

**DHANALAKSHMI SRINIVASAN COLLEGE OF ENGINEERING AND
TECHNOLOGY**

DEPARTMENT OF CIVIL ENGINEERING

COURSE TITLE : WATER RESOURCES AND IRRIGATION ENGINEERING

COURSE CODE : CE 6703

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UNIT-I - WATER RESOURCES

PART-A

1. Write short notes on Global water resources survey?

The world total water resources potential are estimated to be 1.37×10^8 million ha-m. Of these global water resources about 97.2% is salt water, mainly in oceans and only 2.8% is available as fresh water at any time on planet earth

2. Mention about the ground water potential of the planet earth?

Saline Water = 97.2%

Fresh Water = 2.8%

Out of these 2.8% ,about 2.2% is available as surface water and 0.6% as ground water. Even out of this 2.2% of surface water, 2.15% fresh water available in glaciers and icecaps and only of the order of 0.001% is available in lakes and reservoirs, 0.0001% in streams; the remaining in other forms 0.001% as water vapor in atmosphere. Out of 0.6% of stored ground water, only about 0.3% can be economically extracted with the present drilling technology, the remaining being unavailable as it is situated below a depth of 800 m.

3. Write short notes on India's water resources potential?

India's with a geographical area of nearly 3.3 million square kilometers experiences extremes of climate. Normal annual rainfall varies from 100 mm in Western Rajasthan to over 1100 mm at Cherabunji at Meghalaya. Variability of rainfall from season to season is also very high. The average annual rainfall over the country is of the order of 1170 mm. The average flow in the river systems of the country has been estimated to be 1880 km^3 , but over 90% of the annual runoff in peninsular rivers and over 80% of the annual runoff in Himalayan rivers occur during the four monsoon months of June to September.

4. What are the steps involved in water resources planning?

- (i) Statement of purpose
- (ii) Evaluation of alternatives
- (iii) Systematic consideration of project
- (iv) Selection of project.

5. What are all the investigations in project planning?

- (i) Explanatory Studies
- (ii) Feasibility studies
- (iii) Final studies

6. What are all the essential data's necessary for water resources planning?

(i) Hydrological and climate data to ascertain rainfall, surface and ground water availabilities.

- (ii) Geological data to determine the type of foundation available for locating dam site.
- (iii) Topographical data to collect information of land use, land slopes, valleys, ridges, etc.

7. What are all the steps involved in project formulation?

- (i) Defining boundary conditions
- (ii) Defining project alternatives
- (iii) Timing of alternatives

8. What are all the drawbacks in project planning?

- (i) Unsound preliminary report
- (ii) Inappropriate design criteria
- (iii) Time lag in the construction and use of the project
- (iv) Neglecting economic analysis of the project
- (v) Failure to consider all alternatives
- (vi) Non-Consideration of the next best alternative

9. Differentiate b/w single and multipurpose reservoir.

A single purpose reservoir is for a single purpose. e.g conservation or flood control. They are constructed to store water during the period of high flow for use during periods of drought when the demand is more due to depletion of natural water storage.

A multipurpose reservoir is a man-made **lake** which is managed for multiple purposes like water supply, flood control ,soil erosion, environmental ,management ,Hydroelectric power generation, navigation, recreation and Irrigation.

10. What are the different types of single purpose reservoirs?

Depending upon the arrangement for releasing stored water,single purpose flood control reservoir may be further sub-classified as

- (i) Retarding reservoir
- (ii) Detention reservoirs.

11. Differentiate b/w Levees and Flood walls.

The main purpose of artificial levees is to prevent flooding of the adjoining **countryside** and to slow natural course changes in a waterway to provide reliable shipping lanes for maritime commerce over time; they also confine the flow of the river, resulting in higher and faster **water** flow. Levees can be mainly found along the sea, where dunes are not strong enough, along rivers for protection against high-floods, along lakes or along **polders**.

A flood wall (or floodwall) is a primarily vertical artificial barrier designed to temporarily contain the waters of a **river** or other waterway which may rise to unusual levels during seasonal or extreme weather events. Flood walls are mainly used on locations where space is scarce, such as cities or where building **levees or dikes (dykes)** would interfere with other interests, such as existing buildings, historical architecture or commercial use of embankments.

12. What are the preferable combinations for a multipurpose reservoir?

The preferred combinations are:

- (i) Irrigation and power

- (ii) Irrigation, power and navigation
- (iii) Irrigation, power and water supply
- (iv) Recreation, fisheries and wild life
- (v) Flood control and water supply
- (vi) Power and water supply
- (vii) Flood control, irrigation, power and water supply

13. List out the various zones of storage in a reservoir.

Reservoir storage is divided into four zones, or pools. These include, from top to bottom, the flood-control zone, conservation zone, buffer zone and inactive zone.

The conservation and buffer pools, together, constitute the reservoir's active storage. WEAP will ensure that the flood-control zone is always kept vacant, i.e., the volume of water in the reservoir cannot exceed the top of the conservation pool.

14. Write short notes on reservoir sedimentation.

Sediment load carried by a flow will drop out if the transport capacity of flow is diminished. In general, the capacity of a given flow decreases with a reduction of its velocity. As a river enters the reservoir, the cross-sectional area of flow is increased, the average velocity is decreased and sediment load starts dropping out. The order in which different sediment sizes settle down and the location of deposits depends on three physical phenomena—cessation of drag force on particles rolling along the stream bed (bedload); reduction in turbulence level which determines the capacity of flow to maintain sediment suspension and, development of density currents.

15. Enlist few major river basins of India.

- i) Indus
- ii) Ganga
- iii) Brahmaputra
- iv) Brahman
- v) Mahanadhi
- vi) Godavari
- vii) Krishna
- viii) Pennar
- ix) Cauvery
- x) Tapti
- xi) Narmadha
- xii) Mahi
- xiii) Sabarmati
- xiv) Subernareke

16. What are the steps involved in water project planning?

- i) Systematic consideration of project
- ii) Selection of project.

17. What are all the investigations in project planning?

- i) Explanatory Studies
- ii) Feasibility studies
- iii) Final studies

18. What are all the essential data's necessary for water resources planning?

- i) Hydrological and climate data to ascertain rainfall, surface and ground water availabilities.
- ii) Geological data to determine the type of foundation available for locating dam site.

iii) Topographical data to collect information of land use, land slopes, valleys, ridges, etc.

19. What are all the steps involved in project formulation?

- i) Defining boundary conditions
- ii) Defining project alternatives
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20. What are all the drawbacks in project planning?

- i) Unsound preliminary report
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PART-B

1. How water requirement for drinking purpose is estimated? Discuss.
2. What are the flood control methods? Explain.
3. Differentiate between single and multipurpose reservoir.
4. Briefly explain about water resources in India and Tamil Nadu.
5. Illustrate the importance of design flood in the design of levees and flood walls.
6. How will you fix the capacity of reservoir? Explain.
7. Discuss in detail about the water quality standards for irrigation and drinking water purpose.
8. Write stepwise planning procedure for multipurpose projects.
9. Write short note on single and multipurpose reservoir with its advantages and disadvantages.
10. Explain the water requirements for irrigation, hydropower generation, navigation, drinking and disposal of sewage and industrial waste.
11. What are the various types of data required for water resources planning and development? Explain in detail.
12. Distinguish between structural and nonstructural measures for flood control.
13. Analyse the strategies for efficient reservoir operation.
14. Explain in detail about economics of water resource planning.

UNIT - II WATER RESOURCES MANAGEMENT

PART-A

1. How the precipitation can be measured?

It can be measured by the rain gauge. The rain gauge may be

- i) Recording type rain gauge
- ii) Non-Recording type rain gauge.

2. What are the demerits of Non-recording type rain gauge?

It does not give information regarding Beginning of the rainfall, End of the rain, Intensity of rainfall.

3. Enlist the three types of recording type rain gauge.

- i) Tipping bucket
- ii) Weighing bucket
- iii) Floating bucket

4. Write short notes on rain gauge density.

It is the number of rain gauge is to erected in an given area.

Rain gauge density = No of rain gauges / Area

5. What is the use of Double mass curve?

It is used to check the consistency of the rainfall record. In double mass curve a graph is draw between the cumulative values of average rainfall of base stations as the abscissa against the corresponding cumulative value of rainfall of the stations under let as ordinate.

6. What is the use of frequency analysis?

It is used to find the probability of occurrence of extreme rainfall. The probability of occurrence of rainfall whose magnitude is equal to or greater than specified magnitude is given by: $T = N+1/m$

Where, T = return period

m = rank

n = no of years of rainfall record

7. Enumerate the methods used to estimate the amount of evaporation from a water surface?

- i) Evaporimeters
- ii) Analytical methods
- iii) Empirical formulae

8. Write short notes on Evaporimeters.

- i) Class A evaporation pan
- ii) ISI Standard pan
- iii) Colarodo sunken pan
- iv) US geological survey floating pan.

9. Define pan co efficient.

Pan co efficient = lake evaporation/pan evaporation

10. Enlist the instruments used to measure transpiration.

- i) Lysimeter
- ii) Field plots

11. Define infiltrometers and mention its type.

Infiltrometers are the devices used to measure infiltration. There are two kinds of infilterometer. They are

- i) Flooding type infiltrometer
- ii) Rainfall simulator

12. What are the consumptive uses of water?

The following are the consumptive uses of water :

- (i) Irrigation
- (ii) Domestic use like cooking, washing etc.
- (iii) Drinking

13. What are the non-consumptive uses of water ?

- (i) Fishing
- (ii) Navigation
- (iii) Recreation

14. What are the two common measures of water use ?

- (i) Withdrawal
- (ii) Consumption

15. What is withdrawal?

Withdrawal is process of taking water from a surface or ground water source and conveying it to a place for a particular type of use.

16. What is meant by consumptive use of water ?

Consumption takes place when water is removed from available supplies by evaporation or transpiration ,manufacturing and agriculture or for food preparation and drinking.This is called consumptive use.

17. What is water budget?

Water budget for a specified water system whether ground water,surface water ,or the complete water system within a geographic area, is a summation of inputs and outputs to the system.

18. What is master plan?

It is an integrated plan of development of all activities related to water such as irrigation, domestic use, industries, energy etc.

19. What is the aim of Master plan?

- a) To generate Wealth.
- b) To generate Employment.
- c) Optimize the resource to maximize wealth and employment.

20. What are the aspects that a master plan should incorporate?

- (a) Total potential or scope for development of the activity in question.
- (b) Scope of Management of the activity in question.
- (c) Status of development / management.
- (d) Gaps, shortcomings experienced in above.

21. What is a river basin?

The total land area that contributes water to a river is called a Watershed, also called differently as the Catchment, River basin, Drainage Basin, or simply a Basin.

22. When is inter-basin water transfer required?

It is possible that the water availability in a basin (Watershed) is not sufficient to meet the maximum demands within the basin. This would require Inter-basin water transfer.

23. Write short notes on Peninsular river development.

This component is divided into four major parts:

- (i) Interlinking of Mahanadi-Godavari-Krishna-Cauvery rivers and building storages at potential sites in these basins.
- (ii) Interlinking of west flowing rivers, north of Mumbai and south of Tapi.
- (iii) Interlinking of Ken-Chambal rivers.

(iv) Diversion of other west flowing rivers.

24. What is a donor basin and recipient basin?

A Donor basin is the basin, which is supplying the water to the downstream basin. A Recipient basin is the basin, which is receiving the water from the Donor basin.

26. What are the possible implications of inter - basin water transfer ?

Since a large scale water transfer would be required, it is necessary to check whether there shall be any of the following:

- River bed level rise or fall due to possible silt deposition or removal.
- Ground water rise or fall due to possible excess or deficit water seepage
- Ecological imbalance due to possible disturbance of flora and fauna habitat.
- Desertification due to prevention of natural flooding (i.e. by diversion of flood water).

27. List the methods of estimation of consumptive use.

To measure or estimate the consumptive use, there are three main methods:

- (i) Direct Methods/Field Methods
- (ii) Empirical Methods
- (iii) Pan evaporation method

28. List the direct methods for estimation of consumptive use.

In this method field observations are made and physical model is used for this purpose. This includes :

- (i) Vapour Transfer Method/Soil Moisture Studies
- (ii) Field Plot Method
- (iii) Tanks and Lysimeter
- (iv) Integration Method/Summation Method
- (v) Irrigation Method
- (vi) Inflow Outflow Method

29. Write short notes on vapour transfer method.

In this method of estimation of water consumptive use, soil moisture measurements are taken before and after each irrigation. The quantity of water extracted per day from soil is computed for each period. This method is suitable in those areas where soil is fairly uniform and ground water is deep enough so that it does not affect the fluctuations in the soil moisture within the root zone of the soil.

30. Write short notes on field plot method.

We select a representative plot of area and the accuracy depends upon the representativeness of plot (cropping intensity, exposure etc). It replicates the conditions of an actual sample field (field plot). Less seepage should be there.

PART-B

1. What is the Necessity of National Water Policy? Explain
2. What are the different equations for determination of consumptive use? Briefly explain it.
3. Explain in detail the conjunctive use of surface and ground water.
4. Discuss about the economics of water resource planning.
5. Discuss the points about water allocation priorities in National Water Policy.
6. Define Master Plan in water resources? Explain the scope and aims in detail.
7. Briefly explain the methods for determination of consumptive use?

8. Classify the different characteristics of water? Briefly discuss about it?
9. Explain the water characteristics to be investigated?
10. What is the concept of basin as a unit for development?
11. Write briefly about water budget and its development plan.
12. Show the features and limitations of National Water policy.
13. Write short notes on
 - (i) Water budget equation (8)
 - (ii) Components of Master Plan (8)
14. Summarize the consumptive use of water and the factors affecting consumptive use of water. How will you measure it?

UNIT-III IRRIGATION ENGINEERING **PART A**

1) Define irrigation

Irrigation is defined as the science of artificial application of water to the land in accordance with the crop requirements.

2) What are the necessity of irrigation?

- (i) Inadequate rainfall
- (ii) Increasing yield of crops
- (iii) Growing perennial crops
- (iv) Uneven distribution of rainfall.

3) What are the advantages of irrigation?

- Increase in food production
- Optimum benefits
- General prosperity
- Afforestation

4) What are the disadvantages of irrigation?

- (i) Over irrigation may lead to water logging
- (ii) It may reduce crop yield
- (iii) It is expensive and complex.

5) What are the types of irrigation?

- (i) Surface irrigation
- (ii) sub-surface irrigation.

6) What are the techniques of water distribution in the farms?

- Free flooding
- Border flooding
- Check flooding
- Basin flooding, furrow irrigation method, drip irrigation method.

7) What are the types of sprinkler system?

- (i) Permanent system
- (ii) Semi-permanent system

(iii) Portable system

8) What are the advantages of sprinkler irrigation?

- Land levelling is not required
- Fertilisers can be uniformly applied
- It is less labour oriented

9) What are the limitations of sprinkler irrigation?

- Initial cost of the system is very high
- It requires larger electrical power
- High wind may distort sprinkler pattern

10) What is arid and semi-arid region?

The area where irrigation is must for agriculture is called arid region. The area in which inferior crops can be grown without irrigation

11) What is crop, base and rotation period?

The time period that elapses from the instant of its sowing to the instant of its harvesting is called crop period. The time between the first watering of a crop at the time of its sowing to its last watering before harvesting is called the base period. The time interval between two such consecutive watering is called frequency irrigation.

12) Define duty of water?

It is the relationship between the volume of water and the area of crops it matures is called duty of water.

13) Define delta of a crop

Each crop requires a certain amount of water after a certain fixed interval of time, through its period of growth is called delta of a crop

14) What are the factors on which duty depends?

- Type of crop
- Climate and seasons
- Useful rainfall
- Type of soil
- Efficiency of cultivation method

15) What are kharif and rabi crops?

The kharif crops are rice,bajra,jawar,maize,cotton,tobacco, groundnut,etc. Rabi crops are wheat,barley,gram,linseed,mustard,potatoes,etc

16) Define irrigation efficiency.

It is the efficiency of water output to the water input,and is usually expressed as percentage.

17) What is called effective rainfall?

Precipitation falling during the growing period of a crop that is available to meet the evapo-transpiration.

PART-B

1. Define consumptive use of water? Explain the Factors affecting consumptive use of Water.
2. What are the different types of flooding methods? Explain with a neat sketch.
3. Write the factors affecting Duty, Delta and Base period.
 - (i) Derive the relationship between Duty and Delta for the given base period (7)
 - (ii) What are the factors affects the duty? How to improve duty? (6)
4. Discuss about the factors affecting the consumptive use of water.
 - (i) Describe the necessity of irrigation in India. (7)
 - (ii) Write the benefits and ill effects of irrigation. (6)
5. Illustrate the methods to measure the consumptive use of water? explain
6. Explain in detail about irrigation efficiencies.
7. List and explain the main crop seasons of India.
8. Consumptive use is related to the total requirement of the water for the crop. How?
9. Briefly give a short note on:
 - (i) Duty (ii) Delta (iii) Base Period (iv) Crop Period (v) Crop Ratio
10. Explain the Necessity and scope of Irrigation in India and List out some of the major water resources in India?

UNIT -IV CANAL IRRIGATION

PART A

1. What are Impounding structures ?

Impounding structure" means a man-made structure, whether a dam across a watercourse or other structure outside a watercourse, used or to be used to retain or store water or other materials. The term "impounding structure" shall not include: (a) dams licensed by the State Corporation Commission that are subject to a safety inspection program; (b) dams owned or licensed by the United States government; (c) dams operated primarily for agricultural purposes which are less than twenty-five feet in height or which create a maximum impoundment capacity smaller than 100 acre-feet; (d) obstructions in a canal used to raise or lower water.

2. What is a gravity dam ?

A gravity dam is a solid structure, made of concrete or masonry, constructed across a river to create a reservoir on its upstream . The section of the gravity dam is approximately triangular in shape, with its apex at its top and maximum width at bottom.

3. What are the forces acting on a gravity dam ?

- (i) Weight of the Dam
- (ii) Water Pressure
- (iii) Uplift Pressure
- (iv) Seismic Force
- (v) Silt Pressure
- (vi) Wave Pressure
- (vii)Ice Pressure
- (viii) Wind Pressure

4. Write short notes on (i) Storage head works (ii) Diversion head works.

(i) Storage head works: when a dam is constructed across a river valley to form a storage reservoir, it is known as storage head works. The water is supplied to the canal from this reservoir through the canal head regulator. Again this reservoir serves the multipurpose functions such as hydro-electric power generation, flood control, fishery, etc.,

(ii) Diversion head works: when a weir or barrage is constructed across a perennial river to raise the water level and to divert the water to the canal then it is known as a diversion head works. The flow of water in the canal is controlled by canal head generator.

5. What are the points to be remembered while selecting the site for diversion head works?

The following points should be remembered while selecting the site for diversion head works:

- At the site, the river should be straight and narrow.
- The river banks should be well defined
- The valuable land should not be submerged when the weir or barrage is constructed
- The elevation of the site should be much higher than the area to be irrigated

6. What is a weir?

Normally, the water level of any perennial river is such that it cannot be diverted to the irrigation canal. That level of the canal may be higher than the existing water level of the river. In such a case, weir is constructed across the river to raise the water level from H_1 to H_2 . Then, the water can be easily diverted to the canal. The surplus water passes over the crest of the weir.

7. What is a divide wall ?

The divide wall is a long wall constructed at right angles 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 head regulator and on the downstream side it is extended up to the launching apron.

8. What is a canal head regulator?

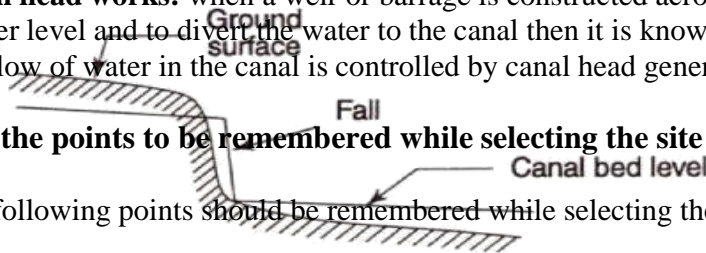
A structure which is constructed at the head of the canal to regulate flow of water is known as canal head regulator. It consists of a number of piers which divide the total width of the canal into a number of spans which are known as bays.

9. What are canal falls?

Generally, the slope of the natural ground surface is not uniform throughout the alignment. Sometimes, the ground surface may be steep and sometimes it may be very irregular with abrupt change of grade. In such cases, a vertical drop is provided to step down the canal bed and then it is continued with permissible slope until another step down is necessary. This is done to avoid unnecessary huge earth work in filling. Such **vertical drops** are known as **canal falls** or **simply falls**.

10. What is the necessity for canal falls?

When the slope of the ground suddenly changes to steeper slope, the permissible bed slope cannot be maintained. It requires excessive earthwork in filling to maintain the slope. In such a case falls are provided to avoid excessive earth work in filling.



11. Write short notes on cross-drainage works.

In an irrigation project, when the network of main canals, branch canals, distributaries, etc. are provided, then these canals may have to cross the natural drainages like rivers, streams, etc. at different points within the command area of the project. The crossing of the canals with such obstacle cannot be avoided. So, suitable structures must be constructed at the crossing point for the easy flow of water of the canal and drainage in the respective directions. These structures are known as *cross-drainage works*.

12. What is the necessity for cross drainage works ?

The water-shed canals do not cross natural drainages. But in actual orientation of the canal network, this ideal condition may not be available and the obstacles like natural drainages may be present across the canal. So, the cross drainage works must be provided for running the irrigation system. At the crossing point, the water of the canal and the drainage get intermixed. So, for the smooth running of the canal with its design discharge the cross drainage works are required. The site condition of the crossing point may be such that without any suitable structure, the water of the canal and drainage cannot be diverted to their natural directions. So, the cross drainage works must be provided to maintain their natural direction of flow.

13. What are the common materials used for canal lining ?

The commonly used materials for canal lining are :

- (i) Concrete
- (ii) Rock masonry
- (iii) Brick masonry
- (iv) Bentonite-earth mixtures
- (v) Natural clays of low permeability
- (vi) Different mixtures of rubble, plastic, and asphaltic materials.

14. Write short notes on concrete lining.

Concrete lining is probably the best type of lining. Cement concrete lining made from selected aggregate gives very satisfactory service. Despite the fact that they are frequently high in their initial cost, their long life and minimum maintenance make them economical.

15. Write short notes on (i) Bricks and Tiles lining and (ii) Stone lining.

- (i) Bricks are installed in layers of two with about 1.25 cm of 1 : 3 cement mortar sandwiched in between. Good quality bricks should be used. Brick tiles can be plastered to increase the carrying capacity of canal with same section and help in increasing the life span of the lining.
- (ii) Stone lining of canals, if economically feasible, is useful for preventing erosion and where the ground water level is above the bed of the canal and there is a possibility of occurrence of damaging back pressures. The stones used for boulder linings should be hard, durable, and capable of sustaining weathering and water action.

16. What are the drawbacks of Kennedy's theory ?

Drawbacks of Kennedy's Theory are:

- (i) The theory is limited to average regime channel only.
- (ii) The design of channel is based on the trial and error method.
- (iii) The value of m was fixed arbitrarily.
- (iv) Silt charge and silt grade are not considered.
- (v) There is no equation for determining the bed slope and it depends on Kutter's equation only.

17. What are the drawbacks of Lacey's theory ?

Drawbacks of Lacey's Theory are:

- (i) The concept of true regime is theoretical and can not be achieved practically.
- (ii) The various equations are derived by considering the silt factor f which is not at all constant.
- (iii) The concentration of silt is not taken into account.
- (iv) Silt grade and silt charge is not taken into account.
- (v) The equations are empirical and based on the available data from a particular type of channel.
So, it may not be true for a different type of channel.

18. Compare Kennedy's and Lacey's theories.

KENNEDY'S THEORY	LACEY'S THEORY
1. It states that the silt carried by the flowing water is kept in suspension by the vertical component of eddies which are generated from the bed of the channel.	It states that the silt carried by the flowing water is kept in suspension by the vertical component of eddies which are generated from the entire wetted perimeter of the channel.
2. In this theory, a factor known as critical velocity ratio 'm' is introduced to make the equation applicable to different channels with different silt grades.	In this theory, a factor known as silt factor 'f' is introduced to make the equation applicable to different channels with different silt grades.

19. Write short notes on Soil -Cement linings.

These linings are constructed using cement (15 to 20 per cent by volume) and sandy soil (not containing more than about 35 per cent of silt and clay particles). Cement and sandy soil can be mixed in place and compacted at the optimum moisture content. This method of construction is termed the *dry-mixed soil-cement method*.

20. What are the factors to be considered before selecting the type of material for lining?

- (i) Economy
- (ii) Structural stability
- (iii) Resistance to erosion
- (iv) Durability

21. What is a permanent canal?

A permanent canal has a continuous source of water supply. Such canals are also known as perennial canals.

22. What is an inundation canal ?

This type of canal draws its supplies from a river only during the high stages of the river. Such canals do not have any head works for diversion of river water to the canal, but are provided with a canal head regulator.

23. Briefly explain the points to be considered for canal alignment.

- (i) An irrigation canal should be aligned in such a way that maximum area is irrigated with least length of canal.
- (ii) Cross drainage works should be avoided as far as possible, such that the cost is reduced.
- (iii) The off taking point of the canal from the source should be on a ridge, such that the canal must run as a ridge canal and irrigate lands on both sides.
- (iv) Sharp curves in canals must be avoided.

24. Briefly explain the problem in the design of unlined canals in alluvial soils.

When water from the catchment or drainage basin enters the river it carries huge amounts of silt or sediments along with it. The sediment is carried either in suspension or dragged along the rivers bed. A portion of this silt or sediment also enters the canals. These sediments can cause a problem in the design of unlined canals in alluvial soils.

25. What are the measures to be taken for improving the duty of irrigation system ?

- (i) The channel should not be in sandy soil and be as near the area to be irrigated as possible so that the seepage losses are minimum. Wherever justified, the channel may be lined.
- (ii) The channel should run with full supply discharge as per the scheduled program so that the farmers can draw the required amount of water in shorter duration and avoid the tendency of unnecessary over-irrigation.

26. What is a Barrage ?

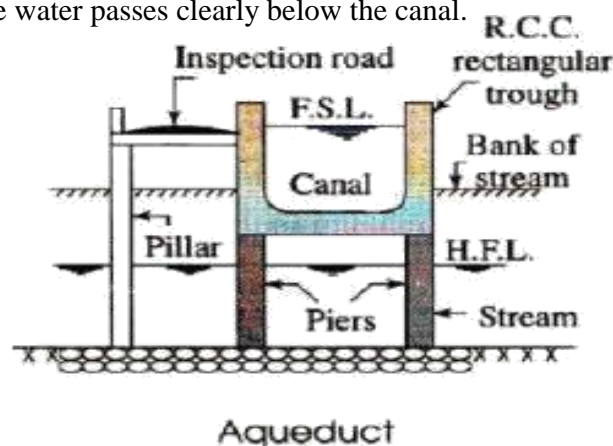
When the water level on the upstream side of the weir is required to be raised to different levels at different times, then the barrage is constructed. Practically a barrage is an arrangement of adjustable gates or shutters at different tiers over the weir. The water level can be adjusted at H_1 , H_2 , etc. by operating the adjustable gates.

27. What are the functions of a divide wall ?

- a. To form a still water pocket in front of the canal head so that the suspended silt can be settled down which can later be cleaned through the scouring sluice from time to time.
- b. It controls the eddy current or cross current in front of the canal head.
- c. It provides a straight approach in front of the canal head.
- d. It resists the overturning effect on the weir or barrage caused by the pressure of the impounding water.

28. What is an aqueduct ?

The hydraulic structure in which an irrigation canal is passing over the drainage is known as an aqueduct. This structure is suitable when the bed of the canal is above the highest flood level of the drainage. In this case, the drainage water passes clearly below the canal.



29. What are the main functions of a cross-regulator ?

The main functions of a cross-regulator are listed below|:

- (i) To control the entire Canal Irrigation System.
- (ii) To help in heading up water on the upstream side and to fed the off-taking canals to their full demand.
- (iii) To help in absorbing fluctuations in various sections of the canal system, and in preventing the possibilities of breaches in the tail reaches.
- (iv) Cross regulator is often combined with bridges and falls, if required.

30. What are the non-structural measures for reducing waterlogging?

- (i) Adoption of tolerant crops
- (ii) Restricting canal supplies close to crop water needs
- (iii) Switch over to drip irrigation
- (iv) Conjunctive use of surface and ground water

PART-B

1. What do you understand by the term 'Cross drainage works'. Explain it with neat sketches.
2. How will you design the canal by using Kennady's and Lacey's Regime theory?
3. Describe in detail about the component parts of diversion works.
4. Briefly explain the cross drainage works.
5. Write briefly about the necessity of irrigation in India and mention the benefits and ill effects of irrigation.
 - (i) Explain the classification of dams with examples.
 - (ii) Discuss about the points to be considered for selection of site for a dam.
6. Write detailed notes on the preliminary investigations that are to be carried out for the selection of dam site.
7. Explain the properties of canal lining materials suitable for canal lining
8. Distinguish between Aqueduct and super passage.
9. What are canal outlets? Explain it with neat sketches.
10. Explain the types of canal escapes with neat sketches and list the factors to be considered in the alignment of canal.

UNIT V - IRRIGATION METHODS AND MANAGEMENT

PART-A

1. Write a short note on Lift irrigation

In lift irrigation water is lifted from a river or a canal to the bank to irrigate the land which are not commanded by gravity flow. Lift irrigation is being increasingly practiced in India.

2. What is Lift area?

Lift area is defined as the area the level of which is too high to permit irrigation by gravity flow from the source, but which can be irrigated by lifting water to the necessary level by means of pump.

3. Write a short note on Tank irrigation.

A tank act as an irrigation storage system which is developed by constructing a small bund of earth or stones built across a stream. Tank irrigation is more suitable in the

peninsular plateau area such as Andhra Pradesh (Including Telangana) and Tamil Nadu. According to reports, Tamil Nadu has the second largest area which is over 23 per cent of tank irrigated area of India and about one-fifth of the total irrigated area of the state.

4. What are the drawbacks of tank irrigation?

The drawbacks of tank irrigation are :

- (i) Major problem with tanks water storage is that tanks dry up during the dry season and fail to provide irrigation when it is needed the most.
- (ii) Tanks cover large areas of cultivable land.
- (iii) Lifting of water from tanks and carrying it to the fields is a tiring and expensive effort which discourages the use of tanks as a source of irrigation.

5. Write a short note on well irrigation.

A well is a hole dug in the ground to get the subsoil water. Normal well is about 3-5 metres deep but deeper wells up-to 15 metres are also dug. This system of irrigation has been used in India from ancient time. Various methods are used to lift the ground water from the well for irrigation, drinking, bathing and for other purposes. Well irrigation is more popular in those regions where ground water is in ample and where there are few canals.

6. What is a tube well ?

Tube well is a deeper well (generally over 15 metres deep) from which water is lifted with the help of a pumping set operated by an electric motor, a diesel engine or solar power.

7. What are the disadvantages of well and Tube-well irrigation ?

- (i) With these methods, only limited area can be irrigated.
- (ii) Normally, a well can irrigate 1 to 8 hectares of land. The well may dry up and may be rendered ineffective for irrigation if excessive water is taken out.
- (iii) In the drought situation, the ground water level falls and enough water is not available in the well when it is needed the most. Tube wells can draw a lot of groundwater from its neighbouring areas and make the ground dry and not suitable for agriculture.
- (iv) Well and tube well irrigation is not possible in areas of salty groundwater.

8. Write a short note on surface irrigation.

In this technique water flows and spreads over the surface of the land. Varied quantities of water are allowed on the fields at different times. Therefore, flow of water under surface irrigation comes under wobbly flow. Consequently, it is very difficult to understand the hydraulics of surface irrigation.

9. What is micro-irrigation?

Micro irrigation is defined as the frequent application of small quantities of water directly above and below the soil surface; usually as discrete drops, continuous drops or tiny streams through emitters placed along a water delivery line.

10. Write a short note on irrigation scheduling.

Irrigation scheduling is the use of water management strategies to prevent over application of water while minimizing yield loss due to water shortage or drought stress.

11. What is participatory irrigation management ?

Participatory Irrigation Management (PIM) refers to a management approach that embraces the involvement of the people who directly use the irrigation water i.e farmers.

12. What are the objectives of participatory irrigation management ?

The objectives of PIM are :

- i) To create a sense of ownership of water resources and the irrigation system among the users, so as to promote economy in water use and preservation of the system.
- ii) To improve service deliveries through better operation and maintenance.
- iii) To achieve optimum utilization of available resources through sophisticated deliveries, precisely as per crop needs.
- iv) To achieve equity in water distribution.

13. What are the main functions of Pani Panchayat ?

The main functions of Pani Panchayat are :

- To prepare cropping programme considering the soil and agro climatic condition with due regards to crop diversification.
- To prepare a plan for the maintenance of irrigation system in the area of its operation at the end of each crop season and carryout the maintenance works with the funds of the Pani Panchayats from time to time.
- To regulate the use of water among the various pipe outlets under its area of its operation according to the warabandi schedule of the system.
- To promote economy in the use of water allocated.

14. What are the sub-systems present in any irrigation system?

- (i) The water supply sub-system which may include diversion from rivers or surface ponds or pumped flow of ground water.
- (ii) The water delivery subsystem which will include canals,branches and hydraulic structures on these.
- (iii) The water use subsystems,which can be one of the four main types,namely
 - a) Surface irrigation
 - b) Subsurface irrigation
 - c) Sprinkler irrigation
 - d) Trickle irrigation
- (iv) The water removal system i.e,the drainage system.

15. List the various irrigation methods.

Irrigation water can be applied to croplands using one of the irrigation methods listed below:

- (i) Surface irrigation which includes the following:
 - Uncontrolled flooding method
 - Border strip method
 - Check method
 - Basin method
 - Furrow method
- (ii) Sub-surface irrigation
- (iii) Sprinkler irrigation
- (iv) Trickle irrigation

16. How is the most suitable irrigation method selected ?

Choice of the irrigation method depends on the following factors:

- (i) Size,shape and slope of the field
- (ii) Soil characteristics
- (iii) Nature and availability of the water supply subsystem
- (iv) Types of crops being grown.
- (v) Initial development costs and availability of funds

(vi) Preferences and past experience of the farmer

17. Write a short note on furrow method of irrigation

An alternative to flooding the entire land surface is to construct small channels along the primary direction of the movement of water and letting the water flow through these channels which are termed 'furrows'. Furrows are small channels having a continuous and almost uniform slope in the direction of irrigation. Furrows are used to irrigate crops planted in rows.

18. What are the disadvantages of furrow irrigation ?

- (i) Possibility of increased salinity between furrows
- (ii) Loss of water at the downstream end unless end dikes are used
- (iii) The necessity of one extra tillage work viz., furrow construction
- (iv) Possibility of increased erosion.

19. What are the conditions favoring sub-surface irrigation ?

The conditions favoring sub-surface irrigation are :

- i) Impervious sub-soil at a depth of 2 m or more
- (ii) A very permeable sub-soil
- (iii) A permeable loam or sandy loam surface soil
- (iv) Moderate ground slopes

20. Write short note on sprinkler irrigation

Sprinkling is a method of applying water to the soil surface in the form of a spray which is somewhat similar to rain. In this method, water is sprayed to the air and allowed to fall to the soil surface in a uniform pattern at a rate less than the infiltration rate of the soil.

21. What are the conditions favoring sprinkler irrigation ?

The following conditions are favourable for sprinkler irrigation :

- (i) Very pervious soils that do not permit good distribution of water by surface methods.
- (ii) Lands which have steep slopes and easily erodible soils.
- (iii) Irrigation channels which are too small to distribute water efficiently by surface irrigation.

22. What are the merits of irrigation?

Some of the advantages of irrigation are as follows :

- Increase of food production.
- Modify soil or climate environment – leaching.
- Lessen risk of catastrophic damage caused by drought.
- Increase income & national cash flow.
- Increase labor employment.
- Increase standard of living.
- Increase value of land.
- National security thus self sufficiency.
- Improve communication and navigation facilities.
- Domestic and industrial water supply.
- Improve ground water storage.
- Generation of hydro-electric power.

23. What are the demerits of irrigation?

The following are the disadvantages of irrigation :

- Water logging.

- Salinity and alkalinity of land.
- Ill aeration of soil.
- Pollution of underground water.
- Results in colder and damper climate causing outbreak of diseases like malaria.

24. Explain the term water distribution.

Water distribution is the process of bringing water to consumers. It takes a number of forms around the world from pressurized municipal water that delivers water directly into homes to traveling tanker trucks that distribute water to community access points. Distribution of water resources is usually overseen by a government agency, although private utilities may also be involved.

25. Write short note on quality of irrigation water

Irrigation water must not have direct or indirect undesirable effects on health of humans, animals and plants. The irrigation water must not damage the soil and not endanger the quality of surface and ground waters with which it comes into contact. Attention is given to the physical, chemical and biological characteristics of water.

26. What do you meant by water user association (WUA)?

It is a self-managing group of farmers working together to operate and maintain their irrigation and drainage network, to ensure fair and equitable water distribution, and to increase crop yield.

27. What are the problems of irrigation management without participatory management?

- Inadequate water availability at the lowest.
- Poor condition / maintenance of the system.
- Lack of measuring devices and control structures.
- Inadequate allocation fro operation and maintenance.
- Lack of incentives fro saving water.
- Poor drainage.

28. Define long – term stability.

The long – term stability is defined as “environmental stability” and “durability” and refers to the prevention or minimizing of adverse physical changes such as waterlogging, leaching of nutrients form soils, salinity, erosion, silting, the ‘mining’ of ground water, and infestations with weeds.

29. What is meant by Productivity?

Productivity is defined as the ratio of output and input. The output can be water delivered, area irrigated, yield, or income, and the input can be water in the root zone, at the farm gate at the outlet or at upstream points in the system including the point of diversion or storage. Improved water supply influences the adoption of high – yielding agricultural practices by farmers, which justify the productivity criterion of performance.

30. Write the methods used for controlling water logging?

The following measures may be taken to control water logging :

- Prevention of percolation from canals.
- Prevention of percolation from reservoirs.
- Control of intensity of irrigation.
- Economical use of water.

31. Define on-farm water management.

It can be defined as manipulation of water within the borders of an individual farm, a farming plot or field. Example: in canal irrigation system, OFWM starts at the farm gate and ends at the disposal point of the drainage water to a public watercourse, open drain or sink.

PART-B

1. What are the various types of irrigation? Explain in detail.
2. Write in detail about i) lift irrigation and ii) tank irrigation.
 - (i) Describe the tank irrigation.
 - (ii) Discuss about well irrigation.
3. Distinguish between Surface, Sub-surface and micro irrigation methods.
4. Describe the modes of applying water to crops with neat sketches.
5. Explain in detail about the methods of Surface and Sub-Surface irrigation.
6. Write in detail about the water distribution techniques.
7. Briefly explain about irrigation management in India and Tamil Nadu.
8. How will you format irrigation scheduling? Explain.
9. What kinds of participation are necessary for irrigation management activities?
10. Illustrate the importance for inter disciplinary approach in irrigation management.
11. Write stepwise planning and executing procedure for lift irrigation.
12. (i) Explain water users association in irrigation water management.
13. (ii) Discuss the performance evaluation of implanted project.
14. Write short note on tank and well irrigation with its advantages and disadvantages.
15. Discuss about the favorable conditions for sub-surface irrigation.