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Subject : Irrigation Engineering

Semester : 6th

Section : "B"

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Question no: 01

Part (a): Define Delta and Duty and derive their relationship in MKS and FPS systems.

Delta (Δ): The total quantity of water or depth of water, required by a crop throughout its growth period / Base period is called Delta.

⇒ Each crop requires a certain amount of water after a certain fixed interval of time, throughout its period of growth or Base period.

⇒ The depth of water required every time, generally varies from 5-10cm depending upon the type of crop.

Duty (D): Duty of water represents the irrigating capacity of a unit water. It is the relationship between the volume of water and the area of crop it matures.

⇒ It is denoted by "D"

⇒ Volume of water is generally expressed by a unit discharge flowing for a time of base period of the crop.

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⇒ 1 cu.m per Second / 1 cu.ft per Second of water for B-days matures D-hectares of land. Then the duty of water for that particular crop is D-hectare/cumecs or D acres/cusecs.

Relationship of Delta and Duty in MKS:

Let D = Duty (hectares/cumecs)

Δ = Delta = A meters Base period

⇒ One cumec of water flowing continuously for "B" days gives a depth of water "A" over an area of "D" hectares.

⇒ volume of water @ $1m^3$ sec in one day = $1*24*60*60$

$= 86400m^3$

⇒ volume of water @ $1m^3$ sec in "B" days = $1*24*60*60$

$= 86400B.m^3$

$= 86400m^2.m$ —(i)

As 1 Hectare = $10000m^2$

$1m^2 = 1104H$

Then equation (i) becomes:

volume of water @ $1m^3.sec$ in "B" days = $86400Bm^3$

$= 86400*1104$ H-m

volume of water @ $1m^3.sec$ in "B" days = $8.64*B$ H-m —(ii)

Depth of water required by crop (A) = $8.64*\frac{B}{D}$ Ha-m = DHA

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Hence $\Delta = \frac{8.64B}{D.m} \Rightarrow \Delta = \frac{8.64B}{D.cm}$

Relationship of Delta and Duty in FPS System:

Let Duty = D (Acres/cusecs)

Delta = A feet Base period = B days

⇒ One cusec of water flowing continuously for "B" days gives a depth of water "A" over an area of "D" acres.

Volume of water @ $1ft^3$ sec in one day = $1*24*60*60$

$= 86400\ ft^2\ ft$ —— (i)

As $1 acre = 43560 ft^2$

$1 ft^2 = \frac{1}{43560} Acre$ Then equation (i) becomes,

Volume of water @ $1ft^2$ sec in "B" days = $86400\ B.ft^3$

$= 86400B * \frac{1}{43560} Acre\text{-}ft$

Volume of water @ $1ft^3$ sec in "B" days = $1.983 * B\ Acre.ft$ (ii)

Depth of water required by a crop, A = Volume / Area A =

$\frac{1.983B.Acre/ft.D}{Acre}$

Depth of water required = $\Delta = 1.983\ B/D.ft$

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Question no: 01

Part (b): If wheat requires about 9cm of water after every 35 days and the base period or crop period of wheat is 140 days. Find out the Delta (Δ) for wheat?

Given Data: Base period = 140 days

No of days = 35 days

Required water = 9cm

Required Data: Delta (Δ) = ?

Solution: 9cm ⇒ 35 days ⇒ By Ratio Method

9cm ⇒ 140 days

$$\Delta = \left(\frac{140}{35}\right) * (35)$$

$$\boxed{\Delta = 36\,cm}$$

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Question no: 01

Part (c): Explain Indus water Treaty.

Indus Water Treaty: The water distribution treaty between India and Pakistan, brokered by the world bank, to use the water available in the Indus system of rivers located in India, is called Indus water Treaty.

⇒ It is signed in Karachi on September 19, 1960 by the Indian P.M Jawahalal Nehru and Pakistani President Ayub Khan.

Indian Rivers	Pakistani Rivers
(1) Ravi	(1) Jhelum
(2) Beas	(2) Chenab
(3) Sutlej	(3) Indus

↳ According to the agreement, control over the Eastern rivers (Ravi, Beas, Sutlej) with the mean annual flow of 33 or 34 million acre-ft (MAF) were given to India.

↳ while the control over western rivers (Jhelum, Indus, Chenab) with the mean annual flow of 80MAF was given to Pakistan.

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↳ Since Pakistan's rivers recieve more water flow from India, the treaty allowed India to use western rivers water for limited Irrigation use and unlimited use of power generation, domestic, Industrial and non-consumptive uses such as fish culture, navigation etc.

Role of World bank:

⇒ In 1951, David E. Lilienthal, former chairman of Tennessee valley Authority, visited India and Pakistan.

⇒ Lilienthal wrote an article with suggestions that ~~Indian~~ Indus Basin be treated, exploited and developed as single Unit.

⇒ Initially the world bank was reluctant to get involved.

⇒ world bank refuses loans to both countries.

⇒ world bank offered an impartial third party.

⇒ it offered an option taking into account both countries needs.

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Advantages of Indus Water Treaty:

(1). Canal and Reservior constructed financed through Bank.

(2). Commission to resolve future disputes.

(3). Treaty guaranteed 10 yeaus of Uninterrupted water Supply.

(4). Treaty allowed india to use the western riuers for Power Generation.

(5). India and Pakistan controversies ouer water ended.

(6). Pakistan got free from droughts feal.

Question no: 01

Part (D): Write Significance of Duty of a Crop?

Significance: It helps in designing efficient Canal irrigation System, knowing the total available water at the head of the main Canal and the Overall duty for all the crops required to be irrigated in different Seasons of the yeau, the area which can be irrigated can be worked out.

* Inversely if we know the crop area required to be irrigated and their duties, we can work out the dischauge required for designing the canal.

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Question no:02

Part (a): Explain the factors affecting consumptive use.

Ans: The following are the factors affecting consumptive use:

(i) Temperature
(ii) Humidity in air
(iii) Velocity of wind
(iv) Soil Topography
(v) Sunlight etc.

(i) Temperature:

The rate of consumptive use of water is probably affected by more by temperature, which for long-time periods is a good measure of solar radiation, then by any other factor.

Abnormally low temperatures retard plant growth and unusually high temperatures may produce dormancy.

(ii) Humidity in air:

The rate of consumptive use of water are accelerated on days of low humidity and slowed during periods of high humidity. During Periods of low relative humidity, greater rate of use of water by vegetation may be expected.

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(iii) Velocity of wind:

Evaporation of water from land and plant surfaces takes more rapidly when there is moving air then under calm air conditions. Hot, dry winds during growing period will effect the amount of water consumptively used.

However there is a limit in the amount of water that can be utilized. As soon as the land surface is dry, evaporation practically stops and transpiration is limited by the ability of the plants to extract and convey the soil moisture through the plants.

(iv) Soil Topography:

If a soil is made more fertile through the application of manure or by some other means, the yields may be expected to increase with an accompanying small increase in use of water. However, an increase in fertility of the soil causes a decrease in the amount of water consumed per unit of crop yield.

(v) Sunlight:

The Sun is the source of all energy used in crop growth and evaporation of water, this longer day may allow plant transpiration to continue for a longer period each day and to produce an effect similar to that of lengthening the growing season.

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Question no: 02

Part (b): Wheat is to be grown at a certain place, the useful rainfall for the whole season is 10cm and its commulative consumption use is 40cm. Determine consumptive irrigation requirement (CIR) and Field Irrigation Requirement (FIR) if the water application efficiency is 80%.

Given Data: ⇒ Useful rainfall for whole season = 10cm

⇒ Commulative Consumption use = Cu = 40cm

⇒ Water Application Efficiency = η_a = 80% = 0.8

Required: (i) Consumption Irrigation Requirement = CIR = ?

(ii) Field Irrigation Requirement = FIR = ?

Solution: (i) $CIR = Cu - Re$

Re = effective rainfall

$CIR = 40 - 10$

$\boxed{CIR = 30cm}$

(ii) $FIR = CIR / \eta_a$

$FIR = 30 / 0.8$

$\boxed{FIR = 37.5cm}$

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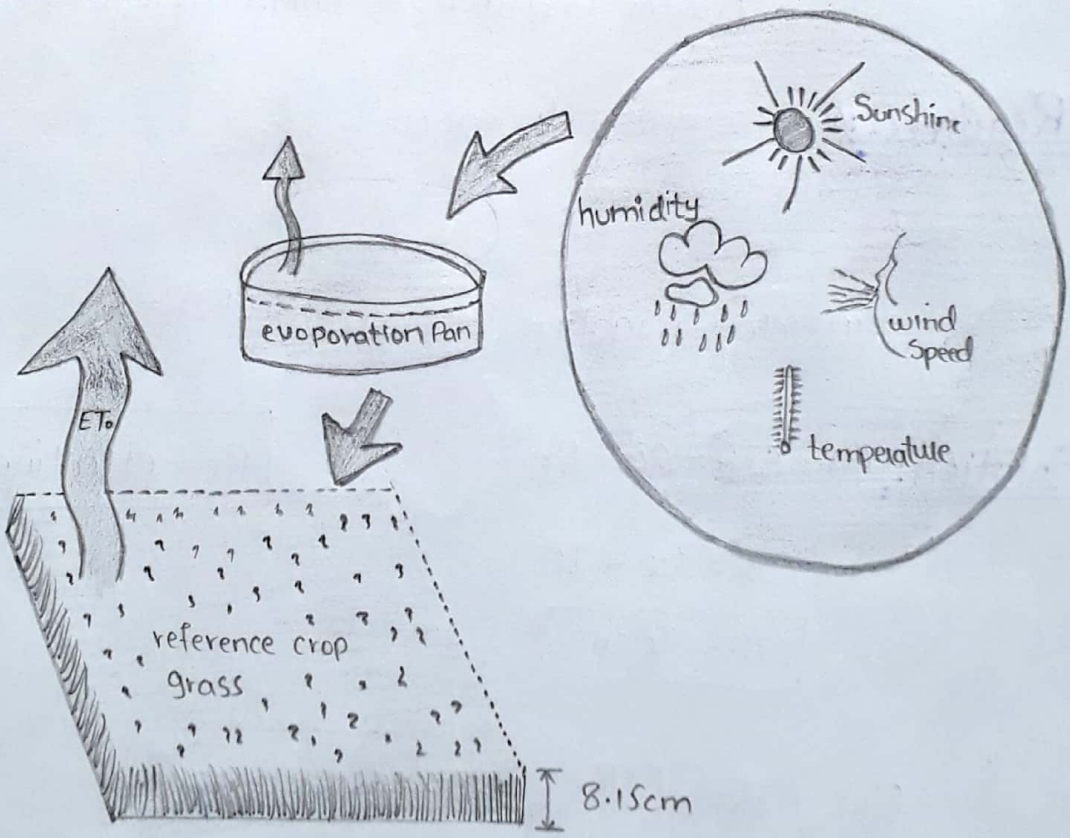
Question no: 02

Part (c): Explain Class A Pan Evaporation (Ep) measurement with the help of a diagram.

Class A Pan Evaporation measurement: Ep can be experimently determined by directly measuring the quantity of water evaporated from this standaud class a pan. This Pan is 1.0m in diameter, 25cm deep and bottom is raised 15cm above the ground surface. The depth of water is to be kept in a fixed range such that the water surface is atleast 5cm, and never more than 7.5cm, below the top of pan.



▲ Class A Pan Evaporation

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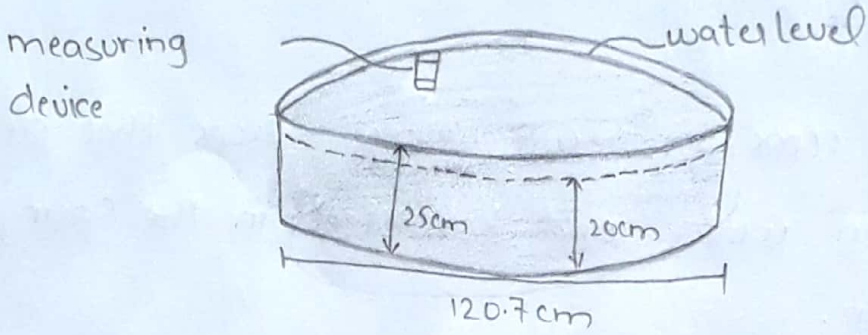

Evaporation Pan

⇒ The pan evaporation Ep can also determined by using the christiansen formula which states

⇒ $Ep = 0.459 \; R \cdot Ct \cdot Cw \cdot Ch \cdot Cs \cdot Ce$

* R = extra Terrestrial radiation in the same units as Ep in cm or mm.
* Ct = Coefficient for temperature
* Cw = Coefficient for wind velocity.
* Ch = Coefficient for relative humidity.
* Cs = Coefficient for percent of possible sunshine
* Ce = Coefficient for elevation.

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Question no: 02

Part (d):

Rabi: Rabi crops are agricultural crops that are sown in winter and harvested in the Spring in Pakistan.

⇒ These crops are having there growth period from 1st october to 31st mauch.

⇒ Rabi crops are wheat, Bailey, Gram, Mustaud.

⇒ These crops are either grown with rainwater that has percolated in ~~rainwater~~ ground.

⇒ A good rain is not good and can spoils the rabi crops.

Kharif: Khaif crops are grown after the rabi crops.

⇒ These crops are having there growth period from 1st april to 30th septembei.

⇒ ~~Rabi~~ Kharif crops are Rice, Bajra, Jawar, Maize, cotton.

⇒ A good rainfall is good for Khaif crops.

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Kharif Rabi ratio: The area to be irrigated for rabi crops generally more then that of Khaif crops. The ratio of proposed areas, to be irrigated in Khaif Season to that in Rabi Season is called Khaif rabi ratio. The ratio is generally 1:2 i.e. Khaif area in one half of Rabi area.

Question no: 03

Define and Explain the terms.

Part (a): Field Capacity: When all gravity water has drained down to water table, a certain amount of water is retained by surface soil. This water which cannot be easily drained under the action of gravity and is called F.C.

Period of drainage = 2-5days.

FC is measured after 2 or 5days.

(1) Capillary water: water attached to soil by surface tension, which can easily be extracted by plants by capillary action.

(2) Hygroscopic water: water attached to soil by chemical bonds, which cannot be extracted by plants by capillary action.

$$\text{Field Capacity} = \frac{\text{weight of water retained in certain volume of soil}}{\text{weight of same volume of soil}} * 100$$

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(b) Permanent Welting Point: A Plant can extract water from soil till a permanent wilting is reached. PWP is that water content at which a plant can no longer extract sufficient water for its growth and wilts up.

(c) Available and readily available moisture Contents:

Available moisture content: The difference in moisture content of soil b/w field capacity and permanent wilting is termed the available moisture. Available moisture content is expressed as percentage moisture PW as Percentage PV or as depth.

readily moisture Content: It is the water that a plant can easily extracted from the soil.

* it is approximately 75- 80% available moisture.

(d) Optimum Utilization of water: The yield increase with water can reached a certain maximum value and then falls down. The quantity of water at which the yield is maximum is called the optimum water depth. Therefore the optimum utilization of water means getting maximum yield with any amount of water.

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