UNIVERSITY OF ESWATINI

DEPARTMENT OF GEOGRAPHY, ENVIRONMENTAL SCIENCE AND PLANNING

MAIN EXAMINATION DECEMBER 2018

B.Sc. II

TITLE OF PAPER	:	WATER RESOURCES
COURSE NUMBER	:	GEP 232
TIME ALLOWED	:	THREE (3) HOURS
INSTRUCTIONS	:	SECTION A IS COMPULSORY ANSWER ANY TWO (2) QUESTIONS FROM SECTION B. ILLUSTRATE YOUR ANSWERS WITH APPROPRIATE DIAGRAMS AND SHOW YOUR WORKING IN ALL CALCULATIONS
MARKS ALLOCATED	:	QUESTION ONE CARRIES 40 MARKS AND THE OTHER QUESTIONS CARRY 30 MARKS EACH

THIS PAPER IS NOT TO BE OPENED UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR

SECTION A: COMPULSORY QUESTION

Question 1

a) What are the pathways by which precipitation falling onto the earth surface is dispersed into the hydrologic cycle? (20 marks)

b) Discuss any two (2) types of precipitation. (20 marks)

(40 marks)

SECTION B: ANSWER ANY TWO QUESTIONS

Question 2

a) Explain the factors influencing the runoff in a drainage basin. (15 marks)

b) Describe the assumptions of the unit hydrograph and its practical application. (15 marks)

(30 marks)

Question 3

Explain three (3) methods used in measuring flow discharge. **(30 marks)**

Question 4

Estimate the net radiation, over an open water surface, of Swaziland for the month of December, given the minimum and maximum temperatures of 25 and 37.5°C, respectively. In this particular day, you are told that the actual number of sunshine hours were 10 and the relative humidity was 60%. The shortwave radiation is given by $(0.25 + 0.5\ n/N)R_a$.

(30 marks)

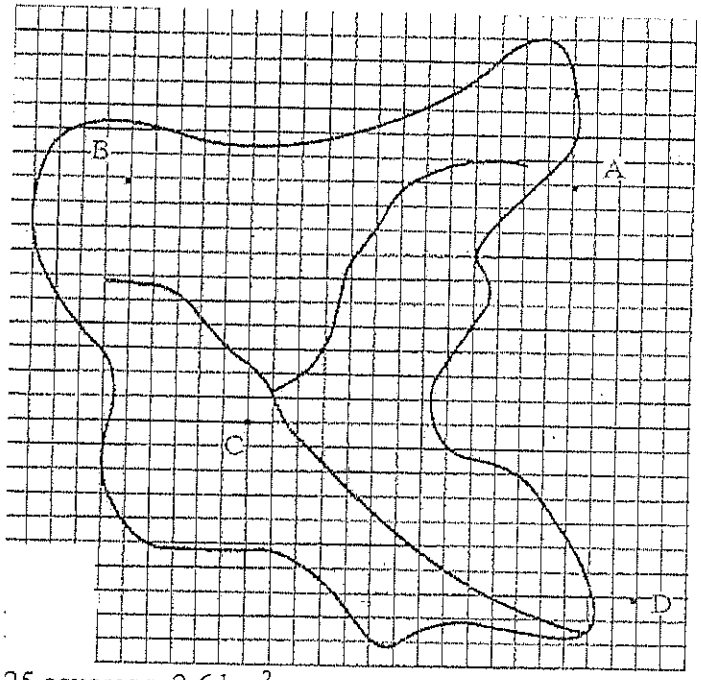
Question 5

A small watershed at Eswatini has 4 rainfall gauges as located in Figure 1. Total rainfall recorded at each gauge during a storm event is listed in Table 1. Compute the mean areal rainfall for this storm using a) arithmetic mean and b) Thiessen method.

(30 marks)

Table 1. Total rainfall recorded at each gauge

Gauge	Rainfall (mm)
A	82.8
B	74.2
C	76.5
D	77.5



25 squares = 2.6 km^2

Figure 1. A small watershed at Eswatini

ADDITIONAL MATERIAL

$$R_n = (1 - r)R_s - R_{nL} \tag{1}$$

$$R_{nL} = \sigma \frac{(273 + T_{min})^4 + (273 + T_{max})^4}{2} (0.34 - 0.139\sqrt{e_d})(0.1 + 0.9\, n/N) \tag{2}$$

$$\sigma = 5.6745 \times 10^{-8}$$

Table 1. Saturation vapour pressure ($e_o(T)$) for different temperatures (T)

$$e^o(T) = 0.6108 \exp\left[\frac{17.27\ T}{T + 237.3}\right]$$

T °C	e_s kPa	T °C	e°(T) kPa	T °C	e°(T) kPa	T °C	e_s kPa
1.0	0.657	13.0	1.498	25.0	3.168	37.0	6.275
1.5	0.681	13.5	1.547	25.5	3.263	37.5	6.448
2.0	0.706	14.0	1.599	26.0	3.361	38.0	6.625
2.5	0.731	14.5	1.651	26.5	3.462	38.5	6.806
3.0	0.758	15.0	1.705	27.0	3.565	39.0	6.991
3.5	0.785	15.5	1.761	27.5	3.671	39.5	7.181
4.0	0.813	16.0	1.818	28.0	3.780	40.0	7.376
4.5	0.842	16.5	1.877	28.5	3.891	40.5	7.574
5.0	0.872	17.0	1.938	29.0	4.006	41.0	7.778
5.5	0.903	17.5	2.000	29.5	4.123	41.5	7.986
6.0	0.935	18.0	2.064	30.0	4.243	42.0	8.199
6.5	0.968	18.5	2.130	30.5	4.366	42.5	8.417
7.0	1.002	19.0	2.197	31.0	4.493	43.0	8.640
7.5	1.037	19.5	2.267	31.5	4.622	43.5	8.867
8.0	1.073	20.0	2.338	32.0	4.755	44.0	9.101
8.5	1.110	20.5	2.412	32.5	4.891	44.5	9.339
9.0	1.148	21.0	2.487	33.0	5.030	45.0	9.582
9.5	1.187	21.5	2.564	33.5	5.173	45.5	9.832
10.0	1.228	22.0	2.644	34.0	5.319	46.0	10.086
10.5	1.270	22.5	2.726	34.5	5.469	46.5	10.347
11.0	1.313	23.0	2.809	35.0	5.623	47.0	10.613
11.5	1.357	23.5	2.896	35.5	5.780	47.5	10.885
12.0	1.403	24.0	2.984	36.0	5.941	48.0	11.163
12.5	1.449	24.5	3.075	36.5	6.106	48.5	11.447

Table 2. Short wave radiation R_a received at the outer limits of the atmosphere expressed in $W.m^{-2}$.

	Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
	NORTHERN HEMISPHERE												
	60	40	103	200	317	417	469	446	360	243	134	57	26
	52	91	157	252	357	440	475	457	389	292	192	111	74
	50	106	172	263	363	443	475	460	392	297	203	126	89
	40	177	240	317	395	455	477	466	420	346	266	194	160
	30	232	300	366	420	460	472	463	435	386	320	260	226
	20	309	354	400	435	449	452	452	440	412	369	323	297
	10	366	397	423	435	429	423	426	429	423	406	375	357
Equator	0	415	429	435	420	397	383	389	409	426	429	417	409
	10	455	449	432	397	357	334	343	375	412	440	449	452
	20	489	457	415	357	306	277	289	332	389	437	469	483
	30	492	452	386	312	246	214	226	277	352	423	477	500
	40	495	432	349	254	183	149	160	217	306	395	472	509
	50	483	403	297	192	117	83	97	154	249	357	457	503
	60	472	360	237	123	51	26	37	89	186	309	432	500
	SOUTHERN HEMISPHERE												

Table 3. Maximum possible sunshine hours

Lat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
S Lat	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
50	8.5	10.1	11.8	13.8	15.4	16.3	15.9	14.5	12.7	10.8	9.1	8.1
48	8.8	10.2	11.8	13.6	15.2	16.0	15.6	14.3	12.6	10.9	9.3	8.3
46	9.1	10.4	11.9	13.5	14.9	15.7	15.4	14.2	12.6	10.9	9.5	8.7
44	9.3	10.5	11.9	13.4	14.7	15.4	15.2	14.0	12.6	11.0	9.7	8.9
42	9.4	10.6	11.9	13.4	14.6	15.2	14.9	13.9	12.6	11.1	9.8	9.1
40	9.6	10.7	11.9	13.3	14.4	15.0	14.7	13.7	12.5	11.2	10.0	9.3
35	10.1	11.0	11.9	13.1	14.0	14.5	14.3	13.5	12.4	11.3	10.3	9.8
30	10.4	11.1	12.0	12.9	13.6	14.0	13.9	13.2	12.4	11.5	10.6	10.2
25	10.7	11.3	12.0	12.7	13.3	13.7	13.5	13.0	12.3	11.6	10.9	10.6
20	11.0	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
15	11.3	11.6	12.0	12.5	12.8	13.0	12.9	12.6	12.2	11.8	11.4	11.2
10	11.6	11.8	12.0	12.3	12.6	12.7	12.6	12.4	12.1	11.8	11 6	11.5
5	11.8	11.9	12.0	12.2	12.3	12.4	12.3	12.3	12.1	12.0	11.9	11.8
0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0	12.0