DEPARTMENT OF CIVIL ENGINEERING, IIT DELHI

Major Exam: CEL 453 - WATER RESOURCES MANAGEMENT

Date: 06-05-2015

Max. Marks: 50

Time: 10.30 – 12.30 hrs

Note: **(i) Questions 1-6 are compulsory; Answer any three from 7-10**
(ii) Reasonably assume and state any data that are not provided
(iii) Marks for each question are indicated on the right side

1) At a climate station, the following measurements are made. Surface air pressure = 101.1 kPa; Surface air temperature = 27^0C; Dew point temperature = 19^0C. Calculate the corresponding vapour pressure, vapor pressure deficit and relative humidity. **(2)**

2) Using Green-Ampt equation for flow through unsaturated porous media, $F(t) = kt + \psi\Delta\theta \ln\left(1 + \frac{F(t)}{\psi\Delta\theta}\right)$, compute the infiltration rate after 34 minutes of infiltration into a soil having suction head = 16.7 cm, hydraulic conductivity = 0.65 cm/h, porosity = 60% and initial moisture content = 16%. (Approximate $F(t)$ with 3 iterations) **(3)**

3) In a 200-min storm the following rates of rainfall were observed in successive 25-min intervals: 3.5, 2.2, 7.5, 6.5, 2.0, 4.0, 3.0, and 1.5 mm/h. Determine the total rainfall, ϕ-index and W-index for the storm if net runoff = 5.0 mm and initial loss = 0.9 mm. **(3)**

4) Compute the flow duration curve for the river and determine 75% dependable flow if the river flows (Gm^3) for the past 17 years are: 15.9, 14.8, 11.7, 11.8, 12.6, 15.7, 8.3, 12.9, 16.2, 10.4, 16.6, 14.6, 10.7, 11.6, 10.8, 9.5, and 9.7 respectively. **(4)**

5) The operating head in a lateral of a drip irrigation system is 8 m and the design discharge is 4.5 litres/hr. Compute the length of the long path emitter, if the diameter of the micro-tubing is 1 mm and the kinematic viscosity is 1×10^{-6} m^2/s. Absolute roughness is 0.004 mm. What will the length requirement if the design discharge increases to 35 litres/hr. Comment on the results. **(4)**

6) A lateral of length 396 m and 10 cm diameter aluminium pipe has 33 sprinklers spaced at 12 m apart, laid at a downslope of 0.005 m/m. The design operating pressure of the nozzle is 40 m. Design nozzle discharge (litres/sec) is related to design nozzle pressure (kPa) as $q = 0.0177\ H^{0.5}$. Use Darcy – Weisbach equation for calculate friction loss and assume a friction factor of 0.04 for aluminium. Check whether the friction loss is in permissible limit, if the allowable pressure difference between critical nozzles is 20%.

The pump is operated in such a manner that the pressure available at the lateral head is 42 m. If the riser head is 1 m, what is the percentage difference in the discharge between critical sprinklers and check whether it is in allowable limits. **(10)**

Answer any three from 7-10

7) The following are the average monthly inflow (m^3/s) into a reservoir in a year:

Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Inflow	20	60	200	300	200	150	100	80	60	40	30	25

If a uniform discharge 90 m^3/s is required from this reservoir what should be minimum storage capacity? If the reservoir capacity is 6.48×10^8 m^3, estimate the maximum uniform rate of withdrawal possible from the reservoir. **(8)**

8) (a) Derive an expression for the stability of channel slopes with unprotected side slopes. **(4)**

(b) An irrigation channel is to be constructed in coarse alluvium gravel with 4 cm grain size. The channel has to carry 5 m^3/s of discharge and longitudinal slope is 0.04. The banks of the channel is protected against scouring. Find the minimum width of the channel. Assume n = 0.0258 **(4)**

9) **a)** Define incipient motion condition, critical tractive force and Shield's entrainment function. **(3)**

b) Design an irrigation canal (of trapezoidal cross-section, to carry a discharge of 14 cumecs. Assume Mannings n = 0.0225; critical velocity ratio = 1; side slope = ½ : 1 and $\frac{Bed\ Width,\ B}{Depth, D}$ ratio = 5.7. Use Kennedy's theory for design (find B, D and S) **(5)**

10) **a)** A grower has two choices to buy a pumping equipment for an irrigation system for operate for 30 years in the future (a) buy a pump today at 150,000 and buy a replacement pump in year 15 for 275,000 (b) buy a pump today at 120,000 and buy a replacement pump in year 10 for 160,000 and buy an additional pump in year 15 for 205,000. Assume operation cost is same for both cases and salvage value is negligible. Interest rate is 11%. Which option would you recommend? **(5)**

b) The total benefit function for a crop is given by: $B = 200 + 610\,I - 61\,i^2$ where B is the benefit in thousands and I is the level (or depth) of irrigation. Total cost of irrigation is 200 thousands per level (or depth) of irrigation. What level of irrigation would you recommend the farmer and why? **(3)**