MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous)
(ISO/IEC-27001-2005 Certified)

WINTER-12 EXAMINATION

Subject Code: 12136 Model Answer Page No: 01/16

Q. 1. a) Attempt any THREE **(12 Marks)**

i) **Necessity of Irrigation in India**

1. Less rainfall
2. Non uniform rainfall or ill timed rainfall
3. Cultivation of cash crops with additional supply of water
4. Controlled water supply (01 mark each point) (04)

ii) **Hydrological Cycle** –It is cycle followed by the water in three phases i.e. evaporation, precipitation and runoff. (02)
For hydrologic equilibrium
Inflow= Outflow + Water Stored
and Precipitation =Runoff+ Evaporation
The precipitation and evaporation continues for ever and thereby a balance is maintained between two. This process is known as hydrological cycle

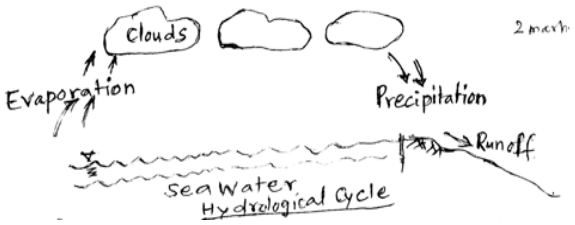


Figure : Hydrological Cycle (02)

iii) **Runoff** – Runoff is that part of the rainfall which is available for storage by construction of dam across a river at a particular site along the course of river.
Runoff = Rainfall – losses

(02)

Factors affecting runoff

a) Rainfall and its quantity
b) Wind
c) Temperature
d) Characters of catchment (02)

iv) **Factors affecting selection of site for a reservoir of dam**

1. Sufficient catchment area
2. Storage capacity
3. Minimum length of dam
4. Fondation
5. Water-tightness
6. Command area
7. Site for spillway
8. Submergence
9. Materials and manpower (Any Eight) (1/2 each) (04)

Q.1 b) Attempt any ONE of the following (06)

i) **Duty (D)** - It is the area in hectares irrigated by one cubic meter per second (cumec) of water supplied continuously throughout the crop period for a particular crop.

Delta (Δ)- It is the total depth of water in cm required by a crop to come to maturity.

Base Period (B)- It is the period in days from first watering at the time of sowing to the last watering before harvesting. (03)

Relation between D, B and Δ

Let D= duty in hectares per cumec reckoned at place

Δ = delta for a crop in meters at the same place

B= base period of this crop in days

Volume of water supplied to the crop corresponding to water depth Δ in meters

= Δ x D ha-m

= Δ x D x 10^4 cum ---------- (1)

Again for the same field D hectares, one cumec of water is required to flow during the entire Base period B days

= (1 x B x 24 x 60 x 60) cum---------- (2)

Equating equation 1 and 2

Δ x D x 10^4 =(1 x B x 24 x 60 x 60)

$\Delta = \frac{8.64\ B}{D}$ or $D = \frac{8.64\ B}{\Delta}$

ii) Gravity Dam- It is a dam in which the external forces acting on the dam are resisted by its own weight (02)

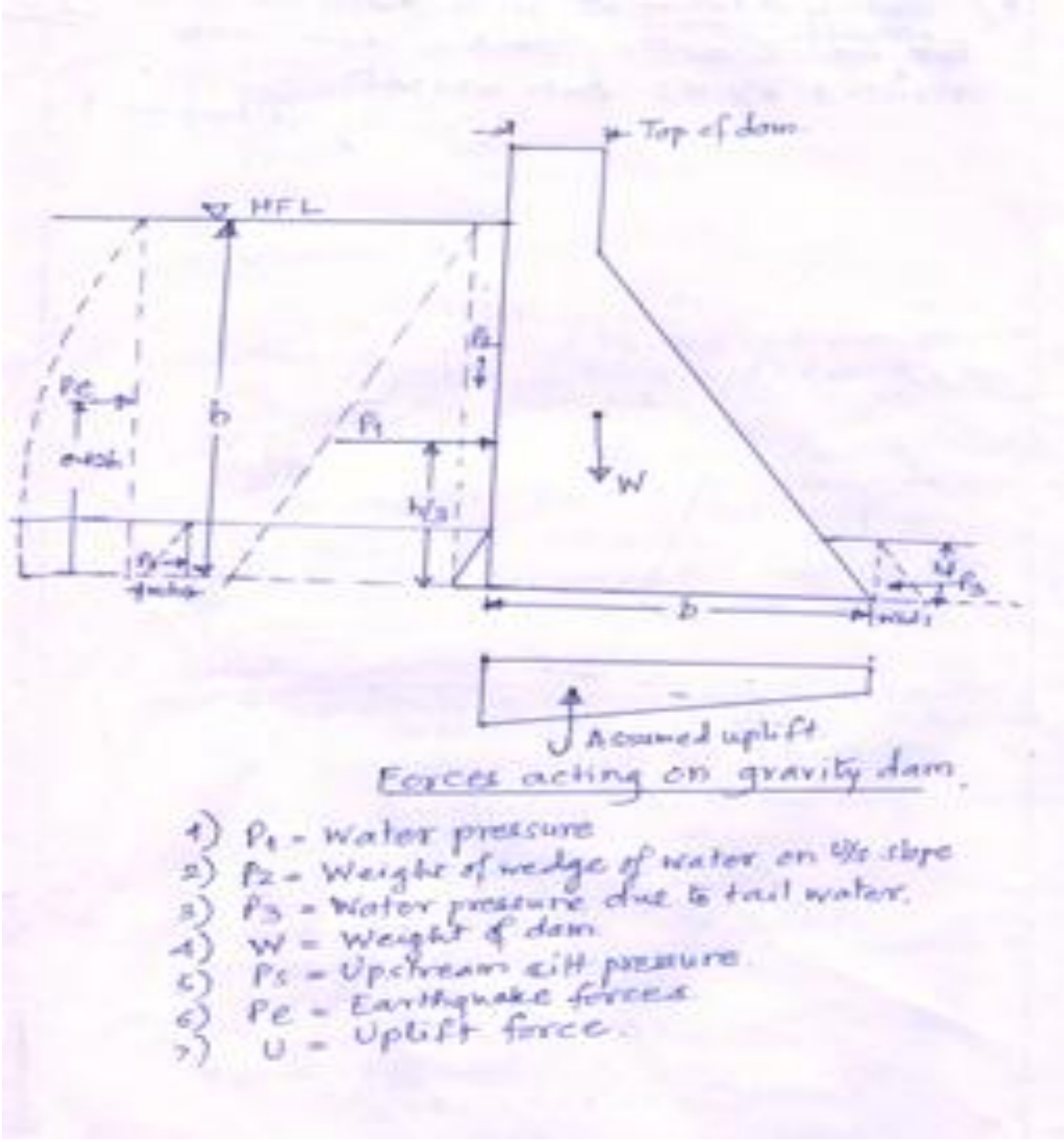


Figure: Forces Acting on Gravity Dam (04)

Q. 2 Attempt any TWO of the following (16)

a) **Engineering surveys to be conducted for irrigation project** (Any Eight)

- Catchment area survey
- Tank basin survey
- Dam line survey
- Survey for spillway, approach and tail channel
- Survey for approach road
- Camp sites
- Main canal survey
- Command area survey
- Construction material survey (1/2 marks each = 04)

Data to be collected for engineering surveys

- Contour maps
- Contour Area curves
- Storage elevation curves
- Hydrological data i.e. rainfall, runoff, MFD etc.
- Materials for construction
- Population survey for submergence area
- Land acquisition details
- Existing roads, railway lines and historical monument (04)

b) **Solution**

1) Wheat

Discharge required $= \frac{Area}{Duty} = \frac{10000}{1900}$

Volume of water required = Discharge x Base period

$= \frac{10000}{1900}$ x 150

= 789.47 cumec days (01)

2) Rice

Discharge required $= \frac{Area}{Duty} = \frac{5000}{800}$

Volume of water required = Discharge x Base period

$= \frac{5000}{800}$ x 120

= 750 cumec days (01)

3) Sugarcane

Discharge required = $\frac{Area}{Duty} = \frac{2500}{750}$

Volume of water required = Discharge x Base period

$= \frac{2500}{750}$ x 320

= 1066.67 cumec days (01)

4) Cotton

Discharge required = $\frac{Area}{Duty} = \frac{2500}{1500}$

Volume of water required = Discharge x Base period

$= \frac{2500}{1500}$ x 210

= 350 cumec days (01)

5) Other Crops

Discharge required = $\frac{Area}{Duty} = \frac{1500}{600}$

Volume of water required = Discharge x Base period

$= \frac{1500}{600}$ x 120

= 300 cumec days (01)

Total volume of water required on the field

= 789.47+750 +1066.67+350+300

= 3256.14 cumec day

1 cumec day = 8.64 Ha-m

Total volume of water =3256.14 x 8.64 = 28133.05 Ha-m (01)

Considering reservoir losses 10 %

Total volume = 28133.05 x 1.10

= 30946.355 Ha-m (01)

Considering canal losses 20 %

Total volume = 30946.355x 1.20

= 37135.625 Ha-m

Storage required = 37135.625 Ha-m (01)

c) **Functions of components**

1. Hearting- It provides water tightness to the dam and adequate shear resistance against slipping. It controls the seepage flow through the body of the dam
2. Casing- Casing provides a cover to the hearting protecting it from cracking. It also helps in drainage.
3. Cutoff trench (COT)- The function of cutoff trench is to prevent or reduce seepage flow through the pervious foundation.
4. Rock Toe- It helps to prevent slogging of the toe due to seepage flow and increases the stability of dam. (04)

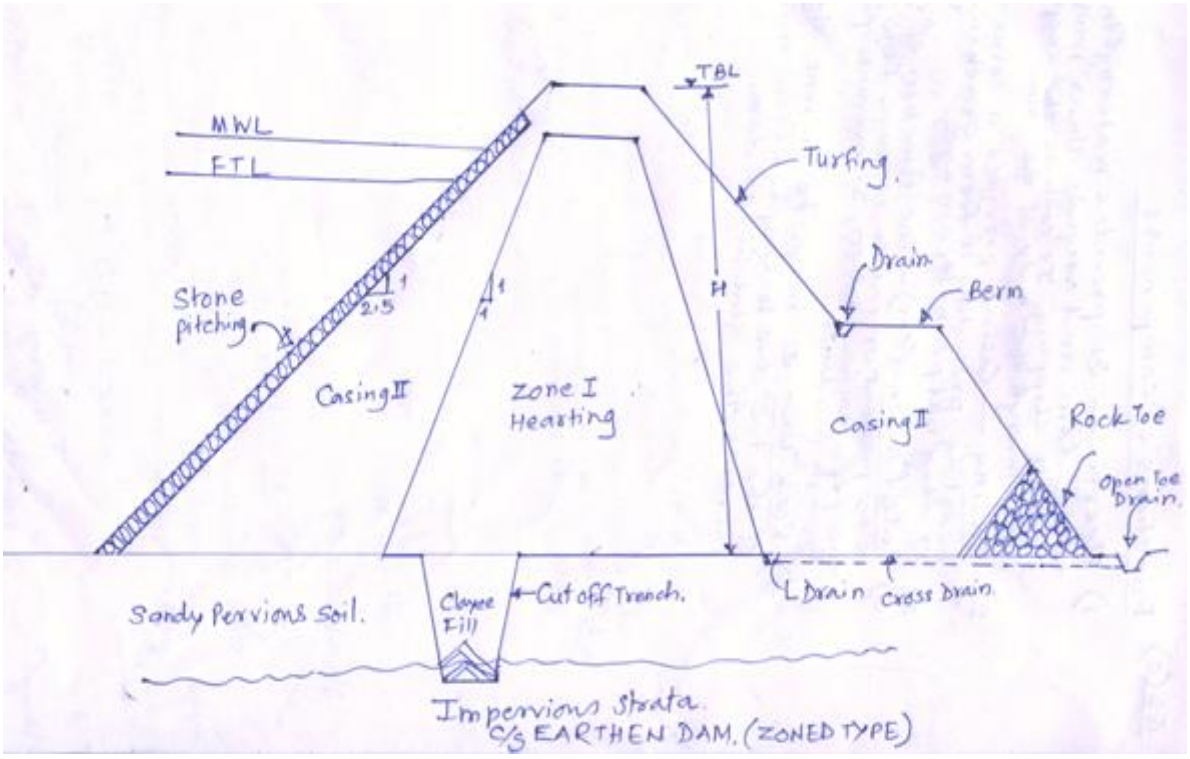


Figure: Cross section of a Zoned type Earthen Dam (04)

Q.3 a) Calculate MFD

i) Inglish Formula $Q = \frac{123A}{\sqrt{A+10.24}}$, Where A= Catchment area in Km^2

Discharge $Q = \frac{123x900}{\sqrt{900+10.24}} = 3669.1855\ m^3/sec$ (02)

ii) Dickens Formula $Q = C\ A^{3/4}$, C=30

$Q = 30\ X\ (900)^{3/4}$

$Q = 4929.503\ m^3/sec$ (02)

b) Methods of improving duty (any 4 methods) (04)

i) Proper method of applying water i.e. sprinkler, drip, etc.

ii) Proper tiling of farms

iii) Training farmers to use water economically

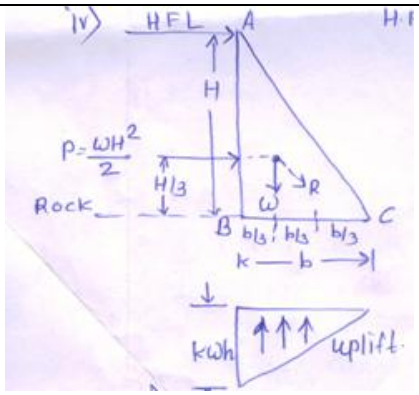
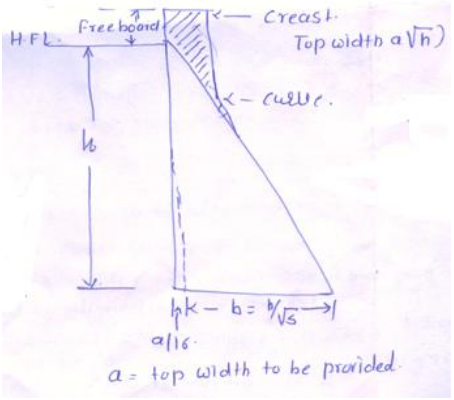
iv) Lining of canals and proper maintenance of canal system

v) Using appropriate variety of manure and seed.

vi) Assessing irrigation water on volumetric basis.

c) Any four differences (04)

Theoretical Profile	**Practical Profile**
Profile will be right angled triangle with water face vertical and apex at HFL.	Practical profile is that which is actually provided in practice.
Profile will not have free board and top width.	Profile will have free board and top width.
The base width is determined to fulfill stability conditions	Minimum top width is equal to 0.55 $\sqrt{h}$
Crest is at HFL	Free board is provided above HFL.

Theoretical profile	**Practical Profile**
Imaginary Profile	Actual Profile
No roadway	Road way can be provided
Only two forces water pressure and weight of dam are considered	Additional weight of free board construction is considered
	

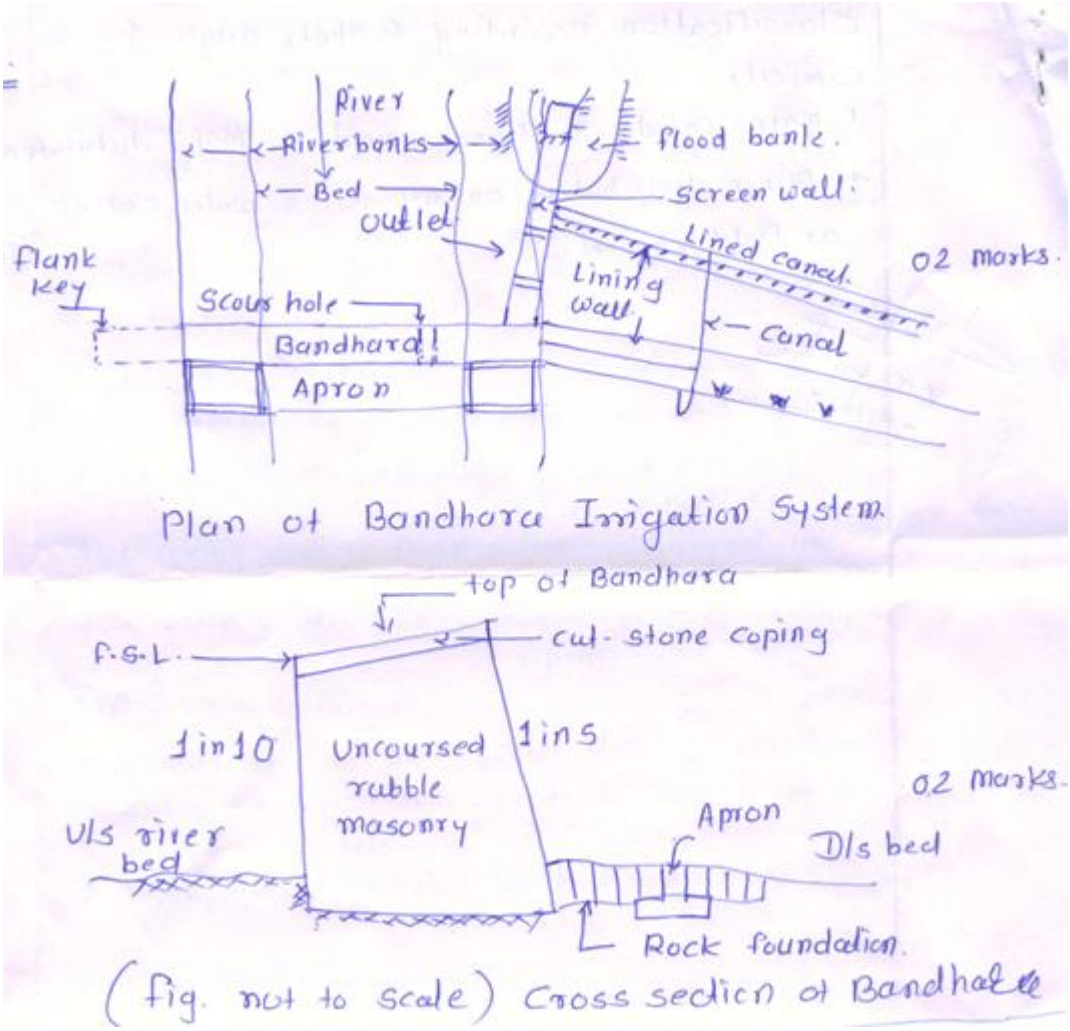
d)

Gravity Dam	**Earthen Dam**
Foundation should be of solid sheel rock having no fissures, cracks, faults, cavities etc.	**Foundation** should be impervious to reduce seepage. Rock should be available at reasonable depth.
Seepage is practically nil	**Seepage** through the body of the dam and its foundation
Constructed with mass concrete or stone masonry. Joints are provided.	**Constructed** with pervious and impervious soil. Compaction method is adopted.
Maintenance cost is less	**Maintenance** cost is high.

01 mark to each point (04)

e) Plan and cross section of Bandhara Irrigation System (04)

02 marks for plan and 02 marks for cross section



f) **Definition**: Total quantity of water available from catchment area in a period of one year (01)

Various methods of calculations: Empirical method, Curves & table method, runoff coefficient, infiltration capacity, hydrograph, rational, rainfall runoff co relation, watershed stimulation (any two) (01)

Explanation of dependable yield

(02)

Q.4. a) i) Various materials used in various components of earthen dam

Clayee materials: B.C. soil, silty clayee loams etc. for hearting and cut off.

Sandy material: Murum, soft rock, sandy silts etc.
Rock: Pitching, riprap, masonry etc.
Sand: For filters, seepage drains, masonry
Cement, steel, lime etc: For spillway and outlets (01 mark for each) (04)

ii) Factors affecting site selection of KT weir. Foundation: Availability of good rock

- Availability of some past monsoon flow. Discharge observations should be arranged.
- The bed nalla or stream is practically flat or with a very mild slope.
- Some well irrigation should exist on the bank or upstream side.
- Inclination of people to practice lift irrigation direct from the storage or from wells on banks. (01 mark for each) (04)

iii) **Spillway:** Spillway is a masonry overflow portion provided for every dam. Also called overflow dam or waste weir. (01)
Types: Ogee, Bar, Side Channel, Trough or Chute, shaft Spillway. (01)
Ogee Spillway: Shape is ogee or S shaped. Overflowing water guided smoothly over the crest. Smooth flow is ensured, free from separation. (02)

iv) **Pick Up weir –** Water from reservoir is released & flows down the river & is picked up by pick up weir on the upstream side of pick up weir. (01)
Situations under which puck up weir is constructed (03)

1. The command area is not near the reservoir.
2. Canal has to be run idle.
3. Geographically difficult terrain so that canal alignment is very costly or impossible

Q.4. b) i) Types of failure in earthen dam with remedial measures

A) Hydraulic failure: (any two) (02)
1. By overtopping:- provision of sufficient free board.
2. Erosion of U/S and D/.S slope:- Pitching and turfing respectively.
3. Cracking due to frost action:- Provision of additional 1m free board.
4. Erosion of D/S toe:- Stone pitching or riprap.

B) Seepage failure: (02)
1. Piping through the body of the dam:- Use of impervious soil or cement concrete wall in hurting.
2. Piping through the foundation:- Provision of cut off trench.

C) Structural Failure: (any two) (02)
1. U/s and D/s slope failure:- Provision of flat slope.
2. Sudden draw down:- Provision of flat slope
3. Faulty construction and improper maintenance:- Regular repair of gullies and rain cuts.

ii) Various types of irrigation canals:

A) According to their origin and capacity:-1. Main canal 2. Branch canal 3.Major distributor. 4. Minor distributor or minors. 5. Water courses or field channels.(any three) $(1\frac{1}{2})$.

B) According to alignment:- 1. Ridge 2. Contour 3. Side long channel $(1\frac{1}{2})$.

1. Ridge canal:- aligned along a natural water shed known as ridge. Irrigates both sides.CD work can be avoided.
2. Contour canal:- A canal follows a contour. Irrigate only one side i.e. lower side. Risk of breaching and silting.
3. Side long canal:- Canal is aligned across the contour. No CD works are required. (03)

Q. 5.a) Gross storage = Dead storage + Live storage

Live storage = Effective CWR + Tank losses + Carry over allowance

$$= 32 + \frac{20}{100} \text{ x } 32 + \frac{10}{100} \text{ x } 32 = 41.60 \text{ Mm}^3$$

Gross storage = DS + LS

$= 10\ \%$ of GS + 41.60 Mm^3

Gross storage = 46.223 Mm^3

From the capacity table by interpolation, RL corresponding to the capacity of 46.223 Mm^3 will be 105.980, rounded off to 106.00. This is FRL (03)

Dead storage = 10% of 46.223 = 4.6223 Mm^3 and corresponding RL will be

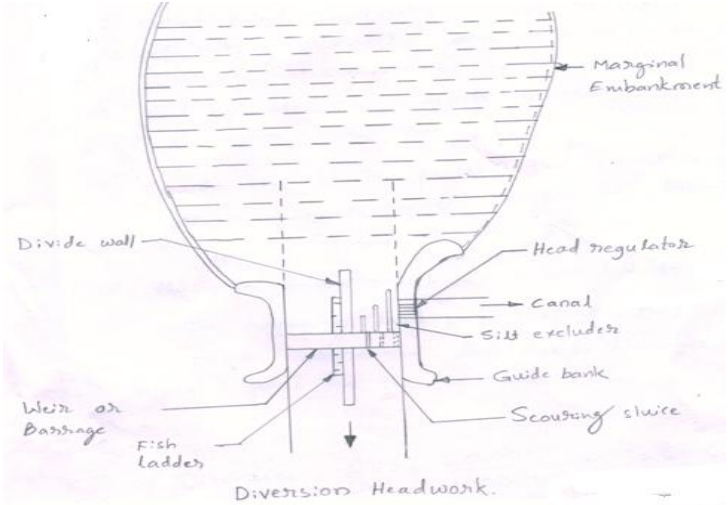
$$\frac{5.33 - 4.25}{87 - 84} = \frac{5.33 - 4.6223}{87 - X}$$

X= DSL = 85.00 (03)

HFL =FRL + Flood lift = 106.00 + 2.00 = 108.00 (01)

TBL = HFL + FB = 108.00 + 3.0 = 111.00 (01)

b) Neat Labelled sketch of Diversion Head Work (04)



(any four points) (1X4 = 4)

1. Weir: It consists of a wall constructed across a river. Temporary water storage on U/s side and divert into the off taking canal.
2. Divide wall: Divides the river into two parts. Weir portion and under sluice portion.
3. Scouring (under) sluices: These are gated openings provided into the weir. Located on same side of off taking canal. Controls entry of silt into canal.
4. Fish Ladder: Provides smooth passage for fish to ascend the head water of the river for the search of the food etc. The slope should not exceed 1:10. Sufficient light should be provided.
5. Canal head regulator: control the supply to the off taking channel, serves as a meter for measuring discharge entering into the canal. Controls silt entry.
6. Silt Excluder: it assists in excluding the entry of slit into the canal.
7. Guide Bank: To protect the structure from erosion & scouring. It provides straight approach towards the barrage
8. Marginal Embankment: It is provided to protect the adjoining land & property that is likely to be submerged due to the formation of pond on the U/S side.

c)

Discharge = Area /Duty = 20000 Ha / 1000(Ha/cumec) = 20 cumec

$b = 2d\sqrt{n^2 + 1} - 2 \times n \times d$

$= 2d\sqrt{1.5^2 + 1} - 2 \times 1.5 \times d$

$b = 0.6d$ (02)

$A = (b + nd)d$

$= (0.6d + 1.5d)\, d$

$A = 2.1\, d^2$ (02)

$Q = A \times V$

$$20 = 2.1\ d^2 \times \frac{1}{0.01}\left(\frac{d}{2}\right)^{2/3}\left(\frac{1}{2000}\right)^{1/2}$$

d = 2.04 m (02)

b = 0.6 x d = 1.22 m (02)

Q.6.**a)** i) Sub-surface Method , Surface Method- Furrow, contour farming, flooding (02)

ii) 1) Rainfall – quantity of water naturally available. Rainfall is the depth in mm (or cm) of water that would stand on the surface of the earth if it were not to be lost in any manner. (01)

2) Catchment area: The catchment area of river means the area from where the surface runoff flows to that river through the tributaries, streams, springs etc. The area is bounded by watershed line. (01)

b) Weir and Barrage

WEIR	**BARRAGE**
Initial cost is low	Initial cost is high
Area of submergence is more due to large afflux	Area of submergence is less due to less afflux
Less control over silting problem	Good control over silt entry into canal
The control over flood is not possible	Good control over flood situation
Raising & lowering of shutter is not convenient. It requires more time & labour as it is done manually	Raising & lowering of shutter is convenient as it can be operated mechanically
Roadway is not possible across river	Roadway can be provided across river
Storage of water is done by crest and very little or nil portion of water is by gate	Most of Storage of water is done by shutter and very less or nil portion of water is by crest

(any four points 1x4=4)

c)

Head Regulator	Cross Regulator
It is provided at the head of the main canal	It is provided in the main channel parent canal
It controls the entry of silt at head of canal	It controls entry of silt from main canal to parent canal
Discharge capacity is more	Discharge capacity is less
It's function is to feed the parent canal to the taking off canal	It's function is to feed the off taking canals
Construction depends upon size of canal and location	In construction, abutments with grooves and piers are constructed parallel to parent canal
Classification i) Normal ii) Flumed with pipe outlet or gated outlet	Classification: i) Permanent ii) Temporary

(any four points) (04)

d) The purposes of lining of canal are:

1. Reduction in losses due to seepage.

2. Prevention of water logging.

3. Low maintenance cost.

4. Prevention of weed growth.

5. Steeper bed slope can be provided.

6. To increase the capacity of canal.

7. To increase the command area.

8. To protect the canal from the damage by flood. (any four points) (02)

And various lining materials are: Cement concrete lining, precast lining, brick lining, cement mortar lining, boulder lining, lime concrete lining, shot crete lining, asphalt lining, bentonite and clay lining, soil cement lining etc. : (any four points) (02)

e) Different types of CD works are:

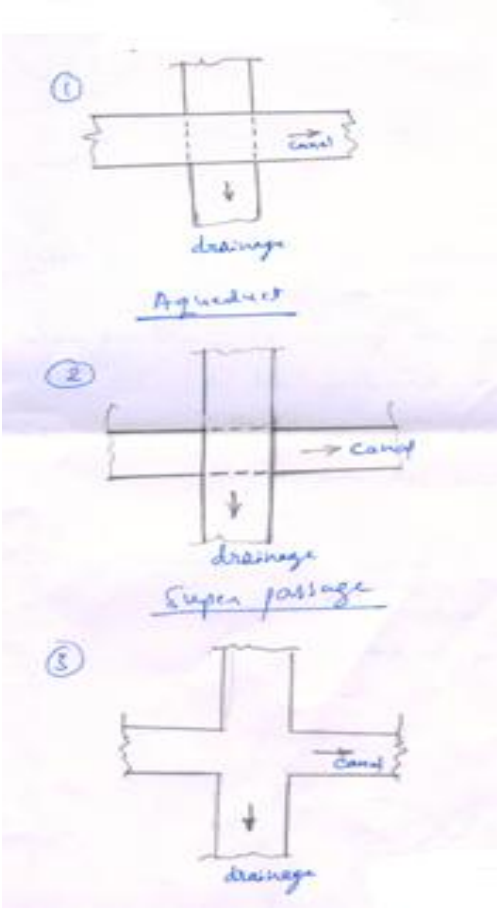
i) Culverts

ii) Aqueduct

iii) Supper passage

iv) Level crossing

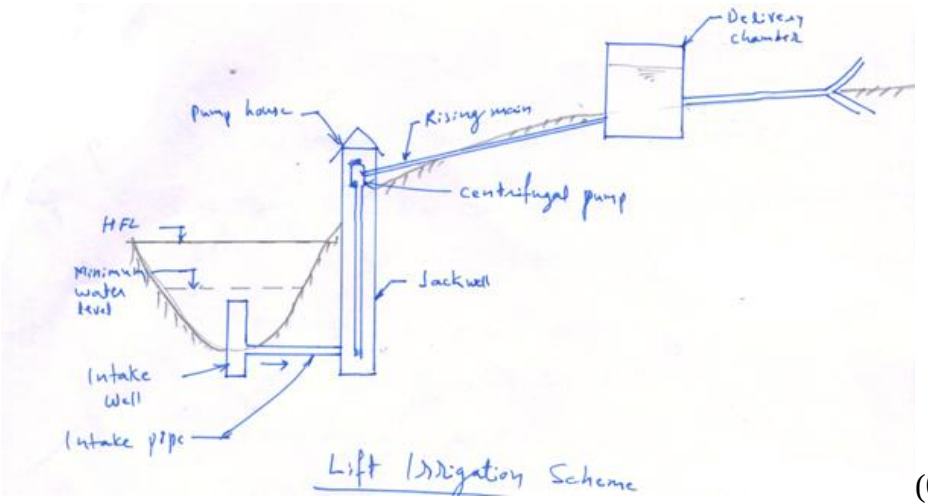
v) Inlet and outlet. (any four 4*1/2=02**)**



Level crossing

(any two 2*1=02)

f) **Lift Irrigation Scheme Components:**



(02)

1. Intake well: It is a well constructed in the bed of river at suitable site to tap the water.
2. Intake pipe: To convey the water from intake well to the Jack Well by gravity force.
3. Jack Well: It facilitates location of engine house above HFL and allows pumping during floods.
4. Delivery chamber: The water from rising main is collected in a delivery chamber and then it is allowed to flow in field ditches. Any two (02)
