MACHAKOS UNIVERSITY

University examinations 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

FOURTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR BACHELOR IN CIVIL ENGINEERING

ECV 407 HYDROLOGY II

Date 8/3/2023 **Time: 8:30 – 10:00 AM**

INSTRUCTIONS

- *This paper comprises of FIVE questions. Answer **THREE** questions*
- *Question one is **compulsory** and carry 30 marks*
- *Answer any other **TWO** questions*

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 (m^3/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 (m^3/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 an 835 km2 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 m3/s at the beginning of the first storm and 80 m3/s at the end of the runoff of the second storm.

a) Plot the runoff hydrograph (18 Marks)

b) Determine peak discharge and its 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

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)

Figures

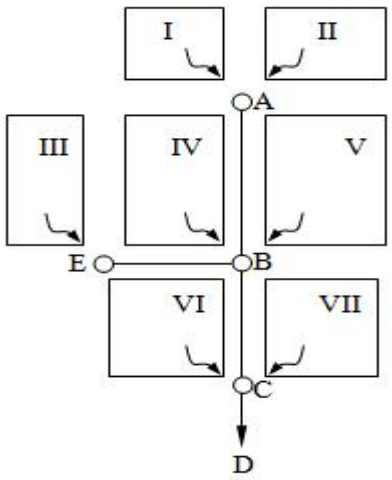

Figure Q3B