MODEL QUESTION PAPER II

HYDRAULICS AND IRRIGATION ENGINEERING

Time : 3 Hour *Max.Marks : 75*

PART A

I. Answer all the following questions (9 x 1 = 9 Marks)

1. Reynolds number is the ratio of ----------
2. An ideal fluid is ---------
3. Flow of fluid in which velocity does not change both in magnitude and direction from point to point in the fluid is known as ----------
4. Priming is essential for ----------
5. ---------- is an example of reaction turbine
6. ---------- is a Kharif crop
7. ---------- is the period in number of daysthat a crop takes from the instant of sowing to harvesting
8. ----------is an irrigation structure constructed across a canal to lower down the water level
9. ---------- is the part of stored water in the reservoirwhich is not available for use

PART B

II. Answer any eight questions from the following. Each question carries 3 marks

(8 x 3 = 24 Marks)

1. Differentiate laminar and turbulent flow
2. Explain simple manometer and differential manometer
3. Draw the hydroelectric installation layout
4. Explain about water hammer and its effects
5. Differentiate between notch and weir
6. Find the duty of paddy in hectares/cumec. Given the depth of water over area required is 1200 mm and base period is 150 days
7. List the methods adopted to maintain an Irrigation canal
8. List the classification of dams
9. Sketch the elementary profile of a gravity dam
10. Enumerate the causes of failure of Earth dams

PART C

Answer ALL questions. Each question carries 7 marks

III. A vertical sluice gate 3 meter wide and 2.5 meter deep contain water on both of its side on the upstream side, the water is 5 m deep on the downstream side it is 2 m deep from the bottom of the sluice. Find the resultant pressure on the gate

OR

IV. A rectangular opening in a vertical reservoir wall is 1 m wide and 3.5 m deep and its top edge is 9.5 m below water level. Find the total pressure on the gate and its point of application

V. The diameter of a pipe changes from 200 mm at a section 5 m above the datum to 50 mm at a section 3 meters above datum. The pressure of water at first section is 500 kpa. If the velocity of flow at the first section is 1 m/s, determine the intensity of pressure at the second section

OR

VI. A venturimeter has an area ratio of 9 to 1 , the large section being 300 mm. During the flow the recorded pressure head in the large section is 6.5 m and that at the throat is 4.25 meters. If the meter coefficient C = 0.99, compute the discharge through the meter

VII. Water flows over a rectangular notch of 1 meter length over a depth of 150 mm then the same quantity of water passes through a triangular right angled notch. Find the depth of water through the notch. Take the coefficient of discharge for rectangular and triangular notch as 0.62 and 0.59 respectively

OR

VIII. A rectangular channel has a cross section of 8 square meters. Find its size and discharge through the most economical section, if the bed slope is 1 in 1000. Take C = 55

IX. Describe different classification of canals based on carrying capacity

OR

X. Explain the advantages of irrigation

XI. Describe the component parts of a weir

OR

XII. write short notes on the following

i) Scouring Sluice
ii) Fish Ladder
iii) Divide Wall
iv) Head Regulator

XIII. Explain the factors influencing selection of site for reservoir

OR

XIV. Explain the cross drainage works

Prepared by
Jaisa Jamal
Lecturer in Civil Engineering
GPTC Kalamassery

MODEL QUESTION PAPER 1

HYDRAULICS AND IRRIGATION ENGINEERING

ANSWER KEY

PART A

I. Answer all the following questions **(9 x 1 = 9 Marks)**

10. Inertia force to Viscous force
11. Frictionless and incompressible
12. uniform flow
13. Centrifugal pump
14. Francis turbine
15. Rice/ Maize/ Bajra/ Jowar/ Cotton/ Tobacco/Groundnut
16. Crop Period
17. Canal drop /Fall
18. Dead storage

(9 x 1 = 9 marks)

PART B

II. Answer any eight questions from the following. Each question carries 3 marks

(8 x 3 = 24 Marks)

1. Laminar Flow

In laminar flow, the fluid particles move along a straight, parallel paths in layers or laminae . The magnitudes of velocities of adjascent laminae are not same

Turbulent Flow

In turbulent flow, the particles of the fluid move in a haphazard manner in all directions. It is impossible to trace the motion of an individual particle

(1.5 x 2 = 3 marks)

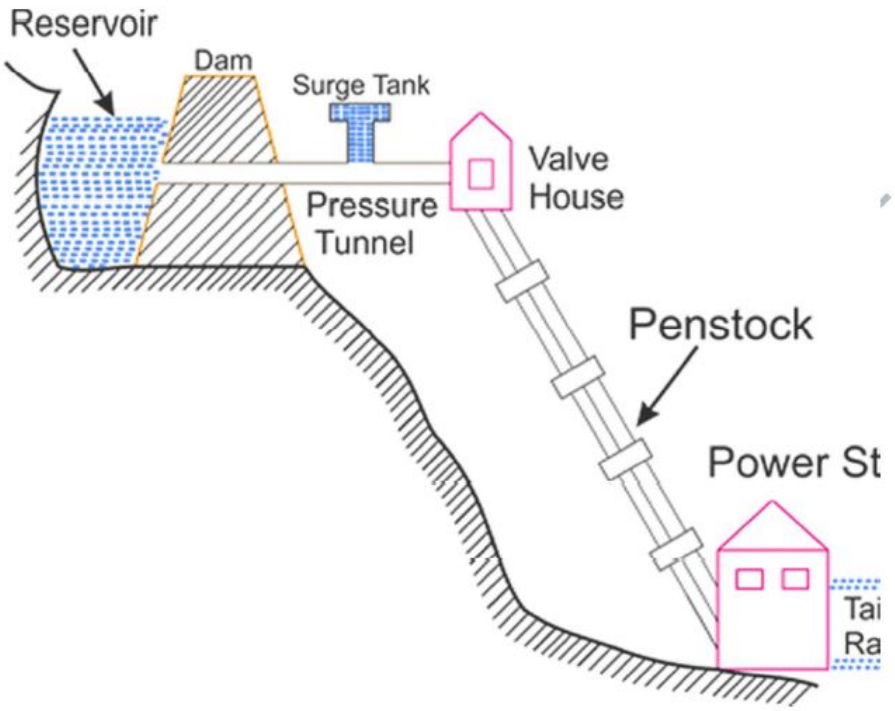
2. Simple manometer

one end of simple manometer is attached to the gauge point and theother is open to the atmosphere. it is used for measuring high as well as negative pressure.

In differential manometer whose 2 ends are connected to the point whose difference of pressures is required to found out .

(1.5 x 2 = 3 marks)

3.



3 marks for figure

4. Water Hammer

When the valve of a pipeline suddenly closed the momentum of the flowing water is destroyed and because of very high pressure wave is generated upward the pipe and velocity = sound wave ,thisexhert very high noise known as knocking. the intensity of pressure raise due to above phenomenon is known as water hammer. it depends

- velocity of water flow
- length of pipe
- time taken to close the valve
- elastic property of pipe materials

(3 marks)

5. Notch

- Notch is basically defined as a device which is used for determining the flow of liquid through a small channel or a tank.
- Notches might be defined as the opening provided in one side of a tank or reservoir or a small channel in such a way that the liquid surface in the tank or channel is below the top edge of opening
- Bottom edge of notch over which liquid flows will be termed as sill or crest. The material of casting of notch will be usually a metallic pipe.
- Notches will be small in size and will be preferred to use for measuring the small discharge of small stream or canal.

Weir

- A weir will be basically a concrete or masonry structure which will be located in an open channel over which flow will take place.

- We can also define as the structure constructed across the river or large canal for storing water on upstream side.
- Top of weir over which water flow will take place will be termed as crest
- Weir will be used for measuring the large discharge of rivers or large canals.
- Weir will be usually in the form of vertical wall, with a sharp edge at the top, running all the way across the open channel.
- Notches will be small in size but weir will be bigger in size
- A weir will be basically made by a concrete or masonry structure.

Any 3 points x 1 = 3 marks

6. Given

Δ= total depth of water over area required = 1200 mm

B= base period in days = 150 days

To find D= duty in hectares/cumec

$$D = 8.64 \frac{B}{\Delta} \quad \text{hectares/cumec}$$ **1 mark**

$$= 8.64 \times \frac{150}{1.2}$$

= 1080 hectares/cumec

2 marks

7. <u>Methods adopted to maintain an Irrigation canal</u>

a. Controlling the weed growth.
b. Removal of silt deposits
c. Strengthening the canal banks
d. Closing the canal breaches

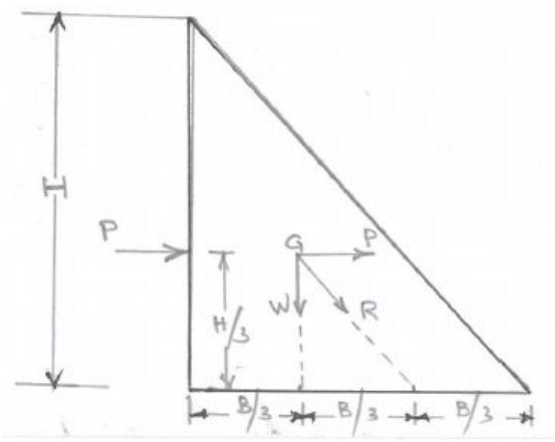
(3 marks)

8. <u>Classification of Dams</u>

- Based on function
  - Storage dam / Impounding Dam
  - Detention Dam
  - Diversion Dam
  - Coffer Dam
  - Debris Dam
- Based on hydraulic design
  - Overflow Dam
  - Non-overflow Dam
- Based on material of construction
  - Rigid Dam
  - Non-rigid Dam
- Based on structural behavior
  - Gravity dam
  - Arch Dam
  - Buttress Dam
  - Embankment Dam
- Based on size
  - Small Dam
  - Intermediate Dam
  - Large Dam

(Any 3 = 3 marks)

9. Elementary profile of a gravity dam



(3 marks)

10. Causes of failure of earth dam

- Hydraulic failure
  - 40 % of dam fail due to these causes
  - Failure may occur due to following reasons
  - By overtopping – water may overtop the dam
  - Erosion of u/s face – waves erode soil from u/s face
  - Cracking due to frost action
  - Erosion of d/s face by gully formation – heavy rain and erosive action of moving water lead to gully formation
  - Erosion of d/s toe – occurs due to water from spillway and due to tail water
- Seepage failure
  - More than 33 % of earthen dam failure are due to seepage
  - Uncontrolled seepage through the dam may lead to piping or sloughing and subsequent failure of dam
  - Piping – progressive erosion and removal of soil grains from with in the body of dam or foundation
  - Sloughing – progressive removal of soil from wet d/s face
  -
- Structural failure
  - About 25 to 30 % dam failure are due to this reason
  - Sliding of u/s and d/s slopes
  - Liquifaction slides – saturated soil mass move under gravity like a viscous fluid
  - Damage caused by burrowing animals – burrowing animals dig holes to make their home which causes failure
  - Damage caused by water soluble materials – leaching of water soluble materials from abutments and foundation creates holes which causes failure
  - Damage caused by earthquake

(3 marks)

PART C

Answer ALL questions. Each question carries 7 marks

III. Given

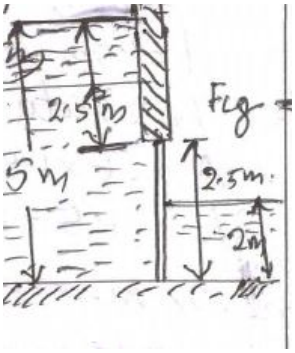


Figure - 1 mark

Width of sluice gate (b) = 3 m
Depth of sluice gate = 2.5 m
Depth of water on the upstream side = 5 m
Depth of water on the downstream side = 2 m
Area of sluice gate submerged on upstream side, A_1 = 2.5 x 3 =7.5 m^2 1 mark
Depth of C.G of the sluice gate from water level on u/s side,

$$\bar{x}_1 = 2.5 + \frac{2.5}{2} = 3.75 \text{ m}$$

A_2= 2 x 3 = 6 m^2

1 mark

$$\bar{x}_2 = \frac{2}{2} = 1\ m$$

Pressure due to water on u/s side of gate

$P_1 = wA_1\bar{x}_1 = 9.81 * 7.5 * 3.75 = 275.9\ kN$ 1 mark

$P_2 = wA_2\bar{x}_2 = 9.81 * 6 * 1 = 58.9\ kN$ 1 mark

Resultant pressure on the gate $P = P_1 - P_2$

= 275.9 -58.9

= 217 kN 2 mark

OR

IV. Given

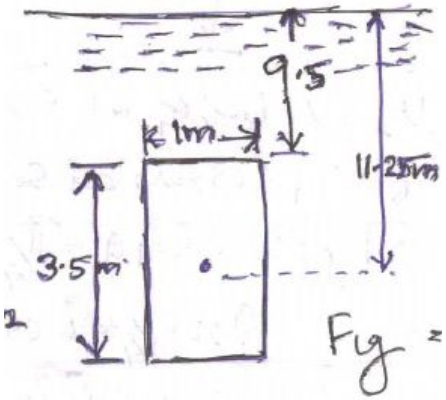


Figure – 1 mark

b = 1 m
d = 3.5 m

To find Total Pressure, P

Point of application, $\bar{h}$

$\bar{x}$ = 9.5 + 3.5/2 = 11.25 m

$area = 3.5 \text{ x} 1 = 3.5 \text{ m}^2$

Total Pressure, P = w$A\bar{x}$

= 9810 x3.5 x11.25

= 386268.75 N

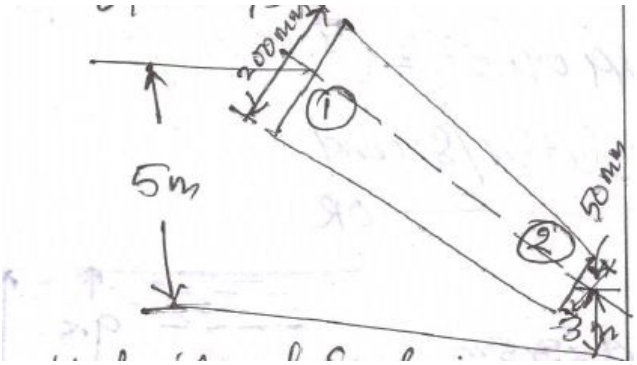
= 386.26 kN

$\bar{h} = \bar{x} + \frac{I_G}{A\bar{x}}$

$I_G = \frac{bd^2}{12} = 1\text{x}\frac{3.5^2}{12} = 3.571 \text{ m}^2$

$\bar{h} = \bar{x} + \frac{I_G}{A\bar{x}} = 11.25 + \frac{3.571}{3.5\ x\ 11.25} = 11.34$ m from water level

V. Given



1 mark

d1 = 200 mm = 0.2 m

d2 = 50 mm = 0.05 m

z1 = 5 m

z2 = 3 m

p = 500 kpa

v = 1 m/s

Let v_2 = velocity at section 2

P_2 = pressure at section 2

Area of pipe section $a_1 = \pi /4 \text{ x } 0.2^2 = 31.42 \text{ x } 10^{-3} \text{ m}^2$

$a_2 = \pi/4 \text{ x } 0.05^{\ 2} = 1.964 \text{ x } 10^{\ -3} \text{ m}^2$

$V_2 = \frac{a_1 v_1}{a_2} = \frac{31.42 \text{ x } 10^{-3} \text{ x } 1}{1.964\ x\ 10^{-3}} = 16$ m/s 3 marks

Applying Bernoulli's Theorem

$z_1 + \frac{{v_1}^2}{2g} + \frac{P_1}{w} = z_2 + \frac{{v_2}^2}{2g} + \frac{P_2}{w}$ 1 mark

$5 + \frac{1^2}{2x9.81} + \frac{500}{9.81} = 3 + \frac{16^2}{2\ x9.81} + \frac{P_2}{9.81}$

$P_2 = 392.4 \text{ kN/m}^2$

2 marks

OR

VI. Given

$\frac{a_1}{a_2} = 9$

$d_1 = 300 \text{ mm} = 0.3 \text{ m}$

Pressure head at large section = $h_1 = 6.5$ m

Pressure head at small section = $h_2 = 4.25$ m

C = 0.99

Area of large section, $a_1 = \pi/4 \text{ x } d^{\ 2}$

$= \pi/4 \text{ x } 0.3^{\ 2}$

$= 70.69 \text{ x } 10^{-3} \text{ m}^2$

Area of large section, a_2= 70.69 x 10^{-3} /9 — 2 mark

= 7.854 x 10^{-3} m^2

Difference of pressure heads = h = h_1-h_2= 6.5 - 4.25 = 2.25 m — 1 mark

Discharge ,Q = $\frac{Ca_1a_2}{\sqrt{a_1{}^2-a_2{}^2}} * \sqrt{2gh}$ — **2 mark**

$=\frac{0.99*70.69 \text{ x } 10-3*7.854 \text{ x } 10-3}{\sqrt{70.69 \text{ x } 10-3^2-7.854 \text{ x } 10-3^2}} * \sqrt{2 * 9.81 * 2.25}$

= 52 x $10^{-3}$$m^3$/s = 52 litres / second — **2 mark**

VII. Given

Length of notch, L = 1 m

Depth of water, H = 15 cm = 0.15 m

Coefficient of discharge, Cd = 0.62

For rectangular notch, discharge = Q

$$Q = \frac{2}{3} C_d L \sqrt{2g} H^{3/2}$$

$$= \frac{2}{3} * 0.62 * 1 * \sqrt{2 * 9.81} * 0.15^{3/2}$$

=1.0629 m^3/s — **3 marks**

For triangular notch

Given angle of notch ,θ = 90°

Coefficient of discharge, = 0.59

Let H = Depth of water in the notch

Using the relation,

$$Q = \frac{8}{15} C_d \sqrt{2g}\ tan\frac{\theta}{2} H^{5/2}$$

$$1.0629 = \frac{8}{15} * 0.59 * \sqrt{2 * 9.81}\ tan45° * H^{5/2}$$

$$H^{5/2} = 0.762$$

$$H = 0.337\ m = 33.7\ cm$$ — **4 marks**

OR

VIII. Given Area, A = 8 m^2, i = 1/1000, C = 55

Let b = Breadth of the channel

d = Depth of channel

for most economical rectangular section, b = 2d — **2 marks**

Area, A = 8 m^2 = b x d = 2d x d = 2d^2

d^2 = 8/2 = 4

d = 2 m

b = 2d = 2 x2 = 4 m — **1 mark**

Hydraulic mean depth, m = d/2 = 2/2 = 1m — **2 marks**

$Q = AC\sqrt{mi}$

$= 8 * 55\sqrt{1 * 0.001}$

= 440 x 0.0316 = 13.9 m^3/s — **2 marks**

IX. Classification of canals based on carrying capacity

i. Main canal

- Principal canal of a network of irrigation canals
- Takes off at headworks directly from a river
- Large capacity canal which supply water to branch canals & major distributories
- Direct irrigation is not carried out since very high discharge is conveyed

ii. Branch canal

- Irrigation canals which takes off from main canal on either side

- Direct irrigation is done from small branches
- Generally carry a discharge of 5 cumecs
- Main function is to supply water to major & minor distributories

iii. Major distributary
- Irrigation canals which takes off from branch canals & sometimes from main canal
- Generally used for direct irrigation
- Carry a discharge varying from 0.25 to 5 cumec

iv. Minor distributary
- Irrigation canals which takes off from major distributaries & branch canals
- Carry a discharge less than 0.25 cumec

v. Water courses or Field channel
- Small channels which carry water from outlet of major or minor distributary or a branch canal to the fields to be irrigated
- Outlets are provided in the irrigation canal at appropriate places
- Beyond outlet, water is handled by cultivators

7 marks

X. Advantages of Irrigation

1. Increase in food production
2. Optimum benefits
    a. Optimum utilization of water is made possible by irrigation obtaining maximum crop yield with required amount of water
3. Elimination of mixed cropping
4. General prosperity
5. Generation of Hydroelectric power
6. Domestic water supply
7. Facilities of communication
8. Inland navigation
9. Afforestation
10. Employment

Any 7 points = 7 marks

XI. Component parts of a weir

1. Body of Weir
    - Function is to raise water level on upstream side
    - Should be sufficiently strong to resist water pressure & uplift pressure from beneath the foundation
2. Upstream Apron
    - Protects the main body of weir during flood from erosive forces
    - Must be strong enough to with stand downward water pressure & also to prevent any leakage in subsoil
3. Upstream curtain wall
    - Provided to reduce uplift pressure
4. Downstream Apron
    - When water falls from a height it will produce kinetic energy which will erode the downstream bed of the river
    - This apron is provided to dissipate kinetic energy
5. Downstream Curtain wall
    - It protects downstream floor from uplift pressure
    - Should be strong to resist falling energy of water
6. Crest

- Top of weir is called crest
- It must be strong to resist water pressure during floods

7. Shutters
    - This is provided on the crest of weir to raise the water level of the river on the upstream side & divert it in to canal

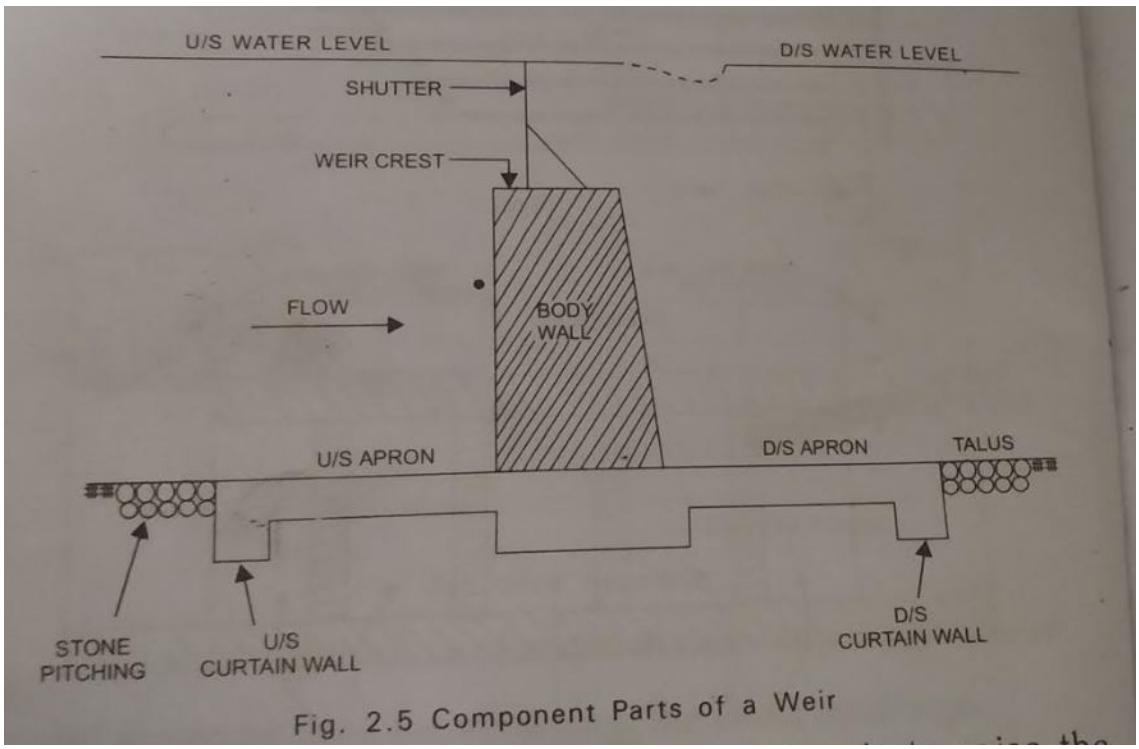


Fig. 2.5 Component Parts of a Weir

Figure - 1 mark
Explanation – 6 marks

XII.

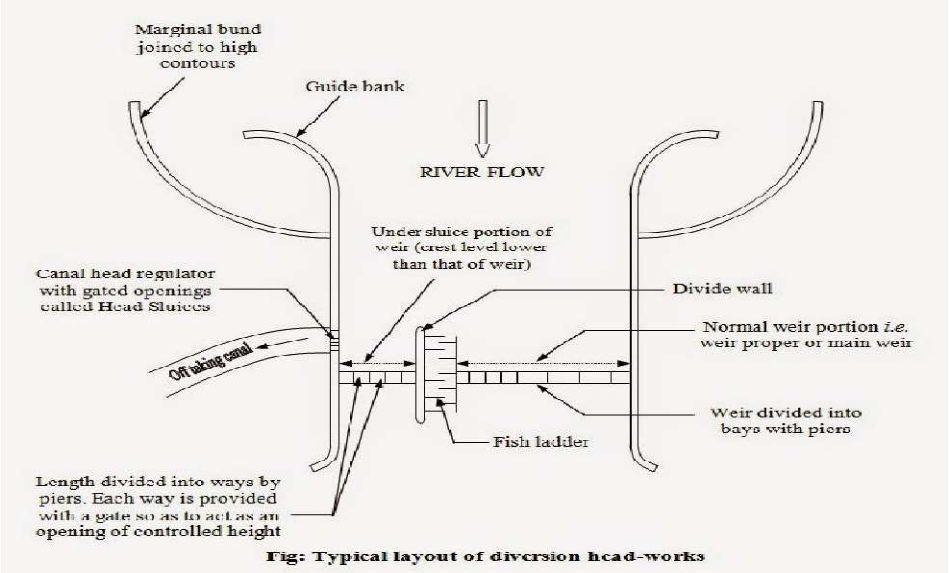


Fig: Typical layout of diversion head-works

i) Scouring Sluices

- openings provided at the base of the weir or barrage.
- These openings are provided with adjustable gates.
- Normally, the gates are kept closed.

- Suspended silt goes on the depositing in front of the canal head regulator.
- When the silt deposition becomes appreciable the gates are opened and the deposited silt is loosened with an agitator mounting on a boat.
- The muddy water flows towards the downstream side through the scouring sluices, the gates are closed
- But, at the period of flood, the gates are kept opened.

ii) Fish Ladder

- openings provided at the base of the weir or barrage.
- These openings are provided with adjustable gates.
- Normally, the gates are kept closed.
- Suspended silt goes on the depositing in front of the canal head regulator.
- When the silt deposition becomes appreciable the gates are opened and the deposited silt is loosened with an agitator mounting on a boat.
- The muddy water flows towards the downstream side through the scouring sluices, the gates are closed
- But, at the period of flood, the gates are kept opened.

iii) Divide Wall

- long wall constructed at right angle to the weir or barrage, it may be constructed with stone masonry or cement concrete.
- On the upstream side, the wall is extended just to cover the canal regulator and on the down stream side, it is extended up to the launching apron.
- The functions of the divide wall are as follows
    - To form a still water pocket in front of the canal head so that the suspended silt can be settled down which then later can be cleared through the scouring sluices from time to time.
    - It controls the eddy current or cross current in front of the canal head
    - It provides a straight approach in front of the canal head.
    - It resists the overturning effect on the weir or barrage caused by the pressure of the impounding water.

iv) Head Regulator

- A structure constructed at the head of the canal regulator to regulate the flow of water is known as canal head regulator.
- It consists of a number of piers which divide the total width of the canal into a number of spans which are known as bays.
- The pier consists of a number of tiers on which the adjustable gates are placed.
- The gates are operated from the top by suitable mechanical device.
- A platform is produced on the top of the piers for the facility of operating the gates.
- Again some piers are constructed on the downstream side of the canal head to support the roadway.

Figure - 1 mark
Explanation – 1.5x4 = 6 marks

XIII.<u>Factors influencing selection of site for reservoir</u>

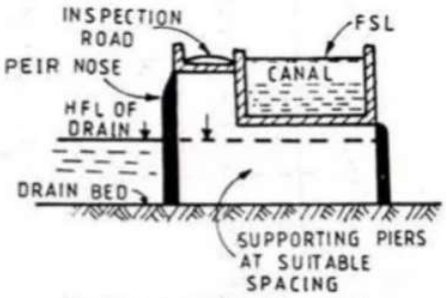
1. Suitable dam site should be available where reservoir is proposed to be constructed
2. River valley should be narrow to reduce length of dam & it should be open to provide large basin for reservoir
3. Surrounding hills should be water tight so that there is no leakage of water
4. Reservoir basin should be water tight
5. Site should be such that minimum land & property is submerged in the reservoir
6. Site should avoid water from tributaries which carry high content of sediment

7. Site should be such that adequate reservoir capacity is available
8. Deep reservoir must be formed to reduce land cost & evaporation losses
9. Site should be such that there is no objectionable minerals & salt present in the soil, rocks at site which deteriorate water quality
10. Quality of water stored in the reservoir must be satisfactory for intended use
11. Site should be such that cost of roads, rails, housing colonies are not excessive

Any 7 points = 7 marks

XIV. Different types of Cross Drainage Works

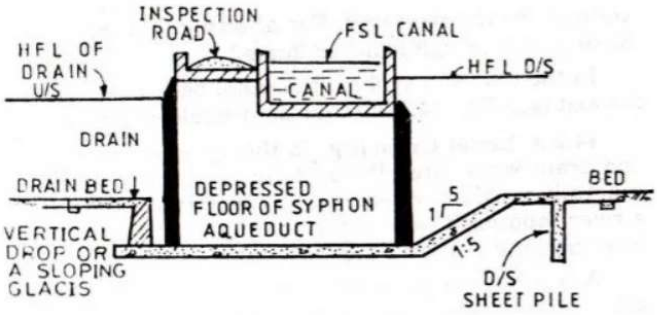
a) Aqueduct: When the HFL of the drain is sufficiently below the bottom of the canal such that the drainage water flows freely under gravity, the structure is known as Aqueduct.



Typical cross-section of an aqueduct.

Fig (a) Aqueduct

b) Siphon Aqueduct:
In case of the siphon Aqueduct, the HFL of the drain is much higher above the canal bed, and water runs under siphonic action.



Typical cross-section of a Syphon Aqueduct.

c) Super passage:
The hydraulic structure in which the drainage is passing over the irrigation canal is known as Super Passage.

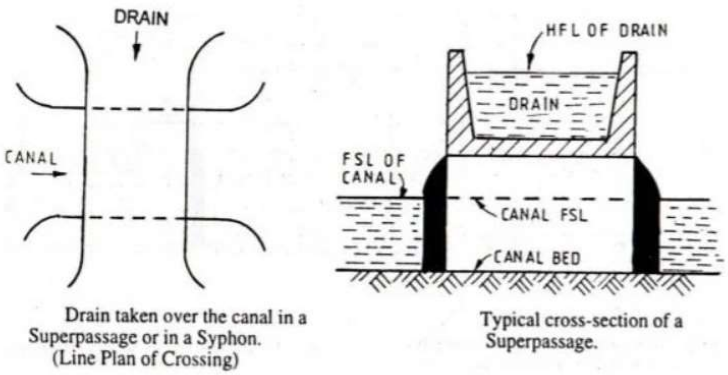


Fig (c) Super passage

d) Siphon Super Passage
Constructed where F.S.L of canal is higher than bed of the drain

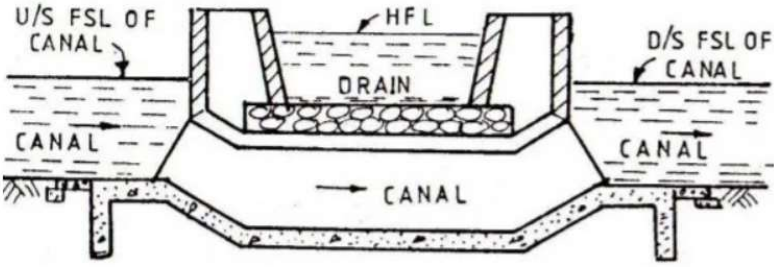
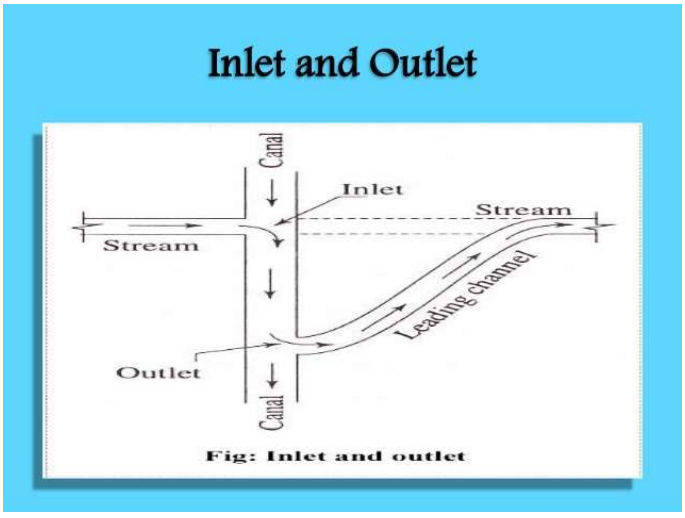


Fig (d) Canal Syphon

e) Level crossing:
This structure makes it possible to dispose off drain water safely at the same level as that of a canal.

f) Inlet and outlet:

When possible drain water is taken in the canal to be discharged afterwards into a drain at suitable location



Explanation – 6x1 = 6 marks

MO	Hr/Module	Marks/M	Part A	Part B	Part C	Total

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COURSE : HYDRAULICS AND IRRIGATION ENGINEERING

			No of questions	Score	No of questions	Score	No of questions	Score	No of questions	Score
1	15	26-36%	3	3	2	6	3	21	8	30
2	14	24-34%	2	2	3	9	3	21	8	32
3	14	24-34%	2	2	2	6	2	14	6	22
4	15	26-36%	2	2	3	9	4	28	9	39
Total			9	9	10	30	12	84	31	123

Blue Print

Cognitive Level Mark Distribution

COGNITIVE LEVEL	MARKS	PERCENTAGE
REMEMBERING	**9**	**7.32**
UNDERSTANDING	**72**	**58.54**
APPLYING	**42**	**34.15**

QUESTION WISE ANALYSIS

COURSE :Hydraulics and Irrigation Engineering

Qn No	Module Outcome	Cognitive Level	Score	Time in Minutes
I.1	1.04	Remembering	1	1.46
I.2	1.01	Remembering	1	1.46
I.3	1.04	Remembering	1	1.46
I.4	2.03	Remembering	1	1.46
I.5	2.04	Remembering	1	1.46
I.6	3.02	Remembering	1	1.46
I.7	3.03	Remembering	1	1.46
I.8	4.01	Remembering	1	1.46
I.9	4.02	Remembering	1	1.46
II.1	1.04	Understanding	3	4.38
II.2	1.02	Understanding	3	4.38
II.3	2.04	Understanding	3	4.38
II.4	2.02	Understanding	3	4.38
II.5	2.01	Understanding	3	4.38
II.6	3.02	Understanding	3	4.38
II.7	3.04	Understanding	3	4.38
II.8	4.02	Understanding	3	4.38
II.9	4.02	Understanding	3	4.38
II.10	4.02	Understanding	3	4.38
III	1.03	Applying	7	10.22
IV	1.03	Applying	7	10.22
V	1.04	Applying	7	10.22
VI	2.01	Applying	7	10.22
VII	2.02	Applying	7	10.22
VIII	2.01	Applying	7	10.22
IX	3.04	Understanding	7	10.22
X	3.01	Understanding	7	10.22
XI	4.03	Understanding	7	10.22
XII	4.03	Understanding	7	10.22

XIII	4.02	Understanding	7	10.22
XIV	4.04	Understanding	7	10.22