III/IV B.Tech (Regular) DEGREE EXAMINATION February, 2021

Civil Engineering

18CE505/ Water Resources Engineering

Scheme of Evaluation

1. Answer all questions (1X10=10 Marks)

a. Define the Isohyetal method?
The isohyetal method is used to estimate the mean precipitation across an area by drawing lines of equal precipitation. The method uses topographic and other data to yield reliable estimates. Isohyets are contours of equal precipitation analogous to contour lines on a topographic map.

b. What are the factors affecting evaporation?
Atmospheric pressure, temperature, size of the catchment, wind speed, radiation, Quality and quantity of water.

c. Distinguish between hyetograph and hydrograph?
A hyetograph is a graphical representation of the relationship between the rainfall intensity and time. A hydrograph is a graph or plot that shows the rate of water flow in relation to time, given a specific point or cross section.

d. Define specific retention and specific capacity?
Specific retention is that volume fraction of water that is held back by adhesion and capillary forces, when an aquifer is drained. Specific yield is the amount of water that is actually available for groundwater pumping, when sediments or rocks are drained due to lowering of the water table.

e. State the assumptions of Dupuit's theory?
The flow is horizontal and uniform throughout the vertical section. Entire thickness of aquifer is contributing water to the well. Coefficient of transmissibility remains constant at all places and all the time. Ground water conditions remain constant all the time.

f. What is balancing depth?
Balancing canal depth comes when the canal is in partially embankment and partially in cutting. It is the depth of the canal (H) which gives equal amount of filling (i.e earth required for formation of Banks) and cutting (i.e earth from digging). For a given cross-section of a canal, it has only one balancing depth.

g. What is canal lining? What are its advantages?
Canal Linings are provided in canals to resist the flow of water through its bed and sides. These can be constructed using different materials such as compacted earth, cement, concrete, plastics, boulders, bricks etc. The main advantage of canal lining is to protect the water from seepage loss.

h. Write the types of canal outlets?
Canal outlets are classified into three types, namely, (a) Non-modular outlets, (b) Semi-modular (or flexible) outlets, and (c) Modular (or Rigid) outlets.

i. Discuss the benefits and ill-effects of Irrigation?
Ill Effects of irrigation: Excess irrigation and unscientific use of irrigation water may give rise to the following ill-effects: Breeding places for mosquitoes: Due to excess application of water, and due to leakage of water, ponds and depressions get filled up with water and create breeding places for mosquitoes.

j. Write the relationship between duty and delta for a given base period.

$$D = \frac{8 \cdot 64B}{\Delta}$$

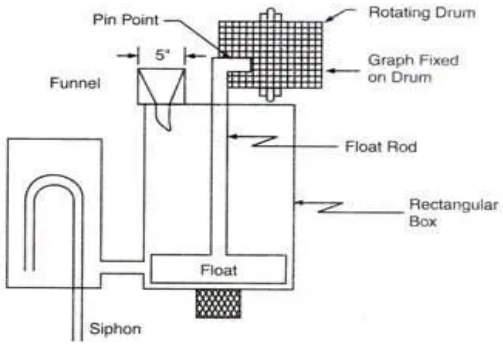
Where
D = Duty in hectare/cumec
B = Base period in days
Δ = Delta in metre

UNIT – I

2. a) **List different types of self-recording rain gangs. Explain the working of any one with help of neat sketches?**

There are three types of recording rain gauges
i) Weighing bucket type
ii) Tipping bucket type
iii) Floating or natural syphon type rain gauge

Floating or natural syphon type rain gauge: The working of this type of rain gauge is similar to weighing bucket rain gauge. A funnel receives the water which is collected in a rectangular container. A float is provided at the bottom of container, and this float rises as the water level rises in the container. Its movement being recorded by a pen moving on a recording drum actuated by a clock work. When water rises, this float reaches to the top floating in water, then syphon comes into operation and releases the water outwards through the connecting pipe, thus all water in box is drained out. This rain gauge is adopted as the standard recording rain gauge in India and the curve drawn using this data is known as mass curve of rain fall.



2. b) **Discuss various factors affecting run off from a catchment area?**

i. Precipitation characteristics
ii. Size and shape of the catchment
iii. Topography
iv. Geological characteristics
v. Meteorological characteristics
vi. Storage characteristics

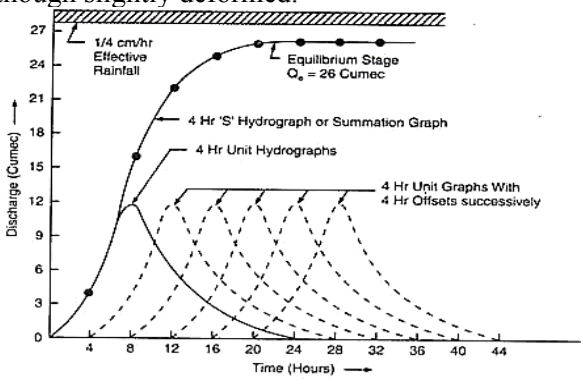
(OR)

3. a) **What is S-hydrograph? How it is constructed?**

S- hydrograph: S-curve or S-Hydrograph is nothing but a hydrograph. It is generated by a continuous effective rainfall occurring at an uniform rate for an indefinite period. S hydrograph because the shape of the hydrograph comes out like alphabet 'S' though slightly deformed.

Construction of 'S' Hydrograph: The method of simple superposition is applicable only when other duration is integral multiple of the available duration of the unit hydrograph. However, many a times it becomes necessary to generate a unit hydrograph of other duration which is not integral multiple of the available duration. In such cases it becomes necessary to evolve a general method based on the principle of superposition. Such a method has been evolved by hydrologists which is called 'S' hydrograph method.

A 'S' hydrograph is nothing but a hydrograph generated by a continuous effective rainfall occurring at an uniform rate for an indefinite period. It is called 'S' hydrograph because the shape of the hydrograph comes out like alphabet 'S' though slightly deformed.



Use of 'S' Hydrograph: It provides convenient method of deriving a unit hydrograph of any duration from the available duration and it may be either long or short duration, integral or fractional multiple of the available unit hydrograph duration.

3. (b)

The hourly ordinates of 2hr unit hydrograph are given below. Derive a 6hr hydrograph for the same catchment.

Time(hr)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Discharge (m^3/s)	0	1	2.7	5	8	9.8	9	7.5	6.3	5	4	2.9	2.1	1.3	0.5	0

Time	Given 2 hours unit hydrograph	Offset unit hydrograph	Offset unit hydrograph	Sum	Ordinates of 6 hr unit hydrograph	Ordinate of 6 hrmoderated hydrograph
00	0.0	–	–	0.0	0.00	0.0
01	1.0	–	–	1.0	0.33	0.3
02	2.7	0	–	2.7	0.90	0.9
03	5.0	1.0	–	6.0	2.00	2.0
04	8.0	2.7	0	10.7	3.57	3.6
05	9.8	5.0	1.0	15.8	5.27	5.3
06	9.0	8.0	2.7	19.7	6.57	6.6
07	7.5	9.8	5.0	22.3	7.43	7.4
08	6.3	9.0	8.0	23.3	7.77	7.8
09	5.0	7.5	9.8	22.3	7.43	7.4
10	4.0	6.3	9.0	19.3	6.43	6.4
11	2.9	5.0	7.5	15.4	5.13	5.1
12	2.1	4.0	6.3	12.4	4.13	4.1
13	1.3	2.9	5.0	9.2	3.07	3.1
14	0.5	2.1	4.0	6.6	2.20	2.2
15	0.0	1.3	2.9	4.2	1.40	1.4
16		0.5	2.1	2.6	0.87	0.9
17		0.0	1.3	1.3	0.48	0.4
18			0.5	0.5	0.17	0.2
19			0.0	0.0	0.00	0.0
Σ 0	65.1				65.10	65.1

UNIT – II

4. a) **Derive the equation for discharge from a well fully penetrated in a confined aquifer?**

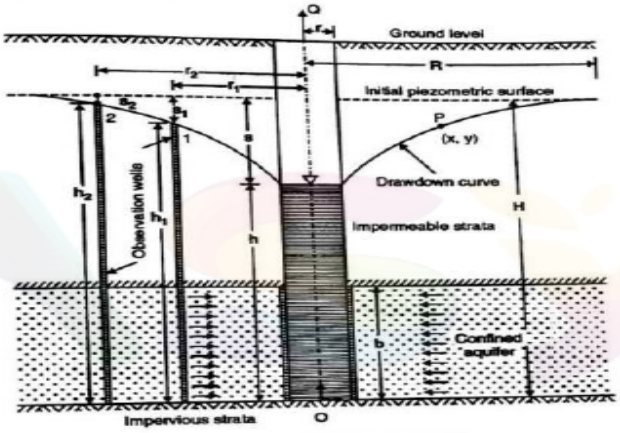


FIG. 5.8 CONFINED AQUIFER.

$$\therefore \quad Q = k\left(\frac{dy}{dx}\right)(2\pi x b)$$

$$\therefore \quad Q\frac{dx}{x} = 2\pi k b\, dy$$

Integrating between the limits (R, r) for x and (H, h) for y, we get

$$Q\int_r^R \frac{dx}{x} = 2\pi k b \int_h^H dy$$

$$\therefore \quad Q\left[\log_e x\right]_r^R = 2\pi k b\left[y\right]_h^H$$

From which $$Q = \frac{2\pi k b (H-h)}{\log_e \frac{R}{r}} = \frac{2.72\, b k (H-h)}{\log_{10} \frac{R}{r}} = \frac{2\pi b k s}{\log_e \frac{R}{r}} = \frac{2.72\, b k s}{\log_{10} \frac{R}{r}}$$

or $$Q = \frac{2.72\, T \cdot s}{\log_{10} \frac{R}{r}}$$

where T = coefficient of transmissibility = bk

4. b) During a recuperation test, the in an open well was depressed by pumping by 2.5m and it recuperated 1.8m in 80 minutes. Find i) yield from a well of 4m diameter under a depression head of 3m, ii) the diameter of the well to yield 8 litres/sec under a depression head of 2m.

$$\frac{K}{A} = \frac{2.303}{T} \log_{10} \frac{h_1}{h_2}$$

where T = time in hours $= \frac{80}{60} = \frac{4}{3}$ hours

$h_1 = 2.5$ m

$h_2 = 2.5 - 1.8 = 0.7$ m

$$\therefore \quad \frac{K}{A} = \frac{2.303 \times 3}{4} \log_{10} \frac{2.5}{0.7} = 0.955.$$

(a) Yield from the well of diameter 4 m :

$$A = \frac{\pi}{4}(4)^2 = 12.56 \text{ m}^2$$

$$Q = \left(\frac{K}{A}\right) A.H. = 0.955 \times 12.56 \times 3 = 36 \text{ m}^3/\text{hour} = 10 \text{ lit/sec.}$$

(b) Yield = 8 lit/sec = 28.8 m^3/ hour (since 1 lit/sec = 3.6 m^3 / hour)

$$\therefore \quad Q = \left(\frac{K}{A}\right) A.H.$$

$$\therefore \quad A = \frac{Q}{H} \times \left(\frac{A}{K}\right) = \frac{28.8}{2} \times \frac{1}{0.955} = 15.08 \text{ m}^2$$

$$\therefore \quad d = 4.38 = 4.4 \text{ m (say).}$$

(OR)

5. a) Explain briefly Kennedy's design procedure.

Case 1: The following data shall be available before hand: Discharge (Q), Rugosity coefficient (N), Critical velocity ratio (m) and bed slope of the channel (s).
Assume suitable full supply depth (D).
Then, find the mean velocity by using Kennedy's equation
After that, find the area of cross section by using continuity equation: Q = A*V
Assume the shape of channel section with side slopes (0. 5V:1H)
Find out the value of base width of channel (B).
Then, find the perimeter of the channel (P). Which helps to find out the hydraulic mean depth of channel (R) = A/P.

Finally, calculate the mean velocity (V) using kutter's formula:

$$V = \left(\frac{1/N(23+0.00155/s)}{1+(23+0.00155/s)(N/\sqrt{R})}\right)\sqrt{Rs}$$

Both the values of V computed using equation and V computed employing equation must otherwise repeat the above procedure by assuming another value of D.
Case 2: When Discharge (Q), Rugosity coefficient (N), Critical velocity ration (m) and B/D ratio.
Assume B/D = X
By using the Kennedy's equation find "V" in terms of D
Find the area of cross section of the channel in terms of D2
By using continuity Equation, find the value of D, and then Find the base width (B)
Find hydraulic mean depth (R)
Finally, find the value of velocity "V"
Substitute the value of V in kutter's Equation; it will give the longitudinal slope of the channel will done by trial and error method.

5. b) Design a regime channel to carry a discharge of 100 cumecs in soil having silt factor of 1.1, using Lacey's theory. Assume side slope of 0.5 horizontal and 1 vertical.

Given : $Q = 100$ cumecs; $f = 1.1$; side slopes 0.5 : 1

$$V = \left(\frac{Qf^2}{140}\right)^{1/6} = \left[\frac{100\,(1.1)^2}{140}\right]^{1/6} = 0.976 \text{ m/sec.}$$

$$A = Q/V = 100/0.976 = 102.46 \text{ m}^2$$

$$P = 4.75\sqrt{Q} = 4.75\,(100)^{1/2} = 47.5 \text{ m}$$

$$D = \frac{P - \sqrt{P^2 - 6.944\,A}}{3.472} = \frac{47.5 - \sqrt{(47.5)^2 - 6.944 \times 102.46}}{3.472} \triangleq \mathbf{2.36\ m}$$

$$B = P - 2.236\,D = 47.5 - 2.236 \times 2.36 \triangleq \mathbf{42.2\ m}$$

$$R = \frac{5}{2}\frac{V^2}{f} = \frac{5}{2}\frac{(0.976)^2}{1.1} \triangleq 2.16 \text{ m}$$

$$R = \frac{BD + D^2/2}{B + 2.236\,D} = \frac{42.2 \times 2.36 + 0.5\,(2.36)^2}{42.2 + 2.236 \times 2.36} \triangleq 2.16 \text{ m}$$

Hence OK.

$$S = \frac{f^{5/3}}{3340\,Q^{1/6}} = \frac{(1.1)^{5/3}}{3340\,(100)^{1/6}} \triangleq \frac{1}{6140}$$

UNIT – III

6. a) Explain causes and remedial measures of water logging?

Causes of Water logging:

i) Inadequate drainage of over-land run-off increases the rate of percolation and in turn helps in raising the water table.
ii) The water from rivers may infiltrate into the soil.
iii) Seepage of water from earthen canals also adds significant quantity of water to the underground reservoir continuously.
iv) Sometimes subsoil does not permit free flow of subsoil water which may accentuate the process of raising the water table.
v) Irrigation water is used to flood the fields. If it is used in excess it may help appreciably in raising the water table. Good drainage facility is very essential.

Remedial Measures:

i) Controlling the loss of water due to seepage from the canals
ii) Preventing the loss of water due to percolation from field channels and fields
iii) Augmentation of outflow and prevention of inflow
iv) Quick disposal of rainwater
v) Installation of lift irrigation systems
vi) Implementation of Drainage Schemes.

6. b) Design a trapezoidal shaped concrete lined channel to carry a discharge of 250m^3/s at a slope of 1 in 6000. The side slopes of the channel are 1.5:1 and limiting depth of 3m is to be maintained. Take the value of N as 0.015.

Solution : For a channel of trapezoidal section, we have

$$A = bd + d^2(\theta + \cot\theta)$$

$$P = b + 2d(\theta + \cot\theta)$$

For $1\frac{1}{2}:1$ side slope, $\cot\theta = 1.5$ and $\theta = 0.59$ radian.

Taking the above values along with $d = 3$ m, we get

$$\therefore \quad A = bd + d^2(0.59 + 1.5) = 3b + 9(2.09) = 3b + 18.81 \quad ...(1)$$

$$P = b + 2d(0.59 + 1.5) = b + 6(2.09) = b + 12.54 \quad ...(2)$$

Hence $$R = \frac{A}{P} = \frac{3b + 18.81}{b + 12.54} \quad ...(3)$$

Now, $$Q = V \times A = \frac{1}{N} A R^{2/3} S^{1/2}$$

$$250 = \frac{1}{0.015}(3b + 18.81) \times \left(\frac{3b + 18.81}{b + 12.54}\right)^{2/3} \frac{1}{\sqrt{6000}}$$

$$\frac{(3b + 18.81)^{5/3}}{(b + 12.54)^{2/3}} = 290.47 \quad ...(4$$

Solving the above equation by trial and error, we get

$$b \simeq 44.6 \text{ m}$$

Hence $b = 44.6$ m and $d = 3$ m.

(OR)

7. a) Discuss the function of head regulator and cross regulator?

Head regulator and cross-regulator regulate the supplies of the off-taking channel and the parent channel respectively. The distributary head regulator is provided at the head of the distributary and controls the supply entering the distributary. It is a necessary link between the parent channel and the distributing channel. A distributary head is a regulator, a metre of supply and a silt selective structure. A cross-regulator is provided on the main canal at the d/s of the off-take to head up the water level and to enable the off-taking channel to draw the required supply.

Functions of distributary head regulator

1. They regulate or control the supplies to the off-taking channel.
2. They serve as a meter for measuring the discharge entering into the off-taking canal.
3. They control the silt entry in the off-taking canal.
4. They help in shutting off the supplies when not needed in the off-taking canal, or when the off taking channel is required to be closed for repairs.

Functions of cross-regulator

1. The effective regulation of the whole canal system can be done with help of cross-regulator.
2. During the periods of low discharges in the parent channel, the cross-regulator raises water level of the u/s and feeds the off-take channel in rotation.
3. It helps in closing the supply to the d/s of the parent channels, for the purposes of repairs etc.
4. They help in absorbing fluctuation in various sections of the canal system, and in preventing the possibilities of breaches in the tail reaches.
5. Incidently, bridges and other communication works can be combined with it.

7. b) Explain classification of canal falls.

i. Ogee fall

ii. Rapid fall

iii. Stepped fall

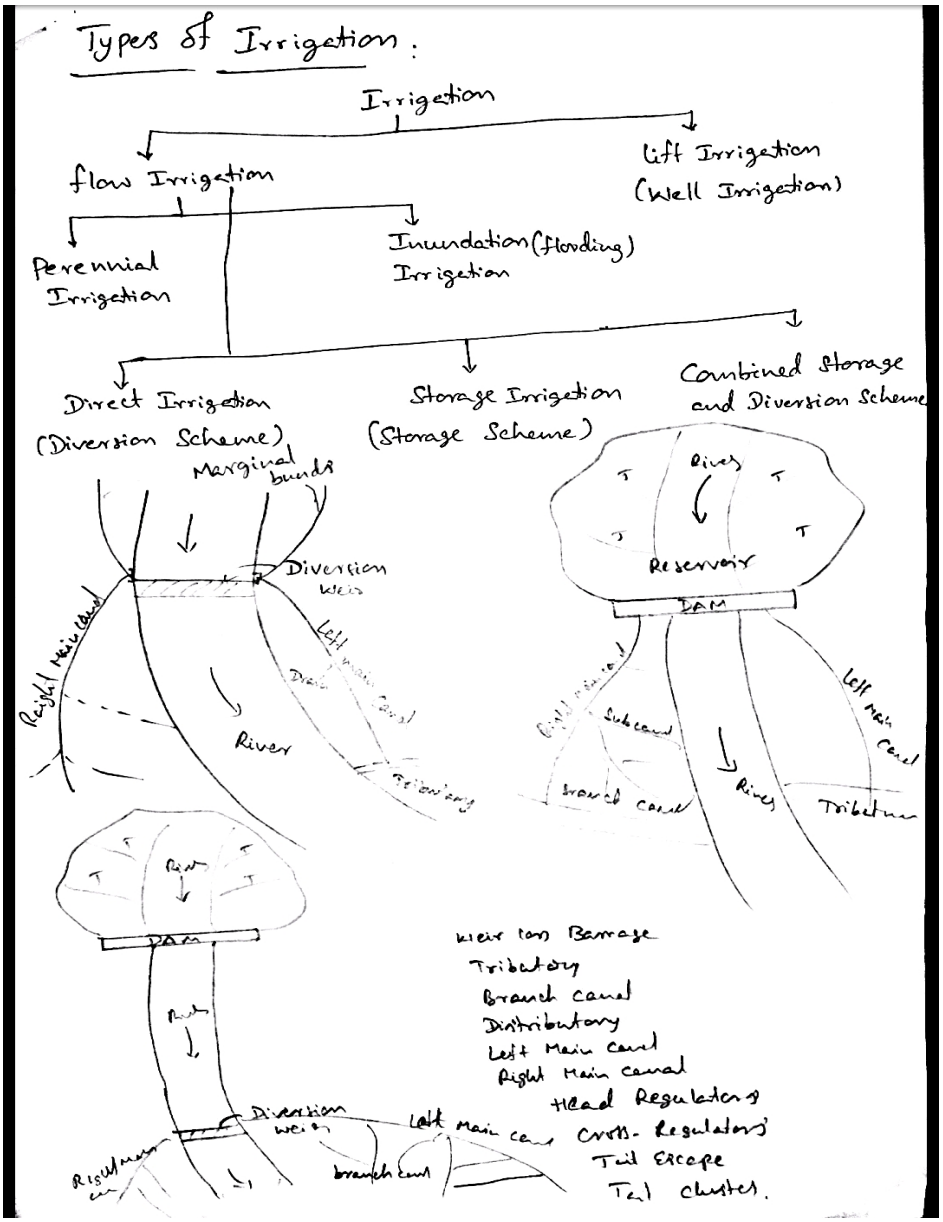
iv. Notch fall

v. Vertical drop fall

vi. Glacis fall

UNIT – IV

8. a) Explain different types of irrigation?



8. b) Explain the working procedure of Drip Irrigation?

a pump to lift water

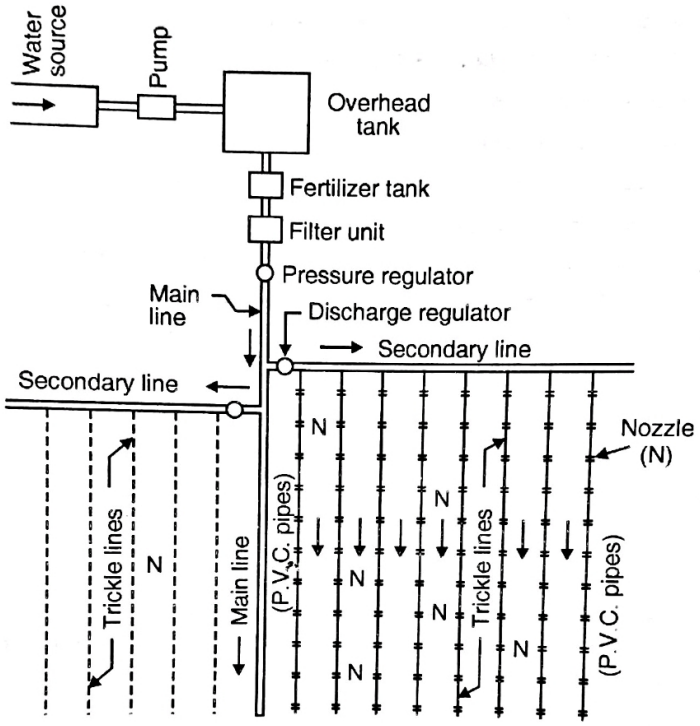
ii) a head tank to store the water and to maintain a pressure head of 5 to 7 m.

iii) Central distribution system which filters the water, adds nutrients (or fertillizer solution) and regulates the pressure and amount of water to be applied.

iv) Mains and Secondary lines made of poly-ethylene, polyvinyle chloride (PVC) material. The dia of pipe may vary from 20 mm to 40 mm. A water meter may be fixed at the beginning of the mains.

v) Trickle lines consisting of 10 to 20 mm dia. The trickle lines are fitted to the secondary lines at a distance equal to the row to row spacing of the crops, which may vary between 60 cm to 90 cm, a more common value being 75 cm for the most of the crops.

The whole field is divied into suitable plots. A secondary line is provided for each such plot, and a number of trickle lines are connected to each secondary line. A discharge regulater is provided at the beginning of each secondary line, and its capacity is fixed in accordance with the size and number of nozzles used. The automatic value at the head is so adjusted to deliver the desired quantity of water. The drip irrigation system is suitable to pardically all types of crops, except paddy which requires standing water. It is also suitable to all climatic conditions and to all types of soils. However, it is most suited to coarse sandy formations.



(OR)

9. a) Discuss the factors affecting duty?

The duty of water of canal system depends upon a variety of the factors. The principal factors are :

1. Methods and system of irrigation ;
2. Mode of applying water to the crops ;
3. Method of cultivation ;
4. Time and frequency of tilling ;
5. Type of the crop ;
6. Base period of the crop ;
7. Climatic conditions of the area;
8. Quality of water ;
9. Method of assessment of irrigation method ;
10. Canal conditions ;
11. Character of soil and sub-soil of the canal ;
12. Character of soil and sub-soil of the irrigation fields.

1. ***Methods and Systems of Irrigation***

In the perennial irrigation system, soil is continuously kept moist, and hence water required for initial saturation is less. Also, due to the shallow depth of the water table, deep percolation losses are less. In the inundation irrigation, there is wasteful use of water. Hence, the perennial irrigation system has more duty than the inundation irrigation. The flow irrigation system has lower duty due to the conveyance losses in the network of the canals, while the lift irrigation system has higher duty because the commanded area of each well is very near to it. Tank irrigation gives high duty due to rigid control.

2. ***Mode of Applying Water***

The flood irrigation system has lesser duty than the furrow system. Sub-irrigation system gives still higher duty. The ring basin irrigation and uncontrolled flooding give less duty.

3. ***Method of Cultivation***

If the land is properly ploughed and made quite loose before irrigating, the soil will have high water retention capacity in its unsaturated zone. Thus, the number of waterings can be reduced, increasing the duty. The old and conventional methods of cultivation gives less duty in comparison to the modern methods.

4. ***Time and frequency of Tilling***

Frequency of cultivation reduces the loss of moisture through weeds. Soil structure affects the plant growth to a very great extent. A good structure (*i.e.* the good arrangement of soil particles in relation to one another) is called good *tilth* of soils. When the soil is in good tilth, evaporation losses from the surface of soil is less, soil becomes properly aerated, and hence the yield of crop is also better.

9. b) Determine the frequency of Irrigation from the following data:
Field capacity: 27%, Permanent wilting point: 14%, Dry density of soil: 15 kN/m^3, effective depth of root zone: 75cm, Daily consumptive use of water for the crop: 11mm, Readily available moisture: 80% of available moisture.

Available moisture = Field capacity – permanent wilting point
= 27 – 14 = 13%

the *readily available moisture* be 80% of the available moisture.

Readily available moisture = 13 × 0.8 = 10.4%

m_0 = 27 – 10.4 = 16.6%

Hence when irrigation water is applied, moisture is raised from 16.6% to 27%.

∴ Depth of water stored in root zone, during each watering

$$= \frac{\gamma_d \cdot d}{\gamma_w} d \text{ [Field capacity} - m_0] = \frac{\gamma_d}{\gamma_w} d \left[0.27 - 0.166\right] \text{ metres}$$

$$= \frac{1.5 \times 0.75}{9.81} \times 0.104 = 0.119 \text{ m} = 11.9 \text{ cm}$$

Thus, depth of water available for evapo-transpiration = 11.9 cm

Daily consumptive use of water = 1.1 cm

∴ Watering frequency $= \frac{11.9}{1.1} = 10.82$ days ≏ 10 days

Hence, water should be applied after every 10 days.