1. (a) (i) Sprinkler irrigation

(b) (iv) difference between filed capacity and permanent wilting point within the root zone of plants.

(c) (iii) 12 cm

(d) (i) percentage of culturable commanded area to be irrigated annually

(e) (iv) 1600

(f) (iv) 90 cm

(g) (iv) used by the crop in transpiration, evaporation and also the quantity of water evaporated from adjacent soil

2. (a) Define irrigation. What are the advantages and disadvantages of irrigation?

Solution: Irrigation is the artificial application of water to plants for their growth and maturity. Irrigation water is supplied to supplement the water available from rainfall and the contribution of soil moisture from ground water.

Advantages 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.

Disadvantages 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.

(b) List the various methods of irrigation. Explain any one.

Solution: There are various ways in which the irrigation water can be applied to the fields.

(a) Surface Irrigation: Just flooding water. About 90% of the irrigated areas in the world are by this method.

(b) Sprinkler Irrigation: Applying water under pressure. About 5 % of the irrigated areas are by this method.

(c) Sub-Surface Irrigation: Flooding water underground and allowing it to come up by capillarity to crop roots.

Surface Irrigation Methods

Their main classification of surface methods is as follows:

(1)Free flooding

(2)Border flooding

(3) Check flooding

(4) Basin flooding

(5) Furrow irrigation method

(6) Drip irrigation method.

(1) Free flooding

▪ Ditches are excavated in the field either on the contour or up and down the slope.

▪ It is also called *wild flooding,* since no attempt is made to control the flow by means of levees, etc.

Characteristics:

▪ land preparation cost is low.

▪ labour requirements are usually high

▪ water application efficiency is also low.

▪ Most suitable for close growing crops, pastures, etc., particularly where the land is steep.

▪ Spacing between contour ditches / laterals / subsidary ditches is kept 20 to 50 m.

- This spacing depends upon the slope, texture of soil, crops to be grown, etc.
- The method may be used on rolling land of irregular topography, where other methods are not feasible.

3. A channel is to be designed for irrigating 5000 hectares in Kharif crop and 4000 hectares in Rabi crop. The water requirements for Kharif and Rabi are 60 cm and 25 cm respectively. The Kor period for Kharif and Rabi is 3 weeks and 4 weeks respectively. Determine the discharge of the channel for which it is to be designed.

Solution:

Soln:- We have,

Kharif

$A_K = 5000$ ha

$\Delta_K = 0.6$ m

$B_K = 3$ weeks $= 3 * 7 = 21$ days

We know that, $\Delta = 8.64 \frac{B}{D}$

$\Rightarrow D_K = \frac{8.64 * 21}{0.6}$

$\Rightarrow D_K = 302.4$ ha/cumecs

$Q_{Kharif} = \frac{A_K}{D_K} = \frac{5000}{302.4}$

$\Rightarrow Q_K = 16.53$ cumecs

Rabi

$A_R = 4000$ ha.

$\Delta_R = 0.25$ m

$B_R = 4 * 7 = 28$ days

$D_R = \frac{8.64 * 28}{0.25}$

$\Rightarrow D_R = 967.68$ ha/cumecs

$Q_R = \frac{A_R}{D_R} = \frac{4000}{967.68}$

$\Rightarrow Q_R = 4.13$ cumecs

$\therefore$ the channel is to be designed for the maximum discharge

$\therefore$ Discharge capacity of channel $= 16.53$ cumecs Ans

4. A stream of 125 lps was diverted from a canal and 100 lps were delivered to the field. An area of 1.8 ha was irrigated in 8 hours. The effective depth of root zone was 1.8 m. The runoff loss in the field was 410 m3. The depth of water penetration varied linearly from 1.8 m at the head end of the field to 1.4 m at the tail end. Available moisture holding capacity of the soil is 20 cm/m depth of soil.

Determine:

(a) Water conveyance efficiency,

(b) Water application efficiency,

(c) Water storage efficiency and

(d) Water distribution efficiency

Irrigation was started at a moisture extraction level of 50 % of the available moisture.

Solution:

Solⁿ:- (i) Water Conveyane Efficiency: (η_c).

We have, W_f = Water deliverd to the field = 100 l/sec

W_r = " " from the Canal (River) = 125 l/sec.

$$\eta_c = \frac{W_f}{W_r} * 100 = \frac{100}{125} * 100 = \boxed{80\%}$$

(ii) Water Application Efficiency (η_a):

W_f = 100 l/sec = $[100*10^{-3}]*[8*3600]$ = 2880 m^3

W_s = Water stored in the root zone during irrigation

= $W_f - V_{runoff}$ = 2880 − 410 = 2470 m^3

$$\eta_a = \frac{W_s}{W_f} * 100 = \frac{2470}{2880} * 100 = \boxed{85.76\%}$$

(iii) Water Storage Efficiency (η_s):

W_s = 2470 m^3

Available moisture depth = (20 cm/m) * (1.8 m) = 36 cm

But When 50% of the available moisture get extracted, irrigation is started to refill this extracted depth.

depth of water required in Root zone = 0.5 (36 cm)

= 18 cm.

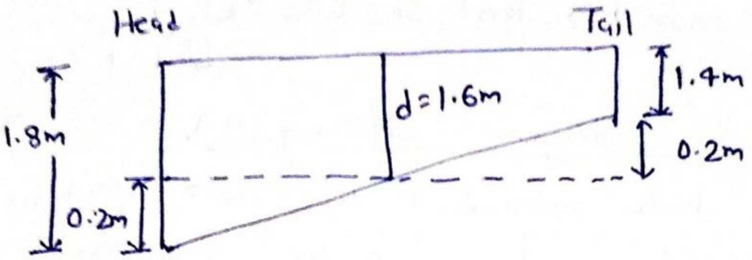
Area of field = 1.8 ha

∴ W_n = Water needed in the root zone prior to irrigation

= $(1.8*10^4)(18*10^{-2})$ = 3240 m^3

$$\eta_s = \frac{W_s}{W_n} * 100 = \frac{2470}{3240} * 100 = \boxed{76.23\%}$$

(iv) Water distribution Efficiency (η_d):



d: Avg depth of water stored in the root zone during irrigation = $\frac{1.8+1.4}{2} = 1.6m$

Deviation in penetration (depth)

at head = $1.8-1.6 = +0.2m$

at tail = $1.4-1.6 = -0.2m$

∴ y = Avg. numerical deviation in the depth of water stored from avg. depth of irrigation stored = $\frac{|+0.2|+|-0.2|}{2} = 0.2m$

∴ $\eta_d = (1-y/d)*100 = \left(1-\frac{0.2}{1.6}\right)*100 = \boxed{87.5\%}$

5. Table given below shows the details for a certain crop:

Month	**Average Monthly Temperature (^0C)**	**Monthly % of day time hours of the year**	**Useful Rainfall (cm)**
November	**19.0**	**7.19**	**-----**
December	**16.0**	**7.15**	**1.2**
January	**12.5**	**7.30**	**0.8**
February	**13.0**	**7.03**	**-----**

Using Blaney Criddle equation and a crop factor of 0.75, determine:

- **a) Consumptive Use (2)**
- **b) Consumptive Irrigation Requirement (1)**
- **c) Field Irrigation Requirement (1)**

d) Gross Irrigation Requirement **(1)**

Given, Water Application Efficiency = 70%

Water conveyance efficiency = 60%

Latitude of the place = 30^0 N

Solution:

Soln:- We know that, $C_u = k.\Sigma f$ (in cm)

where, k = Crop factors (determined by experiment for each crop)

$f = \frac{P}{40}(1.8t + 32)$

t = mean monthly temperature (°C).

P = Monthly % of annual day time hours

f = Monthly Consumptive Use Factor.

$f_{Nov} = \frac{7.19}{40}[1.8(19) + 32] = 11.9$

$f_{Dec} = \frac{7.15}{40}[1.8(16) + 32] = 10.87$

$f_{Jan} = \frac{7.30}{40}[1.8(12.5) + 32] = 9.95$

$f_{Feb} = \frac{7.03}{40}[1.8(13) + 32] = 9.74$

$\therefore \Sigma f = f_{Nov} + f_{Dec} + f_{Jan} + f_{Feb}$

$= 42.46$

Now, (i) $C_u = k\Sigma f = 0.75(42.46) = 31.845$ cm Ans

R_e = effective Rainfall = $1.2 + 0.8 = 2.0$ cm

(ii) CIR = $C_u - R_e = 31.845 - 2 = 29.845$ cm Ans

(iii) NIR = CIR + Water lost in deep percolation for purpose of leaching, etc.

$= 29.845 + 0 = 29.845$ cm Ans

(iv) FIR = $\frac{NIR}{\eta_a} = \frac{29.845}{0.70} = 42.64$ cm Ans

(v) GIR = $\frac{FIR}{\eta_c} = \frac{42.64}{0.6} = 71.07$ cm Ans

6. **Define (any five)**

(a) **Paleo Irrigation**

(b) **Duty and Delta**

(c) **Base Period and Crop Period**

(d) **Field Capacity**

(e) **Hygroscopic Water**

(f) **Kor Watering**

Solution:

(a) Paleo Irrigation

It is the first watering before sowing the crop. This is done in order to add sufficient moisture to the unsaturated zone of the soil and is required for the initial growth of the crop.

(b) Duty and Delta

DUTY

- The duty of water is the relationship between the volume of water and the area of the crop it matures. It is defined as the area irrigated per cumec of discharge running for base period B. The duty is generally represented by D.
- For example, if 3 cumecs of water supply is required for a crop sown in an area of 5100 hectares, the duty of irrigation water will be 5100/3 = 1700 hectares/cumec, and the discharge of 3 cumecs will be required throughout the base period.

DELTA

- It is the total depth of water required by a crop during the entire period and is represented by the symbol D.
- For example, if a crop is in the field and 12 waterings at an interval of 10 days, and a water depth of 10 cm in every watering then the delta for that crop will be $12 \times 10 = 120$ cm = 1.20 meters. If the area under that crop is A hectares, the total quantity required will be $1.20 \times A = 1.2$ A hectare-meters in a period of 120 days.

(c) Base Period and Crop Period

Crop Period

Crop period is the time, in days, that a crop takes from the instant of its sowing to that of its harvest.

Base Period

Base period for a crop refers to the whole period of cultivation from the time when irrigation water is

first issued for preparation of the ground for planting the crop, to its last watering before harvesting.

(d) Field Capacity

Field Capacity

Immediately after the rain or irrigation water application when all the gravity water has drained down to the water table, a certain amount of water is retained on surface of soil grains by molecular attraction and loose chemical bonds which can not be easily drained under the action of gravity and is called the field capacity.

Thus "Moisture content of soil after free drainage has taken place and most of the water is removed (2 to 5 days)" is called field capacity.

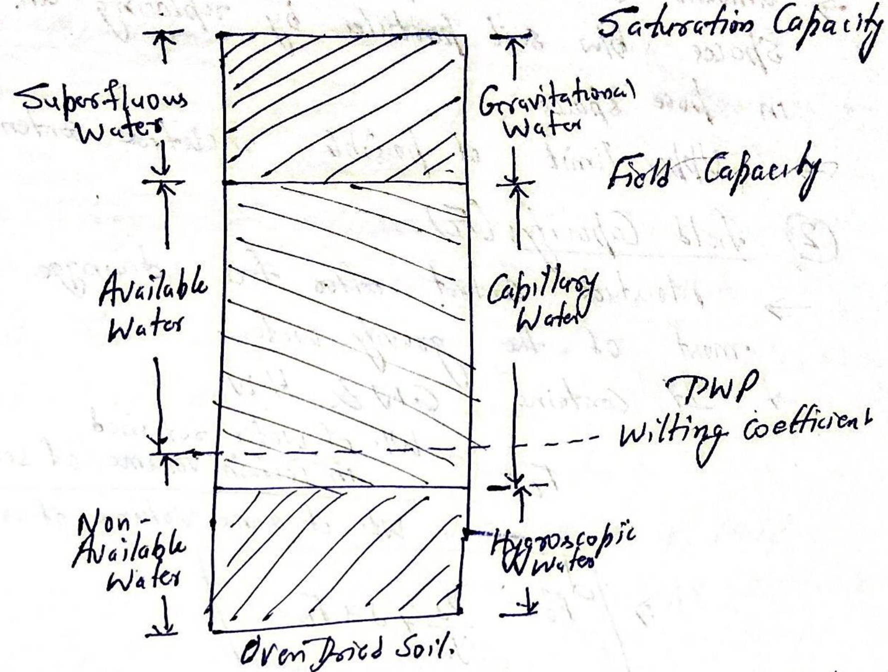
Field capacity contains capillary water and hygroscopic water.

Field capacity is expressed as the ratio of the weight of water contained in the soil to the weight of soil retaining the water.

Field capacity (F) %

$$= \frac{\text{Wt. of water retained in certain vol. of soil}}{\text{Wt. of the same vol. of soil}} \times 100$$

(e) Hygroscopic Water



Water present in soil may be classified under 3 heads

① Hygroscopic Water: (H.W).

→ When an oven dried soil sample is kept open in the atmosphere, it absorbs some amount of water from the atmosphere, this is known as H.W.

→ not capable of movement by force of gravity (or) capillary forces

(f) Kor Watering

- Crops require maximum water during first watering after the crops have grown a few centimeters. The first watering is known as kor watering and the depth applied is known as kor depth.
- The portion of the base period in which kor watering is needed is known as kor period.
- While designing the capacity or a channel, kor water must be taken into account since discharge in the canal has to be maximum during this time.