



MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING & CIVIL ENGINEERING

**FOURTH YEAR SECOND SEMESTER EXAMINATION FOR
BACHELOR OF SCIENCE (CIVIL ENGINEERING)**

ECV 407 HYDROLOGY II

DATE:

TIME:

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

- a) Define the following terms as used in hydrology
 - i) Unit hydrograph (2 Marks)
 - ii) Return period (2 Marks)
 - iii) Flood routing (2 Marks)
- b) With aid of a well labelled sketch explain different mechanisms of streamflow generation (4 Marks)
- c) Explain the space and time modifications of a flood hydrograph in a stream (3 Marks)
- d) State six constraints and assumptions made in storm sewer (3 Marks)
- e) Using a well labeled sketch describe the components of a hydrograph (4 Marks)

- f) Briefly explain the steps of determining streamflow discharge (4 Marks)
- g) From first principles, derive the Muskingum equation of flood routing (6 Marks)

SECTION B (ATTEMPT ANY TWO QUESTIONS)

QUESTION TWO (20 MARKS)

A 1340-m reach of channel has a Muskingum $k = 0.24$ h and $x = 0.25$. Route the inflow hydrograph in Table Q2 through the reach. Assume the initial outflow is 22 m³/s.

Table Q2

Time (h)	0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Inflow (m³/s)	23.2	28.7	35.3	43.6	55.2	73.7	163.5	364.6	508.1

Time (h)	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
Inflow (m³/s)	590.6	596.1	582.6	552.2	413.1	278.0	182.7	129.2

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

- b) A drainage basin comprising seven sub-catchments is shown in Figure Q3B. Determine the required capacity of the sewer EB draining subarea III for a five-year return period storm [refer to a) above]. 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)

The 3-h unit hydrograph for river-gauging station draining a 300 km² catchment is listed in Table Q4. An intermittent storm lasting 9 hours covers the catchment, the gross rainfall being: 17 mm/h for 6 h, followed by 12 mm/h for a further 3 h. The phi-index for the catchment is 7 mm/h. Baseflow was is constant at 20 m³/s.

Table Q4

Time (h)	0	1	2	3	4	5	6	7	8
Inflow (m³/s)	0	22	66	106	120	101	80	58	41

Time (h)	9	10	11	12	13
Inflow (m³/s)	27	17	9	3	0

- Compute and plot the direct runoff hydrograph (18 Marks)
- Determine its peak discharge and time of occurrence (2 Marks)

QUESTION FIVE

A catchment of the following physical characteristics and conditions, experienced a rainfall event shown in Table Q5.

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 Q5

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

- Estimate the curve number (CN) for Normal Antecedent Moisture Conditions (AMC) (4 Marks)
- Estimate cumulative abstractions (8 Marks)
- Estimate and plot the abstractions and excess rainfall hyetograph (8 Marks)

Figures

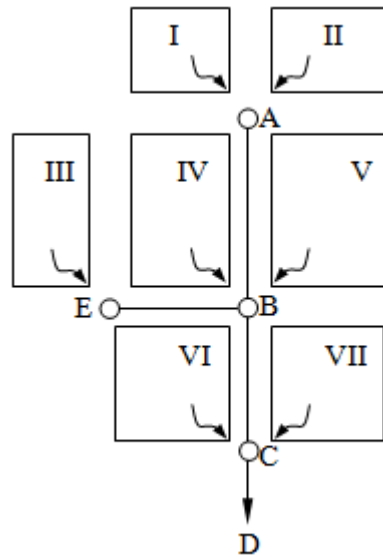


Figure Q3B