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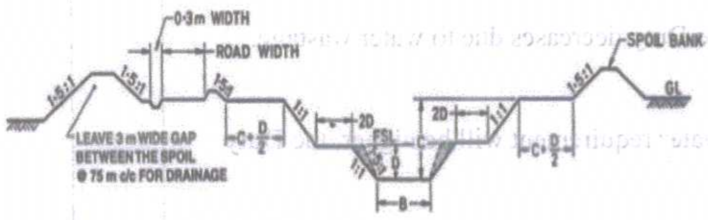
SCHEME OF VALUATION

Course title : 4012-Irrigation Engineering

Qs. No.	Scoring indicator	Split up score	Sub total	Total
I.				
1.	Water available at lower level lifted via mechanical means to supply water on higher level land.	(2)		
2.	Period in days for first irrigation during sowing up to last irrigation before harvesting.	(2)		
3.	Ans. Based on materials of construction, design features and types of soil foundation the weir may be of different types. Such as: 1. Vertical drop weir 2. Rock fill weirs 3. Concrete weir with sloping glacis	(2)		
4.	Diversion dams – to rise water level on u/s and to divert to canals (weir or barrage)	(2)		
5.	Alluvial channels are water channels made up of loose sediments. The loose sedimentary materials are known as alluvium.	(2)		(10)
II. 1.	Let D- duty of crop in ha/cumec B- Base period of crop in days. Δ- Delta is depth of water in m. Volume of water = B x 24 x 60 x 60 x1 m^3 Area of crop irrigated = D x 10000 m^2 Volume of water supplied per unit area or Δ in m = $\frac{8.64\,B}{D}$	(1.5) (1.5) (3)	(6)	
2.	• The site should be on level ground and on open space. It should never be on sloping ground. • The site should be such that the distance between the gauge station and the objects (like a tree, building, etc) should be at least twice the height of the objects. • In the hilly area, where level ground is not available, the site should be so selected that the station may be well shielded from high wind. • The site should be easily accessible to the observer. • The site should be well protected from cattle by wire fencing.	any 4 x1.5	(6)	

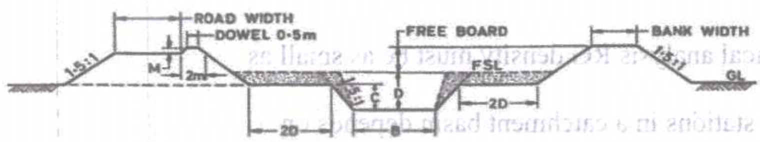
3.	**Ans.** The under sluices are the openings provided in the weir wall with their crest at lower level.. These openings are provided with adjustable gates. The weir proper is constructed in the middle portion of the diversion headworks an at the ends under sluices are provided adjacent to the canal head regulators. If canal takes off only from one side, the under sluice section is provided near that end only. There is a divide wall between the weir proper and the under sluice section to separate the two portions and to avoid cross flows. The under sluice section is similar to the sloping weir section, but its crest is at a lower level. Most of the dry weather flow passes through the under sluices because of the lower bed level. Since relatively clear water is supplied to the canal, some silt gets deposited in the pocket just u/s of the head regulator near the under sluice. The deposited silt is periodically washed through the under sluices. **Functions of under sluices:**	(3)		
	• They maintain a clear and well defined river channel in front of the head regulator. • They are used to scour away the silt deposited in front of the head regulator. • They pass low floods without dropping the weir crest shutters. • They control the silt entry into the canal • They provide greater waterway for floods, thus lowering the flood levels.	(3)	(6)	
4.	• Suitable foundation must be available. • For economy, the length of the dam should be as small as possible and for given height it should store maximum amount of water. • A suitable site for the spillway should be available in or nearby vicinity. • The bed level at the dam site should preferably be higher than that of the river basin. This will reduce the height of the dam and will facilitate the drainage problem. • The reservoir basin should be reasonably water-tight. • Material required for the construction of the dam should be easily available locally. • The value of the land and property submerged by the proposed dam should be as low as possible. • The dam site should be easily accessible, such that it can be economically connected to important towns. • Site for establishing labour colonies and healthy environment should be available near by vicinity.	any6 x1	(6)	
5.	• **Gravity dam** – stability achieved by weight of dam • **Arch dam** – load transferred to abutment by arch action • **Buttress Dam** – Load transferred to supporting buttresses. • **Embankment dams** – resist forces exerted by shear strength of soil	4x1.5	(6)	
6.	Based on the function - Irrigation Canal : Carries water from its source to agricultural fields. - Carrier Canal : Feeds another canal. -Feeder Canal : Feeds two or more canals. - Navigation Canal : Used for transport of goods. - Power Canal : Used to carry water for generation of hydroelectricity.	any4 x1.5	(6)	

7.



1C TYPICAL SECTION OF A CANAL WHOLLY IN CUTTING

(3)



1A TYPICAL SECTION OF CANAL PARTLY IN CUTTING & PARTLY IN FILLING

(3) (6) (30)

III. (a)

1.Type of crop

✓The water demand for numerous crops is entirely different. So, the Duty varies from crop to crop.

✓ The Duty is less for a crop requiring high water and vice versa.

2. Climate & Season

✓ The Duty varies from season to season and also from time to time in the same season. The Duty also includes the water lost in evaporation and percolation.

✓ Losses due to evaporation and percolation vary with climatic conditions. The values of duties generally expressed are their average values considered in the entire crop period.

✓ Duty in the winter season & rainy season is more and less in the summer.

3. Rainfall

9x1

✓ More rainfall leads to less requirement for irrigation water.

✓ This means that if rain falls during the crop period, Duty will be more and vice versa.

4. Soil type

✓ The Duty in irrigation will be less for porous soil and vice versa.

✓ In coarse-grained soil, percolation is high, so Duty is low.

✓ In fined-grained soil, percolation is less, so Duty is high.

✓ The Duty of clayey soil is more than the Duty of sandy soil.

5. Method of Ploughing

✓ Proper Ploughing of the land reduces the number of watering & increases Duty. But for faulty cultivation & improper Ploughing, Duty is decreased.

6. Method of irrigation

✓ The Duty of water is high in the case of the perennial irrigation system as compared to the inundation irrigation system.

7. The topography of agricultural land

✓ If the agricultural land is uneven, the water requirement will be higher; hence Duty will be low and vice versa.

✓ As the ground slope increases, the Duty decreases due to water wastage.

8. Base period

If the base period is extended, the water requirement will be higher, the Duty will be low, and vice versa.

9. Skill of cultivation

✓ A skilled & properly trained cultivator can make judicious use of water; therefore, Duty will be high. (9)

III. (b)

- For accurate hydrological analysis RG density must be as small as possible
- Number of rain-gauge stations in a catchment basin depends on
  - Extent of area
  - Climatic conditions
  - Topographic conditions
  - Finances
- At each RG station rainfall is measured every 24 hours.
- Measurements are taken at 8.30am.
- Total rainfall occurred in the past 24 hours is entered.
- Rainfall recorded on a day thus comprises of rainfall on that particular day and previous day
- Rainfall recorded are maintained daily, monthly, yearly basis for every rain gauge station. (3)

IS Recommendations

- One gauge per 520 km^2 in plain areas, denser network for areas in path of low pressure systems.
- One gauge per 260 to 390 km^2 in regions with an average elevation of 1000m above mean sea level.
- One gauge per 130 km^2 in predominantly hilly regions with heavy rainfall.
- It is also recommended that at least 10% of the gauges are of recording type. (3) (6) (15)

IV (a)

Rain gauge instrument used for measuring rain.

Types of Rain guages

- Non – Automatic Rain gauge (Non- Recording Type)
  - Symon's rain gauge
- Automatic rain gauge (Recording Type)
  - Weighing bucket
  - Tipping bucket (01)

- Float or natural syphon

Non-recording gauges

Non-recording rain gauges are the most widely used type of rain gauge in India for measurement of rainfall. They are called so because they do not record the rain but only collect the rain. This type of rain gauge consists of a cylindrical vessel whose base area is known and which has graduations.

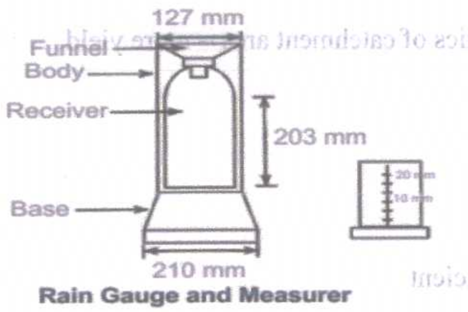


Fig.1 Symon's Rain Gauge

(2)

Recording Rain Gauges for the Measurement of Rainfall

Recording rain gauges are those that provide a permanent automatic rainfall record without the use of a bottle reading for the measurement of rainfall. One does not need to go to the gauge to measure or read the amount of rain that has fallen with this type of rain gauge. There is a mechanical arrangement in place that automatically records the total amount of rain that has fallen on graph paper. As a result, the rain gauge generates a record of cumulative rain vs time in the form of a graph known as the mass curve.

Apart from indicating the total amount of rain that has fallen at a station, such a curve will also assist in indicating the times of onset and cessation of rain and, thus, its duration. Furthermore, the slope of the curve indicates the intensity of rainfall for any given time period. Because such rain gauges record cumulative rainfall, they are also known as Integrating rain gauges. They are extremely useful in hilly and remote areas for the measurement of rainfall, where it is impractical to visit the gauge station daily. As a result, such rain gauges are also known as continuous rain gauges. On the basis of various models available in the market, the recording rain gauges can be of different types:-

1.Tipping bucket rain gauge- Rainwater is collected in a collector and passed through a funnel in tipping bucket rain gauges. The water is discharged through the funnel into a two-compartment bucket. When one compartment fills with 0.1mm of rainwater, the bucket tips, emptying into a reservoir and moving the second compartment beneath the funnel. Tipping the bucket completes an electric circuit, causing a pen to make a mark on a rotating drum. Such rain gauges are installed in hilly and inaccessible areas, where they can provide measurements directly to the controlling meteorological station's control room. This type of rain gauge for the measurement of rainfall contains no graph paper or drum, and it only requires periodic repairs and inspections.

2.Weighing bucket rain gauge- This type of rain gauge measures the amount of rain that falls into a bucket placed on the platform of a spring, lever balance, or other weighing mechanism. By moving a pen on a revolving drum, the increasing weight of the bucket aids in recording the increasing quantity of collected rainwater over time.

3.Natural Syphon (Float) Recording rain gauges- In such a rain gauge, the rising of the floating body as the rain catch increases aids in lifting the pen point, which records the cumulative rain over time on graph paper wrapped around a rotating drum. The Natural Syphon recording rain gauge is a float-type rain gauge with a self-starting syphoning arrangement that is most commonly used in India for the measurement of rainfall. (3) (6)

IV (b)

Good catchment – if characteristics of catchment area – more yield.

- Fan shaped area
- High rainfall zone
- Light soil
- Less vegetation
- No ponds
- High run off coefficient

(3)

Bad catchment – if characteristics of catchment area – less yield.

- Fern shaped area
- Low rainfall zone
- High porosity soil
- Large vegetation
- More No. of ponds
- low run off coefficient

(3)

Average catchment– if characteristics of catchment area – average yield.

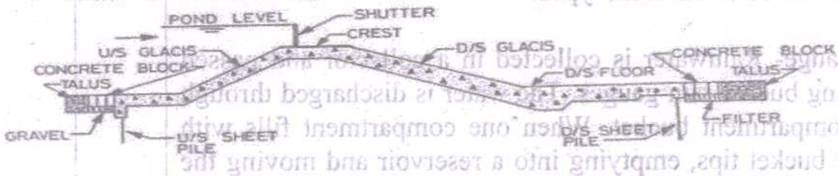
- Average rainfall zone
- Medium porosity soil
- Medium vegetation

(3) (9) (15)

V. (a)

Ans. Concrete weir with sloping glacis are of relatively recent origin. The crest has glacis (sloping
floors) in u/s as well as d/s. There are sheet piles (or cut off walls) driven up to the maximum scour depth at the u/s and d/s end of the concrete floor. Some times an intermediate pile is also driven at the beginning of the u/s glacis or at the end of the d/s glacis.
There is a concrete block protection in the continuation of the concrete floor both at the u/s and d/s side. On the u/s of the u/s concrete block protection as well as on the d/s of the d/s block protection, there is talus. This type of weir may be constructed in pervious foundations and are commonly adopted these days.

fig-5 4



(9)

V (b)

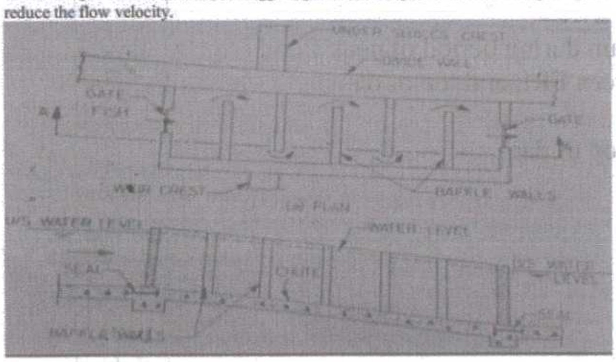
Ans. A fish ladder is a passage provided adjacent to the divide wall, on the weir side, for the fish to travel from the upstream to the down stream of the weir and also in the reverse direction.

In north Indian rivers, the fish generally travel from the cold water in hills to warmer water in plains during winter. In the months of May and June, they move in the reverse direction in search of clear water.

It has been established that most types of fish can travel upstream against a flow velocity of about 3 to 3.5 m/s. If no fish ladder is provided at the weir site and only a gap is left, even the strongest fish will not be able to travel upstream.

In a fish ladder, the head is gradually dissipated so as to provide smooth flow at sufficient low velocity. Suitable baffles (or Staggering devices) are provided in the fish passage to reduce the flow velocity.

(3)



figs

(6) (15)

VI (a)

Ans. A vertical drop weir consists of a masonry wall with a vertical (or nearly vertical) downstream face and a horizontal concrete floor. The shutters are provided at the crest, which are dropped during flood so as to reduce afflux. The water is pounded up to the shutters during the rest of the period.

The weir floor is designed as gravity section. Immediately at the upstream end of the floor a block protection and at the downstream end a graded inverted filter are provided. Launching aprons are provided at the u/s and d/s ends of floor to safeguard against scouring action. This type of weir is suitable for hard clay foundation as well as consolidated gravel foundation, and where the drop is small.. Such weirs are obsolete now a days.

(3)

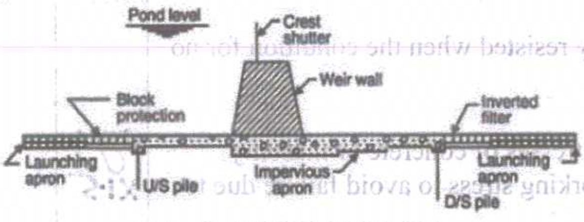


FIG. 12.1. VERTICAL DROP WEIR.

fig-3

(3)

(6)

VI (b)

- U/S apron:
  - Protects main body of weir from floods and erosive forces.
  - Length depends on discharge in river and weir length
  - Strong enough to withstand water pressure and to prevent any leakage in sub soil

(3)

- U/S curtain wall:
  - Provided to reduce uplift pressure
  - Length depends on nature of soil.

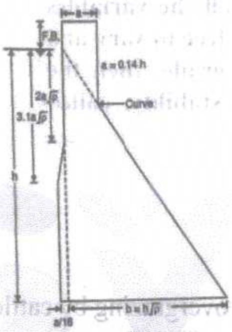
(2)

- D/S apron:
  - When water falls from the crest KE is generated, which erodes d/s bed of the river
  - D/S apron is provided to dissipate the KE

(2)

	• Length depends on : height of fall, nature of soil, discharge in river. • Apron is extended till the point of no erosion • D/S curtain wall: • Protects d/s floor from uplift pressure • Strong enough to resist the falling energy of water.	(2)	(9)	(15)
VII. (a)	• **Full Reservoir Level (FRL):** • Level up to which water is stored. Spill way crest is fixed at this level. • **Maximum Water Level (MWL):** • Water level attained during flood, also called **HFL (High Flood Level),** dams and spill ways are designed to withstand water pressure up to this level. • **Free Board:** • To prevent overtopping of dam during period of peak flood sufficient margin is left between FRL and top of dam • **Gross Free Board:** • Difference between FRL & top of dam	(2) (3) (2) (2)	(9)	
VII (b)	Forces • Water Pressure • Weight of Dam • Uplift Pressure • Pressure due to Earthquake • Ice Pressure • Wave Pressure • Silt Pressure • Wind Pressure	any6 x1	(6)	(15)
VIII (a)	• To prevent overturning, the resultant of all forces acting on the dam should remain within the middle third of the base width of the dam. • In the dam, the sliding should be fully resisted when the condition for no sliding exists in the dam section. • In the dam section, the compressive stresses of concrete or masonry should not exceed the permissible working stress to avoid failure due to crushing. • There should be no tension in the dam section to avoid the formation of cracks. • *The factor of safety should be maintained between 4 to 5.	any4 x1.5	(6)	

VIII (b)



PRACTICAL PROFILE OF A GRAVITY DAM.

fig-4

The elementary profile of a gravity dam, (i.e.. triangle with maximum water surface at apex) is only a theoretical profile. Certain changes will have to be made in this profile in order to cater to the practical needs.

These needs are,

(i) providing a straight top width for road construction over the top of the dam

(ii) providing a free-board above the top water surface, so that water may spill over the top of the dam due to wave action, etc.

(2)

Free board

Free board is the margin provided between the top of the dam and maximum or High flood level, so as to prevent the splashing of the waves over the non - overflow section. This provision also takes care of the unforeseen floods. The free board should be 1.5 times the maximum height of the wave. However, a minimum free board of 0.9m should be provided. In the modern day design a maximum free board equal to 3 to 4% of the dam is provided.

Top width

Top width an top of the dam provided an access for transporting men and vehicles. Usually top width of the dam is selected on the road requirements as specified by Indian road Congress (IRC) or equivalent to 14% of the hight of the dam. Usual widths provided vary from 6 to 10 metres.

(3)

(9) (15)

IX (a)

Regime Channel

- When the character of the bed and bank materials of the channel are same as that of the transported materials and when the silt charge and silt grade are constant, then the channel is said to be in its regime and the channel is called regime channel.
- This ideal condition is not practically possible.

(2)

	When only the bed slope of a channel varies due to dropping of silt , and its cross-section or wetted perimeter remains unaffected, even them the channel can exhibit 'no silting no scouring' properties, called *INITIAL REGIME.*	(2)	
	IF there is no resistance from the sides, and all the variables such as perimeter, depth, slope etc. are equally free to vary and get adjusted according to discharge and silt grade, then the channel is said to have achieved permanent stability, called *FINAL REGIME.*	(2)	(6)
IX (b)	Causes of Soil Erosion Various agents, like wind, water, <u>deforestation</u>, overgrazing by cattle, etc., cause soil erosion. The various factors of soil erosion are: 1. Wind When strong winds blow, the topsoil along with the organic matter is carried away by the wind. This happens more often when the land is not covered with grass or plants. Such conditions are very common in desert and semi-desert regions where strong winds blow very frequently. 2. Water When it rains in the hilly areas, the soil gets washed away towards the plains. The running water deposits the mineral-rich soil in the riverbed and over the years this deposition of soil can change the course of the river. This can lead to floods which cause the destruction of life and property. Water erosion leads to loss of agriculture potential. 3. Overgrazing When cattle are allowed to graze on the same field repeatedly, all the available grass, including the roots are eaten by them. This makes the topsoil vulnerable to wind and flowing water, leading to soil erosion. 4. Deforestation Humans have taken land from the forest to cultivate in order to feed the ever-increasing population and to build houses, industries, etc. Cutting down trees on a large scale for these purposes is **deforestation.** The roots of trees hold the soil together, thus preventing the <u>soil</u> from getting uprooted. When large areas of the forest are cleared, the topsoil gets eroded by wind and flowing water.	4x 1.5 =6	

X (a)	Impacts Of Soil Erosion • Soil erosion destroys the most fertile section of the soil, which contains the majority of the nutrients and organic matter required by plants, leaving behind the less fertile subsoil. • As a result of the removal of seeds or seedlings, the soil becomes bare, making it more susceptible to erosion. • It also decreases the soil's ability to hold water.	(3)	(9)	(15)
	Canal Lining • Advantages – Water conservation – Preventing Seepage Losses – Avoiding Water-Logging in adjoining – Rugosity Co-efficient is reduced, by increased smoothness – Increased velocity – decreased losses due to evaporation – Only a Narrow Cross section is needed as the velocity is increased (to keep constant discharge) – Higher velocity offers flatter hydraulic gradient or bed slope – Better command is obtained – Higher velocity prevents silting – More stable banks – Reduced maintenance and possibility of breaching due to increased stability – Reduced weed growth – Increased head availability – flatter gradient – Assures economical water distribution – Avoids contact of water with harmful salts	any 4 × 1 = (4)		
	• Disadvantages – Heavy initial cost. – Difficulty in providing outlets – Difficulty in Maintenance – Absence of berm – absence in additional stability for vehicular and pedestrian traffic	any 2 × 1 = (2)		
X (b)	Canal Escape It is a side channel constructed to remove surplus water from an irrigation channel (main canal, branch canal, or distributary etc.) into a natural drain. The water in the irrigation channel may become surplus due to - • Mistake • Difficulty in regulation at the head • Excessive rainfall in the upper reaches • Outlets being closed by cultivators as they find the demand of water is over	(2)		
	Escapes are usually of the following three types. **Surplus Escape**			

	It is also called regulator type. In this type sill of the escape is kept at canal bed level and the flow is controlled by a gate. This type of escapes are preferred now-a-days as they give better control and can be used for employing the canal for maintenance.	(2)		
	Tail Escape A tail escape is provided at the tail end of the canal and is useful in maintaining the required FSL in the tail reaches of the canal and hence, they are called tail escape.	(2)		
	Scouring Escape This escape is constructed for the purpose of scouring of excess silt deposited in the head reaches from time to time. Hence, it is called scouring escape. Here the sill of the regulator is kept at about 0.3 m below the canal bed level at escape site. When deposited silt to be scoured, a higher discharge than the FSL is allowed to enter the canal from the head works. The gate of the escape is raised so as to produce scouring velocity which remove the deposited silt. This type of Escape has become obsolete as silt ejector provided in the canal can produce better efficiency	(3)	(9)	(15)