DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

Minor II: CEL 745 - WATER MANAGEMENT

Max. Marks: 40 Date: 19-03-2015

Time: 16.00 – 17.00 (1hr)

Note: (i) **Answer all questions from 1-4 and any two from 5-7**
(ii) Reasonably assume and state any data that are not provided
(iii) Marks for each question are indicated on the right side

1) Define

(a) Reference evapotranspiration. (2)

(b) Dual crop coefficient and draw dual crop coefficient curve (3)

2) A crop is to be grown in the following climatological conditions. Determine the evapotranspiration using Blaney-Criddle method $C_u = c(p(0.46T + 8))\ mm/day$ and consumptive irrigation requirement of the crop. Also, determine the field irrigation requirement if the water application efficiency is 80%. Adjustment factor, $c = 0.8$.

Month	Monthly temperature in ^{0}C	Monthly % of day time hr	Useful rainfall in cm
Nov	18.0	7.20	1.7
Dec	15.0	7.15	1.42

(5)

3) The infiltration characteristics of field can be expressed in $Z = 0.003\ \tau^{0.651} + 0.00022\ \tau$ where Z is in m^3/m^2 and τ is in minutes. The duration of advance phase is observed to be 160 min. The runoff is allowed for some time after advance phase. The duration of recession phase is estimated to be 55 min. If the required depth of irrigation is 9 cm and the design is aimed at complete irrigation, then when the inflow should be shut off? Assume that the depletion phase is negligible (5)

4) A canal diverts 150 litres/sec of discharge from the reservoir and delivers 125 litres/sec to the field of area 1.6 hectares, for a continuous period of 8 hours. Field is open draining, resulting to a total runoff loss of 420 m^3. Effective depth of root zone of crop cultivated is 1.7 m. The measured depths of water penetration are 1.7m and 1.1 m at head and tail end of the field respectively. Assume infiltration is linearly varying along the field. Available moisture holding capacity of the soil is 20cm per metre depth of soil. Irrigation was started at a moisture extraction level of 70% of the available moisture. Determine the conveyance efficiency, water application efficiency, water storage efficiency, and water distribution efficiency. Also, determine the total efficiency of the conveyance system (Assume reservoir efficiency=100%) (5)

Answer any two (5 to 7)

5) An evaluation was done on a border irrigation field of length 400 m and slope of 0.6%. Mannings' roughness coefficient = 0.04. The infiltration can be expressed in the form $Z = 0.00875\ \tau^{0.43} + 0.0005\ \tau$ and a flow of 0.38 m^3/min/m is applied to the field. If the advance

time is 110 min and the required depth of application is 18 cm, then calculate the depletion and recession time and determine whether the irrigation is over-irrigated, complete or under-irrigated. Time of cut-off =230 min. (10)

6) A furrow irrigated set consists of 27 furrows spaced at 76 cm apart with a furrow length of 400 m. At the time the irrigation event was begun, soil moisture deficit was 110 mm. Each furrow had an inflow of 49.2 litres/min for 24 hours. The distribution of infiltrated water depth along the furrow length is as follows

Furrow length (m)	20	60	100	140	180	220	260	300	340	380
Infiltrated depth (m)	158	153	148	142	136	129	121	110	95	76

What is the volume of deep percolation and tailwater runoff in cubic meters? What is the application efficiency, DPR and TWR for this irrigation event? (10)

7) An evaluation was made on a furrow system with the following characteristics. Slope 0.8%; length = 240 m; Spacing = 0.8 m. The soil depletion is measured as 10 cm. A steady flow of 0.125 m^3/min was introduced and advance - recession trajectories were observed. The constants in the flow rate equation, C_1 = 1.55 and C_2 = 0.74. Time taken for the flow to reach mid-field and tail end of field are 20 and 60 min respectively. The flow is cutoff at 350 mins and the duration of recession phase is 19 mins. A steady runoff of 0.085 m^3/min was reached by the time flow was shutoff.

(a) Find the infiltration parameters in Kostiakov's equation (5)

(b) Find whether the field is over, under or complete-irrigated and calculate the application efficiency (3)

(c) At what time the flow should have cut off, if the field is to be complete-irrigated? (2)

Formulae:

$$A_0 = C_1\left(\frac{Q_0\, n}{60 S_0^{0.5}}\right)^{C_2}$$

$$Q_0 = \left[C_1\left(\frac{n}{60 S_0^{0.5}}\right)^{C_2} \times V_{max}\right]^{1/1-C_2}$$

$$\sigma_z = \frac{a + r(1-a) + 1}{(1+a)(1+r)}$$

$$Q_0 t_L = \sigma_y A_0 \times L + \sigma_z k (t_L)^a \times L + \frac{f_0 t_L \times L}{1+r}$$

$$t_d = t_{co} + \frac{y_0 L}{2 q_0}$$

$$\bar{I} = \frac{ka}{2}\left[t_d^{a-1} + (t_d - t_L)^{a-1}\right] + f_0$$

$$S_y = \frac{y_1}{L} = \frac{\left[(q_L n)/(60\sqrt{S_0})\right]^{0.6}}{L} = \frac{1}{L}\left[\frac{q_L n}{60\sqrt{S_0}}\right]^{0.6}$$

$$q_L = q_0 - \bar{I} \times L$$

$$t_r - t_d = \frac{0.095\, n^{0.47565} S_y^{0.20735} L^{0.6829}}{\bar{I}^{0.52435} S_0^{0.237825}}$$