UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2016

Module Number: CE6303 Module Name: Engineering Hydrology

[Three Hours]

[Answer **all questions**, each question carries 12 marks]

Rainfall Intencity-Frequency-Duration curves for Station GALLE is provided

Q1

a) Briefly explain the necessity of performing consistency checks with preprocessing of rainfall data for hydrological applications.

[03 Marks]

b) (i) The annual rainfall at station X and the average annual rainfall at 6 surrounding stations are given in table Q1. Check the consistency of the record at station X and determine the year in which a change in regime has occurred.

(ii) State how you are going to adjust the records for the change in regime.

[04 + 02 Marks]

Table Q1: Annual rainfall data for station X and its surrounding stations

	Annual rainfall (mm)	
Year	*Station X*	*Average of 6 surrounding stations*
1992	305	228
1993	389	350
1994	437	302
1995	322	274
1996	274	252
1997	320	282
1998	493	361
1999	284	184
2000	246	251
2001	218	236
2002	282	333
2003	173	234
2004	223	360
2005	284	312

c) Explain three methods of determining the mean areal depth of precipitation over a basin covered by several rain-gauge stations.

[03 Marks]

Q2

a) Describe the concept of *Extreme Value Distribution* in the field of statistical hydrology?

[03 Marks]

b) An extract of a set of maximum annual daily rainfall data for Colombo meteorological station between 1941 to 1990 is as follows (ranked in descending order). $\bar{X}$ and s are the mean and the standard-deviation at each ranked position.

Year	1976	1962	1977	1969	1975	1980	1944	1952
Rainfall (mm)	322.8	297.1	226.8	210.5	81.3	79.6	78.4	71.6
Rank	1	2	3	4	47	48	49	50
$\bar{X}$	142.54	138.88	135.57	133.63	77.73	76.53	75.0	N/A
s	51.77	45.30	39.31	37.34	4.25	4.31	4.81	N/A

Estimate the probability of exceedence and return period of precipitation of 226.8 mm (1977 value).

[02 Marks]

c) Figure Q2 illustrates x_T versus y_T relationship for the dataset of above part (b) with standard notations.
Does this dataset follow Extreme Value Type I (EVI) probability distribution? Explain your answer.

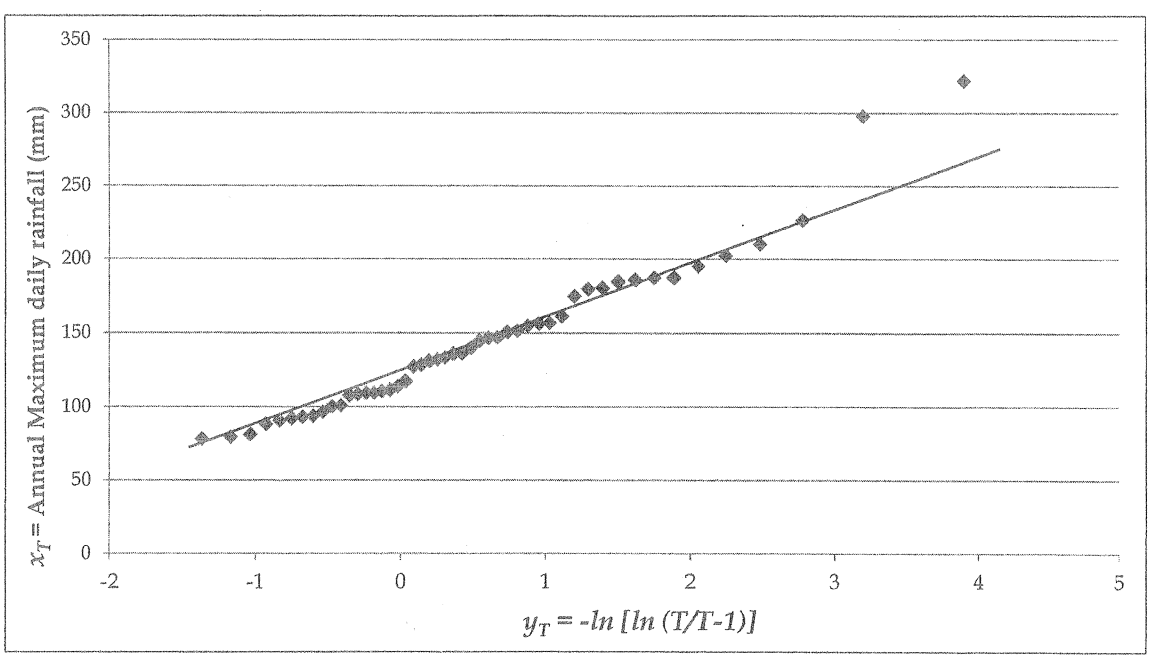

Figure Q2: x_T versus y_T relationship for maximum annual daily precipitation (1941-1990)

[03 Marks]

d) Using the data presented in above part b) and part c), estimate 100 year return period maximum daily rainfall for Colombo meteorological station.
$x_T = u + \alpha y_T$ where; $y_T = -\ln\left[\ln\frac{T}{T-1}\right]$, $u = \bar{x} - 0.5772\alpha$ and $\alpha = \frac{\sqrt{6}\,s}{\pi}$ with standard notations shall be used without proof.

[04 Marks]

Q3

a) Evaporation from free water surfaces and soil are of great importance in hydro-meteorological studies. Briefly explain the influencing factors for evaporation from open water surfaces.

[02 Marks]

b) Compute the daily evaporation from a Class A pan if the amounts of water added to bring the level to the fixed point are as illustrated in Table Q3.

Table Q3: Class A pan evaporation data.

Day	1	2	3	4	5	6	7
Rainfall (mm)	14	6	12	8	0	5	6
Water Added (mm)	-5 (removed)	3	0	0	7	4	3

Estimate loss of water due to evaporation during this week from reservoir (surface area = 640 ha) in the vicinity, assuming a pan coefficient of 0.75?

[04 Marks]

c) (i) The catchment area up to the reservoir (in above part b) inlet point is 300 km^2. A total observed runoff volume during a storm of 6-hr duration with a uniform intensity of 15 mm/hour is estimated as 21.6 Mm^3. Find the average infiltration rate for the catchment.

(ii) Compare the answer of above part c) (i) and the Hortons' infiltration concept.

[03 + 01 Marks]

d) Briefly explain the importance of the infiltration loss in hydrological cycle highlighting artificial techniques to enhance infiltration in areas where it is significantly declined.

[02 Marks]

Q4

a) Define hydrograph. Draw a single-peaked hydrograph and indicate its various components.

[02 Marks]

b) It is ascertained that various factors affect the shape of the flood hydrograph. What are those factors? Indicate how all these affect the shape of the hydrograph.

[03 Marks]

c) Describe with the help of a neat sketch any three methods of separation of base flow from the stream flow hydrograph. Indicate the situations under which you advocate them.

[03 Marks]

Q4 continued to page 4 ...

Q4 continued from page 4 ...

d) A small catchment (located in close proximity to city of Galle) consists of 1.5 km^2 of cultivated area (C = 0.2), 2.5 km^2 under forest (C = 0.1) and 1 km^2 under grass cover (C = 0.35) where C is the runoff coefficient. There is a fall of 20 m in the main stream of length 2 km. Estimate the peak rate of runoff for a 50-year frequency.

Some useful equations.

Peak discharge, Q in m^3/s is given by; $Q = 2.78 \times CiA$

where i is the rainfall intensity measured in *cm/hour* and A is the area of the catchment measured in km^2.

Time of concentration, t_c in *minutes* is given by; $t_c = 0.02\, L^{0.8} S^{-0.4}$

where L (in *km*) and S are length and slope of the main stream respectively.

[04 Marks]

Q5

a) Briefly discuss the use of Intensity-duration-frequency (IDF) curves in hydrological design.

[02 Marks]

b) The IDF curves developed for Galle principal meteorological observation station are based on 30-year high resolution rainfall data for 1965-1995. Explain why it is required to consider minimum of 30 years of high resolution rainfall data in developing IDF curves.

[02 Marks]

c) (i) Using alternative block method, determine, in **05 minutes** increments, the design rainfall hyetograph for a **one-hour** storm using Galle IDF curves with a 50-year return period.

(ii) Comment on applicability of the result obtained in above part C) (i) for present climatological conditions.

[06 + 02 Marks]

RAINFALL INTENSITY DURATIOIN FREQUENCY CURVES
STATION GALLE