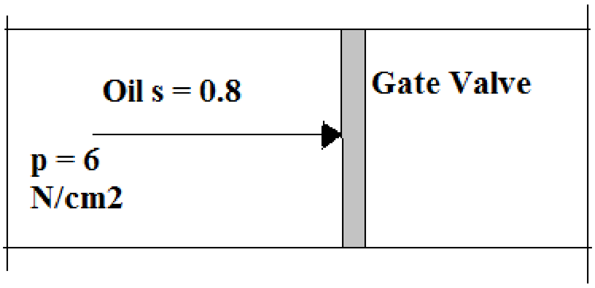
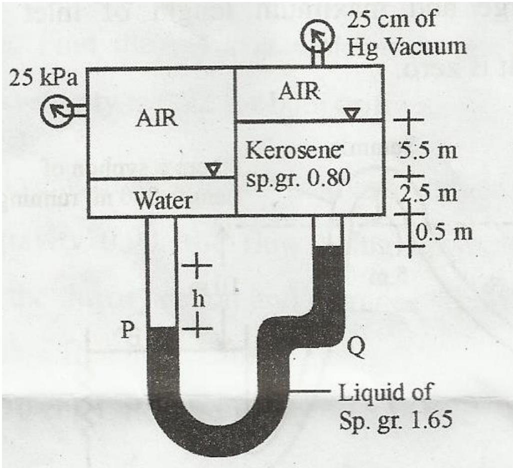
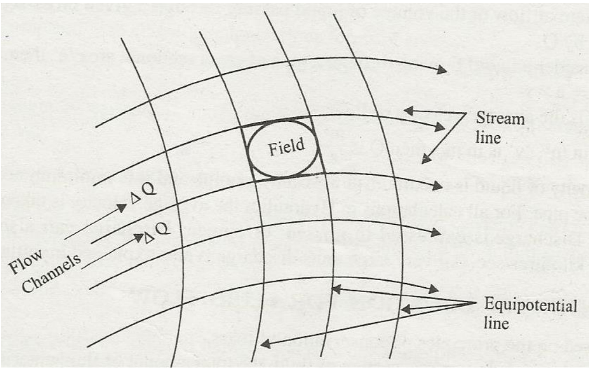
Q. 2	**(b)**	**Define Pascal's law and state its applications and limitations.**		
	Ans.	Pascal's Law :- It states that the pressure intensity or pressure at a point in a static fluid is equal in all directions.	**02**	
		Applications of Pascals law :- It is applied in the construction of machines used for multiplying forces e.g. hydraulic jacks, hydraulic press, hydraulic lifts, hydraulic crane etc.	**01**	
		Limitations of Pascals law : Fluid must be in rest condition only.	**01**	**04**
	(c)	**A pipe line which is 2 m in diameter contains a gate valve. The pipe contains oil of specific gravity of 0.80. The pressure at the centre of pipe is 6 N/cm^2. Find the force exerted by the oil upon the gate and position of centre of pressure.**		
	Ans.	Givens :- d = 2 m s = 0.80 p = 6 N/cm^2 Solution :-		
		 		
		Converting pressure into pressure head (1) Equivalent height of oil above the pipe $h = \bar{x} = \frac{P}{\gamma} = \frac{6 \times 10^4}{9810 \times 0.8} = 7.645$ m	**01**	
		(2) Force exerted by oil upon gate $A = (\pi/4)(2^2) = 3.142$ m^2 $Ig = (\pi/64)(2^4) = 0.785$ m^4 $P = \gamma \bar{x} A$ $= 9810 \times 0.8 \times 7.645 \times 3.142$ $= 188.489$ KN	**01**	
		(3) $\bar{h} = \frac{Ig}{A\bar{x}} + \bar{x}$ $= \frac{0.785}{(3.142 \times 7.645)} + 7.645$ $= 8.168$ m	**01**	
		(4) Centre of pressure = $\bar{h} - h$ $= 8.168 - 7.645 = 0.523$ m from centre of pipe	**01**	**04**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	(d)	**Calculate height 'h' as shown in Fig.**		
				
	Ans.	Solution :- Pressure head on Left Hand Side = Pressure head on Right Hand Side (25 / 9.81) + 2.5 + 0.5 + h = (-13.6 x 0.250) + [0.80 X (5.5+2.5+0.5)] +1.65 h	02	
		5.548 + h = -3.4 + 6.8 + 1.65 h 5.548 + h = 3.4 + 1.65 h 5.548 – 3.4 = 1.65 h – h 2.148 = 0.65 h	01	
		h = 2.148 / 0.65 h = 3.305 m	01	04
	(e) Ans.	**Classify and define types of fluid flow.** Classification of Fluid flow :- (1) Steady and Unsteady Flow (2) Uniform and Non-uniform Flow (3) Laminar and Turbulent Flow (4) Rotational and irrotational flow	02	
		Definations :- (1) Steady Flow :- It is defined as that type of flow in which the fluid characteristics like velocity, pressure, density etc. at a point does not change with time. (2) Unsteady Flow :- It is defined as that type of flow in which the fluid characteristics like velocity, pressure, density etc. at a point changes with time. (3) Uniform Flow :- It is defined as that type of flow in which the velocity at any given time does not change with respect to space. (4) Non-Uniform Flow :- It is defined as that type of flow in which the velocity at any given time changes with respect to space. (5) Laminar Flow:- It is defined as that type of flow in which the fluid particles move along well – defined path and all stream lines are straight and parallel.		

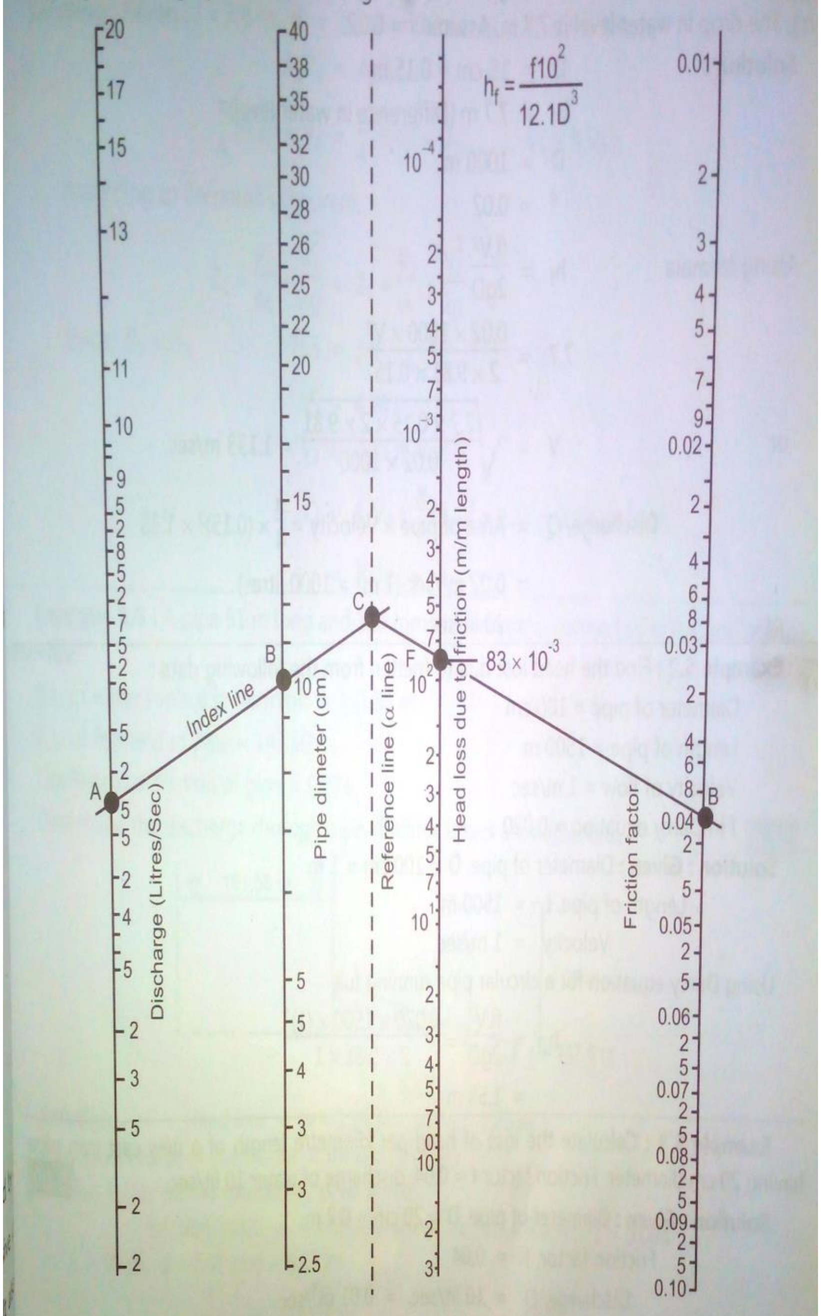
Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.2	**(e)**	(6) Turbulent Flow:- It is defined as that type of flow in which the fluid particles moves in a zig – zag way. (7) Rotational Flow :- It is defined as that type of flow in which the fluid particles while moving along stream line, also rotates about their own axis. (8) Irrotational Flow :- It is defined as that type of flow in which the fluid particles while moving along stream line, does not rotates about their own axis.	**1/2 (any four types)**	**04**
	(f)	**Define and draw flow net. State properties and applications of flow net.**		
	Ans.	Flow net :- Pattern obtained by the intersections of_stream lines and equipotential lines is called as flow net.	**01**	
			**01**	
		Properties of flow net :- (1) Equipotential lines and stream lines are perpendicular to each other. (2) Discharge through each channel is same. (3) The obtained grid of Equipotential lines and stream lines forms a square.	**01 (any two)**	
		Applications of flow net :- After drawing a flow net for a given set of boundary conditions, (1) It may be used for all irrotational flows with geometrical similar boundaries. (2) The spacing between the adjacent streamlines is determined & application of the continuity equation gives velocity of flow at any point, if velocity of flow at any reference point is known. (3) To know seepage pressure and discharge.	**01 (any two)**	**04**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**a.**	**Find the height at which water jet will shoot out of nozzle. Neglect loss of energy pressure p= 20kN/m2.**		
	Ans.	using continuity equation, $A_1V_1 = A_2V_2$ $\frac{\pi}{4} \times {d_p}^2 \times v_1 = \frac{\pi}{4} \times {d_Q}^2 \times v_2$ $v_1 = 0.25v_2$	**1**	
		using Bernoulli's theorem to points Q and R where R is the point till the jet reaches, $5 + 0 + \frac{{v_2}^2}{2g} = 5 + 0 + h + 0$ $\frac{{v_2}^2}{2g} = h$	**1**	
		Again, using bernoulli's equation to points P and Q $0 + \frac{20}{9.81} + \frac{{v_2}^2}{2g} = 5 + 0 + \frac{{v_2}^2}{2g}$ $2.04 + \frac{(0.25v_2)^2}{2g} = 5 + 0 + h$ $2.04 + 0.0625h = 5 + h$ $0.9375h = 2.04 - 5$ $h = -3.15$ The height at which jet will shoot out of nozzle=3.15m	**2**	**4**
	b.	**A pipe line changes in size from 30 cm ó at B . It is used to carry oil of specific gravity 0.80. Point A is 5 m lower than point B and the pressure are 80 kN/m^2 and 60 kN/m^2 respectively. If the discharge is 200 LPS. Find the loss of head and direction of flow.**		
	Ans.	$Q = A_1V_1 = A_2V_2$ $V_1 = \frac{0.2}{\frac{\pi}{4} \times 0.3^2}, V_2 = \frac{0.2}{\frac{\pi}{4} \times 0.6^2}$ **V_1 = 2.83 m/s** **V_2 = 0.707 m/s**	**1**	
		Total energy at A= $\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + z_1$ $= \frac{80000}{9810} + \frac{2.83^2}{2g} + 0$	**1**	
		Total energy at A=8.56 m Total energy at B= $\frac{60000}{9810} + \frac{0.707^2}{2g} + 5$ Total energy at B=11.14 m	**1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3		As total energy is more at B than A , flow is from B to A Loss of head = 11.14 – 8.56 = 2.58m	**1**	**4**
	c. **Ans.**	**Explain Moody's diagram and state its application.** Moody's chart is a curve showing the relation between Reynolds Number (Re) and friction factor, f. It is the graph in which Re is plotted on x axis and f on y axis. The curves are plotted on the results of experiments.	**2**	**4**
		Moody's chart is used to find friction factor of a given pipe. If the values of R/K and Re of flow are known. where R is radius of pipe and K is sand grain roughness.	**2**	
	d. **Ans.**	**Find the discharge and maximum length of inlet leg. Permissible pressure at summit is zero.** Applying Bernoulli's theorem at A to B $H = 0.5\frac{v^2}{2g} + \frac{flv^2}{2gd} + \frac{v^2}{2g}$ $10 = \frac{v^2}{2g}(1.5 + \frac{fl}{D}) = \frac{v^2}{2g}(1.5 + \frac{0.02 \times 800}{0.3})$ $V = \sqrt{\frac{10}{2.79}} = 1.89 m/s$	**1**	
		$Q = A.V = \frac{\pi}{4} \times 0.3^2 \times 1.89 = 0.1338 m^3/s$ $Q = 0.1338\ lps$	**1**	
		Now, for finding length of inlet leg, apply Bernoulli's equation between A & summit $10.3 = 5 + 0.5\frac{v^2}{2g} + \frac{fl_1v^2}{2gD} + \frac{v^2}{2g}$	**1**	
		$0 = -10.3 + 5 + 0.5\frac{v^2}{2g} + \frac{fl_1v^2}{2gD} + \frac{v^2}{2g}$ $= -10.3 + 5 + \frac{v^2}{2g}(1.5 + \frac{0.02l_1}{0.3})$ $l_1 = 414.16m$	**1**	**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	e.	**Draw nomogram axis diagram and explain how it is used for design water distribution pipes.**		
	Ans.			

Nomograph is a graph as shown in Fig.



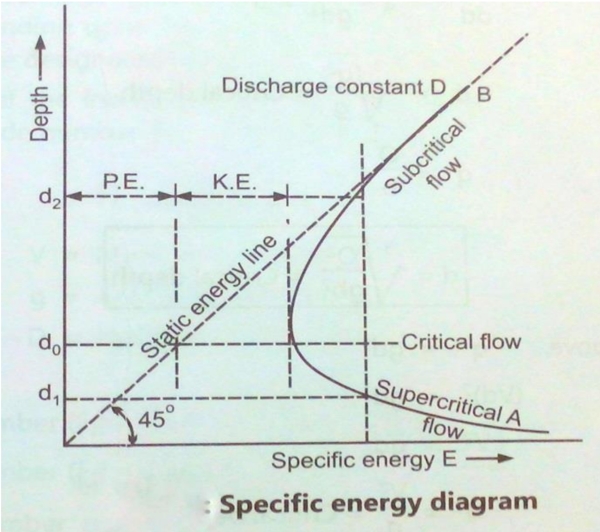
Nomograph of Darcy - Weisbach equation

Use : Nomographs are used in the design of sewer-line for determining the diameter according to discharge, friction factor and head loss. (Marks: 3)

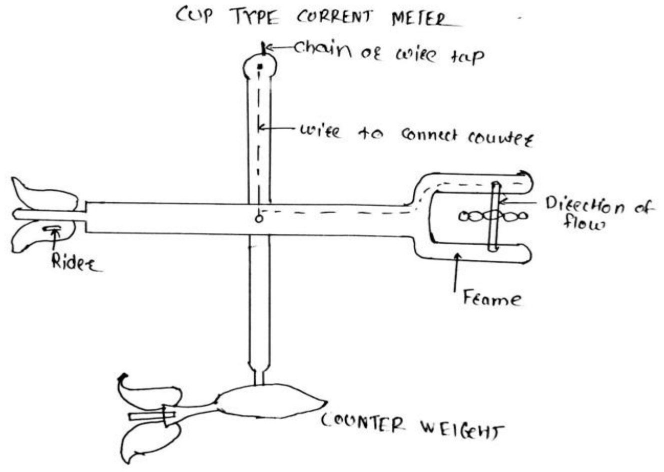
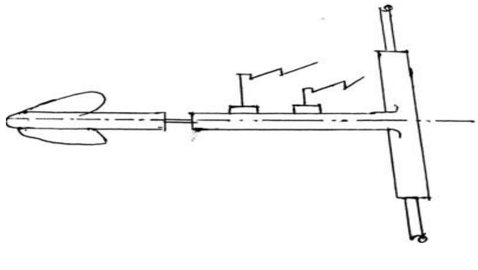
If any three terms are known then by drawing the lines, the fourth unknown term can be find out (Marks: 1)

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.3	**f.** **Ans.**	**State types of open channels. Give hydraulic properties of circular and trapezoidal channels.** Types of channels are as follows- 1. Rectangular channel 2. Trapezoidal Channels 3. Semicircular channels 4. Circular channels	**2**	
		Hydraulic properties of circular channel $A=\frac{\pi}{4}d^2$ $P=\pi D$ $R=\frac{d}{4}$	**1**	
		Hydraulic properties of trapezoidal channel $A=d(b+nd)$ $P=b+2d\sqrt{1+n^2}$ $R=\frac{d(b+nd)}{b+2d\sqrt{1+n^2}}$	**1**	**4**
Q.4	**a.** **Ans.**	**Define steady, unsteady, uniform and non uniform flow in open channel** **Steady flow** : Flow characteristics like velocity, pressure, temperature and density do not change with respect to time at any point.	**1**	
		Unsteady flow is one in which flow characteristics changes with respect to time	**1**	
		Uniform flow is a one in which the velocity and flow does not change in magnitude and direction at different cross sections.	**1**	
		In non uniform flow the velocity of flow changes at different cross sections.	**1**	**4**
Q.4	**b.**	**Design a trapezoidal channel to carry a maximum discharge of 5 cumecs. The longitudinal slope is 1:4000 side slopes 1:1, N=0.02, b=3d.**		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**b.** **Ans.**	Area of section A= (b+nd)d =(3d+1× d)d (b=3d given) A =4d^2 wetted perimeter $P = b + 2d\sqrt{n^2+1}$ $= 3d + 2d\sqrt{1^2+1}$ $= 5.83d$ $R = \frac{A}{P} = \frac{4d^2}{5.83d} = 0.69d$	**1**	
		Using Mannings formula, $V = \frac{1}{N} \times R^{\frac{2}{3}} \times S^{\frac{1}{2}} = \frac{1}{0.02} \times (0.69d)^{\frac{2}{3}} \times \left(\frac{1}{4000}\right)^{\frac{1}{2}}$ $V = 0.617d^{\frac{2}{3}}$	**1**	
		We have, Q = A× V 5 = 4d^2 $\times 0.617d^{\frac{2}{3}}$ $d = 1.3m$ $b = 3d = 3.9m$	**2**	**4**
	c.	**Define Froude's number. What is gradually varied flow and rapidly varied flow on open channel? How it is classified according to Fr. No.?**		
	Ans.	Froude's number is a dimensionless number and is the ration of inertia forces to gravity force.	**1**	
		In gradually varied flow, the depth of flow changes over a long distance.	**1**	
		In rapidly varied flow the depth of flow abruptly changes over a short distance.	**1**	**4**
		For, GVF, Fr< 1 RVF, Fr>1	**1**	
	d.	**Define specific energy. Explain specific energy diagram.**		
	Ans.	The specific energy of a flowing liquid is defined as the energy per unit weight with respect to the bed of the canal as datum.	**1**	

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.4	**d. Ans.**		1	
		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.	2	4
	e.	**A tank has two identical orifices in one of its vertical sides. The upper orifice is 2m below the water surface and lower orifice is 4 m below the water surface. Find the point at which two jets will intersect. If the coefficient of velocity is 0.92 for orifices**.		
	Ans.	Given, Cv=0.92 We have,for top orifice, y=y+2 & H=2 $Cv = \sqrt{\frac{x^2}{4yH}} = \sqrt{\frac{x^2}{4(y+2)\times 2}}$	1	
		for bottom orifice, H=2 $Cv = \sqrt{\frac{x^2}{4yH}}$	1	
		As Cv is same for both orifice, $\sqrt{\frac{x^2}{4(y+2)\times 2}} = \sqrt{\frac{x^2}{4yH}}$ (H=4 for bottom orifice) $y = 2m$	1	
		substituting y in equation 2 0.92=$\sqrt{\frac{x^2}{4\times 2\times 4}}$ The two jets will intersect at $x = 5.2m$	1	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
	f.	**A 30 x 15 cm venturimeter is provided in a vertical pipe line carrying oil of specific gravity 0.90, the flow being upwards. The difference in elevations of the throat section and entrance of the venturimeter is 50 cm. The difference U- tube mercury manometer shows a gauge deflection of 30 cm. Calculate i. Discharge ii. Pressure difference between the entrance and throat section Cd=0.98**		
	Ans.	Inlet area, $A_1 = \frac{\pi}{4} \times 30^2 = 706.86 cm^2$ Throat area, $A_2 = \frac{\pi}{4} \times 15^2 = 176.71 cm^2$ Gauge deflection interms of oil $h = 30cm$ of Hg $h = 30\left(\frac{13.9 - 0.9}{0.9}\right) = 423.3cm$ of oil	1	
		$Q = \frac{Cd \times a_1 \times a_2 \times \sqrt{2gh}}{\sqrt{a_1^2 - a_2^2}}$ $Q = \frac{0.98 \times 706.86 \times 176.71 \times \sqrt{2g \times 423.3}}{\sqrt{706.86^2 - 176.71^2}}$ $Q = 163000 cm^3 / s$ $Q = 163 lps$	1	
		$Q = A_1 V_1 = A_2 V_2$ $V_1 = 230.6 cm/s$ $V_2 = 922.4 cm/s$	1	
		Applying Bernoulli's therem at inlet &throat $Z_1 + \frac{P_1}{\gamma} + \frac{V_1^2}{2g} = Z_2 + \frac{P_2}{\gamma} + \frac{V_2^2}{2g}$ $0 + \frac{P_1}{\gamma} + \frac{230.6^2}{2g} = 50 + \frac{P_2}{\gamma} + \frac{922.4^2}{2g}$ $\frac{P_1 - P_2}{\gamma} = 456.53 cm$	1	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	a Ans.	**Explain working principle of current meter with sketch. State types of it** **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. **Types of current meter** 1)Cup type current meter 2)Propeller or screw type current meter	1 1	
		 SCREW TYPE CURRENTMETER 	(Any one diagram) 2	4
	b ans.	**A weir 6m long has 70cm head of water over its crest. Using Franci's formula, find the discharge over the weir. If approach channel is 7m wide & 1.5 m deep , calculate the new discharge considering velocity approach** For Case 1- Length=6m Head=70 cm=0.7m		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q. 5	**b**	**Francis formula**		
		$Q = 1.84 \times (L - 0.1nH) H^{\frac{3}{2}}$	**1**	
		$Q = 1.84 \times (6 - 0.1 \times 2 \times 0.7) \times 0.7^{\frac{3}{2}}$		
		$Q = 6.31$	**1**	
		Case II Length=6m		
		Approch velocity =Q/A		
		=6.31/ (7X1.5)		
		Va =0.6m/s		
		Head due to velocity approach=$Va^2/2g$		
		$=0.6^2/2$ x9.81		
		=0.0184m		
		Discharge considering velocity approach		
		$Q = 1.84(L - 0.1nH)\left[(H + h_a)^{\frac{3}{2}} - h_a^{\frac{3}{2}}\right]$	**1**	
		$Q = 1.84 \times 5.86 \times \left[(0.7 + 0.0184)^{\frac{3}{2}} - (0.0184)^{\frac{3}{2}}\right]$		**4**
		$Q = 10.78 \times [0.597]$	**1**	
		$=6.43\ m^3/s$		
	c	**A reservoir has catchment area of 30km² .The maximum rainfall over the area is 2.5 cm/hr, 45% of which flows to the reservoir over a weir . Find length of weir. The head over weir is 80 cm.**		
	Ans.	Area = 30 km^2=30 x10^6 m^2		
		Discharge =(30 x 10^6 x2.5) / (100x60x60)	**1**	
		=208.33 m^3/s		
		Discharge over weir 45%=45/100 x208.33	**1**	
		=93.75 m^3/s		**4**

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	c	We know		
		$Q = 1.84 \times (L - 0.1nH)H^{\frac{3}{2}}$	1	
		$93.75 = 1.84 \times (L - 0.1 \times 2 \times 0.8) \times (0.8)^{\frac{3}{2}}$		
		$93.75 = 1.84 \times (L - 0.16) \times 0.715$		
		$93.75 = 1.316 \times (L - 0.16)$		
		$71.20 = (L - 0.16)$		
		L =71.36 m	1	4
	d.	**Differentiate between centrifugal pump & reciprocating pump.**		
	Ans.	(see table below)	1 mark each (Any four)	

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 in construction because of 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	Suction and delivery valve are not necessary	Suction and delivery valve are necessary
10	Requires less floor area and simple foundation	Requires more floor area and requires heavy foundation

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	**e**	**Enlist operating troubles & remedial measures in centrifugal pump.**		
	Ans.	(see table below)	**1 mark each** **(Any four)**	**4**

	Troubles	**Remedies**
1	Pump does not primed	Reprime the pump
2	Total static head more than design head	Use multistage pump
3	Direction of rotation of impeller is wrong	Check the poles of motor
4	Clogging of impeller	Clean impeller
5	Suction lift is more	Lower the setting of pump
6	Clogging of strainer	Clean strainer
7	Speed is low	Wait till voltage becomes proper
8	Other troubles	Contact maintenance person

f. **Find the power required to drive a centrifugal pump which delivers 50 lps of water to height of 20 m through a 150mm diameter & 120m long pipe line .The overall efficiency of pump is 75% Assume Darcy's f=0.06, total minor loss=0.35m**

Ans

Q=50 lps

$=0.05 m^3/s$

D =150mm=0.15m

L= 120 m

Efficiency %η=75%

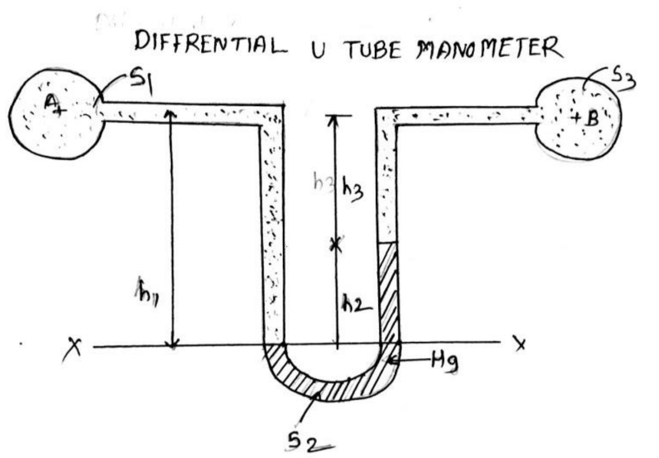
$$\text{Head loss} = \frac{FLQ^2}{12.1D^5}$$ **1**

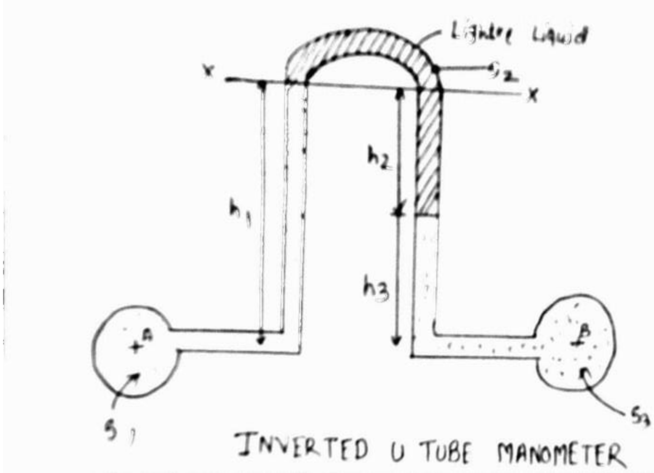
$$\text{Head loss} = \frac{1.487\times10^{-3}}{0.15^5}$$

Head loss = 19.5 m

Total head = 20+19.5+0.35 **1**

39.85 m

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.5	f.	Power required $P = \frac{w \times Q \times H_m}{\eta}$ $P = \frac{9.81 \times 0.05 \times 39.85}{0.75}$ P = 26.06 Kw	1 1	4
Q.6	(a) Ans.	**Derive relation for pressure head difference for U tube manometer &inverted U tube manometer**  Differential manometer h_1= height of liquid in left limb above xx h_2 = height of manometric liquid above xx h_3=height of liquid in right limb above manometric liquid S_1 = Specific gravity of liquid at A S_2 = Specific gravity of manometric liquid S_3 = Specific gravity of liquid at B H_A = Pressure Head at A H_B = Pressure Head at B P_A = Pressure at A P_B = Pressure at B The difference of pressure is Pressure in left limb =Pressure in right limb $H_A + h_1 S_1 = H_B + h_2 S_2 + h_3 S_3$ $(H_A - H_B) = h_2 S_2 + h_3 S_3 - S_1 h_1$ **Or** $(P_A - P_B) = \gamma_2 h_2 + \gamma_3 h_3 - \gamma_1 h_1$	1 1 1 1	4

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	a.	**Inverted U tube manometer**		
			1	
		h_1 = Height of liquid in left limb below the datum line X- X h_2 = Height of lighter liquid below X- X h_3 = Height of liquid in right limb below the manometric liquid S_1 = Specific gravity of liquid at A S_2 = Specific gravity of lighter liquid S_3 = Specific gravity of liquid at B P_A = Pressure at A P_B = Pressure at B The difference of pressure is Pressure in left limb =Pressure in right limb	1	
		$H_A-h_1s_1 = H_B-h_2s_2- h_3s_3$	1	
		$(H_A - H_B) = s_1 h_1 - s_2 h_2 - s_3 h_3$ Or		8
		$(P_A - P_B) = \gamma_1 h_1 - \gamma_2 h_2 - \gamma_3 h_3$	1	
	b.	**A pipe PQRS of uniform diameter PQ= 120m QR=150m RS =60m ,RL at P,Q,R,S are 160,145, 175, 190m respectively.** **Pressure at P=0.30Mpa** **Pressure at R=0.07Mpa** **Find pressure at Q & R & find direction of flow.Neglect minor losses**		
	Ans.	Pressure head at P $= \frac{P_P}{\gamma_L} = \frac{0.3\times10^6}{9810} = 30.58m$		

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**b. Ans.**	Pressure head at S $= \frac{P_S}{\gamma_L} = \frac{0.07 \times 10^6}{9810} = 7.135m$	**1**	
		Let, V be the velocity of flow through pipe Total energy head at P= $Z_P + \frac{P_P}{\gamma_L} + \frac{V_P{}^2}{2g}$ $= 60 + 30.58 + \frac{V_P{}^2}{2g}$ $= 90.58 + \frac{V_P{}^2}{2g}$	**1**	
		Total energy head at S=$Z_S + \frac{P_S}{\gamma_L} + \frac{V_S{}^2}{2g}$ Total energy head at S= 90+7.135+$\frac{V_S{}^2}{2g}$ Total energy head at S= 97.135 + $\frac{V_S{}^2}{2g}$	**1**	
		Since $V_p = V_s$, because diameter of pipe is same, the total energy head at S is greater than total energy head at P, the flow is from S to P. The loss of head = 97.135 – 90.58 = 6.555 m.	**1**	
		Total length of pipe = 120 +150+ 60 = 330 m. Calculation of pressure at R Length SR = 60 loss of head from to S to R=$\frac{60}{330} \times 6.555 = 1.19m$ Applying Bernoulli's theorem to points S to R, $Z_S + \frac{P_S}{\gamma_L} + \frac{V_S{}^2}{2g} = Z_r + \frac{P_R}{\gamma_L} + \frac{V_R{}^2}{2g} + \text{head loss}$ 90+7.135+$\frac{V_S{}^2}{2g} = 75 + \frac{P_R}{\gamma_L} + 1.19$ $90 - 75 + 7.135 - 1.19 = \frac{P_R}{\gamma_L}$ $\quad (V_S = V_R)$ $\frac{P_R}{\gamma_L} = 20.945m$	**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>Q.6</td><td>b. Ans.</td><td>Pressure intensity at R=$P_R = 20.945 \times 9810$
$P_R = 205470.45 N/m^2$
$P_R = 0.205\ N/mm^2$
Calculation of pressure at P
loss of head from to Q to P=$\frac{120}{330} \times 6.555 = 2.38m$
$Z_Q + \frac{P_Q}{\gamma_L} + \frac{V_Q^2}{2g} = Z_P + \frac{P_P}{\gamma_L} + \frac{V_P^2}{2g} + \text{head loss}$
$45 + \frac{P_Q}{\gamma_L} = 60 + 30.58 + 2.38$
$\frac{P_Q}{\gamma_L} = 47.96m$
$P_Q = 47.96 \times 9810$
$P_Q = 470523.27 \text{N/m}^2$
$P_Q = 0.470 \text{N/mm}^2$</td><td>2</td><td>8</td></tr>
<tr><td></td><td>c.

Ans.</td><td>The spillway of a tank discharge with a head of 1.5 m. The length ofCrest is 10m. Calculate the dimensions of most economical section of trapezoidal channel with side slopes 1:1.5 (V:H) & bed slope 0.5/1000 .Assume Cd for weir = 0.78 Manning's N=0.016
Given,
C_d for weir = 0.78
Length of weir = 10 m
H for weir = 1.5 m
Side slopes = 1 :1.5 (V:H)
Bed slope = 0.5/1000 = 5 x 10^{-4}
For finding out discharge, use formula for weir
$Q = \frac{2}{3} \times C_d \times \sqrt{2g} \times L \times H^{\frac{3}{2}}$
$Q = \frac{2}{3} \times 0.78 \times 4.43 \times 10 \times (1.5)^{\frac{3}{2}}$
$Q = 42.32 m^3/s$
Now, For most economical trapezoidal section conditions are
$b + 2nd = 2d\sqrt{n^2+1}$
$b + 2 \times 1.5 \times d = 2d\sqrt{(1.5)^2+1}$
$b + 3d = 3.6d$
$b = 0.6d$
$A = bd + nd^2$
$A = 2.1d^2$</td><td>1

1

1

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

Que. No.	Sub. Que.	Model Answers	Marks	Total Marks
Q.6	**c. Ans.**	Now, we know manning's formula $Q = \frac{A}{N} \times R^{\frac{2}{3}} \times S^{\frac{1}{2}}$ $44.32 = \frac{2.1d^2}{0.016} \times (\frac{d}{2})^{\frac{2}{3}} \times (5 \times 10^{-4})^{\frac{1}{2}}$ $44.32 = 82.69 \times d^{\frac{2}{3}} \times d^2 \times 0.22$ $44.32 = 1.82d^{2.67}$ $d^{2.67} = 23.25$ $d = (23.25)^{\frac{1}{2.67}}$ $d = 2.37$ And, b=0.6d b= 0.6 x 2.37 b= 1.42 m Therefore, dimensions of trapezoidal section b =1.42 m d = 2.37 m	**1** **1** **1** **1**	**8**
