DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

Minor I: CEL 453 - WATER RESOURCES MANAGEMENT

Date: 14-02-2015

Max. Marks: 40

Time: 4.00 – 5.00
(1hr)

Note: (i) **All questions are compulsory**
(ii) Reasonably assume and state any data that are not provided
(iii) Marks for each question are indicated on the right side

I. Briefly (in one or two sentences) answer the following:

(a) List out two promising trends and two disturbing trends as per IWMI Assessment Report (2)

(b) Explain virtual water, green and blue water resources (2)

(c) Arrange the following in ascending order of available moisture holding capacity: Clay, Clay loam, Sandy loam , Loam, Silty clay and Sand. (2)

(d) List the assumptions taken to derive Horton's and Philip's equations. (2)

(e) Draw the variation of suction head and hydraulic conductivity as moisture content increases and explain why. (2)

II. A storage structure (reservoir) meant for irrigation purpose is feeding a command area of 80,000 hectares. Details of crops cultivated in that area is as below. Determine the desired minimum capacity of the structure assuming the losses as 15%. (3)

Crop	Base period (days)	Duty (hectare/cumec)	Percentage area covered by the crop
Rice	120	1800	45
Wheat	120	2000	55

III. Explain the requirement of a combination method for calculating evaporation or ET? Derive the expression for 'γ' in the combination equation $E = \frac{\Delta}{\Delta+\gamma}E_r + \frac{\gamma}{\Delta+\gamma}E_a$, if transport equations for vapour and heat are $\dot{m}_v = -\rho_a K_w \frac{dq_v}{dz}$ and $H_s = -\rho_a C_p K_h \frac{dT}{dz}$ (4)

IV. A soil core of 7.5 cm diameter and 15 cm depth was drawn from a sunflower field two days after irrigation when the soil was approximately at field capacity. The soil core weighted 2.76 kg and that on oven drying weighted 2.61 kg. After a few days, another core sampling was done when the crop showed signs of wilting and it weighted 2.71 kg. Compute the depth and frequency of irrigation required for the crop if root zone depth = 100cm; Specific gravity of soil = 1.5; Consumptive use = 25 mm/day. Assume the allowed deficit is 90%. (4)

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V. The details of a flood occurred in 1981 over a watershed of area of 1820 hectares is given. Flood occurred due to a storm event which lasted for 3.5 hours. The incremental rainfall observed and the streamflow values recorded at the outlet of the watershed at definite intervals are shown in the table below. Calculate the storage of water on this watershed as a function of time assuming that the initial storage is zero. Neglect all losses. Identify the maximum storage and time at which it occurred. (5)

Time (hours)	0	0.5	1	1.5	2	2.5	3	3.5	4
Incremental rainfall (cm)		0.38	0.66	3.38	5.59	5.28	0.51	0.23	
Streamflow (cumecs)	5.75	6.97	8.01	23.45	65.78	161.32	269.89	312.19	233.16

Time (hours)	4.5	5	5.5	6	6.5	7	7.5	8
Incremental rainfall (cm)								
Streamflow (cumecs)	122.36	63.60	51.03	34.83	20.19	11.16	10.02	8.58

VI. At a particular place, the total heads are measured at depths of 0.8 m and 1.8 m from ground level at weekly intervals as shown in the table below. The soil exhibits a relationship between hydraulic conductivity and suction head as $K = 250\,(-\psi)^{-2.11}$. Determine the magnitude and direction of flow occurred between these two depths during each period. From these observations, what is your opinion about the probable time rainfall/irrigation would have occurred and Why? Assume K is uniformly varying in the depth considered. (6)

Week	1	2	3	4	5
Total head at 0.8 m depth (cm)	-140	-125	-105	-135	-150
Total head at 1.8 m depth (cm)	-240	-240	-230	-215	-230

VII. Hyetograph of a rainfall event falling on a sandy loam is given. Determine the runoff hydrograph using Horton's approach if $f_o = 6$ cm/h, $f_c = 1$ cm/h, $k = 2\ h^{-1}$. What is the range in which ponding equations are applicable in Horton's case? (8)

Time (hr)	0	0.25	0.5	0.75	1	1.25	1.5	1.75	2
Incremental Rainfall (cm)	0.3	0.4	0.5	0.6	0.7	0.8	0.4	0.6	0.6

Formulae:

$$t_p = \frac{1}{ik}\left[f_0 - i + f_c \ln\left(\frac{f_0 - f_c}{i - f_c}\right)\right] \qquad t_0 = t_p - \frac{1}{k}\ln\left(\frac{f_0 - f_c}{i - f_c}\right)$$