INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date of Examination: 2012 **Time** 3hours
Department: Agricultural and Food Engineering Department
Course: **Third Year B. Tech (Hons) in Agricultural and Food Engineering**
Subject: Irrigation & Drainage Engineering (No. AG 31004)
No. of Students: 45 **Max. Marks**: 50

Instructions: All questions are compulsory. Assume reasonable data if not available in question. Question paper consists of 2 pages.

1. (a.) The average drainable porosity of a soil is 0.15. Find the volume of water that will be retained in saturated soil column of 1 cm^2 area and 100 cm height, if the water table drops to 60 cm below the soil surface and find the corresponding moisture content. The bulk density of soil is 1.4g/cc and soil particle density is 2.7 g/cc. (4)

1. (b.) Define drainable porosity. Draw a diagram of an experimental setup for determination of drainable porosity. (3)

1. (c.) Write expressions for velocity of flow through **a.)** saturated porous medium, **b.)** an open channel and **c.)** a pipe and discuss their relationships. (3)

2. (a.) In the 100 days long rabi cropping season in semi arid region, average crop water requirement is 4 mm/day, which is met through surface irrigation at suitable irrigation interval with an application efficiency of 60 %. The electrical conductivity (EC) of irrigation water is 1 dS/m and electrical conductivity of the soil (ECe) is 5 dS/m, which is to be reduced to 2 dS/m by leaching. If leaching efficiency is 70% calculate the leaching requirement. (3)

2. (b.) What are relief and interceptor drains and where are they used? (2)

2. (c.) A watershed has total area of 50 km^2 with network of 4 drains. The contributing area to the first drain is 5 km^2. This drain joins at a point A with second drain contributing area of 22 km^2. At a downstream point B, the third drain joins which has a contributing area of 15 km^2. Finally, at a further downstream point C, the fourth drain joins which has contributing area of 8 km^2. (5)

Using Cypress Creek formula and proportionating the discharge in drainage channel, compute the design discharge for drain section from A to B, B to C and downstream from C up to outlet. Use Cypress Creek Coefficient (C) value as 1.05.

3. (a.) What are Dupit Forchheimer assumptions and their significance? (5)

Listing assumptions involved in development of Hooghougt's equation, obtain expression for spacing of subsurface drains.

3. (b.) In an area depth to water table is 1.4 m. A total of six irrigations of 10 cm each are applied at an interval of 15 days. The daily evapotranspiration loss is 5 mm. The drainable porosity of soil is 0.1. Find the water table after last irrigation if the initial water table is 1.4 m below the surface and 40 cm soil depth above water table is between field capacity and saturation. (5)

The drainage system is to ensure that the water table does lie in the top 1 m zone for more than 2 days. The depth of impervious layer is 3 m below the proposed drain level and soil is homogeneous with a K of 0.6 m/day. Estimate suitable drain spacing using Glover's formula.

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4. (a.) What are the variables influencing the hydraulics of border irrigation? How do they differ from those influencing furrow irrigation? (2)

4. (b.) Furrows 110 m long and spaced 90 cm apart and having slope of 0.2 % are irrigated for 45 min by an initial stream size equal to the maximum non erosive stream. The stream is then reduced to half and continued for 1 hr 20 min. Determine the average depth of irrigation. (2)

4. (c.) Amongst the two methods of pressurized irrigation systems, namely, sprinkler and drip which are the specific situations where sprinkler irrigation is more advantageous than drip irrigation. (2)

4. (d.) A 120 mm diameter aluminum sprinkler lateral has 20 equally spaced, 40 l/min sprinklers. The spacing between sprinklers is 12 m. The first sprinkler is 6m from the sub main. Determine the difference in pressure between up and down stream ends of the laterals for a difference in elevation between up and downstream ends of the laterals as **A)** 5 m and **B)** (-)5 m. Use Hazen William's constants as c= 591722, m=1.85 and n=1.17 C=130, The reduction factor F as 0.360. (4)

5. (a.) Design a drip irrigation system for 3 ha Citrus orchard to be grown in a hot arid region. The field is rectangular with a length of 300 m along the head end and a width of 100 m. The field is nearly flat and soil is sandy loam. The crop spacing is 3m x 3m. The irrigation water source is river flowing close to the top corner of the field. The maximum pan evaporation in the hottest month of May is 245.4 mm. Pan Coefficient is 0.8, the canopy coefficient/ wetting fraction is 0.6. The water application efficiency is 90 % and the duration of daily operation of the drip system is 2 hours. 100 m long 20 mm diameter lateral has head loss due to friction as 0.8 m. The drip system supplies water in three segments. The head loss due to friction in 85 mm main and 75 mm sub main is 0.9 m and 1 m respectively. Assume suction head as 5 m and head loss due to fittings and accessories as 7 m, the pump efficiency as 65 %, electric motor efficiency as 80 % and operating pressure for drippers as 10 m. (7)

Determine **a.)** Daily irrigation requirement, **b.)** Capacity of the system, **c.)** Number of laterals and drippers, **d.)** Total head requirement, **e.)** Horse power requirement for electric motor

5. (b.) What are the advantages of Fertigation over conventional methods of fertilizer application? List commonly used fertilizer injection devices in pressurized irrigation system. (3)