



# INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

## End-Spring Semester Examination 2022-23

Date of Examination: 20/04/2023 Session (FN/AN): AN Duration: 3 hrs. Full Marks: 50

Subject No.: AG31004

Subject: Irrigation & Drainage Engineering

Department/Center/School: Agricultural and Food Engineering

Specific charts, graph paper, log book etc., required : No

Special Instructions (if any): Assume reasonable data, if not given in the question

Q-1. A farmer uses canal water through field supply channel to irrigate his field of size 1.2 ha. The field has a crop with root-zone depth of 50 cm, before irrigation moisture content as 12%, field capacity moisture content as 25% and bulk density of field soil as 1.6 g/cc. If the measured discharge from canal to field supply channel is 150 l/s and at the field delivery point is 96 l/s, what will be the conveyance and field storage efficiencies for the irrigation time of 2.5 hours.

[05 marks]

Q-2. A most economical earthen channel section of rectangular cross-section was designed with a grade of 0.20% to supply water from source to field. If the width of the channel is 60 cm, what will be the velocity and discharge of water in the channel? (Manning's retardance coefficient of channel section = 0.018)

[05 marks]

Q-3. In a subsurface drainage network, 10 lateral drains laid at a spacing of 40m and each 150m long, join a collector drain. The average discharge at the outlet of the collector drain was 10 litre-per-second when the water table dropped from surface to 40cm below surface in 3 days. Find the average drainable porosity (in percentage) of the soil.

[05 marks]

Q-4. Calculate the required drain diameter if the length of each parallel drain is 300m, drain line slope is 0.2%, average percolation rate towards drain is 0.0026m/day, spacing between two drain is 60m, drain discharge is 0.000542 m<sup>3</sup>/sec, and Mannings roughness coefficient of the baked clay tile drains of smooth internal surface is 0.018.

OR

An urban catchment has an area of 85ha. The slope of the catchment is 0.006 and the maximum length of travel of water is 950m. The maximum depth of rainfall with a 25-year return period is as below:

Duration (min)	5	10	20	30	40	60
Maximum depth of rainfall (mm)	17	26	40	50	57	62

If a culvert for drainage at the outlet of this area to be designed for a return period of 25 years, estimate the required peak flow rate, by assuming the runoff coefficient as 0.3. [05 marks]



Q-5. Calculate the total head at pump, power requirement (water horsepower of the pump) and number of sprinklers required for a sprinkler irrigation system to be used to irrigate 25 ha of farm using following data: [07 marks]

- Soil texture: loam-to-silt loam.
- An infiltration test data showed that constant (basic) infiltration rate ( $I_b$ ) is 2 mm/h and hardpan (relatively impervious layer) exists at a depth of 2.0 m below the soil surface.
- Field Capacity moisture content 42% and Permanent Wilting Point (PWP) of about 42% (by volume) and 26% (by volume), respectively.
- Long-term average reference evapotranspiration ( $ET_o$ ) rate in that area is 4.5 mm/day.
- Vegetable crops are planned to grow in the farm, and the crop coefficient ( $K_c$ ) at maximum vegetative period is 1.0.
- The climate is moderately windy in a part of the season. Pump Operation duration is 4 hours per setting and application efficiency is 80%.
- $D_{ml}$  and  $D_{ml}$  - manufacturers rated wetting diameter of mainline and lateral sprinklers are 12m and 10 m respectively. Manufacturer specified overlapping factor  $F = 0.7$ .
- $H_m$ : Pressure head required to operate the sprinklers at minimum required pressure = 28.05m.
- Frictional head in the pipes = 5% of  $H_m$ , Bend and minor losses = 0.05.
- Maximum riser height from the pump level (m) = 1.5 m.
- Delivery head including friction loss in the delivery pipe and velocity head = 5m.
- Vertical difference between pump level and source water level (i.e. canal) after drawdown = 5 m, and friction loss in the mainline = 0.5 m.

Q-6. Write short notes on any six of the below terms:

- (i) Infiltration Opportunity Time, (ii) Dupuit-Forchheimer Assumptions, (iii) Equivalent Depth, (iv) Darcy's law with assumptions, (v) Venturi Injection System, (vi) Osmotic Problems in soil water zone, (vii) Tension Saturated zone, and (viii) Effective porosity

Q-7. Match the following:

[18 marks]

(a) Overland flow in border irrigation	I. Soil Salinity <b>f</b>
(b) Manning's velocity equation	II. Flow through saturated porous media <b>(e)</b>
(c) Central pivot system	III. Surface drainage
(d) Water application to soil surface as a small stream/fountain	IV. Infiltration through soil <b>(i)</b>
(e) Spaghetti tube and goof plug	V. Bubbler Irrigation
(f) Leaching Requirement	VI. Unsteady flow with decreasing discharge in open channel
(g) Herringbone system	VII. Sub-surface drainage <b>(g)</b>
(h) Impeded percolation in topsoil	VIII. Sprinkler Irrigation <b>(d)</b>
(i) Kostikov equation	IX. Drip Irrigation <b>c</b>
(j) Darcy's equation	X. Uniform flow in open channels <b>(b)</b>

[05 marks]