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April 2024

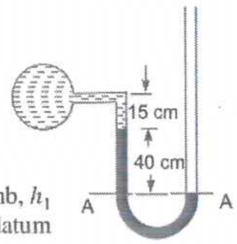
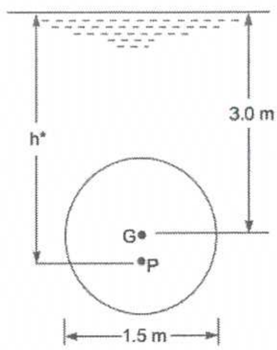
Hydraulics & Irrigation Engineering
Answerkey

PART A

Answer all the following questions (9x1 = 9 marks)

Q No.	Answer	Splitup	Marks
1.	Ideal fluid	1	1
2.	$Re > 4000$	1	1
3.	Gauge pressure	1	1
4.	$Q = \frac{1}{N} A R^{2/3} S^{1/2}$	1	1
5.	Tail Race	1	1
6.	Kharif, Rabi	1	1
7.	2000 hectares	1	1
8.	Fish ladder	1	1
9.	Level cross	1	1
	PART - B		
1.	Pascal law states that, for a static fluid the pressure intensity of a fluid particle at any direction is same. $P_x = P_y = P_z$	2 1	3
2.	It states that in a steady, ideal flow of an incompressible fluid the total energy at any point is constant. The total energy consist of pressure energy, kinetic energy and potential energy. $\frac{P}{\rho g} + \frac{V^2}{2g} + Z = \text{constant}$	2 1	

Q No	Answer	Splitup	Marks
3.	Orifice : Small openings provided on side or bottom of a tank for measuring discharge. Mouthpiece : An orifice fitted with a small tube for measuring discharge.	1.5x2	3
4.	The momentum of flowing water will give rise to a wave of high pressure when the valve is suddenly closed. This high pressure creates a hammering effect on walls of pipe.	3	3
5.	(1) Methods and system of irrigation (2) Mode of applying water to crops (3) Method of cultivation (4) Type of crop (5) Base period of crop (6) Climatic conditions of area. (7) Quality of water (8) Canal conditions (9) Nature of soil	Any 6 $\frac{1}{2} \times 6$	3
6.	$B = 110$ days $\quad D = 1400$ ha/cumec $\Delta = \frac{8.64 B}{\Delta}$ $= 0.68$ m or 68 cm	1 2	3
7.	Balancing depth comes when the canal is in partial embankment and in partial cutting. It is the depth of canal which gives equal amount of cutting and filling.	3	3
8.	(1) Maintains water level. (2) Protect banks from erosion (3) Control over flow of dam (4) It makes the way of transfer from the reservoir to different sectors.	(Any three) 1x3	3
9.	(1) To cater for drainage in dam section (2) To provide access to the interior for inspection. (3) To provide access for carrying out drilling & grouting operation. (4) Operation of gates & control equipments.	Any three 1x3	3

Qn No.	Answer	Splitup mark	Marks
10.	Structure constructed to dispose surplus /excess water from time to time. It serves as a safety valve for canal system. It provides protection to the canal from possible damage due to excess supply.	3	3
	PART – C		
1.	Given : Sp. gr. of fluid, $S_1 = 0.8$ Sp. gr. of mercury, $S_2 = 13.6$ Density of fluid, $\rho_1 = 800$ Density of mercury, $\rho_2 = 13.6 \times 1000$  Difference of mercury level, $h_2 = 40$ cm $= 0.4$ m. Height of liquid in left limb, $h_1 = 15$ cm $= 0.15$ m. Let the pressure in pipe $= p$. Equating pressure above datum line A-A, we get $\rho_2 g h_2 + \rho_1 g h_1 + p = 0$ $\therefore$ $p = -[\rho_2 g h_2 + \rho_1 g h_1]$ $= -[13.6 \times 1000 \times 9.81 \times 0.4 + 800 \times 9.81 \times 0.15]$ $= -[53366.4 + 1177.2] = -54543.6\ \text{N/m}^2 = \mathbf{-5.454\ N/cm^2}$.	Fig:1 1 2 1 2	7
	OR		
2.	Given : Dia. of plate, $d = 1.5$ m  $\therefore$ Area, $A = \frac{\pi}{4}(1.5)^2 = 1.767\ \text{m}^2$ $\bar{h} = 3.0$ m Total pressure is given by equation (3.1), $F = \rho g A \bar{h}$ $= 1000 \times 9.81 \times 1.767 \times 3.0$ N $= \mathbf{52002.81\ N.}$ Ans. Position of centre of pressure (h^*) is given by equation $h^* = \frac{I_G}{A\bar{h}} + \bar{h}$ where $I_G = \frac{\pi d^4}{64} = \frac{\pi \times 1.5^4}{64} = 0.2485\ \text{m}^4$ $\therefore$ $h^* = \frac{0.2485}{1.767 \times 3.0} + 3.0 = 0.0468 + 3.0$ $= \mathbf{3.0468\ m.}$ Ans.	1 1 2 1 2	7

Qn.	Answer	Split up	Marks
3.	(1) Steady & Unsteady flow : with respect to time (2) Uniform & Non uniform flow : with respect to space (3) Laminar, Turbulent, Transitional flow : with respect to Re. (4) Compressible & Incompressible flow : with respect to density. (5) Rotational & Irrotational : with respect to rotation of fluid particle. (6) 1D, 2D & 3D : with respect to directions of flow	Any 5 1.4×5	7
	OR		
4.	**Solution.** Given : Sp. gr. of oil, $S_o = 0.8$ Sp. gr. of mercury, $S_h = 13.6$ Reading of differential manometer, $x = 25$ cm $\therefore$ Difference of pressure head, $h = x\left[\frac{S_h}{S_o} - 1\right]$ $= 25\left[\frac{13.6}{0.8} - 1\right]$ cm of oil $= 25\,[17 - 1] = 400$ cm of oil. Dia. at inlet, $d_1 = 20$ cm $\therefore$ $a_1 = \frac{\pi}{4}d_1^2 = \frac{\pi}{4} \times 20^2 = 314.16\ \text{cm}^2$ $d_2 = 10$ cm $\therefore$ $a_2 = \frac{\pi}{4} \times 10^2 = 78.54\ \text{cm}^2$ $C_d = 0.98$ $\therefore$ The discharge Q is given by equation (6.8) or $Q = C_d \frac{a_1 a_2}{\sqrt{a_1^2 - a_2^2}} \times \sqrt{2gh}$ $= 0.98 \times \frac{314.16 \times 78.54}{\sqrt{(314.16)^2 - (78.54)^2}} \times \sqrt{2 \times 981 \times 400}$ $= \frac{21421375.68}{\sqrt{98696 - 6168}} = \frac{21421375.68}{304}\ \text{cm}^3/\text{s}$ $= 70465\ \text{cm}^3/\text{s} =$ **70.465 litres/s. Ans.**	2 1 1 2 1	7

<table>
<tr><th>Qn.</th><th>Answer</th><th>Splitup</th><th>Marks</th></tr>
<tr><td>5.</td><td>
<table>
<tr><th>Centrifugal pumps</th><th>Reciprocating pumps</th></tr>
<tr><td>1. The discharge is continuous and smooth.</td><td>1. The discharge is fluctuating and pulsating.</td></tr>
<tr><td>2. It can handle large quantity of liquid.</td><td>2. It handles small quantity of liquid only.</td></tr>
<tr><td>3. It can be used for lifting highly viscous liquids.</td><td>3. It is used only for lifting pure water or less viscous liquids.</td></tr>
<tr><td>4. It is used for large discharge through smaller heads.</td><td>4. It is meant for small discharge and high heads.</td></tr>
<tr><td>5. Cost of centrifugal pump is less as compared to reciprocating pump.</td><td>5. Cost of reciprocating pump is approximately four times the cost of centrifugal pump.</td></tr>
<tr><td>6. Centrifugal pump runs at high speed. They can be coupled to electric motor.</td><td>6. Reciprocating pump runs at low speed. Speed is limited due to consideration of separation and cavitation.</td></tr>
<tr><td>7. The operation of centrifugal pump is smooth and without much noise. The maintenance cost is low.</td><td>7. The operation of reciprocating pump is complicated and with much noise. The maintenance cost is high.</td></tr>
<tr><td>8. Centrifugal pump needs smaller floor area and installation cost is low.</td><td>8. Reciprocating pump requires large floor area and installation cost is high.</td></tr>
<tr><td>9. Efficiency is high.</td><td>9. Efficiency is low.</td></tr>
</table>
</td><td>1x7
(Any 7)</td><td>7</td></tr>
<tr><td>6.</td><td>
OR
Solution. Given :
Width of rectangular channel, $b = 6$ m
Depth of channel, $d = 3$ m
∴ Area, $A = 6 \times 3 = 18 \text{ m}^2$
Bed slope, $i = 1 \text{ in } 2000 = \frac{1}{2000}$
Chezy's constant, $C = 55$
Perimeter, $P = b + 2d = 6 + 2 \times 3 = 12$ m
∴ Hydraulic mean depth, $m = \frac{A}{P} = \frac{18}{12} = 1.5$ m
Velocity of flow is given by equation (16.4) as,
$V = C\sqrt{mi} = 55\sqrt{1.5 \times \frac{1}{2000}} = \mathbf{1.506 \text{ m/s.}}$ Ans.
Rate of flow, $Q = V \times \text{Area} = V \times A = 1.506 \times 18 = \mathbf{27.108 \text{ m}^3\text{/s.}}$ Ans.
</td><td>1
2
1
2
1</td><td>7</td></tr>
<tr><td>7.</td><td>
(1) Based on nature of source of supply : (a) Permanent (b) Inundation
(2) Based on financial output : (a) Productive (b) Protective
(3) Based on function of canal : (a) Irrigation (b) Carrier (c) Feeder (d) Navigation (e) Power
(4) Based on boundary surface (a) Alluvial (b) Non-alluvial (c) Rigid boundary
(5) Based on discharge (a) Main canal (b) Branch canal (c) Major distributary (d) Minor distributary (e) Water course
(6) Based on its allignment
</td><td>1
1
2
1
2</td><td>7</td></tr>
</table>

	OR		
8.	(a) Crop period : Time in days that a crop takes from sowing to harvesting. (b) Base period : Time from first watering to last watering before harvesting. (c) Delta : Total depth of water required by a crop during entire crop period. Denoted by Δ. (d) Duty : Irrigating capacity of a unit quantity of water. It is the relation between area of a crop irrigated and quantity of water required during entire period of growth of crop. unit : hectares/cumecs.	1.5 1.5 2 2	7
9.	A canal lining material, to be suitable, should have the following properties : 1. The material used for lining should provide complete *water tightness.* 2. The material used should have low coefficient of rugosity so as to make the section *hydraulically more efficient.* 3. The material chosen for canal lining should be *strong and durable.* 4. The lining should not have a very *high initial cost.* Subsequent maintenance cost of canal lining should be *very low.* 5. The material used should be able to *resist growth of weeds and attack of burrowing animals.* 6. The material used should be unaffected by *tramping of cattles.* 7. The material should withstand high velocity. 8. The material should permit construction of required slope easily.	1X7	7
10.	A diversion headwork consists of the following component parts (Fig. 12.3): 1. Weir *or* barrage 2. Divide wall *or* divide groyne 3. Fish ladder 4. Pocket *or* approach channel 5. Scouring sluices 6. Canal head regulator 7. River training work (Marginal bunds and guide banks) (Explanation of any 4 component)	1X4	

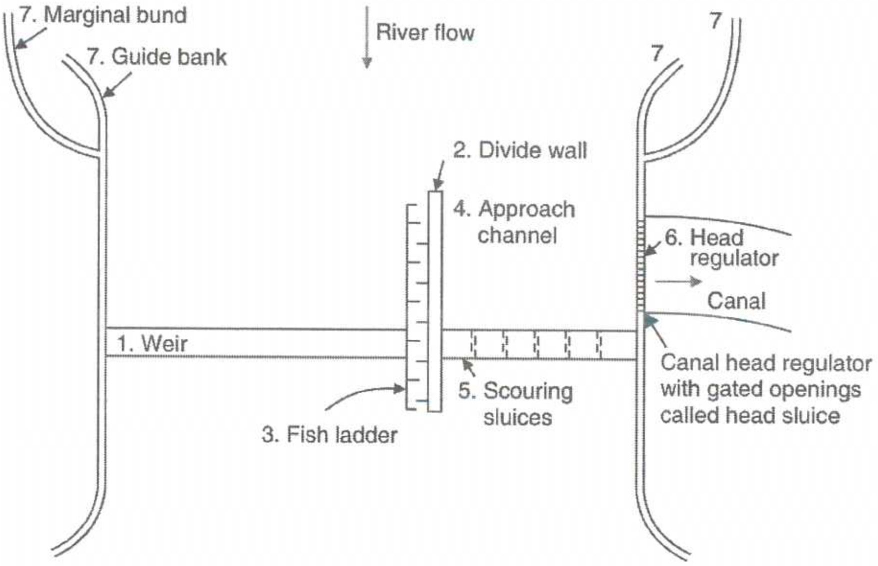


Figure with labelling — 3

7

11.

Parameters	Earth Dam	Gravity Dam
Seepage	More seepage	Less seepage
Foundation	Suitable on almost any foundation	Suitable only when foundation is rock having no fissures, crack
Construction	Materials are stone, earth containing silt, clay, sand	Construction materials stone, brick, masonry
Maintainance	More costly	Less costly
Labour	Require less skilled labour	More skilled labour
Stability	More susceptible to failure	Less susceptible to failure

Any 5

7

OR

12.	**Functions of distributary head regulator** 1. They regulate or control the supplies to the off-taking channel. 2. They serve as a meter for measuring the discharge entering into the off-taking canal. 3. They control the silt entry in the off-taking canal. 4. They help in shutting off the supplies when not needed in the off-taking canal, or when the off-taking channel is required to be closed for repairs.	3.5	7
	Functions of cross-regulator 1. The effective regulation of the whole canal system can be done with help of cross-regulator. 2. During the periods of low discharges in the parent channel, the cross-regulator raises water level of the u/s and feeds the off-take channel in rotation. 3. It helps in closing the supply to the d/s of the parent channels, for the purposes of repairs etc. 4. They help in absorbing fluctuation in various sections of the canal system, and in preventing the possibilities of breaches in the tail reaches. 5. Incidently, bridges and other communication works can be combined with it. Akhil B. Nair, Lecturer in Civil Engg. Central Polytechnic College.	3.5	

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Mark Distribution

Module	Hr/Module	(hi/Σhi)*123	TYPE OF QUESTIONS							
			PART A		PART B		PART C		TOTAL	
			No. of Questions	Marks	No. of Questions	Marks	No. of Questions	Marks	No. of Questions	Marks
I	15	31.81	3	3	2	6	3	21	8	30
II	14	29.69	2	2	2	6	3	21	7	29
III	14	29.69	2	2	3	9	3	21	8	32
IV	15	31.81	2	2	3	9	3	21	8	32
TOTAL	58	123.00	9	9	10	30	12	84	31	123

COGNITIVE LEVEL WISE QUESTION ANALYSIS

Mark Distribution

Cognitive Level	% Marks	Marks	TYPE OF QUESTIONS							
			PART A		PART B		PART C		TOTAL	
			No. of Questions	Marks	No. of Questions	Marks	No. of Questions	Marks	No. of Questions	Marks
R	30	36.90	9	9	7	21	1	7	17	37
U	50	61.50	0	0	3	9	7	49	10	58
A	20	24.60	0	0	0	0	4	28	4	28
TOTAL	100	123.00	9	9	10	30	12	84	31	123

Questionwise Analysis

Course : 4012 - Hydraulics and Irrigation Engineering

Qn No.	Module Outcome	Cognitive level	Score	Time in Minutes
I.1	1.01	Remembering	1	2
I.2	1.01	Remembering	1	2
I.3	1.02	Remembering	1	2
I.4	2.03	Remembering	1	2
I.5	2.04	Remembering	1	2
I.6	3.01	Remembering	1	2
I.7	3.03	Remembering	1	2
I.8	4.03	Remembering	1	2
I.9	4.04	Remembering	1	2
II.1	1.02	Remembering	3	9
II.2	1.04	Understanding	3	9
II.3	2.01	Understanding	3	9
II.4	2.02	Remembering	3	9
II.5	3.02	Remembering	3	9
II.6	3.01	Remembering	3	9
II.7	3.04	Remembering	3	9
II.8	4.01	Remembering	3	9
II.9	4.02	Remembering	3	9
II.10	4.03	Understanding	3	9
III.1	1.02	Applying	7	15
III.2	1.02	Applying	7	15
III.3	1.04	Understanding	7	15
III.4	2.01	Applying	7	15
III.5	2.04	Understanding	7	15
III.6	2.03	Applying	7	15
III.7	3.04	Understanding	7	15
III.8	3.01	Understanding	7	15
III.9	3.04	Remembering	7	15
III.10	4.03	Understanding	7	15
III.11	4.01	Understanding	7	15
III.12	4.03	Understanding	7	15