MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 407 HYDROLOGY II

DATE: 26/7/2019 **TIME: 2.00-4.00 PM**

INSTRUCTIONS: Answer questions **ONE** and any other **TWO** questions.

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Define the following terms as used in applied hydrology:

i. Design storm. (2 marks)

ii. Effective rainfall (2 marks)

iii. Unit hydrograph (2 marks)

iv. Flood routing (2 marks)

v. Return period (2 marks)

b) With aid of sketches, state three major principles of unit hydrograph theory (6 marks)

c) With aid of sketches, describe the reservoir operation for flood control (6 marks)

d) The record of annual peak discharges at a stream gaging station is as listed in Table Q1:

Table Q1

Year	1981	1982	1983	1984	1985	1986	1987	1988	1990
Discharge (m^3/s)	45.3	27.5	16.9	41.1	31.2	19.9	22.7	59.0	35.4

Determine using the lognormal distribution

i. The probability that an annual flood peak of $42.5 m^3/s$ will not be exceeded

ii. The return period of a discharge of $42.5\ m^3/s$

iii. The magnitude of a 20-year flood (8 marks)

QUESTION TWO (20 MARKS)

The data in Table Q2 represent observed inflow and outflow floods hydrograph for a channel reach. Derive the Muskingum constant k and x for the reach. Using the Muskingum constants *K* and *x*, route the observed inflow hydrograph through the reach and plot the calculated outflow hydrograph obtained. Compare the observed and the routed hydrograph. Hint: Make trial plots of $x = 0.3$ and $x = 0.4$ only. (20 marks)

Table Q2

Time (h)	0	12	24	36	48	60	72	84	96	108	120	132
Inflow (m^3/s)	22	35	103	109	86	59	39	28	22	20	19	18
Outflow (m^3/s)	22	21	34	55	75	85	80	64	44	30	22	20

QUESTION THREE (20 MARKS)

a) The mean and standard deviation of the annual maximum rainfall depths for various durations in a city are shown in Table Q3.

i. Determine, for each duration, the design rainfall intensity for return periods of 2, 5, 10, 25, 50 and 100 years. Use the Extreme Value Type I (Gumbel) distribution. (6 marks)

ii. Plot the results as a set of intensity-duration-frequency curves for 2, 10 and 100 years return periods. (5 marks)

iii. Using the method of alternating block method, obtain and plot the design precipitation hyetograph for a 2-hour storm in 10 minute increments with a 10 year return period. (The equation for IDF curve for 10 year return period takes the form $I = CT^{-S}$), where I is the intensity in mm/h, T is the storm duration in hours, and C and S are constants). (9 marks)

Table Q3

Duration	Mean depth (mm)	Standard deviation (mm)
5 min	12	12
10 min	20	6
15 min	26	8
30 min	37	12
1 hour	48	17
2 hours	55	21
3 hours	62	20
1 day	104	62

QUESTION FOUR (20 MARKS)

a) A drainage basin comprising seven sub-catchments is shown in Figure Q4. Determine the required capacity of the sewer EB draining subarea III for a five-year return period storm. The sub-catchment has an area of 4 acres, a runoff coefficient of 0.6, and an inlet time of 10 minutes. (6 marks)

b) Determine the diameter for pipes AB, BC, and CD in the 27 acre drainage basin shown in table in Figure Q4. The area, runoff coefficients, and inlet time for each subcatchment are shown in Table Q4a, and the length and slope for each pipe are shown in Table Q4b. Use the rational equation and assume the pipes have Manning's coefficient 0.015. (14 marks)

Table Q4a

Catchment	Area (Acres)	Runoff coefficient	Inlet time (min)
I	2	0.7	5
II	3	0.7	7
III	4	0.6	10
IV	4	0.6	10
V	5	0.5	15
VI	4.5	0.5	15
VII	4.5	0.5	15

Table Q4b

Sewer pipe	Length (m)	Slope (m/m)
EB	150	0.0064
AB	170	0.0081
BC	120	0.0064
CD	150	0.0064

QUESTION FIVE (20 MARKS)

The 3-h unit hydrograph for river-gauging station draining an 835 km^2 catchment is listed in Table Q5. An intermittent storm lasting 7 hours covers the catchment, the gross rainfall being: 17 mm/h for 4 h, followed by 12 mm/h for a further 3 h. The phi-index for the catchment is 7

mm/h. Baseflow was estimated to be 30 m^3/s at the beginning of the first storm and 80 m^3/s at the end of the runoff of the second storm.

a) Plot the runoff hydrograph

b) Determine peak discharge and its time of occurrence. (20 marks)

Table Q5

Time (hr)	3-h unit hydrograph (m3/s)	Time (hr)	3-h unit hydrograph (m3/s)
0	0	11	102
1	22	12	85
2	120	13	68
3	240	14	55
4	318	15	42
5	298	16	30
6	250	17	20
7	206	18	12
8	174	19	7
9	144	20	3
10	123	21	0

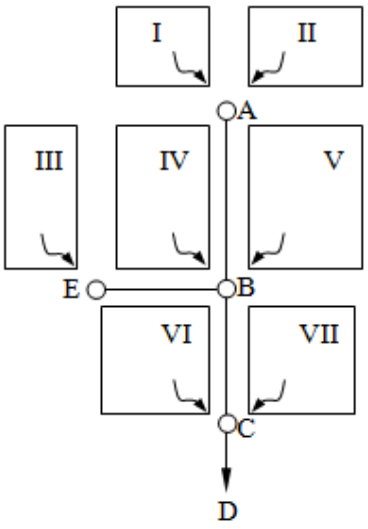

Figure Q4