

National Exams November-December 2016

04-Agric-B7 Principles of Hydrology

**NOTES:**

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.  
Any non-communicating calculator is permitted.
3. Any THREE (3) questions constitute a complete exam paper.  
The first three questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Most questions require answers involving calculations. Clarity and organization of the answers are important.

**Question 1**

- 1.1 A 35 Km<sup>2</sup> rural watershed outlets into a small lake with a surface area of 70.8 hectare. During the month of April, the lake had an inflow of 1.5 m<sup>3</sup>/s and an outflow of 1.25 m<sup>3</sup>/s. During this month +1.0 m of storage change (increase) was recorded in the lake. The rain gauge located in the watershed recorded 22.5 cm of rainfall for the month of April.
- Determine evaporation from the lake. Assume the seepage losses from the lake are negligible.
  - Determine what percentage of rainfall changed to stream flow during April when base flow was 40 percent of stream flow.
- 1.2 For the following data collected at a rain gauge for a 40-minute summer storm compute the maximum depth and rainfall intensity recorded in 10 and 30 minutes.

Time, min	0	5	10	15	20	25	30	35	40
Rainfall, mm	-	2	5.1	6.4	5.6	5.3	4.1	3.0	0.8

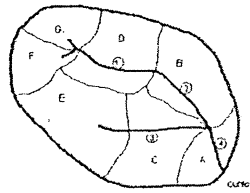
**Question 2**

- 2.1 The 1-hr unit hydrograph (for 1 cm rainfall excess) for a creek is given as a triangle, with base of 3 hours, peak is 6.7 m<sup>3</sup>/s, and times of rise and recession of 1 hr and 2 hr, respectively.
- Compute the 2-hr unit hydrograph for this Creek using the S hydrograph method.
  - Compute the hydrograph for a 2-hour rainfall event when the net rainfall (rainfall excess) during the 1<sup>st</sup> and 2<sup>nd</sup> hours are 3 and 6 cm, respectively.
- 2.2 A sandy loam soil has an initial water content of 0.18 m<sup>3</sup>/m<sup>3</sup>, a saturated hydraulic conductivity (K<sub>s</sub>) of 7.8 mm/hr and an average capillary suction at the wetting front (S<sub>f</sub>) of 10 cm. Rain fell at a rate of 2.9 cm/hr for six hours, saturating the soil, and leaving a final water content of 0.45 m<sup>3</sup>/m<sup>3</sup>.
- Develop the infiltration rate curve up to the time to ponding using the Green and Ampt approach.
  - Suggest the possible shape (without computation) of the infiltration curve after ponding.

**Question 3**

- 3.1 Develop a procedure (list of steps or a schematic diagram) for estimation of runoff at the outlet of the watershed shown in the following figure for a given rainfall event covering the entire watershed. The developed procedure should indicate the order of computation of runoff from sub-watersheds, combining of hydrographs and routing the hydrographs through the channel network.

- A - Sub-watershed
- B - Sub-watershed
- C - Sub-watershed
- D - Sub-watershed
- E - Sub-watershed
- F - Sub-watershed
- G - Sub-watershed



- 1 - Channel
- 2 - Channel
- 3 - Channel
- 4 - Channel

3.2. A reservoir has the following linear relationship between storage and outflow

$$S = K O$$

- Where: S = Storage ( $m^3$ )  
 O = Outflow ( $m^3/s$ )  
 K = Constant = 1.21 sec

Determine the outflow out of the reservoir at  $t = 4$  hour and  $t = 8$  hour using  $\Delta t = 1$  hour. The inflow hydrograph is given below.

Time (hr)	0	1	2	3	4	5	6	7	8	9	10	11
Inflow ( $m^3/s$ )	0	100	200	400	300	200	100	50	0	0	0	0

**Question 4**

- 4.1 A recreation park is built near a river. The river has a carrying capacity (i.e., full bank condition) of  $1,000 m^3/s$ , and this is the peak flow rate for a 10-year return period. Determine the probability that the park will be flooded at least 3 times during the next 20 years.
- 4.2 The peak flow ( $m^3/s$ ) data ( $y = \log Q$ ) for a river has the following probability distribution characteristics.

Mean,  $\bar{y} = 2.09$   
 Standard Deviation,  $S_y = 0.4439$   
 Skew Coefficient,  $C_s = -0.244$

During 2008 the peak flow rate in the river was  $875 m^3/s$ , Determine the return period for this peak flow rate.

- 4.3 The random variable  $x$  represents the depth of rainfall in June, July and August at Toronto. The value of PDF (Probability Distribution Function) is symmetrical and is shaped as an isosceles triangle, with base 0 - 60 cm. Between value of  $x = 0$  and  $x = 30$ , the probability distribution function has the equation  $f(x) = x/900$ .
- a) Sketch the complete PDF and prove that  $\int f(x) dx = 1.0$ .
  - b) Find the probability that next summer's rainfall will not exceed 20 cm.
  - c) For the above PDF, what is the mean value of summer rainfall?