SRI SHANMUGHA COLLEGE OF ENGINEERING AND TECHNOLOGY

(Approved By AICTE, Accredited by NAAC, Affiliated to Anna University)

Tiruchengode – Sankari Mani Rd, Pullipalayam, Morur (PO), Sankari (Tk), Salem 637304.

AI8513 – IRRIGATION FIELD LABORATORY

DEPARTMENT OF AGRICULTURE ENGINEERING

Anna University - Regulation: 2017

B.E AGRICULTURE ENGINEERING – V SEMESTER

AI8513 –IRRIGATION FIELD LABORATORY

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RECORD NOTE BOOK

REGNO. ______________________

Certified that this is a bonafide observation of Practical work done by Mr/Ms/Mrs……………………………………of the…………………………………… Semester……………………………………………… Branch during the Academic year……………in the………………………………laboratory.

Staff–in–Charge **Head of the Department**

Internal Examiner **External Examiner**

GENERAL INSTRUCTIONS

- All the students are instructed to wear protective uniform and shoes before entering into the laboratory.
- Before starting the exercise, students should have a clear idea about the principles of that exercise
- All the students are advised to come with completed recorded and corrected observation book of previous experiments, defaulters will not allowed to do their experiment.
- Don't operate any instrument without getting concerned staff member's prior permission.
- All the instruments are costly. Hence handle them carefully, to avoid fine for any breakage.
- Almost care must be taken to avert any possible injury while on laboratory work. In case, anything occurs immediately report to the staff members.
- One student from each batch should put his/her signature during receiving the instrument in instrument issue register.

LIST OF EXPERIMENTS

S.No	Date	Name of the Experiments	Page No	Mark Obtained	Faculty Signature

Ex.No.	1	TO STUDY VARIOUS INSTRUMENTS IN THE METEOROLOGICAL LABORATORY
Date		

AIM:

To study various instruments in the meteorological laboratory

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Rainguage	1
2.	Cup count Anemometer	1
3.	Wind Vane	1
4.	Sunshine Recorder	1
5.	Open Pan evaporation	1
6.	Stevenson Screen	1
7.	Dry bulb and Wet bulb thermometer	1

PROCEDURE:

RAINGUAGE

1. The bottom segment of this instrument is places firmly into the ground.
2. Rainfall is collected in a bottle inside of the instrument.
3. The bucket ensures retention of rainfall for measurement as it facilitates for overflow of the bottle in heavy downpours.
4. This instrument should not be situated near tall buildings and trees since these obstruct the rain collection.
5. Put the jar out in the rain. Note: the rain gauge should not be put it near or under trees or too close to buildings which may block the rain.
6. Read the ruler to determine how much rain was collected.
7. Empty the jar after each use.

CUP COUNTER ANEMOMETER

1. Wind pushes into the cups causing the instrument to spin. The amount of rotations is recorded by the counter on the device. This gives an idea of the wind speed.
2. Placement of this instrument is critical. It should not be close to buildings or tall obstructions.
3. Tall obstructions cause eddies, turning in the wind around obstacles.

DIAGRAM

WIND VANE

1. Place the paper plate on a flat surface and put the wind vane on the plate.
2. Use the compass to show the students where north is so that they can set up their plates facing the right direction. If you have access to a blacktop area, mark the compass points in chalk to make it easier for the students to read the wind direction.
3. Students will observe the vane. If it is very breezy, one student should hold down the paper plate while another takes the direction reading. The arrow will point to the direction the wind is blowing from.
4. Check the direction on the paper plate.

SUNSHINE RECORDER

1. A solid glass sphere resting on an adjustable support.
2. The sun's rays are focused by the sphere, thus burning a mark onto a card held inside the bowl.
3. Three cards are used: summer card (long & curved), winter card (short & curved) and equinoctial card (a straight card). This is because of the apparent movement of the sun.

OPEN PAN EVAPORATION

1. Evaporation is the process by which water is converted from its liquid form to its vapour form and thus transferred from land and water masses to the atmosphere. It is an important process in the water cycle.
2. Evaporation from the oceans accounts for 80% of the water delivered as precipitation, with the balance occurring on land, inland waters and plant surfaces.
3. Three key parts to evaporation are heat, humidity, and air movement.
4. A pan filled with water to a known depth.
5. The stilling well is placed in the pan and supports the hook gauge, which is used to measure the height of the water in the pan.
6. Over a 24 hour period some water would be added by rainfall and removed by evaporation.
7. Rainfall is recorded and is thus known. Therefore the volume of water evaporated can be derived.

DIAGRAM

STEVENSEN SCREEN

- To obtain measured parameter of weather at a particular place, instruments should be placed at that specific location. However, the instruments must be protected from the direct effects of the elements (sunshine, rainfall, wind) yet be able to be influenced by them as would occur in the real world.
- The Stevenson screen holds instruments that may include thermometers, a hygrograph and a thermograph and thus, forms part of a standard weather station.
- A doubled-louvered wooden box that is used to house thermometers and other instruments from precipitation and radiation while also allowing free passage of air.
- The screen stands 1.25m above the ground covered with short grass – this ensures that the ground does not heat up quickly and the heat from the ground does not influence the temperatures of the thermometers housed in the screen.
- The screen faces north in the Northern Hemisphere and south in the Southern Hemisphere. This is so to ensure that the inside of the screen is never exposed to the sun.
- It is lowered so that air can pass through the screen – ventilation.

DRY BULB WET BULB THERMOMETER

1. Dry bulb and wet bulb thermometers are supported vertically. The wet bulb thermometer is has its bulb wrapped in a muslin and the wick in a reservoir of distilled water. Together, they measure the relative humidity.
2. The dry bulb thermometer measures the temperature of the atmosphere.
3. The wet bulb thermometer measures the temperature of the atmosphere if the atmosphere is 100% saturated.
4. Low humidity occurs when the difference between the dry bulb temperature and the wet bulb temperature are far apart.
5. High humidity occurs when the difference between the dry bulb temperature and the wet bulb temperature are close together.
6. Maximum and minimum thermometers are supported horizontally and measures the maximum (daytime) temperature and minimum (night time) temperature respectively. They must be read at least twice a day. Usually it is done every main hour (8 a.m., 2 p.m., 8 p.m., 2 a.m.)
7. All are mercury-in-bulb thermometers except the minimum thermometer, which is an alcoholin- bulb thermometer.
8. Care must be taken when reading thermometers to avoid errors due to parallax.

DIAGRAM

INFERENCE:

VIVA QUESTIONS:

1. List out the application of rainguage.

2. List out any six equipments of meteorological laboratory

3. What is the purpose of using dry bulb and wet bulb thermometer

4. List out the application of stevensen screen.

5. Write the principle of cup count anemometer

6. What is purpose of using open pan evaporation

Ex.No.	2	DETERMINATION OF INFILTRATION RATE USING DOUBLE RING AND DIGITAL INFILTROMETER
Date		

AIM:

Infiltration refers to the entry of water from the surface of soil. Infiltration rate is much higher at the beginning of rain or irrigation and gradually decreases with time. It is an important soil property based on which rate of water application and time required to apply appropriate amount of water can be decided.

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Galvanized iron cylinders 40 cm and 30 cm in diameter with circular caps	1
2.	Hammer	1
3.	Hook gauge	1
4.	Stand	1
5.	Spade	1

PROCEDURE:

1. Drive the cylinder vertically downwards into the soil to a depth of about 10-15 cm by hammering gently on the circular cap of the cylinder.
2. Remove the cap and tap the soil into the space between the soil column and the cylinder.
3. Then drive the higher outer ring to the same depth as inner cylinder. The region between inner ring and outer ring is known as buffer pond.
4. Place the hook gauge in the inner ring. The n pour water first to the outer ring followed by inner cylinder to a height to 7-12 cm.
5. Record recession in water level against time at certain time intervals and plot the curve.

DIAGRAM

CALCULATION

S. No.	Elapsed time (min.)	Initial reading (cm)	Final reading (cm)	Depth (cm)	Av. Infiltration rate (cm/hr.)	Cumulative Infiltration (cm)

INFERENCE

VIVA QUESTIONS:

1. What is meant by infiltration?
2. Write the dimensions of double ring infiltrometer?
3. What is the purpose of using double ring infiltrometer?
4. Write the Hortan's infiltrate equation?
5. What is meant by infiltration rate?

Ex.No.	3	DETERMINATION OF SOIL MOISTURE WETTING PATTERN FOR IRRIGATION SCHEDULING
Date		

AIM:

To determine the soil moisture wetting pattern for irrigation scheduling

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Main line	1
2.	Submain	1
3.	Lateral	1
4.	Emitter	1
5.	Spade	1

PROCEDURE

1. The field layout consists of a mainline connecting the source of water with the sub-main, both made of PVC pipes.
2. The sub-main was linked to two laterals. The emitters are fitted at 60 cm interval and each discharges at a fixed flow rate of 4 litres per hour. The irrigation system was set up on sandy loam.
3. This is to determine the configuration of their wetted radius on the surface, as well as at different depth of 0.0 cm, 5.0 cm, 10.0 cm, 15.0 cm, 20.0 cm, 25.0 cm, 30.0 cm and 35.0 cm intervals from the surface at the same discharge rate.
4. Water was discharged to the sub main from the source through the main line with a control valve; this was discharged at the different emitter location with a filament fitted at the drippers, which regulated the discharge to 4 litres per hour.
5. A coordinate system of the wetted soil was established on the profile between 30 min to 2 hour of irrigation, with the centre of the soil surface directly under the emitter.
6. At the end of every 30.0 min, three points of the lateral line around the emitter that were wetted were excavated to expose the vertical soil profile.
7. The distance of the wetted front was measured horizontally and vertically downwards at the above mentioned depths.

DIAGRAM

WETTING PATTERN FOR DIFFERENT SOIL CONDITION

CALCULATION

S.No.	Time elapsed	Wetting depth horizontal (cm)	Wetting depth vertical (cm)

INFERENCE

VIVA QUESTIONS:

1. What is meant by wetting pattern?
2. Write is meant by irrigation scheduling?
3. Draw the wetting pattern for clay soil?
4. Draw the wetting pattern for sandy soil?
5. Draw the wetting pattern for loamy soil

Ex. No.	4	DESIGN OF DRIP IRRIGATION SYSTEM
Date		

AIM:

To design the drip irrigation system for different crops and field

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Pump	1
2.	Header Assembly	1
3.	Filters – Hydro cyclone, Sand, Screen Filter	1
4.	Fertigation Equipment - Ventury Injector, Fertilizer Tank, Injector Pump	1
5.	Main Line	1
6.	Submain Line	1
7.	Control Safety Valves	1
8.	Laterals / Polytubes or Inline	1
9.	Emitters - Drippers, Mini Sprinklers, Jets	1
10.	Pressure gauge	1
11.	Air release valve	1

PROCEDURE

Design criteria of drip system

1. Calculation of plant population
2. Calculation of daily Irrigation requirement
3. Calculation of duration of Irrigation
4. Calculate total dynamic head required for operating drip system of the pump
5. Calculate electricity consumption
6. Calculation of pipe size and length
7. Determine the size of lateral
8. Determine the size of submain

DIAGRAM

INFERENCE

PROBLEM:

Considered the area of 1 ha square area planted with coconut with spacing of 7.5 m x 7.5 m. Design drip irrigation system

CALCULATION

1. **Calculate Plant population** =

   Square Population =

2. **Daily Irrigation requirement**

   Peak evaporation rate (E_T) =

   This quantum of water is required, if entire grid area around the tree is irrigated. In case of drip system the thumb rule is one fourth of the spacing is assumed as radius of wetting

   Wetting Radius (R_w) =

   Wetting area $A_w = \pi$ x R_w

   =

   Now volume of water required/day = A_w x E_T

3. **Calculate the duration of irrigation**

   Select emitter discharge of 16 l/hr with 4 number of emitters around individual

   Combined discharge /hr =

   Duration of Irrigation =

4. **Calculate discharge of pump**

   Total volume of water to be delivered/day =

   Duration of Irrigation

   Pump Discharge = Q =v/t

5. **Calculate Total Dynamic Head (H) required for operating drip system and the pump**

For drip irrigation system the criteria assume that even the last emitter along last lateral have the operating pressure head of 1.0 kg/cm^2 (10 m of water head)

Operating head required of pump, Assuming

20 % permissible variation of friction losses along lateral

10 % submain

5 % along mains

Assuming say 8m suction Head; 2m Pumping Head; 6m Delivery Head

Pumping Head =

Total Dynamic Head (H) = $H_{SY} + H_P$

$HP_{gross} = (QH/75\eta_P)$

6. **Calculate Electrical consumption**

7. **Calculate the pipe sizes, match the commercially available sizes**

Total lateral discharge =

(a) Diameter of Lateral

(b) **Diameter of submain**

Head loss due to friction = H_f = $[(K' \text{ x } L \text{ x } Q^m \text{ x } f)/H_f]^{1/n}$

(c) Diameter of main

VIVA QUESTIONS:

1. What is meant by drip irrigation?

2. What are the advantages of drip irrigation system?

3. Write a formula Head loss due to friction?

4. What are the components of drip irrigation?

5. What is the operating pressure of drip irrigation system?

DIAGRAM

Ex. No.	5	DESIGN OF SPRINKLER IRRIGATION SYSTEM
Date		

AIM:
To design the sprinkler irrigation system for different crops and field

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Pump	1
2.	Header Assembly	1
3.	Filters – Hydro cyclone, Sand, Screen Filter	1
4.	Fertigation Equipment - Ventury Injector, Fertilizer Tank, Injector Pump	1
5.	Main Line	1
6.	Submain Line	1
7.	Couplers	1
8.	Sprinkler head	1
9.	Pressure gauge	1
10.	Air release valve	1

PROCEDURE

Design criteria for sprinkler irrigation:

1. Access basic infiltration rate of the soil and limit water application rate never exceeding the basic infiltration rate.
2. To calculate the individual sprinkler discharge depend on sprinkler spacing and lateral spacing and the limited water application rate
3. To determine system capacity
4. To calculate the total dynamic head for operating system
5. Calculate Horsepower

Calculation:

Step: 1

Access basic infiltration rate of the soil and limit water application rate never exceeding the basic infiltration rate.

Step: 2

To calculate the individual sprinkler discharge depend on sprinkler spacing and lateral spacing and the limited water application rate

Sprinkler spacing S_S =

Lateral spacing S_L =

The rate of application by usual sprinkler

$$q = (S_S \text{ x } S_L \text{ x } I)\text{x } 360$$

Step: 3

To have find out system capacity (Q)

Q = N x Q

Where

N = Total number of sprinklers used for unit design area of 1ha. For a sprinkler and lateral spacing. We can accommodate five sprinklers on each lateral

System capacity (Q) =

Step: 4

To calculate the total dynamic head for operating system as well as pumping unit, for consider the last lateral with the last sprinkler spray water at operating pressure head 2.5 cm of 25 m of water

Assuming 20 % permissible loss along lateral

Assuming 10 % permissible loss along submain

Assuming 5 % permissible loss along main

The system operating pressure head at delivery point of pump

H_{sys} =

For the pumping plant assuming of 8m suction head the delivery head of 6m and pumping friction head of 2m

H_{pump} =

$H = H_{sys} + H_{ump}$

Step: 5

Calculate $H_P = (QH/75\eta_P)$

From the point of view of cost involved and huge HP requirement it is preferable to convert to soil system 5 lateral and 5 sprinkler each, the portable system of single lateral with 5 sprinklers

Now total pumping discharge is reduced by 5 times

Now the HP =

INFERENCE

VIVA QUESTIONS:

1. What is meant by sprinkler irrigation?
2. What are the advantages of sprinkler irrigation system?
3. Write the formula for system capacity for sprinkler?
4. What are the components of sprinkler irrigation?
5. What is the operating pressure of sprinkler system?

Ex.No.	6	MEASUREMENT OF FLOW PROPERTIES IN OPEN IRRIGATED CHANNELS (FLUMES, NOTCHES)
Date		

AIM:

To study and measure the flow properties in open irrigated channel

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Triangular weir	1
2.	Rectangular weir	1
3.	Trapezoidal weir	1
4.	Parshall flume	1
5.	Scale	1

PROCEDURE

Direct discharge methods

In this method, the volume of flow of water is determined directly by installing certain devices of known dimensions at a desired point across the channel.

Devices for measuring the irrigation water

1. Weirs   2. Flumes   3. Orifices

1. Weirs

i) Weirs are used to measure the flow in an irrigation channel or the discharge of a well or canal.

ii) A weir is a notch of regular farm through which the irrigation stream is made to flow.

iii) Weirs may be built as stationary structures or they may be made portable.

iv) Rectangular weirs and 90^{o}V notch weirs are commonly used.

v) The discharge through a weir is calculated as

$$Q = CLH^{m}$$

DIAGRAM

where,

Q = discharge L = length of crest

C = a coefficient H = head of the crest

m = an exponent depending on weir opening

a) Triangular weir (90^ov notch)

i) It is commonly used to measure small and medium size streams accurately.

ii) The discharge through 90^oV notch weir may be computed either by using the following formula

$Q = 0.0138\ H^{5/2}$

where,

Q = discharge (lit/sec) H = Head (cm)

b) Rectangular weir

i) It is used to measure comparatively larger discharges.

ii) It has a horizontal crest and vertical sides.

iii) They may be either contracted rectangular weirs or suppressed rectangular weirs.

iv) The discharge through rectangular weirs may be computed by the Francis formula stated below.

i. Suppressed rectangular weir : $Q = 0.0184\ LH^{3/2}$

ii. Contracted rectangular weir : $Q = 0.0184(L-0.2)H^{3/2}$

where,

Q = discharge (lps)

L = length of crest (cm)

H = head over the weir (cm)

c) Trapezoidal weir (Cipoletti weir)

i) This is invented by an Italian Engineer by name Cipoletti therefore it is called as Cipoletti weir.

ii) Each side of the weir has a slope of 1 horizontal to 4 vertical. It is used to measure medium discharges.

iii) The discharge through Cipoletti weir is computed by the following formula.

CALCULATION

1. Weirs

$$Q = CLH^m$$

where,

Q = discharge L = length of crest

C = a coefficient H = head of the crest

m = an exponent depending on weir opening

2) Rectangular weir

i. Suppressed rectangular weir : $Q = 0.0184\ LH^{3/2}$

ii. Contracted rectangular weir : $Q = 0.0184(L-0.2)H^{3/2}$

where,

Q = discharge (lps)

L = length of crest (cm)

H = head over the weir (cm)

3) Trapezoidal weir (Cipoletti weir)

$$Q = 0.0186\ LH^{3/2}$$

where, L = Length of crest (cm)

H = Head over the weir (cm)

$Q = 0.0186\ LH^{3/2}$

where, L = Length of crest (cm)

H = Head over the weir (cm)

2. Parshall flume (Venturi flume)

i) This has been designed by Parshall in the year 1950 and hence named after him.

ii) Parshall flume is an open channel type measuring device that operates with a small drop in head.

iii) It is a self cleaning device.

iv) Sand or silt in the flowing water does not affect its operation or accuracy.

v) It gives reasonably accurate measurement even when partially submerged.

vi) Flumes of 7.5, 15, 25 and 30 cm sizes are generally used in field measurement.

3. Orifices

i) Orifices are circular or rectangular openings in a vertical bulkhead through which water flows.

ii) They may be operated under free flow or submerged flow conditions.

iii) Under free flow conditions the flow from the orifice discharges entirely into the air.

iv) In submerged flow orifices, the downstream water level is above the top of the opening and the flow discharges into water.

v) Free flow orifice plates can be used to measure comparatively small streams like the flow into border strips, furrows or check basins.

vi) In submerged flow orifice, plastic scale may be fixed on the upstream face to the orifice plate such that the zero of the plastic scale coincides with the centre of the orifice.

vii) The discharge through an orifice is calculated by the following formula.

$Q = 0.61 \times 10^{-3}\ a \sqrt{2gh}$

where,

Q = discharge (lit/sec)

a = area of cross section of the orifice (cm^2)

g = acceleration due to gravity (cm/sec^2)

H = depth of water over the centre of the orifice (cm)

4)Parshall flume

5) Orifices

$$Q = 0.61 \times 10^{-3}\ a \sqrt{2gh}$$

where,

Q = discharge (lit/sec)

a = area of cross section of the orifice (cm^2)

g = acceleration due to gravity (cm/sec^2)

H = depth of water over the centre of the orifice (cm)

INFERENCE:

PROBLEM:

1. Calculate the discharge rate of water of a suppressed rectangular weir 50 cm long with a head of 12 cm.
2. Calculate the discharge rate of water of a contracted rectangular weir 40 cm long with a head of 10 cm.
3. Calculate the discharge rate of water of a 90^0 V-notch with a head of 12 cm. Solution : By using the formula

VIVA QUESTIONS:

1. What are the measuring devices for direct discharge method?
2. Write the formula for weirs
3. Write the formula for rectangular weir ?
4. Write the formula for 90^{0} V -notch?
5. Write the formula for orifices?

Ex.No.	7	EVALUATION OF SURFACE IRRIGATION
Date		

AIM:

Irrigation requirement is the total amount of water applied to the land surface in supplement to the water supply through rainfall and soil profile, to meet the water needs of crops for optimum growth.

PROCEDURE

Net irrigation requirement (NIR)

- Net irrigation requirement is depth of irrigation water, exclusive of precipitation, carry over soil moisture or ground water contribution or other gains in soil moisture that is required consumptively for crop production.
- Net irrigation requirement is the amount of irrigation water just required to bring the soil moisture content in the root zone depth of the crops to field capacity.
- Thus net irrigation requirement is the difference between the field capacity and the soil moisture content in the root zone before application of the irrigation water.
- This may be obtained by the relationship given below

$$d = \sum_{i=1}^{n} [(Mfci - Mbi)/100] x\ Ai\ xDi$$

Where,

d = net amount of water to be applied during an irrigation, cm

Mfci = Field capacity moisture content (per cent, w/w) in the ith layer of the soil,

Mbi = Moisture content before irrigation in the ith layer of the soil, %

Ai = Bulk density of the soil in ith layer

Di = Depth of the ith soil layer, cm, within the root zone and

n = Number of soil layers in the root zone.

PROBLEMS

1. A stream of 135 litres/sec. was diverted from a canal and 100 litres /sec. were delivered to the field. An area of 1.6 ha was irrigated in 8 hours. The effective depth of root zone was 1.8 m. The run off loss in the field was 432 m^3. The depth of water penetration varied linearly from 1.8 m at the head end of the field to 1.2 m at the tail end. Available moisture holding capacity of the soil is 20 cm/m depth of soil. Calculate water conveyance efficiency, water application efficiency, water storage efficiency and water distribution efficiency, irrigation was started at a moisture depletion level of 50 per cent of the available moisture.

2. A stream of 140 lps was diverted from a canal and 110 lps was delivered to the field. An area of 1.5 ha was irrigated in 8 hrs. The effective depth of root zone was 1.6 m and run off during irrigation was 430 m^3. The depth of water penetration varied linearly from 1.6 m at head end to 1.2 m at tail end. AMHC of soil is 25 cm/m depth of soil. Irrigation was started at 50% depletion of available moisture. Calculate water conveyance, water application, water storage and water distribution efficiencies.

Gross irrigation requirement (GIR)

- The total amount of water applied through irrigation is termed as gross irrigation requirement.
- In other words, it is net irrigation requirement plus losses in water application and other losses.
- The gross irrigation requirement can be determined for a field, for a farm, for an outlet command area or for an irrigation project, depending on the need, by considering the appropriate losses at various stages of the crop.

Gross irrigation requirement (in field)

Net irrigation requirement/ Field efficiency of system

The gross irrigation requirement at the field head, can be determined as follows:

$$\text{GIR} = \sum_{i=1}^{n} d/E$$

Where,

GIR = Seasonal gross irrigation requirement at the field head, cm

d = Net amount of water to be applied at each irrigation, cm

E application = Water application efficiency and

n = Number of irrigations in a season

Irrigation frequency

- Irrigation frequency refers to the number of days between irrigations during periods without rainfall.
- It depends on the consumptive use rate of a crop and on the amount of available moisture in the crop root zone and is a function of crop, soil and climate.
- In designing irrigation systems, the irrigation frequency to be used is the time (in days) between two irrigations in the period of highest consumptive use of the crops grown.
- The irrigation frequency may be computed as follows:

$$\text{Irrigation frequency} = \frac{Design\ depth\ of\ Irrigation}{Evapotranspiration(\frac{cm}{days})}$$

Design depth of Irrigation = Field capacity – Existing moisture content

PROBLEM

IRRIGATION EFFICIENCY

Irrigation efficiency indicates how efficiently the available water supply is being used, based on different methods of evaluation. The objective of efficiency concept is to show where improvements can be made, which will result in more efficient irrigation. Various efficiency terms are:

1. Water conveyance efficiency

This term is used to measure the efficiency of water conveyance systems associated with the canal network, water courses and field channels. It is also applicable where the water is conveyed in channels from the well to the individual fields. It is expressed as follows:

$$Ec = (Wd/Wf) \times 100$$

Where,

Ec = Water conveyance efficiency, per cent

Wd = Water delivered to the irrigated plot (at the field supply channel)

Wf = Water diverted from the source

2. Water application efficiency

After the water reaches the field supply channel, it is important to apply the water as efficiently as possible. A measure of how efficiently this is done is the water application efficiency, expressed as follows:

$$Ea = (Ws/Wd) \times 100$$

Where,

Ea = Water application efficiency, per cent

Ws = Water stored in the root zone of the crop

Wd = Water diverted to the field (at the supply channel)

3. Water storage efficiency

The water storage efficiency refers how completely the water needed prior to irrigation has been stored in the root zone during irrigation. It is expressed as :

$$Es = (Ws/Wn) \times 100$$

Where,

PROBLEM

Es = Water storage efficiency, per cent

Ws = Water stored in root zone during irrigation

Wn = Water needed in root zone prior to irrigation

4. Water distribution efficiency

Water distribution efficiency indicates the extent to which water is uniformly distributed along the run. It is expressed as :

$$Ed = [1- \frac{y}{d}] \times 100$$

Where,

Ed = Water distribution efficiency, per cent

d = Average depth of water stored along the run during the irrigation

y = Average numerical deviation from d

5. Water use efficiency

The water utilization by the crop is generally described in terms of water use efficiency (kg/ha-mm or q/ha- cm). It can be defined in following ways:

(i) Crop water use efficiency:

It is the ratio of crop yield (y) to the amount of water depleted by the crop in the process of evapotranspiration (ET).

$$\text{Crop water use efficiency} = Y/ET$$

(ii) Field water use efficiency:

It is the ratio of crop yield (y) to the total amount of water used in the field (WR)

$$\text{Field water use efficiency} = Y/WR$$

PROBLEM

INFERENCE

VIVA QUESTIONS

Problem 1

A persian wheel discharges at the rate of 11,000 litres per hour and works for eight hours each day. Estimate the area commanded by the water lift if the average depth of irrigation is 8 cm and irrigation interval is 15 days.

Problem 2

A tube well with an average discharge of 10 litres per second irrigates one hectare cotton crop in 15 hours. Calculate the average depth of irrigation.

Problem 3

Wheat crop requires 45 cm of irrigation water during crop season of 125 days. How much area can be irrigated with a flow of 18 litres per second for 10 hours each day.

Problem 4

Find out net and gross irrigation requirement with the help of following data :

(i) FC of soil = 21 %

(ii) Moisture content before irrigation = 7%

(iii) Depth of soil = 30 cm

(iv) Apparent density of soil = 1.5 Mg / m3

(v) Field efficiency = 70 %

PROBLEM

Problem 5

After how many days will you apply water to soil if

(i) FC of soil = 28 %

(ii) PWP = 13%

(iii) Apparent density of soil = 1.3 Mg /m^3

(iv) Effective depth of root zone = 70 cm

(v) Daily CU of water for the crop = 12 mm

Problem 6

Calculate irrigation interval on the basis of following data

(i) FC = 20 %

(ii) PWP = 8%

(iii) Bulk density = 1.4 Mg /m3

(iv) Root depth = 60 cm

(v) ET rate = 0.5 cm / day

Allowable soil water depletion is equal to 25 per cent of available soil water.

CALCULATION

Ex.No.	8	DETERMINATION OF UNIFORMITY COEFFICIENT FOR DRIP IRRIGATION SYSTEM
Date		

AIM:
To determine the uniformity coefficient for drip irrigation system

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Pump	1
2.	Header Assembly	1
3.	Filters – Hydro cyclone, Sand, Screen Filter	1
4.	Fertigation Equipment - Ventury Injector, Fertilizer Tank, Injector Pump	1
5.	Main Line	1
6.	Submain Line	1
7.	Pressure gauge	1
8.	Air release valve	1
9.	Catch cans	18

PROCEDURE

1. Select a container for determining flow rate determination (approx. 50 ml)
2. Choose 18 emitters at random in the sub main unit and measure the time taken to fill the container
3. Write the times (t) in descending order
4. Find out the sum of first three values (t_{us})
5. Find out the sum of last three values (t_{ls})
6. Use the following formula to find out the value of Variation of Discharge (V_q). Variation below 10 % is good and variation between 10 % to 20 % is acceptable. Variation between 20 % to 30% is not very bad. Variation above 30 % is unacceptable

$$V_q = 0.667 \frac{tus-tls}{tus+tls} \text{ x } 100$$

INFERENCE

VIVA QUESTIONS:

1. What is meant by Uniformity coefficient?

2. What are the advantages of drip irrigation system?

3. Write a formula Variation of Discharge

4. What are the components of drip irrigation?

5. What is the operating pressure of drip irrigation system?

DIAGRAM

CALCULATION

Ex.No.	9	DETERMINATION OF UNIFORMITY COEFFICIENT FOR SPRINKLER IRRIGATION SYSTEM (CATCH CANS)
Date		

AIM:
To determine the uniformity coefficient for sprinkler irrigation system

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Pump	1
2.	Header Assembly	1
3.	Main Line	1
4.	Submain Line	1
5.	Pressure gauge	1
6.	Air release valve	1
7.	Sprinkler head	1
8.	Catch cans	18

PROCEDURE:

1. Approximately 50 ml catch cans are kept in the field on 2 m x 2m grid
2. Operate all the sprinklers for specified amount of time
3. Find out the volume of water collected in each can
4. Find out the opening of the can
5. Divide the volume of water collected by the area of opening of can to get the depth of water applied at each can
6. Then the formula can be used for finding the uniformity of sprinkling

$$CU = 100 \text{ X } [1 - \frac{\sqrt{\frac{\sum_i^n (z-m)^2}{n}}}{m}]$$

Where,
CU = Coefficient of Uniformity
Z_i = Volume of water applied at the location of each can
m = Mean of water applied in all locations of cans
n = Total number of cans

If the uniformity values obtained from this formula is above 80 % then the design and installation is said to be satisfactory

PROBLEM

INFERENCE

PROBLEM

1. Following are the volume of water (cm^3) collected in each cans from the sprinker catch can test by operation of four sprinklers for 2 hours. Find out the coefficient of uniformity and say whether the value of uniformity is satisfactory. The surface area of opening of each catch can is 20 cm^2. Find out the average precipitation rate

VIVA VOCE

1. What is meant by Uniformity coefficient?

2. What are the advantages of sprinkler irrigation system?

3. Write a formula uniformity coefficient

4. What are the components of sprinkler irrigation?

5. What is the operating pressure of sprinkler irrigation system?

DIAGRAM

Ex.No.	10	TO CONDUCT EXPERIMENT ON DISC FILTER FOR MICRO IRRIGATION SYSTEMS
Date		

AIM:

To study the concept on disc filter for micro irrigation system

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Disc Filter	1

PROCEDURE

1. Disc filters are used to filter small size particles that cannot be separated by sand filter
2. They contain discs with diagonal grooves
3. When the disc are placed one over the other, openings occurs
4. The cross section of opening changes as one moves diagonally
5. The filter needs to be cleaned periodically
6. If arrangements are made to reverse the direction of flow, the accumulated impurities can be removed easily.
7. This filter may cause a pressure head loss of 2m to 3m

INFERENCE:

VIVA VOCE

1. What is the purpose of using disc filter?
2. What is the pressure head loss of disc filter?
3. Write maintenance of disc filter?
4. What is meant by clogging?
5. What is difference between disc filter and sand filter?

DIAGRAM

CONTENT BEYOND SYLLABUS

Ex.No.	11	DETERMINE THE SOIL MOISTURE USING TENSIOMETER
Date		

AIM:

To determined the soil moisture using tensiometer. The measurement of capillary pressure or moisture tension can be used to determine moisture deficiencies and irrigation requirement after suitable calibration.

APPARATUS REQUIRED:

S.No.	COMPONENT / EQUIPMENT	QUANTITY
1.	Tensiometer	1

PROCEDURE

Construction

Tensiometer consists of a porous ceramic cup filled with water which is buried in the soil at desired depth, a water filled tube and a manometer or vacuum gauge. The vacuum gauge indicates the pressure drop on the water in the porous cup which is in equilibrium with the matric potential of the water in the soil. The scales are calibrated in either hundredths of an atmosphere or in cm of water.

Installation and method of determination

Before placing in soil at particular depth, the connecting tube and ceramic cup is filled with deaerated water and saturated properly. While fixing, the cup must make a good contact with soil. When the saturated porous cup is installed in soil, water from cup moves through the tip until pressure inside and outside the ceramic cup is equal. As the soil water is depleted by root action or replenished by rainfall or irrigation, corresponding changes in reading on the tensiometer occurs. The pressure developed in complete system is measured with the help of mercury manometer or vacuum gauge. At a particular pressure, water content is measured only by calibration and irrigation is practised at pre-decided depletion of available water at particular depth if tensiometers are installed at different soil depths.

TABULATION

S.No	Time elapsed	Soil moisture tension

Limitations

1. Working range of tensiometer is only up to 0.85 bar, when tension increases beyond this, air begins to enter the cup and it becomes useless. Hence, it is suitable to use in sandy soils only.
2. Necessity for recharging after entry of air in the cup,
3. The tendency for roots to become concentrated around the porous cup.
4. Small air pockets may develop periodically if deaerated water is not used.

Precautions

1. Before installation, tensiometer should be filled with deaerated water to avoid air pockets.
2. A hole prepared for ceramic cup at particular soil depth should be such that the diameter of cup and hole is same and having good contact between soil and cup. In loose soil, it may be inserted without making hole.
3. Taking observations in early morning is desirable as water movement in plant and soil is practically negligible. After installation stable reading may be obtained after 24 hours.

INFERENCE

VIVA QUESTION

1. What are the different methods to find out soil moisture content?

2. What is the principle involved in tensiometer?

3. What is the advantage of tensiometer?

4. What is the precaution involved in tensiometer?

5. What are the limitations involved in tensiometer?