NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ENGINEERING

DEPARTMENT OF CIVIL AND WATER ENGINEERING

PART II SUPPLEMENTARY EXAMINATION

ENGINEERING HYDROLOGY ECW 2202

AUGUST 2024

This examination paper consists of 6 pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: Graph paper

Lecturer's Name: Eng K Z Mkwananzi

INSTRUCTIONS

1. Answer any four (4) questions
2. Each question carries 25 marks
3. Use of calculators is permissible

MARK ALLOCATION

Question 1 – 25 marks

Question 2 – 25 marks

Question 3 – 25 marks

Question 4 – 25 marks

Question 5 – 25 marks

QUESTION 1

HYDROLOGICAL CYCLE/ WATER BALANCE

a) Illustrate with a schematization -the storage and processes of the terrestrial part of the hydrological cycle.   (5 marks)

b) In a given year, a catchment with an area of 2500 km2 received 100 cm of precipitation.

The average flow rate measured in the river draining the catchment was 20 m3 /s.

i) How much runoff reached the river that year (in m3)   (5 marks)

ii) Estimate the amount of water lost due to the combined effects of evaporation and

transpiration (in mm)   (5 marks)

iii) What is the runoff coefficient of this catchment?   (5marks)

iv) The boundaries of surface watersheds and aquifers are not always contiguous. How

does this affect the water balance?   (5 marks)

Total marks 25

QUESTION 2

FLOODS - RATIONAL METHOD

a) What four methods are available to estimate the magnitude of a flood peak? (8 marks)

b) An urban catchment has an area of 120ha. The slope of the catchment is 0.005 and maximum length of travel of water 1500m. The maximum depth of rainfall with a 25 year return period is as below

Duration (min)	5	10	30	40	60
Depth of rainfall mm	20	30	55	60	65

If a culvert for drainage at the outlet of this area is to be designed for a return period of 25 years, estimate the required peak-flow rate, by assuming the runoff coefficient is 0,5

(17 marks)

(Use Kirpich formula to calculate time of concentration)

Total marks 25

QUESTION 3

GROUNDWATER

a) Explain the meaning of the following:

i) Aquitard   (3 marks)

ii) Aquiclude   (3 marks)

iii) Confined Aquifer   (3 marks)

iv) Unconfined Aquifer   (3 marks)

v) Perched Aquifer   (3 marks)

b) At a certain point in an aquifer of 8km2 area, the water table was at an elevation of 105.00m. Due to natural recharge in a wet season, its level rose to 106.5m. A volume of 2.0 Mm3 of water was pumped out of the aquifer causing the water table to reach a level of 104.10m. Assuming the water table of the entire aquifer to respond in a similar way estimate:

i) the specific yield of the aquifer &   (5 marks)

ii) The volume of the recharge during the wet season. (5 marks)

Total marks 25

QUESTION 4

Floods - Risk & Reliability & Safety Factors

a) Explain and define the following terms:

i) Design flood   (4 marks)

ii) Spillway design flood (SDF)   (4 marks)

iii) Standard Project Flood (SPF)   (4 marks)

iv) Probable Maximum Flood (PMF)   (4 marks)

b) A bridge has an expected life of 25 years and is designed for a flood magnitude of return of 100 years

i) What is the risk of this hydrologic design and   5 marks)

ii) If a 10% risk is acceptable what return period will have to be adopted   (4 marks)

Show your calculations

Total marks 25

QUESTION 5

PRECIPITATION - TEST OF CONSISTENCE OF RECORD

Annual rainfall data for station Mzingwane as well as the average annual rainfall values for a group of ten neighbouring stations located in a meteorologically homogenous region are given below.

Year	Annual Rainfall of Station Mzingwane (m m)	Average Annual Rainfall of the group (mm)	Year	Annual Rainfall Of Station Mzingwane (mm)	Average Annual Rainfall of the group (mm)
1950	678	778	1965	1245	1401
1951	580	662	1966	1000	1140
1952	96	111	1967	574	651
1953	460	521	1968	597	645
1954	470	540	1969	375	350
1955	700	492	1970	636	591
1956	480	540	1971	498	490
1957	430	491	1972	386	400
1958	492	561	1973	439	390
1959	502	576	1974	569	570
1960	416	479	1975	355	377
1961	530	601	1976	686	654
1962	505	580	1977	826	788
1963	830	951	1978	427	410
1964	680	771	1979	613	589

i) Test the consistency of the annual rainfall data of station Mzingwane and   (10 marks)

ii) Correct the record if there is any discrepancy   (10 marks)

iii) Estimate the mean annual precipitation at station Mzingwane   (5 marks)

Total marks 25

END OF THIS EXAMINATION