Study Material

On

Hydrology and Irrigation Engineering

Department of Civil Engineering

CAPITAL ENGINEERING COLLEGE

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(Affiliated to Biju Patnaik University of Technology, Odisha and SCTE & VT, Odisha, Approved by AICTE, New Delhi and Recognised by Govt. of Odisha)

PART-B (Irrigation Engineering)

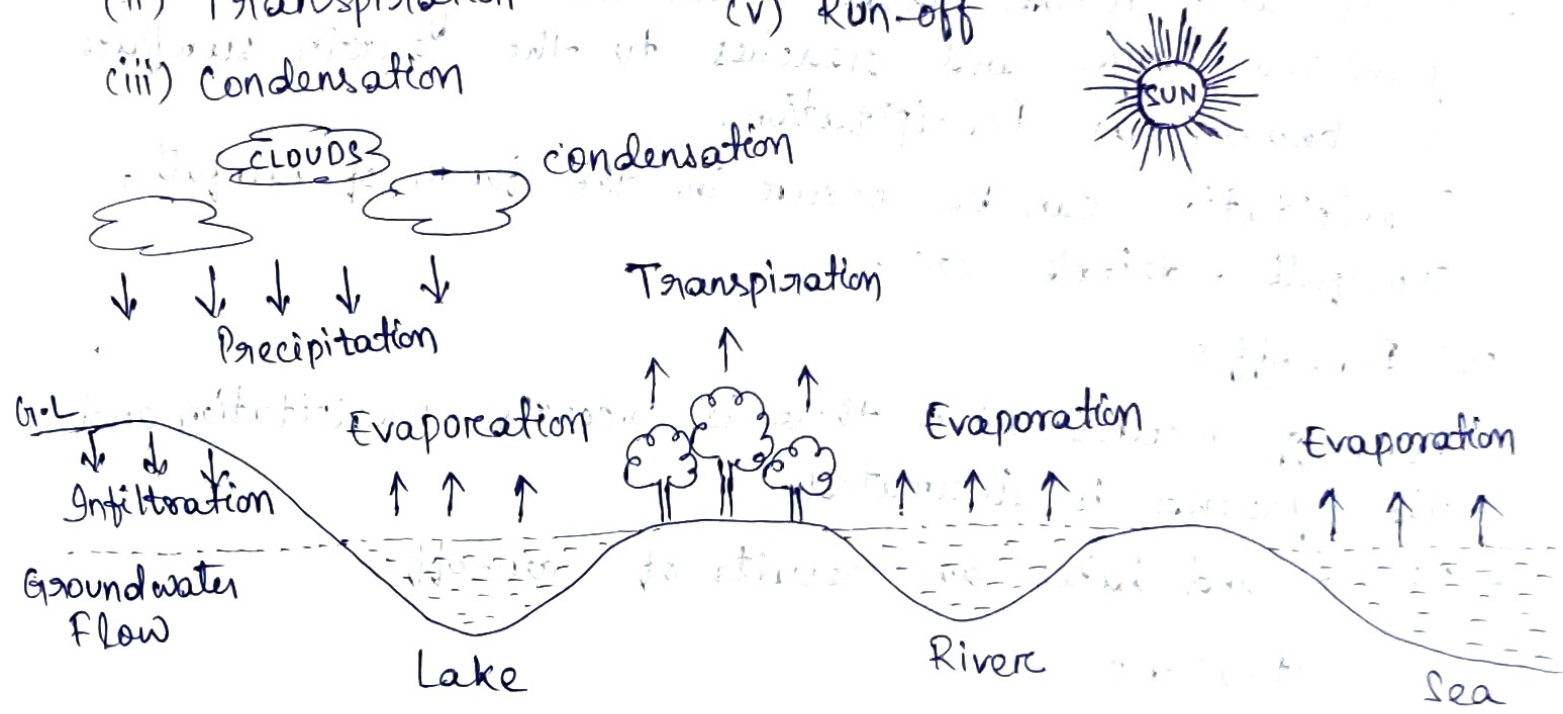
Chapter-1

HYDROLOGY

- Hydrology means the science of water.
- It is the scientific study of the movement, distribution and management of water on Earth.

Hydrologic Cycle:-

- The hydrologic cycle involves the continous circulation of water in the Earth Atmosphere
- The water cycle is the motion of the water from the ground to the atmosphere and back again.
- This involves various process and this process is termed as hydrologic cycle.
- Various process of hydrologic cycle are:
  (i) Evaporation
  (ii) Transpiration
  (iii) Condensation
  (iv) Precipitation
  (v) Run-off



[Fig: Hydrologic Cycle]

(i) Evaporation:-

- Evaporation happens when a liquid turns into gas.
- For Evaporation process energy is required and this energy come from ~~Sun~~ "The Sun".

(ii) Transpiration:-

- Transpiration is the process by which water gets evaporated from the surface of plants such as leaves, stem, flowers etc.

(iii) Condensation:-

- Condensation is the process in which water vapour present in the atmosphere turned into liquid state.
- In the atmosphere condensation may appear as clouds or dew.

(iv) Precipitation:-

- Precipitation is the result when the tiny condensed particles grow too large and reaches to the earth surface is known as Precipitation.
- Precipitation can be occure in the forem of rainfall, snowfall, drizzle etc.

(v) Run-off:-

- Run-off occures when there is excessive precipitation and the ground is saturated.
- Rivers and lakes are results of run-off.

(vi) Infiltration:-

- When the water enters into the ground surface is known as infiltration.
- When infiltration is more, the soil gets saturated.

PRECIPITATION :-

- It is a process of falling atmospheric moisture on the surface in any form due to gravity.
- Precipitation occurs when a portion of the atmosphere becomes saturated with water vapour, so that condensation occurs and precipitation takes place.
- There are 5 forms of precipitation :

(i) **Rainfall :-**
It is the fall of atmospheric moisture in the form of water due to gravity.

(ii) **Snowfall :-**
Precipitation of white crystal when cloud forms below zero degree celcius.

(iii) **Hail :-**
It fall in the form of small ice pallete and is very destructive form of precipitation produced by thunderstorm.

(iv) **Sleet :-**
It is a mix of rain and snow that forms when rain passes through very cold air mass before reaching the land.

(v) **Drizzle :-**
It is the type of precipitation having very small and uniform sized raindrops (less than 0.5mm size)

Rainfall :-

- Rainfall can be defined as the precipitation in the liquid form.
- It is the most common form of precipitation.

Types of Rainfall :-

Rainfall has been classified into 3 main types such as :

(i) Conventional Rainfall
(ii) Orographic Rainfall
(iii) Cyclonic or Frontal Rainfall.

(i) Conventional Rainfall :-

- It occures when the earth's surface becomes more heated than surrounding.
- As the temperature gets high, the warmer air rises up.
- As it reaches to a certain height, the air cools down and expands, thus clouds are formed.
- When the cloud get condensed, rainfall occurs. This type of rainfall is termed as Conventional Rainfall.

(ii) Orographic Rainfall :-

- When the temperature rises, the ~~a~~warmer air rises up.
- When the moist air is lifted upto a mountain range and moves further to cool down.
- As it get condensed, rainfall occures this types of rainfall is known as Orographic rainfall.

(iii) Cyclonic or Frontal Rainfall :-

- Cyclonic rainfall occures when warem air mass and cool air mass meet each other.
- Warem air is lighter than cool air mass, so warem air mass rises above the cool air

- When they rises to a point where it saturates and heavy rainfall occurs ...
- It moves clockwise in the southern hemisphere and anticlockwise in the northern hemisphere.

Types of Rainfall based on Intensity:-

The types of rainfall based on intensity can be classified as:

1. Light Rain → Rate of rain varies between 0 to 2.5 mm.
2. Moderate Rain → Rate of rain varies between 2.6 – 7.6 mm.
3. Heavy Rain → Rate of rain ~~varies~~ is beyond 7.6 mm.

Intensity of Rainfall:-

- Rainfall intensity is defined as the ratio of the total amount of rainfall (rainfall depth) to a given time period.
- It is expressed as "mm/hr".

Mathematically,

$$i = \frac{P}{t} \quad \text{mm/hr}$$

where, i = Rainfall intensity
P = Amount of Rainfall
t = time period.

Example:-

Q) Find the maximum intensity of rainfall in mm/hr from the given data below.

Time (in mins)	0	10	20	30	40	60
Rainfall (in mm)	0	3	8	9	14	18

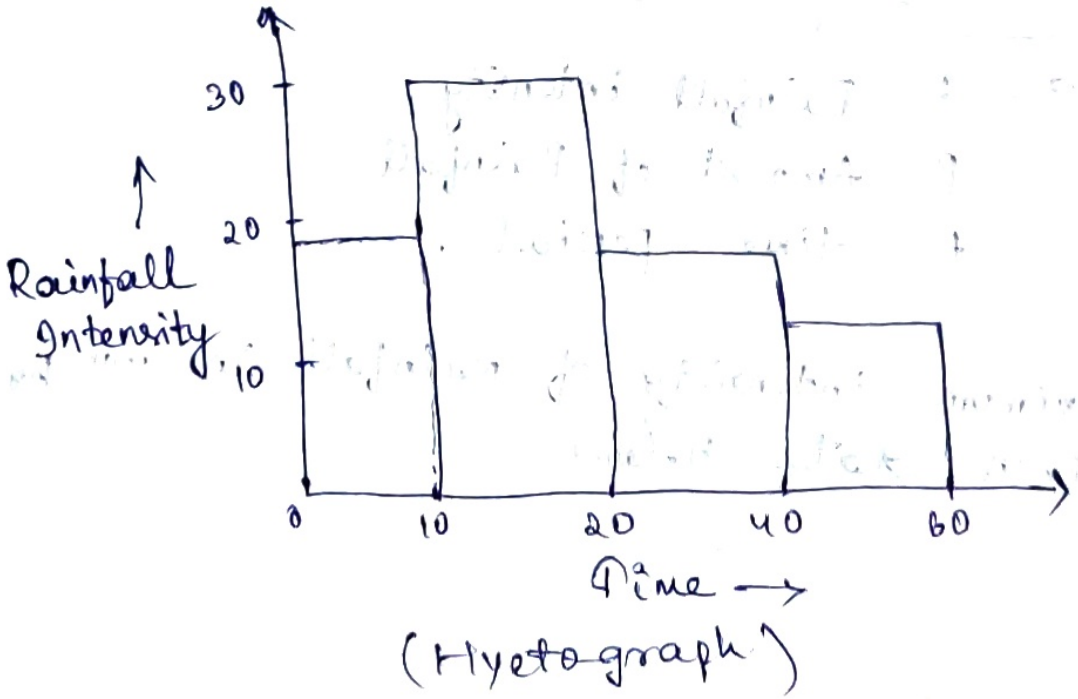
Sol?-

Time	Rainfall	Intensity $i = dP/dt$
0	0	
10	3	$\frac{3-0}{10-0} \times 60 = 18$
20	8	$\frac{8-3}{20-10} \times 60 = 30$
40	14	$\frac{14-8}{40-20} \times 60 = 18$
60	18	$\frac{18-14}{60-40} \times 60 = 12$

∴ Maximum intensity of rainfall = 30 mm/hr

Hyetograph:-

- A ~~hyteg~~ hyetograph is a graphical representation of Rainfall intensity and time interval.
- It is represented in bar graph.



(Hyetograph)

Measurement of Rainfall :-

- Rainfall is expressed in terms of depth for an area.
- The rainfall is collected and measured in an instrument known as "Raingauge".
- A raingauge essentially consists of a cylindrical vessel assembly kept in the open to collect rain water.
- For setting up a raingauge, the following points should be considered.
  (i) The ground must be level and open and the instrument must be placed in a horizontal surface.
  (ii) The gauge must be set near to ground surface to reduce wind effect.
  (iii) The instrument must be surrounded by an open area of atleast 5.5m x 5.5m.
  (iv) No object should be placed nearer to the instrument.

Types of Raingauges :-

Raingauges can be broadly classified into two categories :
(i) Non-Recording Rain Gauge
(ii) Recording Raingauge.

(i) Non-Recording Rain Gauge :-

- These raingauges just collect the rainwater but don't record the quantity of rainfall.
- The most extensively / widely used non-recording rain gauge is Symon's Gauge / Symon's Raingauge

IS: 4986-1968
Detail installation is given

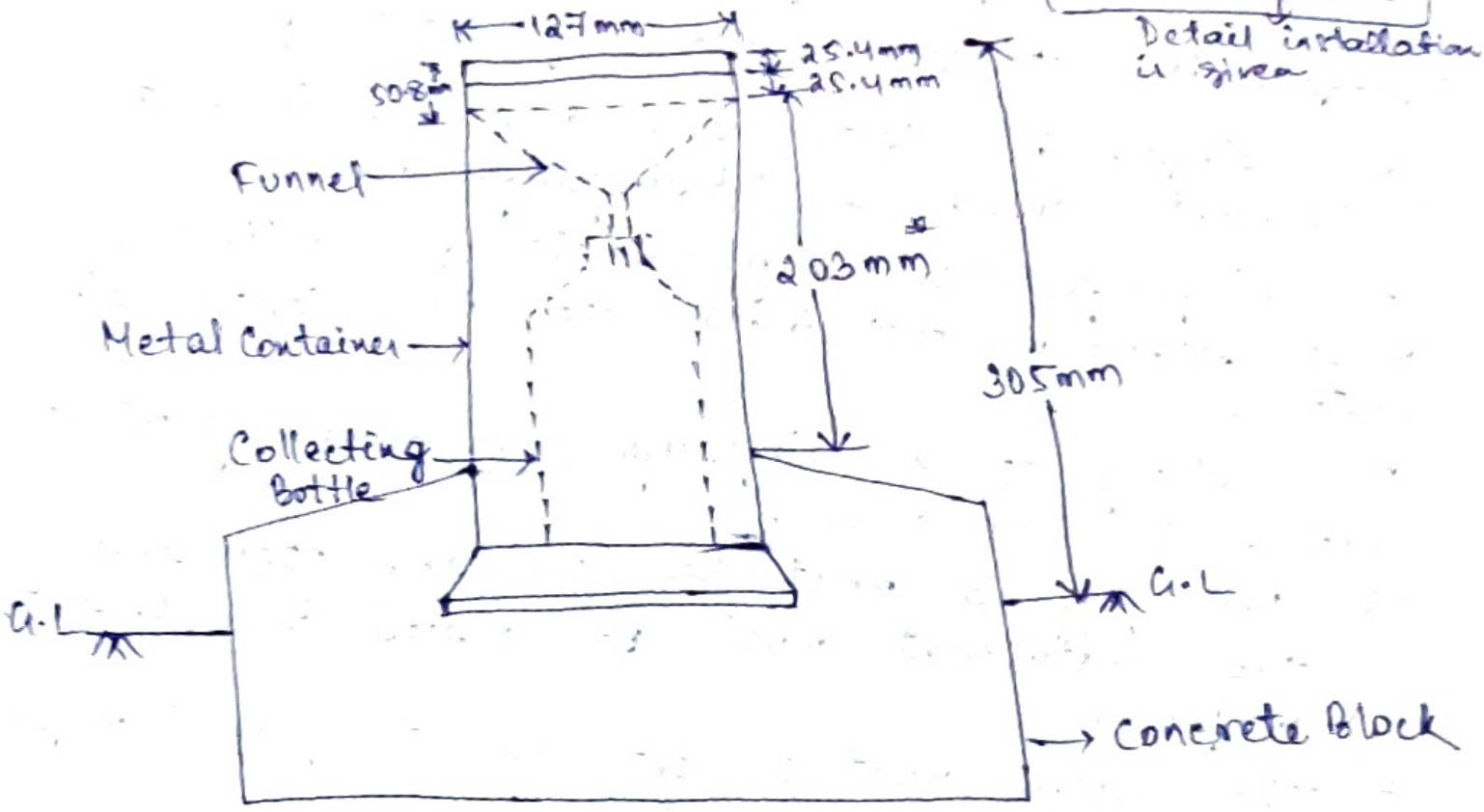


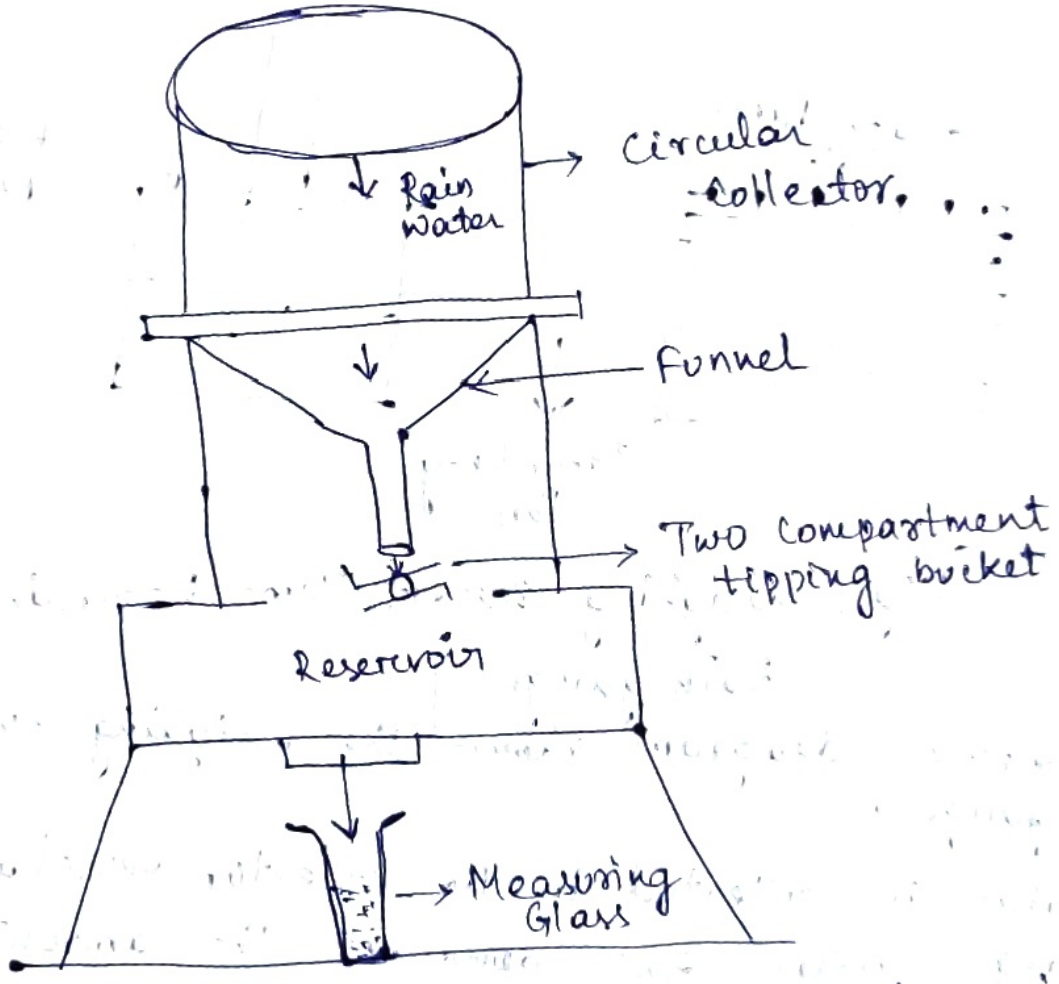
Fig: Non-Recording Rain gauge (Symons' Gauge)

- It consists of a circular collecting area of 127 mm / 12.7 cm diameter ~~coll~~ connected to a funnel.
- The collector is placed on a concrete block of height 305 mm / 30.5 cm.
- The collecting bottle and funnel are assembled in a metal container.
- The above figure shows the detail installation of Symon's Gauge.
- For uniformity, the rainfall is measured everyday at 8:30 AM.
- The receiving bottle does not hold more than 10 cm of rainwater, in case of heavy rainfall the measurem must be done more frequently.

(ii) Recording Rain Gauge :-

- Recording raingauge gives a permanent automatic record of rainfall.
- It has a mechanical arrangement by which the total amount of rainfall gets automatically recorded on a graph paper.
- It produces a plot of rainfall / cumulative rainfall vs time, which is known as "Mass-Curve".
- The type of Recording Rain Gauges are:

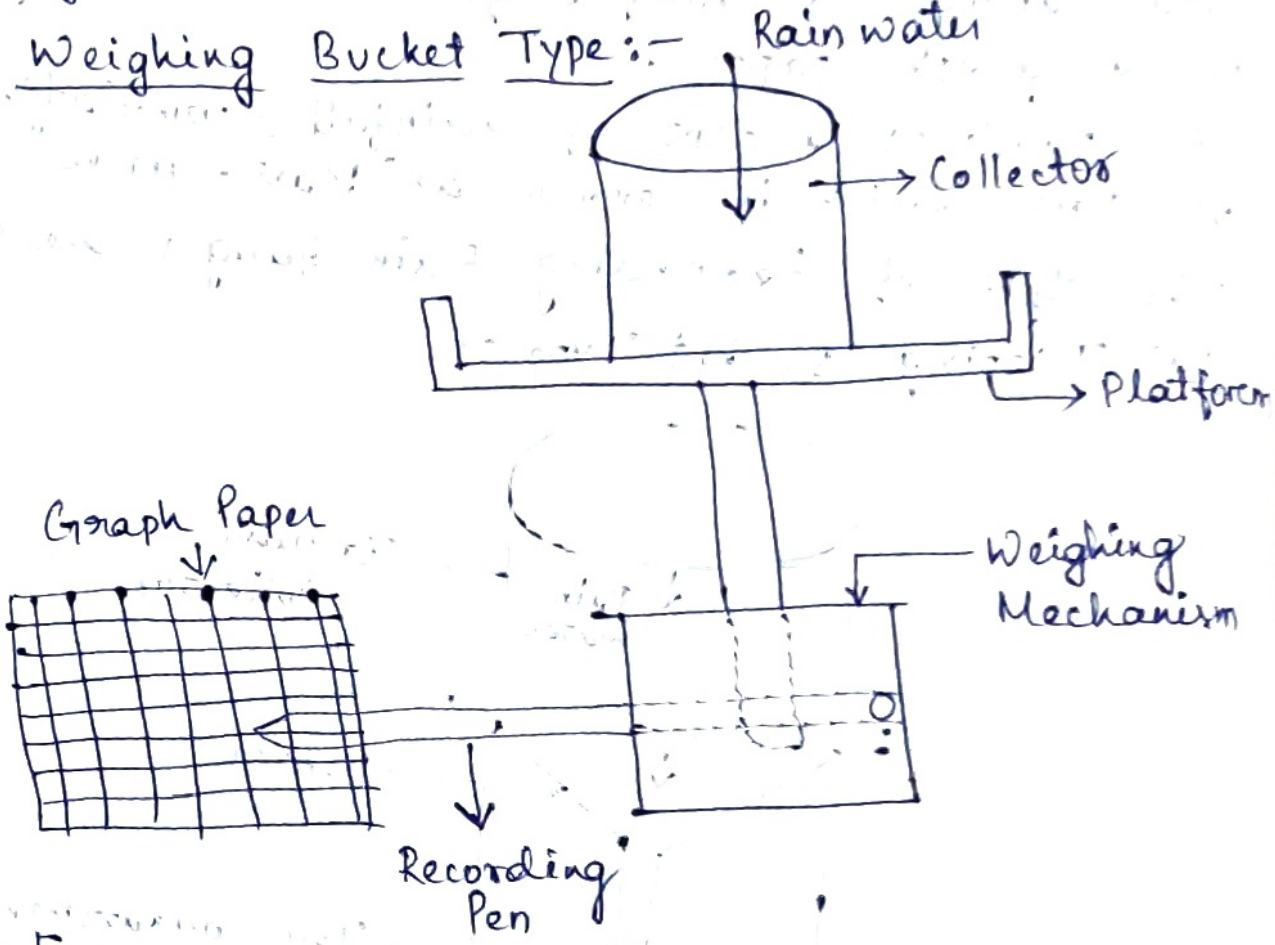
(a) Tipping Bucket Type :-



[Fig: Tipping Bucket type recording rain gauge]

- The size of / height of this gauge is 30.5cm / 305mm
- From the funnel the rainwater is collected to the reservoir and then to the measuring glass.
- These buckets are so balanced, that the 0.25mm of rainwater collects in one bucket and it shifts then it transfer to ~~lower~~ ~~a~~ reservoir.

- The rainwater collected in the storage can measured at regular interval.
- This type of record can also gives data on intensity of rainfall.
- (b) Weighing Bucket Type :-



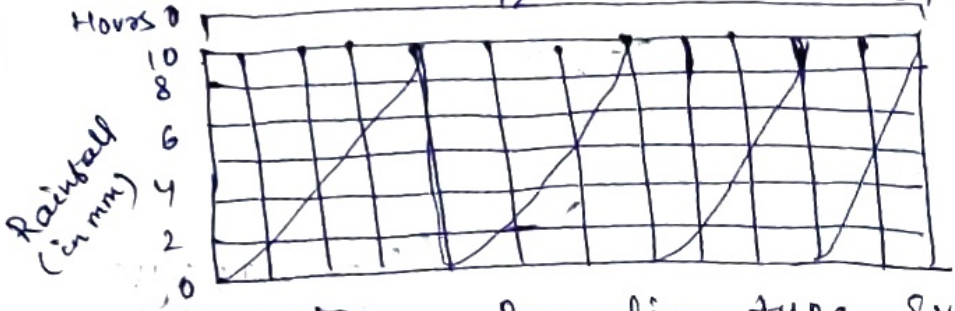
[Fig.: Weighing Bucket Type Recording Rain gauge]

- The above diagram shows the weighing bucket type rain gauge.
- Rain water is collected in the collector vessel and the
- weighing meter goes down as the amount of rain-water increases in collector.

The recording pen recorded the amount of rainfall in the graph paper.

(c) Natural Syphon Type:-

- This type of recording rain gauge is also known as "float type gauge".
- Here the rainfall is collected by a funnel-shaped collector and ~~lead~~ led into a float chamber.
- As the float rises, a pen is attached to a float which records the amount of rainfall.



[Fig: Recording type Syphon Natural Raingauge]

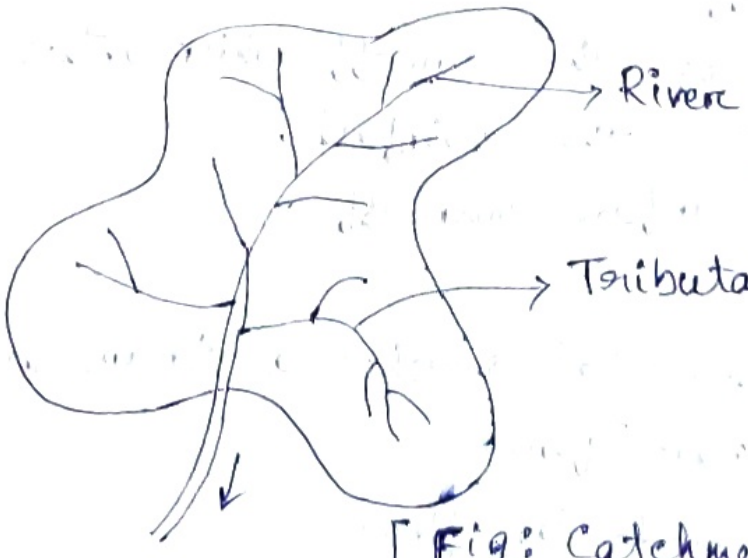
Catchment Area:-

Catchment area may be defined as the area from which the surface runoff is derived.

or

Catchment area may be defined as the area in which no. of water sheds / streams are present.

- It is also known as watershed area, drainage area or simply catchment.
- The unit of catchment area is km^2.



[Fig: Catchment area]

Classification of Catchment Area:-

The catchment area is classified (depending upon the shape into 2 types -

(i) Fan Shaped Catchment

(ii) Fern leaf type catchment or Elongated catchment.

(Fan shaped catchment)

(Fern leaf type catchment)

- Fan shaped catchment is similar to a fan i.e. circular
- Fern leaf type catchment is similar to a leaf i.e. elongated.

Run-off & it's types:-

- Run-off means flowing of rainwater on the surface of Earth. ~~from a catchment area~~
- The run-off is classified into 2 categories:
  (i) Direct Run-off
  (ii) Base Flow.

(i) Direct Run-off:-

- It is that part of the run-off which enters the stream immediately after the rainfall.
- It includes surface run-off.

(ii) Base Flow:-

- The delayed flow that reaches a stream as groundwater flow is called base flow.
- It includes groundwater flow.

Factors Affecting Run-off :-

(i) Degree of saturation of the soil in the catchment area.
(ii) The shape and slope of the catchment area.
(iii) Obstacles to flow such as roots of trees, bushes etc.
(iv) Amount of Evaporation.
(v) Degree of Vegetation.

Flood Discharge :-

The flood discharge can be evaluated by using various formulae such as :

(1) Dicken's Formula :-

$$Q = C(A)^{3/4}$$

where, Q = Discharge in m^3/s
A = Area of the catchment in m^2.
C = A coefficient having value 11 for Northern India, 14 to 19 for Central India and 22 for Western India.

(2) Ryve's Formula :-

$$Q = C(A)^{2/3}$$

where, Q = Discharge in m^3/s
A = Area of the catchment in m^2.
C = A coefficient having value 6.8 for areas within 25 km from the coast, 8.5 for areas bet^n 25 km to 160 km from coast and 10 for limited areas near the hills.

(3) Inglis Formula:

(i) For small areas,

$$Q = 125\sqrt{A}$$

where, Q = Discharge in m^3/s

A = Area of the catchment in km^2

(ii) For all types of catchment area,

$$Q = \frac{125\,A}{\sqrt{A+10}}$$

where, Q = Discharge in m^3/s

A = Area of the catchment in km^2

(iii) For area between 160 to 1000 km^2,

$$Q = 125\sqrt{A} - 2.60(A-260)$$

where, Q = Discharge in m^3/s

A = Area in km^2

Examples:-

Q-1) The area of a catchment is 800 km^2. The area is located in western India within 150 km from coast. Estimate the maximum flood discharge by using the various emperical formulae and compare the flood discharges.

Sol:- Given,

Catchment area (A) = 800 km^2

(i) According to Dicken's formula -

$$Q = C(A)^{3/4}$$

$\Rightarrow Q = 22 \times (800)^{3/4} = 3309.33 \ m^3/s$.

(ii) According to Ryve's formula –

$$\boxed{Q = C(A)^{2/3}}$$

$\Rightarrow Q = 8.5 \times (800)^{2/3} = 732.50 \ m^3/s$.

(iii) According to Inglis' Formula

$$\boxed{Q = 125\sqrt{A} - 2.60(A - 260)}$$

$\Rightarrow Q = (125\sqrt{800}) - [2.60(800 - 260)]$

$\Rightarrow Q = 2131.53 \ m^3/s$.

Q-2) The area of a catchment is 1000 km^2. The area is located in hilly part of North India. Estimate the maximum flood discharge by using the Dicken's formula, Ryve's formula and Ingli's formula.

Sol^n:- Given,

Catchment area (A) = 1000 km^2

(i) According to Dicken's formula

$$\boxed{Q = C(A)^{3/4}}$$

$\Rightarrow Q = 11 \times (1000)^{3/4} = 1956.10 \ m^3/s$

(ii) According to Ryve's formula

$$\boxed{Q = C(A)^{2/3}}$$

$\Rightarrow Q = 10 \times (1000)^{2/3} = 1000 \ m^3/s$

(iii) According to Ingli's formula

$$\boxed{Q = 125\sqrt{A} - 2.60(A - 260)}$$

$\Rightarrow Q = (125\sqrt{1000}) - [2.60(1000 - 260)] = 2028.84 \ m^3/s$.

$\Rightarrow Q = 22 \times (800)^{3/4} = 3309.33 \ m^3/s$.

(ii) According to Ryve's formula –

$$\boxed{Q = C(A)^{2/3}}$$

$\Rightarrow Q = 8.5 \times (800)^{2/3} = 732.50 \ m^3/s$.

(iii) According to Inglis' Formula

$$\boxed{Q = 125\sqrt{A} - 2.60(A - 260)}$$

$\Rightarrow Q = (125\sqrt{800}) - [2.60(800 - 260)]$

$\Rightarrow Q = 2131.53 \ m^3/s$.

Q-2) The area of a catchment is 1000 km^2. The area is located in hilly part ~~of~~ of North India. Estimate the maximum flood discharge by using the ~~vario~~ Dicken's formula, Ryve's formula and Ingli's formula.

Sol":- Given,

Catchment area (A) = 1000 km^2

(i) According to Dicken's formula

$$\boxed{Q = C(A)^{3/4}}$$

$\Rightarrow Q = 11 \times (1000)^{3/4} = 1956.10 \ m^3/s$

(ii) According to Ryve's formula

$$\boxed{Q = C(A)^{2/3}}$$

$\Rightarrow Q = 10 \times (1000)^{2/3} = 1000 \ m^3/s$

(iii) According to Ingli's formula

$$\boxed{Q = 125\sqrt{A} - 2.60(A - 260)}$$

$\Rightarrow Q = (125\sqrt{1000}) - [2.60(1000 - 260)] = 2028.84 \ m^3/s$.

Q.3) A small catchment area of 110 km^2, located within 25 km from the coast in Western India. Estimate the maximum flood discharge by using Dicken's formula, Ryve's formula and Ingli's formula.

Sol:- Given,

Catchment Area (A) = 110 km^2

(i) According to Dicken's formula

$$Q = C(A)^{3/4}$$

$$\Rightarrow Q = 22 \times (110)^{3/4} = 747.25\ m^3/s$$

(ii) According to Ryve's formula

$$Q = C(A)^{2/3}$$

$$\Rightarrow Q = 6.8\ (110)^{2/3} = 156.11\ m^3/s$$

(iii) According to Ingli's formula

$$Q = 125\sqrt{A}$$

$$\Rightarrow Q = 125\sqrt{110} = 1311.01\ m^3/s$$

~~Chapter~~

Assignment-1 :-

Long Questions:-

1. What do you mean by Hydrology? Explain about Hydrologic cycle with neat sketch.
2. What do you mean by Precipitation? Explain about the forems of precipitation.
3. What do you mean by Rainfall and explain it's types?
4. How do we measure rainfall? What are the factors should be considered while setting up a raingauge.
5. What are the types of Recording Raingauge, explain with neat sketch.
6. How many types of Raingauge are present and explain about non-recording raingauge with neat sketch.
7. What do you mean by Catchment area? explain it's type with diagram.
8. What do you mean by Run-off? What are the factors affecting Run-off.
9. Write short note on types of Run-off.
10. Find out the maximum and minimum intensity of rainfall in mm/hr from the given data below,

Time (in hr)	0	1	2	3	4	5
Rainfall (in mm)	0	22	46	55	67	80

11. A catchment area of 770 km^2, located at 150 km from from coast in Central India. Estimate the maximum flood discharge by using Dicken's formula, Ryve's formula and Inglis formula.

Short Questions:-

1. What do you mean by Hyetograph?
2. What do you mean by intensity of rainfall?
3. What are the types of rainfall based on intensity?
4. Differentiate between Precipitation and Rainfall?
5. What are the forms of precipitation?
6. Write down the process of hydrologic cycle.
7. Differentiate between Evaporation and Transpiration.
8. What are the types of raingauges present in India?
9. Differentiate between Direct Run-off and Base flow.
10. How does the flood discharge is estimated?

Chapter-2

-: WATER REQUIREMENTS OF CROPS :-

Irrigation :-

- Irrigation is the practice of applying controlled amount of water to land which helps to grow crops & plants.
- Irrigation helps to grow crops, revegetate disturbed soils in dry areas (during low rainfall).

Necessity of Irrigation :-

- India is basically an agricultural country and maximum people depend on the agriculture.
- Water is the most important resource which supplied to the plants by nature through rainfall.
- However, the total rainfall in a particular area may be insufficient, therefore it is required to supply sufficient water to the crops.
- Thus, necessity of irrigation is as follows :
  - (i) Less Rainfall
  - (ii) Non-uniform Rainfall
  - (iii) Growing a number of crops during a year.
  - (iv) Growing perennial crops.
  - (v) Controlled water supply.

(i) Less Rainfall :-

- When the total rainfall is less than the needed for the crop, artificial water supply is necessary.
- In such case, irrigation works may be constructed at a place where more water is available and then supply of water can be done.

(ii) Non-uniform Rainfall:-

- The rainfall in a particular area may not be uniform throughout the year.
- In monsoon period, rainwater may be available but in dry period no rainwater is available.
- In this case ~~[illegible]~~ artificial water supply is necessary for development of crops.

(iii) Growing a no. of crops during a year:-

- The rainfall in an area may be sufficient to raise only one type of crop during the rainy season, for which no irrigation is required.
- But in case of dry season, irrigation is very essential to grow crops.

(iv) Growing Perennial Crops:-

- Perennial crops required water throughout the year as they ~~[illegible]~~ required water by irrigation.
- Such crops are sugarcane.

(v) Controlled water supply:-

- By construction of proper distribution system, the agriculture ~~system may~~ of crop may be increased because of controlled water supply.

Advantages of Irrigation:-

- The following points are the advantages of irrigation
  (i) Increase in food production.
  (ii) Optimum Benefit.
  (iii) Elimination of Mixed cropping.

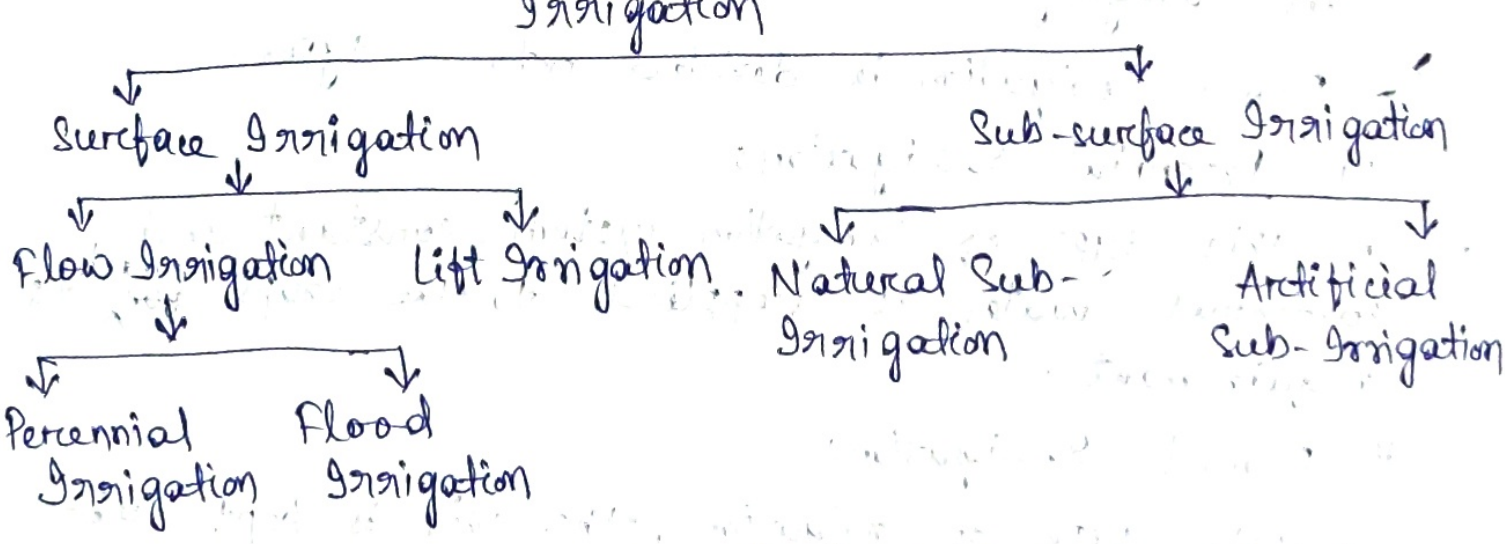
(iv) General Prosperity.
(v) Generation of Hydro-Electric Power.
(vi) Domestic water supply.
(vii) Afforestation.
(viii) Inland Navigation.
(ix) Facilitates of Communication.

Disadvantages of Irrigation:—

The following points are the disadvantages of irrigation —

(i) In some case, irrigation may cause to water pollution.
(ii) If the irrigation water will create a damp area, then it may result of breeding mosquitoes, which can cause disease like malaria.
(iii) Over irrigation may lead to water logging and may reduce ⇒ crop yield.

Types of Irrigation:—



→ Irrigation may be classified into 2 types such as:
(i) Surface Irrigation (ii) Sub-surface Irrigation.

→ Surface Irrigation is divided into 2 types such as
(a) Flow irrigation (b) Lift Irrigation.

Surface Irrigation :-

- Surface irrigation is where water is applied and distributed over the soil surface.
- It is the most common form of irrigation throughout the world.
- It is divided into 2 types -
  (a) Flow Irrigation (b) Lift Irrigation.

(a) Flow Irrigation :-

When the water is available at higher elevation and it is supplied to lower elevation by means of gravity is known as flow irrigation.

(b) Lift Irrigation :-

If water is lifted up by ~~means of~~ mechanical means such as pumps and then supplied for irrigation then it is called as lift irrigation.

example :- Use of wells and tube wells comes under this category.

- Flow irrigation is divided into 2 types -

(i) Perennial Irrigation :

- In this type of irrigation system, constant and continous water is supplied to the crops, ~~for~~ until its requirement.

(ii) Flood Irrigation :

- In this type of irrigation, the soil is kept submerged and thoroughly flooded with water
- This type of irrigation is also known as Inundation Irrigation or Uncontrolled Irrigation.

Sub-Surface Irrigation:-

- In this type of irrigation, water doesn't wet the soil surface. The plants get water through underground water by capillarcity.
- It may be divided into 2 types such as:
  (i) Natural Sub-Irrigation (ii) Artificial Sub-Irrigation.

(i) Natural Sub-Irrigation:-

- Leakage of water from channels goes underground and may irrigate the crop.
- Sometimes, water table may rise up due to sufficient recharge of groundwater, which helps in irrigation.
- When underground irrigation is acheived by natural process without any extra efforts is known as natural sub-surface irrigation.

(ii) Artificial Sub-surface Irrigation:-

- When a system of water supply pipes is artificially laid below to irrigate the crops by capillarcity then it is known as Artificial Sub-surface Irrigation.
- It is very costly process and also adopted in India on a very small scale.

Techniques of Water Distribution in the Farms:-

- There are various techniques in which the irrigation water can be applied to the fields.
- Their classifications are as follows:
  (i) Free Flooding .. (ii) Border Flooding
  (iii) Furrow Irrigation Method
  (iv) Basin Flooding
  (v) Check Flooding

(vi) Sprinkler Irrigation Method.

(vii) Drip Irrigation Method.

(i) Free Flooding :

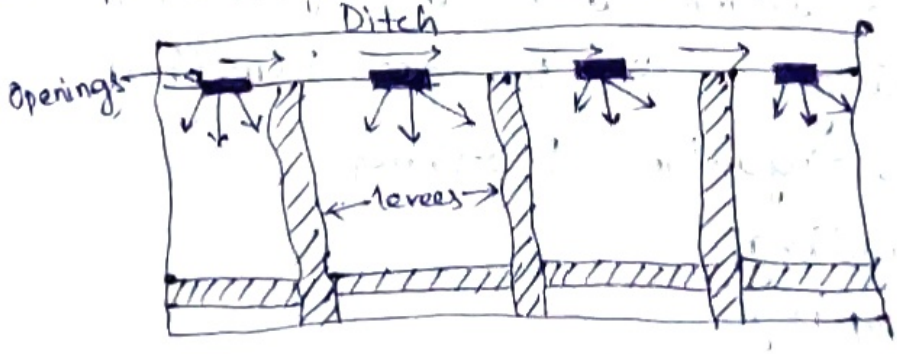
- In this method, ditches are excavated in the field.
- Water is applied from these ditches and it flows across the field.
- After the water leaves the ditches, no attempt is made to control the flow by means of levees.
- Sometimes, it is also known as wild flooding.

(ii) Border Flooding :-

- In this method, the land is divided into a number of strips, separated by low levees called borders.
- The land is separated into ~~strips~~ borders in order of 10 to 20 m. in width and 100 to 400 m. in length.
- The water is supplied to the land through supply ditch.

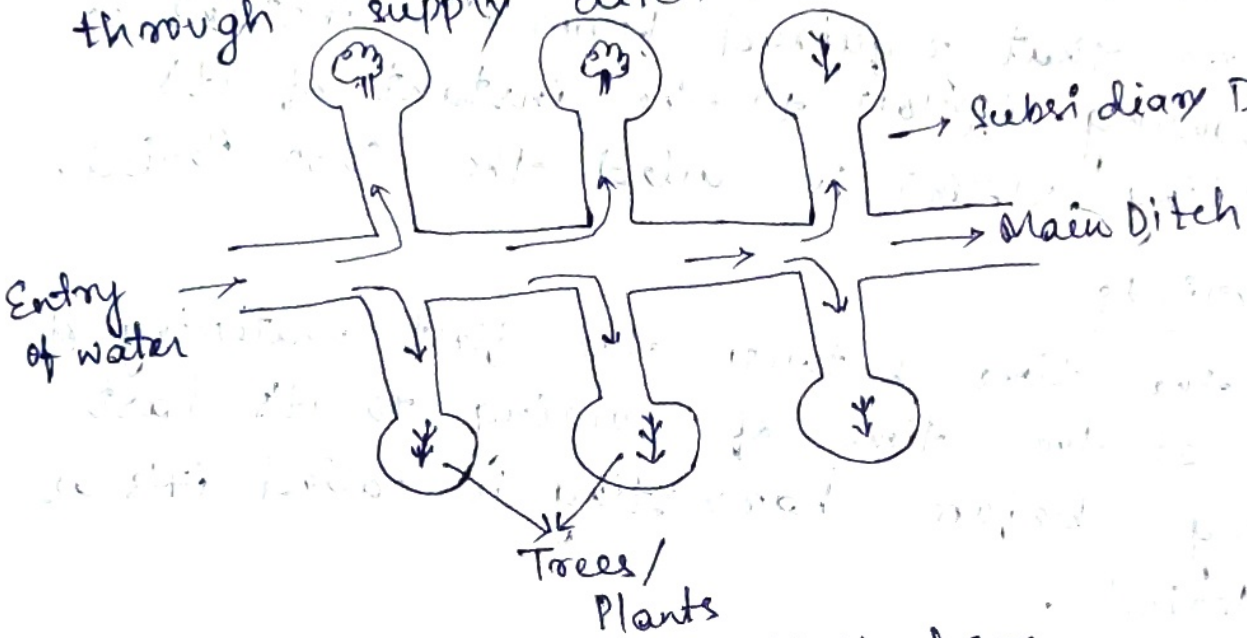
(iii) Check Flooding :-

- Check flooding is similar to ordinary flooding.
- In this type of flooding water is controlled by surround check area
- Levees are constructed ~~ha~~ in vertical interval of about 5 to 10 cm.
- The plot area varies from 0.2 to 0.8 hectare.



(iv) Basin Flooding:-

- In this method, special type of basins are constructed for crops.
- One or more trees are generally placed in the basin and the surface is flooded. The water is applied through supply ditch.



(v) Furrow Irrigation Method:-

- It is the method of irrigation in which the land surface is wetted only one fifth and one half portion.
- In this method only the required amount of water to the crops is supplied.

(vi) Sprinkler Irrigation Method:-

- In this method, water is applied to the land in the forem of spray and pumps.
- It is a kind of artificial rain and therefore gives very good ~~reason~~ results.

(vii) Drip Irrigation Method:-

- It is the latest field irrigation technique.
- This method is adopted in water scarcity area.

- In this method, water is slowly and directly applied to the root zone of the plants.

Crop Period and Base Period :-

Crop Period :

The time that required from the instant of it's sowing (पेरणी) to the instant of it's harvesting (कापणी) is called the Crop Period.

Base Period :

It is the time between the first watering of a crop at the time of sowing to it's last watering before harvesting is called as Base Period.

NOTE :

Crop Period is slightly more than the Base Period.

CROP SEASON :-

- More than 70% of the Indian population is connected with agriculture.
- The chief crops of India are :- Rice, wheat, sugarcane, tea, coffee, cotton, coconut etc.
- Different types of soil are needed for raising different types of crops.
- From the agricultural point of view, the year can be divided into 2 cropping seasons such as :
  (i) Kharif Crop / Kharcif Season.
  (ii) Rabi Crop / Rabi Season.

- Kharif Crop / Kharif Season starts from 1st ~~October~~ April and ends at 30th ~~March~~ September. (Summer crop)
- Rabi Crop / Rabi season starts from 1st October and ends at 31st March. (Winter Crops)
- Kharif crops are rice, bajra, jowar, maize, cotton, tobaco, groundnut etc.
- Rabi crops are wheat, barley, mustard, potatoes etc.
- Kharif crops required more water than Rabi Crops.
- When a crop requires water for its crop season and also some time in the beginning of the ~~crop~~ next crop season, allowance has to be made for this overlap. This allowance is known as overlap allowance.

Example:- Sugarcane.

Irrigation Requirements for Certain Indian Crops:-

Sl. No.	Crop	Period of growth	Average water depth required (in cm)
	~~Kharif~~		
01	Maize	June to Oct.	45
02	Bajra	July to Nov.	30
03	Groundnut	May to Dec.	45
04	Cotton	May-June or Nov-Jan	25 - 40
05	Pulses	July-Aug to Nov-Dec.	30
	Rabi		
06	Wheat	Oct - March/April	7 - 10
07	Potatoes	Sep - Oct to Feb	60 - 90
08	Mustard	Oct to Feb - Mar	45
09	Tobaco	Oct - Feb	60

Delta :-

- It is the total depth of water (in cm) required by a crop to come to maturity, is called it's delta.
- It it denoted as "Δ"

Q-> If rice requires about 10cm depth of water at an average interval of about 10 days and the crop period for rice is 120 days. Find out the delta for rice.

Sol^n:-

No. of watering required = $\frac{120}{10} = 12$

Delta for the crop = $12 \times 10\text{cm} = 120\text{cm}$. (Ans)

Q-2) If wheat requires about 7.5cm of water after every 28 days and the base period for wheat is 140 days. Findout the delta for wheat.

Sol^n:-

No. of watering required = $\frac{140}{28} = 5$

Delta for the crop = $5 \times 7.5\text{cm} = 37.5\text{cm}$. (Ans)

Q-) If vegetables requires about 4cm of water at interval of 5 days and the crop period is 60 days. Findout the delta for vegetables.

Sol^n:-

No. of watering required = $\frac{60}{5} = 12$

Delta for the crop = $4 \times 12 = 48\text{cm}$.

Duty of Water :-

- The duty of water is the relationship between the volume of water and the area of the crop it matures.
- It may be defined as the no. of hectares of land irrigated for full growth of a crop by supplying 1 m^3/sec. of water continously during the entire base period of that crop.
- Duty is generally represented by 'D'.

Relationship Between Duty and Delta :-

$$\text{Delta } (\Delta) = \frac{864\,B}{D} \text{ in cm.}$$

where, Δ = Delta
B = Days
D = Duty in hectares / cumec.

Q-> Find the delta for a crop when its duty is 864 ha/cu.m on the field, the base period of this crop is 120 days.

Sol:- Given, Base Period (B) = 120 days
Duty (D) = 864 ha/cu.m

$$\text{Delta } (\Delta) = \frac{864 \times B}{D}$$

$$= \frac{864 \times 120}{864} = 120 \text{ cm.}$$

Q-2) Find the delta for a crop when it's duty is 920 ha/cumec on the field, the base period of this crop is 145 days.

Sol:

Given,

Base Period (B) = 145 days

Duty (D) = 920 ha/cumec

As we know,

$$\text{Delta } (\Delta) = \frac{864 \times B}{D}$$

$$\Delta = \frac{864 \times 145}{920} = \frac{125280}{920}$$

$$= 136.17 \text{ cm}.$$

Factores on which Duty Depends:-

Duty of irrigation water depends upon the following factors:

(i) Type of Crop

(ii) Climate and season.

(iii) Useful Rainfall

(iv) Type of Soil

(v) Efficiency of cultivation method.

Crop Ratio / Kharif - Rabi Ratio:-

- The area to be irrigated for Rabi crop is generally more than that for the Kharif crop.
- Crop ratio is the ratio of proposed areas to be irrigated in Kharif season to that in Rabi season.

- Kharif - Rabi ratio is generally 1:2 respectively.

Gross Command Area (G.C.A) :-

- It is the total area bounded within the irrigation boundary of a project.
- It includes the cultivable as well as un-cultivable area.

Example:- Ponds, Residential Areas, Roads, Reserved Forests etc. are uncultivable area of the G.G.A.

Cultivable Command Area (C.C.A) :-
or
Culturable

- Cultivable Command Area is the cultivable part of the gross command area and all land of gross command area on which cultivation is possible.
- It does not include uncultivable part of G.C.A like ponds, road, forest etc.
- C.C.A is divided into 2 categories such as:
  (i) Cultivated portion of C.C.A.
  (ii) Cultivable but not cultivated portion of C.C.A.

Intensity of Irrigation :-

- Intensity of Irrigation is defined as the percentage of the culturable commande area proposed to be irrigated annually.
- The yearly intensity of irrigation may be obtained by adding the intensities of irrigation for all the crop season.

Example:-
The sanctioned intensity of irrigation under Bhakra Canal System is 27.6% for Kharif Season & 34.4% for Rabi Season.

Irrigable Area / Area to be Irrigated :-

- The area proposed to be irrigated in any one crop season or in a year is called the area to be irrigated in that season or in that year respectively.
- The areas to be irrigated are usually worked out separately for each crop season because the water requirement of the crops of two seasons are quite different.

Time Factor :-

Time factor is defined as the ratio of the no. of days the canal has actually run to the no. of days it was supposed to run as per the irrigation period.

Example :-

let us assume that, a canal was supposed to run 12 days but actually it runs only 10 days; then the time factor will be -

$$\text{Time factor} = \frac{10}{12} = \frac{5}{6}$$

Ratio is 5 : 6

ASSIGNMENT-02

Long Questions:-

1. What do you mean by Irrigation? What are its advantages and disadvantages?
2. What is the necessity of Irrigation? Explain in details.
3. Explain about the types of Irrigation in details.
4. What are the irrigation Techniques are used in farms. Explain about any 3 types of techniques in details.
5. What do you mean by Crop Season? Explain about Rabi crop and Kharif crop with suitable examples.
6. What do you mean by Delta and Duty of water? Also write down its relationship.
7. What do you mean by Duty of water? Explain about the factors on which duty depends.

Short Questions:-

1. What are the types of Irrigation present in India?
2. Differentiate between Sprinkler Irrigation and Drip Irrigation.
3. Why Irrigation is necessary in India?
4. Differentiate between Crop Period and Base Period.
5. Differentiate between Kharif Crop and Rabi Crop.
6. What do you mean by Overlap Allowance?
7. If cotton requires about 35cm depth of water at an average interval of 8 days and the crop period for cotton is 150 days. Find out the delta for cotton.
8. What do you mean by Delta?
9. Write down the relationship between Duty and Delta.

10. What do you mean by Crop Ratio?
11. Differentiate between G.C.A and C.C.A.
12. What do you mean by Intensity of Irrigation?
13. What is Irrigable Area?
14. What do you mean by Time factor?
15. What are the factors on which duty depends?