UNAM

FACULTY	AGRICULTURE, ENGINEERING AND NATURAL SCIENCE		
SCHOOL	ENGINEERING & THE BUILT ENVIRONMENT		
DEPARTMENT	CIVIL AND MINING ENGINEERING		
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FIRST OPPORTUNITY EXAMINATION

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This question paper consists of 12 pages including this front page and a formula sheet.

Instructions

- This is a **closed book examination.**
- This exam consists of three sections. Section I (25 Questions – multiple choice),
- Section II (12 Questions - structured) and Section III (8 Questions – calculation: Select and answer any questions from the total eight (8) questions that adds up to 50 marks, the marks for each question is shown in brackets).
- Between brackets you find the maximum number of marks you can receive for a correct answer. The maximum score for this examination is 100 marks.
- Do not forget to write your name and student number at each answering sheet.
- Make reasonable assumptions for any missing data and ensure that you are working in corrects units.
- Always give units to your final answer in calculation where applicable.
  All the best and enjoy!

SECTION I .... (25 Marks)

Select the letter of the correct answer.

1. Hydrology helps in: (1 Mark)

a. Predicting maximum flows.

b. Deciding the minimum reservoir capacity.

c. Forecasting the availability of quantity of water at reservoir site.

d. All the above

2. The change in surface water storage in a watershed using water budget equation would be given as (ignoring any stream water inflow): (1 Mark)

a. Precipitation – Infiltration - Evapotranspiration – Net runoff from watershed

b. Precipitation + Infiltration - Evapotranspiration – Net runoff from watershed

c. Precipitation – Infiltration + Evapotranspiration – Net runoff from watershed

d. Precipitation + Infiltration + Evapotranspiration – Net runoff from watershed

3. The water cycle has no starting point. But we begin in the oceans, since that is where most of Earth's water exists. (1 Mark)

a. True

b. False

4. Which of the following method is comparatively very accurate of rain gauging recording type: (1 Mark)

a. Thiessen polygon method

b. Isohyetal method

c. Arithmetic mean method

d. Recording type

5. A-unit hydrograph has one unit of: (1 Mark)

a) Peak discharge

b) Rainfall duration

c) Direct runoff

d) The time base of direct runoff

6. The ordinates of a unit hydrograph can be obtained by dividing each of the ordinates of direct runoff by: (1 Mark)

a. Duration of the unit hydrograph

b. Total runoff

c. Storm duration

d. Depth of direct runoff

7. Rainfall with an intensity of 6mm/h is classified as: (1 Mark)

a. Trace rain

b. Medium rain

c. Heavy rain

d. Light rain

8. The science which deals with the origin, properties, distribution and circulation of the water of the earth is known as: (1 Mark)

a. Hydrography

b. Hydrology

c. Hydrometry

d. Hydrogeology

9. A precipitation in the form of water droplets of size less than 0.5 mm and intensity less than 1mm/h is known: (1 Mark)

a. Rain

b. Sleet

c. Hail

d. Drizzle

10. The hydrologic equation states that: (1 Mark)

a. $\sum inflow$ - $\sum outflow$ = constant

b. Sub surface inflow = sub surface outflow

c. Inflow into the basin = outflow basin

d. Inflow - outflow = change in storage

11. Runoff increases with: (1 Mark)

a. Increase in infiltration capacity

b. Increase in intensity of rain

c. Increase in permeability of soil

d. All of the above

12. Which of the following is not a direct streamflow determination technique: (1 Mark)

a. Dilution method

b. Ultrasonic method

c. Area-velocity method

d. Slope-area method

13. The science and practice of water flow measurement is known as: (1 Mark)

a. Hypsometry

b. Hydrometeorology

c. Fluviometry

d. Hydrometry

14. The average velocity at any vertical section of the stream is: (1 Mark)

a. Not of any use in the streams flow measurement

b. Smaller than the mean velocity in that vertical section

c. Lager than the mean velocity in that section

d. Equal to the velocity in that vertical section at 0.6 times the depth

15. The velocity of flow in stream is measured using: (1 Mark)

a. Floats

b. Current meters

c. All the above

d. None of the above

16. The probability that a hundred-year flood may not occur at all during the 50-year life of a project is: (1 Mark)

a. 0.395

b. 0.001

c. 0.605

d. 1.33

17. The probability of a flood equal to or greater than 1000-year flood, occurring at least once is: (1 Mark)

a. 0.0001

b. 0.001

c.0.385

d. 0.632

18. The general equation of hydrological frequency analysis states that X_T which is the value of a variate with a return period of T years is given by X_T =: (1 Mark)

a. $\bar{X} - K\sigma$

b. $\bar{X} + K\sigma$

c. $K\sigma$

d. $\bar{X}/K\sigma$

19. A unit hydrograph has one unit of: (1 Mark)

a. Peak discharge

b. Rainfall duration

c. Direct runoff

d. Time base of the direct runoff.

20. The basic assumptions of a unit hydrograph theory are: (1 Mark)

a. Nonlinear response and time invariance

b. Time invariance and linear response

c. Linear response and linear time variance

d. Nonlinear time variance and linear response

21. A hydrograph is a graphical representation of: (1 Mark)

a. Runoff and time

b. Surface runoff and time

c. Rainfall and time

d. ground waterflow and time

22. The Muskingum method of flood routing is a: (1 Mark)

a. Form of reservoir routing method

b. Hydraulic routing method

c. Form of a St. Venant equation

d. Hydrologic channel routing method

23. The following statement "With channel routing, storage is function of inflow as well as outflow": (1 Mark)

a. True

b. False

24. Due to flood routing, the: (1 Mark)

a. Peak of the hydrograph (of flood) gets reduced in size and occurs earlier in time.

b. Peak of the hydrograph gets reduced in size and gets delayed in time.

c. peak of the hydrograph is increased in size and time base of hydrograph is increased.

d. Peak of the hydrograph is decreased in size and time base of hydrograph is decreased.

25. The Muskingum method of flood routing gives $O_2=C_0I_2+C_1I_1+C_2O_1$. The coefficients in this equation will have values such that: (1 Mark)

a. $C_0+C_1=C_2$

b. $C_0-C_1-C_2=1$

c. $C_0+C_1+C_2=0$

d. $C_0+C_1+C_2=1$

SECTION II..(25)

1 Name two applications of engineering hydrology. (2 Marks)

2. Write down the Hydrologic equation? (2 Marks)

3. Define infiltration? (1 Mark)

4. Define runoff? (1 Mark)

5. Define evaporation? (1 Mark)

6. Name any two types of recording rain gauges? (2 Marks)

7. Define infiltration capacity? (2 Mark)

8. Name 4 factors affecting infiltration? (4 Mark)

9. What is an infiltrometer and mention its types? (4 Mark)

10. Define what is a unit hydrograph? (2 Marks)

11. Define the term time of concentration? (2 Marks)

12. Define is flood routing. (2 Marks)

SECTION III..(50)

Select and answer any questions from the total eight (8) questions that adds up to 50 marks; the marks for each question are shown in brackets.

Question 1

During a heavy rainfall season in the Zambezi region, a river reach had a flood wave passing through it. At a given instant the storage of water in the reach was estimated as 15.5 x$10^4$$m^3$. What would be the storage in the reach after an interval of 3 hours if the average inflow and outflow during the time period are 14.2 m^3/s and 10.6 m^3/s respectively. **(20 Marks)**

Question 2

The Namibian Meteorological Service is assessing the adequacy of rainfall stations and requires your services. The Kunene catchment has six (6) rainfall station A, B, C, D, E and F with normal annual rainfall depth as provided below. (5 Marks)

Rainfall stations	A	B	C	D	E	F
Annual rainfall depth (mm)	82.6	102.9	180.3	110.3	98.8	136.7

Determine the optimum number of rainfall station for the Kunene catchment if it is desired to limit the error in the mean value rainfall to 10%. **(10 Marks)**

Question 3

The recorded annual rainfall at three stations M, N, O, surrounding X were 6.6 cm, 4.8 cm, & 3.7 cm respectively. The normal annual rainfall at stations X, M, N, & O are 65.6 cm, 72.6 cm, 51.8 cm & 38.2 cm. Conduct a 10% variation check, choose suitable method and estimate the annual rainfall for stations X. **(10 Marks)**

Question 4

The following hydrological data is presented for Oshikoto region. You have been consulted by the meteorological office to determine the average precipitation in the region by means of Thiessen Polygon Method. **(10 Marks)**

Hydrological Data: Oshikoto region					
Gauging station	**OSH-1**	**OSH-2**	**Osh-3**	**OSH-4**	**OSH-5**
Polygon area (km^2)	40	45	38	30	43
Rainfall (mm)	30.8	33.4	34.6	32.6	24.6

Question 5

For a total rainfall of 44 mm received at the Engineering Campus in Ongwediva, distributed as shown in the table below, establish the ϕ-index of the catchment area for a surface runoff of 19.5 mm and calculate the excess rainfall in each hour. **(10 Marks)**

Time t (hr)	Rainfall P (mm)
0	0
1	4
2	21
3	9
4	6
5	4

Question 6

An urban catchment in Oshakati, of area 3.0 km^2 consists of 52% of paved areas, 20% parks, 18% multi-unit residential area. The remaining land use can be classified as light industrial area. The catchment is essentially flat and has sandy soil. If the time of concentration is 50 minutes, estimate using the Rational Method the design peak flow due to a design storm of depth 85 mm in 50 minutes. **(10 Marks)**

Types of area	Value of C
Paved	0.87
Park	0.075
Residential area, multi-unit	0.7
Light industrial area	0.65

Question 7

Provided below is a Unit Hydrograph ordinates of 4 hour. Find the ordinates of an 8-hour Unit Hydrograph. **(10 Marks)**

Time (hr)	0	4	8	12	16	20	24	28	32	36
U.H.O	0	17	28	42	72	60	47	32	15	0

Question 8

For a river reach K=28hr, X=0.25 and take $O_1 = I_1$ for the beginning of time step. Route the following inflow hydrograph and compute values of attenuation and translation of the peak. Use Muskingum method of routing and take Δt =22hr. **(20 Marks)**

Time (hrs)	0	6	12	18	24	30	36	42	48	54	60
Inflow (m^3/s)	30	62	242	170	114	78	56	44	38	34	30

Formula's

Exceedance probability = $1 - (1 - p)^n$

$Risk, R = 1 - (1 - \frac{1}{T})^N$

$$x_T = \bar{x} + K\,\sigma_{n-1}$$

where σ_{n-1} = standard deviation of the sample of size $N = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N-1}}$

K = frequency factor expressed as

$$K = \frac{y_T - \bar{y}_n}{S_n}$$

in which y_T = reduced variate, a function of T and is given by

$$y_T = -\left[\ln.\ln\frac{T}{T-1}\right]$$

or

$$y_T = -\left[0.834 + 2.303\log\log\frac{T}{T-1}\right]$$

$$C_0 = \frac{Kx + 0.5\Delta t}{K - Kx + 0.5\Delta t};\ C_1 = \frac{-Kx + 0.5\Delta t}{K - Kx + 0.5\Delta t}\ \text{and}\ C_2 = \frac{K - Kx - 0.5\Delta t}{K - Kx + 0.5\Delta t}$$

$$O_2 = C_0 I_2 + C_1 I_1 + C_2 O_1$$

$$P_x = \frac{1}{M}[P1 + P2 + \cdots + Pm]$$

$$P_x = \frac{N_x}{m}\left[\frac{P1}{N1} + \frac{P2}{N2} + \cdots + \frac{Pm}{Nm}\right]$$

$$N = \left(\frac{C_v}{\epsilon}\right)^2$$

$$C_v = \frac{\sigma_{m-1}}{\bar{P}} \times 100$$

$$\sigma_{m-1} = \sqrt{\frac{\sum_i^m (P_i - \bar{P})^2}{m-1}}$$

$$\bar{P} = \frac{\sum_i^m P_i}{m}$$

$$Q = \frac{1}{3.6} C * I_{(t_c, P)} * A$$

$$\phi\text{-index} = (P-R)/t_e$$

$$\bar{P} = \frac{P1 + P2 + \cdots + Pn}{N} = \frac{1}{N}\sum_{i}^{N} P_i$$

$$\bar{P} = \frac{P1\,A1 + P2\,A2 + P3\,A3 + P4\,A4 + P5A5 + P6A6}{A1 + A2 + A3 + A4 + A5 + A6}$$

$$\text{Or}\ ;\ \bar{P} = \frac{\sum_{i=1}^{N} PiAi}{A} = \sum_{i=1}^{N} pi\,\frac{Ai}{A}$$

Table: Reduced mean $\bar{y}_n$ in Gumbel's Extreme Value distribution, N = sample size

N	0	1	2	3	4	5	6	7	8	9
10	0.4952	0.4996	0.5035	0.5070	0.5100	0.5128	0.5157	0.5181	0.5202	0.5220
20	0.5236	0.5252	0.5268	0.5283	0.5296	0.5309	0.5320	0.5332	0.5343	0.5353
30	0.5362	0.5371	0.5380	0.5388	0.5396	0.5402	0.5410	0.5418	0.5424	0.5430
40	0.5436	0.5442	0.5448	0.5453	0.5458	0.5463	0.5468	0.5473	0.5477	0.5481
50	0.5485	0.5489	0.5493	0.5497	0.5501	0.5504	0.5508	0.5511	0.5515	0.5518
60	0.5521	0.5524	0.5527	0.5530	0.5533	0.5535	0.5538	0.5540	0.5543	0.5545
70	0.5548	0.5550	0.5552	0.5555	0.5557	0.5559	0.5561	0.5563	0.5565	0.5567
80	0.5569	0.5570	0.5572	0.5574	0.5576	0.5578	0.5580	0.5581	0.5583	0.5585
90	0.5586	0.5587	0.5589	0.5591	0.5592	0.5593	0.5595	0.5596	0.5598	0.5599
100	0.5600									

Table: Reduced standard deviation S_n in Gumbel's extreme value distribution, N = sample size

N	0	1	2	3	4	5	6	7	8	9
10	0.9496	0.9676	0.9833	0.9971	1.0095	1.0206	1.0316	1.0411	1.0493	1.0565
20	1.0628	1.0696	1.0754	1.0811	1.0864	1.0915	1.0961	1.1004	1.1047	1.1086
30	1.1124	1.1159	1.1193	1.1226	1.1255	1.1285	1.1313	1.1339	1.1363	1.1388
40	1.1413	1.1436	1.1458	1.1480	1.1499	1.1519	1.1538	1.1557	1.1574	1.1590
50	1.1607	1.1623	1.1638	1.1658	1.1667	1.1681	1.1696	1.1708	1.1721	1.1734
60	1.1747	1.1759	1.1770	1.1782	1.1793	1.1803	1.1814	1.1824	1.1834	1.1844
70	1.1854	1.1863	1.1873	1.1881	1.1890	1.1898	1.1906	1.1915	1.1923	1.1930
80	1.1938	1.1945	1.1953	1.1959	1.1967	1.1973	1.1980	1.1987	1.1994	1.2001
90	1.2007	1.2013	1.2020	1.2026	1.2032	1.2038	1.2044	1.2049	1.2055	1.2060
100	1.2065									