MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR SECOND SEMESTER EXAMINATION

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 407: HYDROLOGY II

DATE: **TIME:**

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

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

i) Design flood. (2 marks)

ii) Excess 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)

SECTION B: ANSWER ANY TWO QUESTIONS [*40 MARKS*]

QUESTION TWO (20 MARKS)

The data in Table Q4 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.

Table Q4

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. 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. Plot the results as a set of intensity-duration-frequency curves. [*14 Marks*]

Table Q3

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

b) A drainage basin comprising seven sub-catchments is shown in Figure Q3. 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*]

QUESTION FOUR (20 MARKS)

A catchment of the following physical characteristics and conditions, experienced a rainfall event shown in Table Q3.

- Area: 1000-ac
- Soils:
  - A half of the catchment is covered by Class B soils.
  - A half of the catchment is covered by Class C soils.
- Land use
  - Residential
    - 40% with 30% impervious cover
    - 8% with 65% impervious cover
  - Paved roads: 18% with curbs and storm sewers
  - Open land: 20%
    - 50% fair grass cover
    - 50% good grass cover
  - Parking lots, etc.: 14%
- Antecedent moisture: AMC(II)

Table Q3

Time (hr)	Cumulative rainfall (mm)
0	0
1	6
2	24
3	33
4	60
5	119
6	135
7	138

a) Estimate the curve number (CN) for Normal Antecedent Moisture Conditions (AMC). (4 marks)

b) Estimate cumulative abstractions (8 marks)

c) Estimate and plot the abstractions and excess rainfall hyetograph. (8 marks)

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.

Table Q5

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

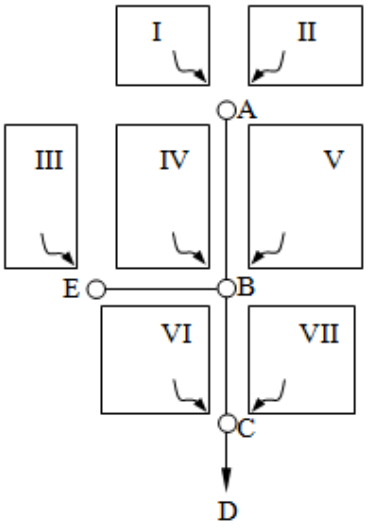

Figure Q2