IRRIGATION Engineering

Topics to be discussed;

GATE : 3-4 marks

ESE : objective → (7-10) questions

Conventional → (25-40) marks

1. Introduction ★★★
2. Soil plant relationship ★★★
3. Water requirement of Crop ★★★
4. Canal design ★★★
5. Sediment transport
6. Lining of Canals
7. Reclamation of waterlog & saline soil
8. Design of Gravity Dam ★★★
9. Theory of Seepage
10. Miscellaneous
    a) River training
    b) Head work
    c) Cross-drainage works } and their design
    d) Modules
    e) Canal fall } Canal Regulation work

1. Introduction

→ Irrigation may be defined as process of supplying water to the field by artificial means for the purpose of cultivation, i.e, in accordance with crop requirement throughout the crop period for optimum growth of crops.

Note :-

→ Crop period is the time period from the instant of sowing to the instant of harvesting.

→ Necessity of irrigation ;

i) In-adequate rainfall

ii) Uneven distribution of rainfall

iii) Increase in Crop yield

iv) Growing perennial crops → Sugar cane (Perennial ?)

v) Growing 2-3 crops in a year

vi) Prevention from drought and Famine Condition

→ Advantages of Irrigation ;

Direct advantages ;

i) Increase in Crop yield

ii) Prevention from Drought and Famine Conditions

iii) Elimination of mixed-cropping

Note :-

→ Mixed-cropping means growing two or more crops simultaneously in the field.

Advantages ;

→ Mixed-cropping is found economical and necessary when irrigation facilities are lacking, i.e, its weather conditions are not suitable for one of the crop they may be suitable for other crop and hence farmer will get some yield from the Area.

Disadvantages ;

→ Different crops requires different type of field preparation, watering and manuring, since it will be difficult to satisfy need of both the crops simultaneously in the same field, it will cause low yield

→ Also at the time of Harvesting crops would get intermixed, thereby reducing its purity and value in the market.

Indirect advantages ;

i) Power generation → Ganga and Sharadha Canal system (80 MWatt Hydropower)

ii) Transportation → Road and Inland Navigation

iii) Ground water recharge

iv) Domestic and industrial water supply

v) Flood control

vi) Employment generation

→ Disadvantages of Irrigation ;

i) Water logging

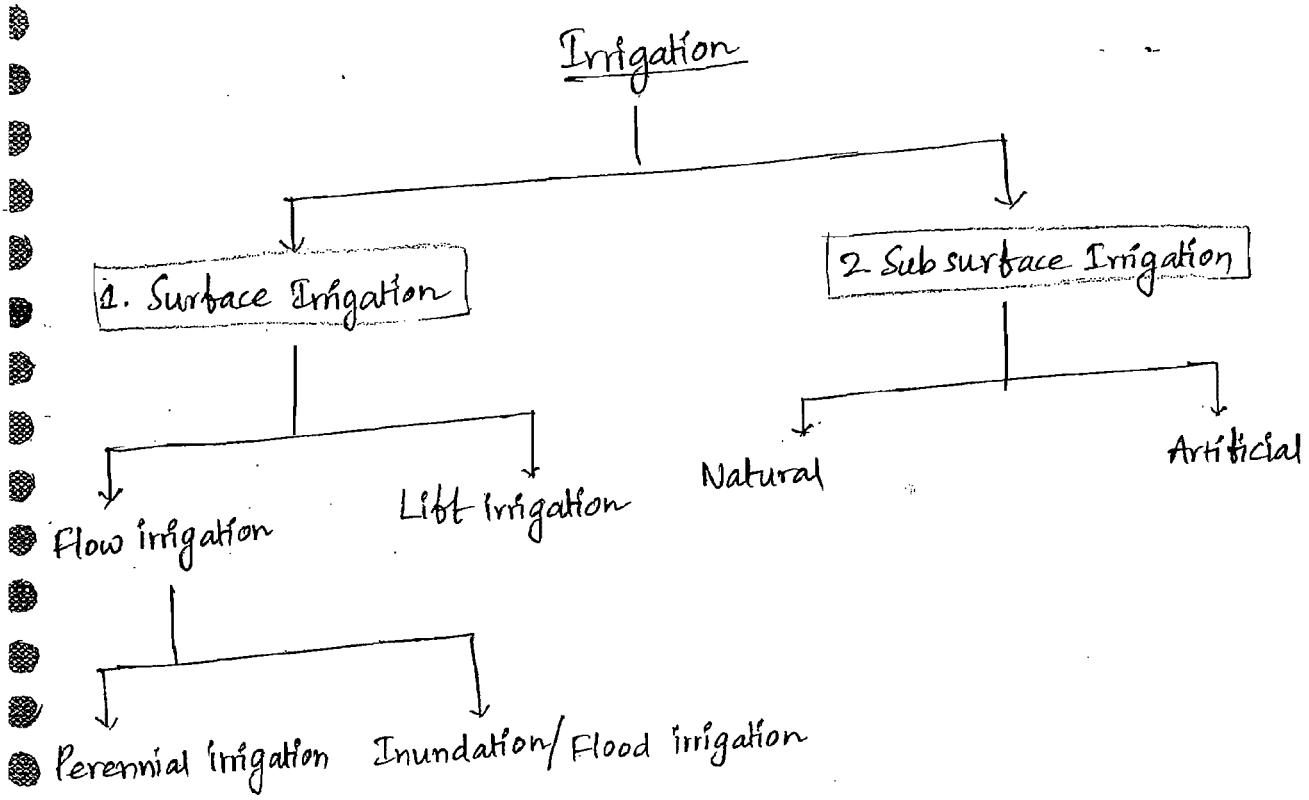
ii) Intense irrigation results in Cold and Damp climate which may cause spreading of disease like Dengue and malaria.

iii) Ground water pollution due to percolation of fertilizers

Note :-

→ These ill effect can be reduced or eliminated by economical and scientific use of water.

→ Types of Irrigation :-



1. Surface Irrigation ;

→ Surface irrigation is a method in which water is directly applied to the soil surface either by gravity or by pumping.

→ It is best suited for soil with low or moderate infiltration capacities and in the area where slope is gentle.

→ Surface Irrigation can be further classified into ;

i) Flow Irrigation ;

→ If water is available at higher elevation and it is supplied to lower level under the action of gravity. it is called as " Flow irrigation".

ii) Lift Irrigation ;

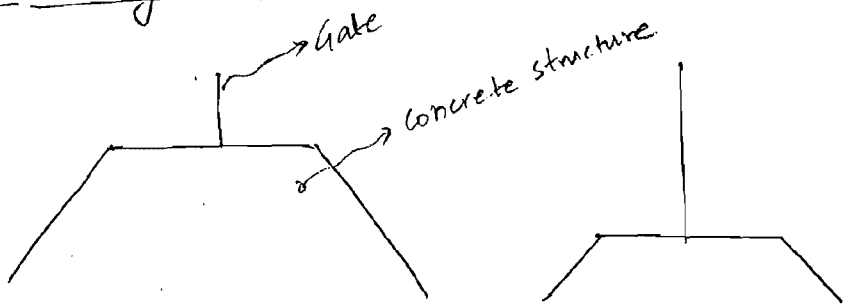
→ If water is lifted by some mechanical or manual means and it is supplied to the agriculture field, it is called as " Lift irrigation".

Ex:- Pump, well and Tube well.

→ It is costlier than Flow irrigation.

→ Flow irrigation can be classified as;

i) Perennial Irrigation;



* weir * Barrage

→ If a constant and continuous water is supplied to the agriculture field as per requirement of crops throughout the crop period, it is called as 'Perennial Irrigation'.

) Direct Irrigation → By diverting river runoff into a canal with the help of weir or Barrage across the river.

Ex: Ganga Canal System.

) Storage irrigation → System of Dam and channels.

Ex: Ramganga Dam project (it is in Uttarkhand).

) Inundation/Flood Irrigation;

→ In this system of Irrigation a large quantity of water flowing in a river during the floods is allowed to flood or Inundate the Area which is to be cultivated, it causes saturation of the area.

, After excess water is drained off then this area is used for cultivation.

. Subsurface Irrigation;

, In this type of Irrigation system water does not wet the soil surface rather it is directly supplied to the root zone of the plants.

'It is classified into two types;

i) Natural Subsurface Irrigation ;

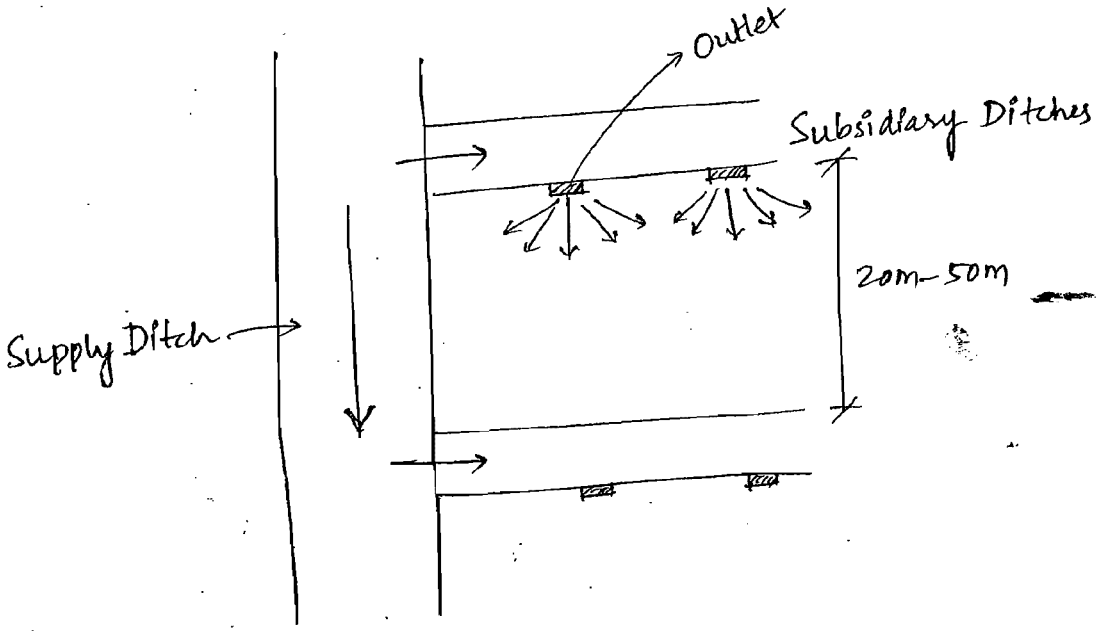
→ In this system water seeping through channels and water bodies may irrigate crops grown on the lower area by capillarity

ii) Artificial Subsurface Irrigation ;

→ In this system, water is directly supplied to the root zone of the plants by a network of perforated pipe laid below the soil surface.

→ Techniques of Irrigation :-

1. Free Flooding / Ordinary Flooding ;



→ In this method, Ditches are excavated in the field and water from these ditches flows across the field.

→ After water leaves the Ditches no attempt is made to control the flow, hence it is called as "wild flooding".

→ It is suitable for rolling terrain.

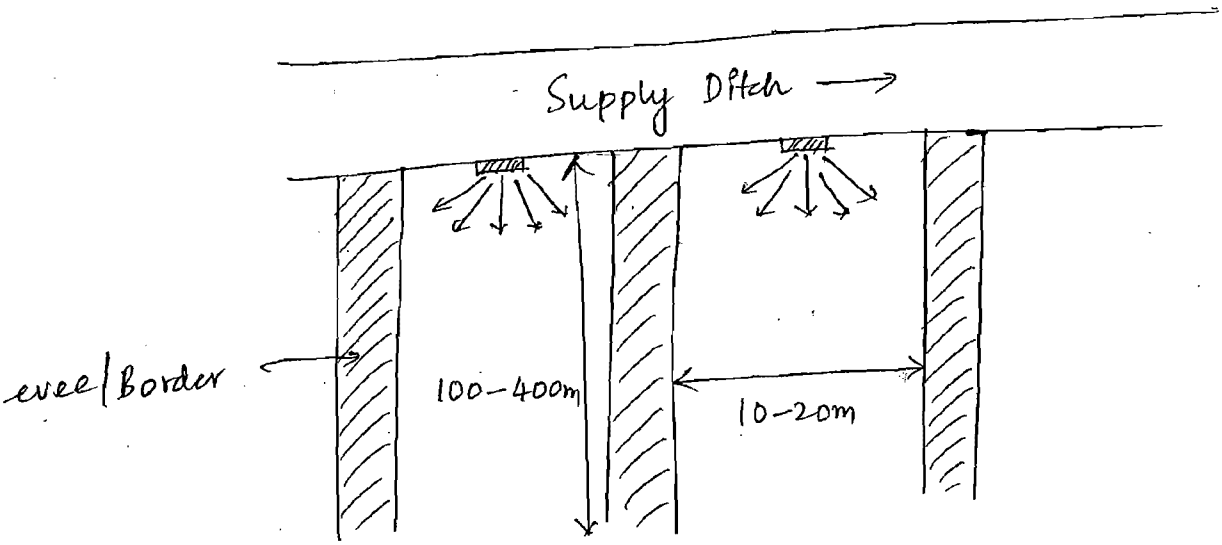
→ field preparation is low.

→ Irrigation efficiency is low

→ It is most suitable for close growing crops and pasture.

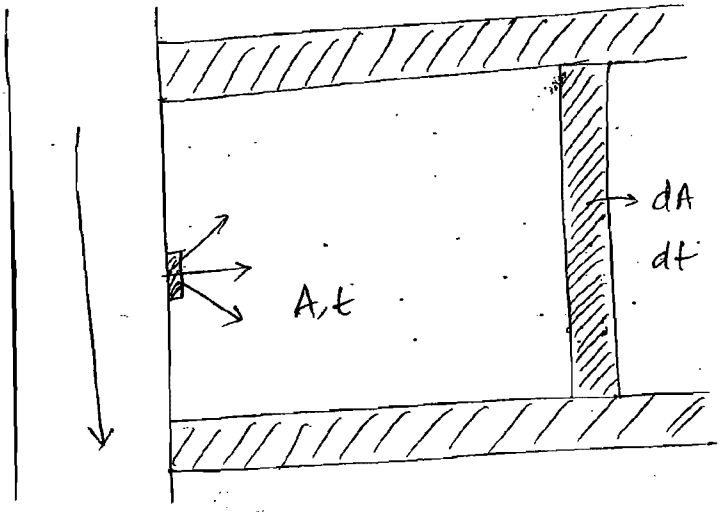
→ Subsidiary/lateral ditches are spaced 20–50m apart depending upon slope, type of soil, crops to be grown etc

. Border flooding ;



→ Area is divided into no. of strips seperated by low levees called "Border" along the slope of the ground.

→ Relation between Discharge through Supply Ditch (Q), Rate of ~~infiltration~~ of soil (f), Average depth of flow over the strip (y), Area to be irrigated (A) and Time required to irrigate the area (t) :-



→ Let dA area is covered in time dt

→ 'A' area is covered in time t.

→ therefore, $\boxed{Q\,dt = y\,dA + Af\,dt}$

for constant Q, y, and f

$$(Q - Af)\,dt = y\,dA$$

$$\int dt = \int \frac{y}{(Q-Af)}\,dA$$

$$t = y \cdot \ln (Q-Af) \times \frac{-1}{f} + C$$

$$= -\frac{y}{f} \ln (Q-Af) + C$$

Since, $t \to 0$; $A \to 0$

$$\therefore \boxed{C = \frac{y}{f} \ln Q}$$

$$\therefore t = -\frac{y}{f} \ln (Q-Af) + \frac{y}{f} \log Q$$

$$= \frac{y}{f} \ln \left(\frac{Q}{Q-Af}\right)$$

$$\therefore \boxed{t = 2.303 \frac{y}{f} \log_{10}\left(\frac{Q}{Q-Af}\right)}$$

⇒ Relation for A_{max} ;

when $t \to \infty$; $A \to A_{max}$

$$\to Q - A_{max} f = 0$$

$$\therefore \boxed{A_{max} = \frac{Q}{f}}$$

→ Size of the strip will depend on discharge Q, slope of the Area and soil characteristic f.

Q:- for Border strip method of Irrigation, Determine time required to irrigate a area of 0.04 ha with a help of a Tube well with a discharge of 0.02 m^3/sec. Infiltration Capacity of the soil may be taken as 5 cm/hour and Average depth of flow on the field is 10cm. Also determine maximum Area which can be irrigated from this Tube well?

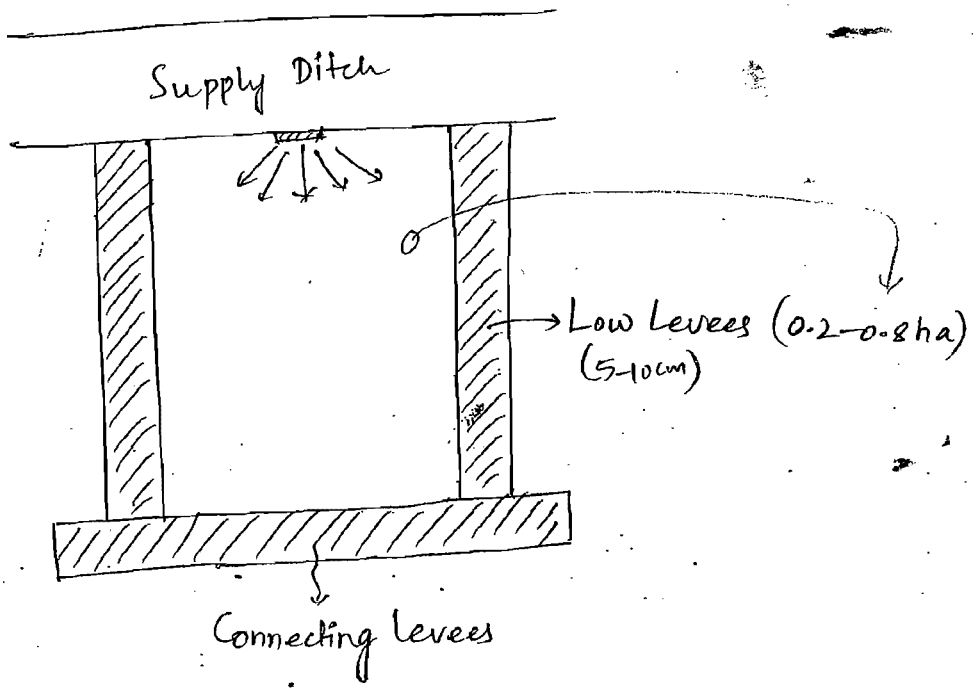
Sol:- $t = 2.303 \frac{y}{f} \log_{10}\left(\frac{Q}{Q - Af}\right)$

$= 2.303 \times \frac{10\,cm}{5\,cm/hr} \log_{10}\left(\frac{0.02}{0.02 - 0.04 \times 10^4 \times \frac{5 \times 10^{-2}}{3600}}\right)$ $\quad [1\,ha = 10^4\,m^2]$

$t = 0.65\,hr$

$\therefore A_{max} = \frac{Q}{f} = \frac{0.02}{\frac{5 \times 10^{-2}}{3600}} = 0.144\,ha.$

:. Check flooding / method of irrigation by plots;



→ In this method, Area to be irrigated is divided into small plots and check area (0.2–0.8 ha) with low flat levees constructed, having a vertical ht. of 5–10cm.