



MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING
THIRD YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR
BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 307 HYDROLOGY I

DATE: 23/7/2019

TIME: 8.30-10.30 AM

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. Base flow (2 marks)
 - ii. Unconfined aquifer (2 marks)
 - iii. Partial vapour pressure (2 marks)
 - iv. Potential evaporation (2 marks)
- b) The following aerological observations were taken from a radio sound ascent.

Table Q1

Pressure	1006	920	800	740	700	660	600	500	400
Specific humidity (g /kg)	14.0	13.4	10.2	9.4	7.2	6.6	5.6	4.0	1.8

If 60% of the precipitable water is produced from the air up to the 600mb level to form precipitation at ground level, what would be the depth of the rainfall? (6 marks)

- c) Sketch and discuss the relationship between soil suction, hydraulic conductivity and soil moisture content. (5 marks)
- d) Using a well labelled diagram, explain the operating mechanism of a tipping bucket rain gauge. (5 marks)

- e) Sketch and name the components of a hydrograph. (6 marks)

QUESTION TWO (20 MARKS)

A rainstorm commenced at 1600hrs. The ordinates of the rainfall mass curve of this storm in millimetres as recorded by an automatic rain gauge at 15 minutes interval is shown in table Q2 (20 marks)

Table Q2

Time (hrs)	1600	1615	1630	1645	1700	1715	1730
Rainfall (mm)	0	13.3	25.2	35.8	52.7	63.0	79.7

Time (hrs)	1745	1800	1815	1830	1845	1900
Rainfall (mm)	102.7	115.8	124.0	133.2	139.3	140.1

- a) Derive and draw the maximum-intensity (I) vs, time (t) graph for a period of up to 3 hrs. (15 marks)

- b) If the general relationship in (I) is given by the equation:

$$I = at^b$$

Where a and b are the locality constants, derive the specific relationship. (5 marks)

QUESTION THREE (20 MARKS)

- a) In a catchment area, the measurement of evaporation (mm) shown in table Q3 (a) were made for the period 1978-1982. For the year 1988-1992, measurements from the US Class A Pan only were available. Estimate the volume of water lost each year in the later period from a reservoir of surface area 1.4km^2 (10 marks)

Table Q3 (a)

Year	UK tank	US Class A pan
1978	351	491
1979	536	713
1980	502	653
1981	437	586
1982	486	612

Year	US Class A pan
1988	621
1989	681
1990	687
1991	624
1992	568

- b) A soil has the following soil properties for use in the Green-Ampt equation:

$K_s = 3.8 \text{ cm/h}$; $\psi = -24.5 \text{ cm}$; rainfall intensity = 21 cm.

$\theta_s = 0.523$; $\theta_i = 0.308$.

Using the Green-Ampt infiltration method:

- Calculate the initial moisture deficit, M_d . (2 marks)
- Find the volume of water that will infiltrate before saturation is reached, F_s . (2 marks)
- Find the time to saturation. (2 marks)
- Plot the infiltration rate, f , vs. the infiltration volume, F , on the plot provided (2 marks)

QUESTION FOUR (20 MARKS)

The catchment shown in figure Q4 has seven rain gauges which recorded the intensities of a storm event in Table Q4. Determine the aerial precipitation over the catchment using:

- Arithmetic mean method (4 marks)
- Thiessen polygon method (6 marks)
- Isohyetal method (6 marks)
- Plot the area-depth relationship for the catchment (4 marks)

Table Q4

Rain gauge	1	2	3	4	5	6	7
Precipitation (mm)	48	45	39	34	32	27	22

QUESTION FIVE (20 MARKS)

In Table Q5 is the total streamflow hydrograph draining a catchment of 18.2 km², and following the indicated rainstorm. Assume that baseflow rises linearly during the period of runoff from 7 to 10 m³/s.

Time	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30
Precipitation (mm)	4	7	33	55	52	5	3		
Streamflow (m ³ /s)	8.0	7.0	9.0	23.4	65.8	161.3	270.0	312.2	233.0

Time	13:00	13:30	14:00	14:30	15:00	15:30	16:00	16:30	17:00
Precipitation (mm)									
Streamflow (m ³ /s)	122.4	63.6	51.0	34.8	20.2	11.2	10.0	8.6	

- a) Determine the direct runoff hydrograph (10 marks)
- b) Determine the phi index (5 marks)
- c) Determine excess rainfall (5 marks)

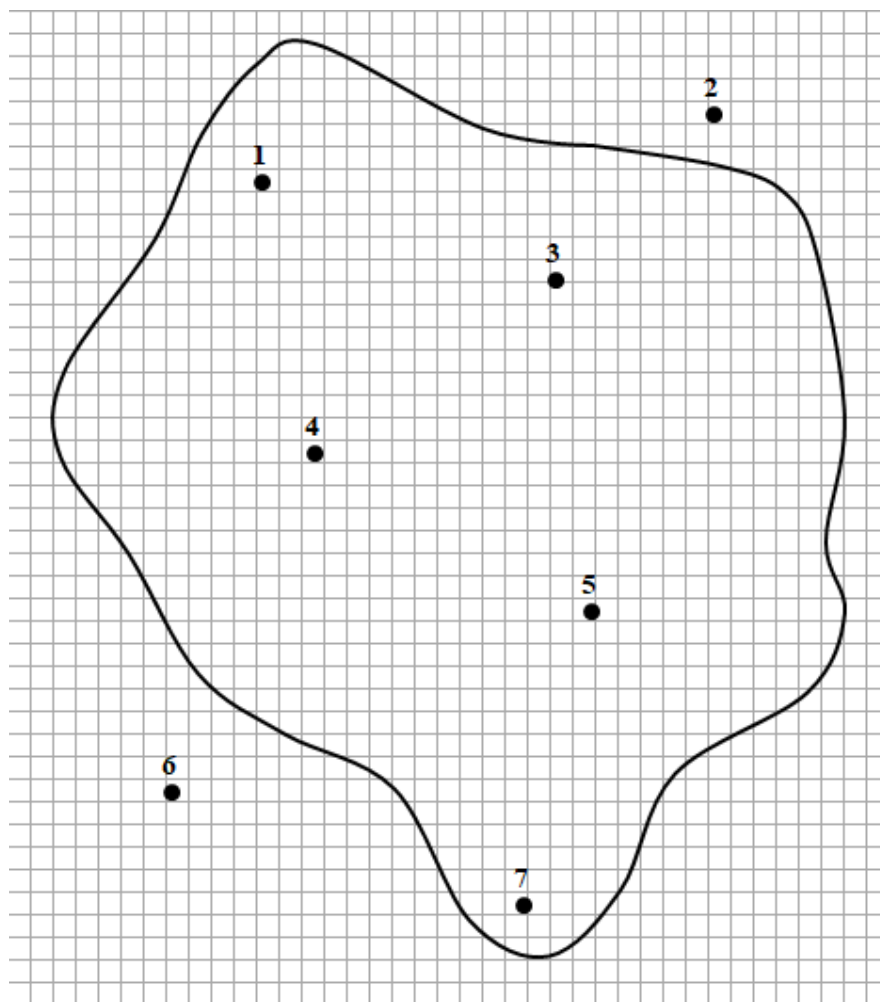


Figure Q4