NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF INDUSTRIAL TECHNOLOGY
DEPARTMENT OF CIVIL AND WATER ENGINEERING
BACHELOR OF ENGINEERING (HONOURS) DEGREE
PART II SECOND SEMESTER EXAMINATIONS APRIL/MAY 2006
HYDROLOGY TCW 2202

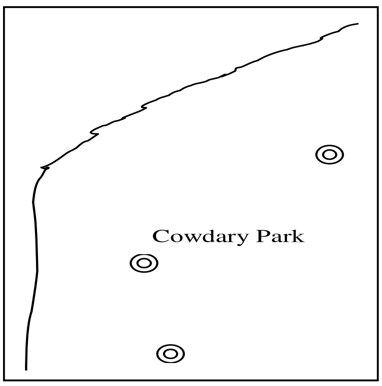
INSTRUCTIONS
Answer any ***four questions****.* ***Illustrate*** *your answers, where appropriate with clearly labeled sketches. Useful formulae are given at the end of the paper.*
Total marks 100 *Time 3 hours*

QUESTION I

(a) Discuss the application of hydrology in Civil Engineering. [7 marks]
(b) Define the terms "Latent heat of vaporization" and "Dynamic cooling". [6 marks]
(c) Describe the advantages of an automatic rain gauge [4 marks]
(d) The average annual rainfalls at 5 gauge stations in Bulawayo (Fig. Q1.1) are given in Table Q1.1. Determine the mean annual rainfall of the city using the isohyetal method. [8 marks]

Table Q1.1

Station	Airport	CBD	Hillside	Luveve	NUST
Rainfall (mm)	610	554	506	531	435



Scale 1:1000
Fig. Q1.1

QUESTION 2

(a) The mean annual rainfalls at NUST for a period of 16 years are in Table Q2.1. Determine:

(i) Rainfall for 50yr recurrence interval [5 marks]

(ii) Probability of occurrence of rainfall of 510mm and the recurrence interval. [5 marks]

(iii) If the risk of failure of a project with a design life of 100yrs is 5%, what is the recurrence interval? [3 marks]

Table Q2.1

Year	Rainfall (mm)	Year	Rainfall (mm)	Year	Rainfall (mm)	Year	Rainfall, (mm)
1986	480	1991	735	1996	515	2001	620
1987	746	1992	625	1997	480	2002	701
1988	689	1993	715	1998	500	2003	600
1989	492	1994	630	1999	520	2004	490
1990	501	1995	545	2000	700	2005	700

(b) The accumulated rainfall for a storm over time is in Table Q2.2.

(i) Derive a fitting equation for the data. [9 marks]

(ii) The rainfall intensity after 95 minutes [3 marks]

Table Q2.2

Time (min)	10	20	30	40	50	60	70	80	90	100
Accumulated rainfall (mm)	5	10	40	45	90	40	50	54	60	62

QUESTION 3

(a) During an infiltrometer test, the following results were obtained after 20 hours:

f_o =2mm/min
f_c =20mm/hour
F =80cm

Assuming that the Horton's model is valid, estimate the recession constant, k. [7 marks]

(b) State the assumptions for the Dupuit-Thiem's equations for steady state flow for confined and unconfined aquifers. [6 marks]

(c) The drawdowns (s) obtained from observation wells which are at a distance r from a pumping well are given in Table Q3.1. If the pump was discharging at 2.3m^3/hr, compute the hydraulic conductivity of the aquifer. Assume an aquifer thickness of 106m. [7 marks]

Table Q3.1

r, m	30	60	90	180	300	600	900
Drawdown (s), m	8.1	6.3	5.85	4.2	3	1.5	0.75

(d) Discuss two factors based on soil type which limits the application of Horton's equation. [5 marks]

QUESTION 4

(a) Define the term "Storage coefficient". [3 marks]

(b) A 375mm well is pumped at the rate of 2560 litres per minute. The drawdowns from an observation well 2.85m away from the pumping well are in Table Q4.1. Compute:-

- (i) Transmissivity [3 marks]
- (ii) Storage coefficient [3 marks]
- (iii) Drawdown in the observation well after 250 days [2 marks]
- (iv) Drawdown in the pumping well after 300 days [2 marks]

(c) Discuss the main advantages of the dilution method in stream gauging. [5 marks]

(d) A plan area of a new housing site is shown in Fig. Q4.1. The catchment characteristics are shown in Table Q4.1 and Fig. Q4.1. Estimate the surface runoff at the outfall point (O) into the secondary drain for a design return period of 1: 5yrs. The other remaining area is open space. [7 marks]

Table Q4.1

	Catchment A	Catchment B
Runoff coefficient for plot area	0.8	0.7
Runoff coefficient for the road	0.95	0.95
Open space runoff coefficient	0.35	0.35
% of road area	20	25
Plot area	60	55

QUESTION 5

(a) With clearly labeled sketches, outline the propositions of a unit hydrograph. [10 marks]

(b) The inflow hydrograph with a rainfall period of 2 hours of a catchment area of 200km^2 is shown in Table 5.1. In the same catchment area, there were three consecutive storms: a 3-hr at 22mm/hr; a 5-hr at 15mm/hr and a 4-hr storm at 20mm/hr. The storm loss for each of the storm was 8mm/hr. Derive a total hydrograph for all the three storms. [15 marks]

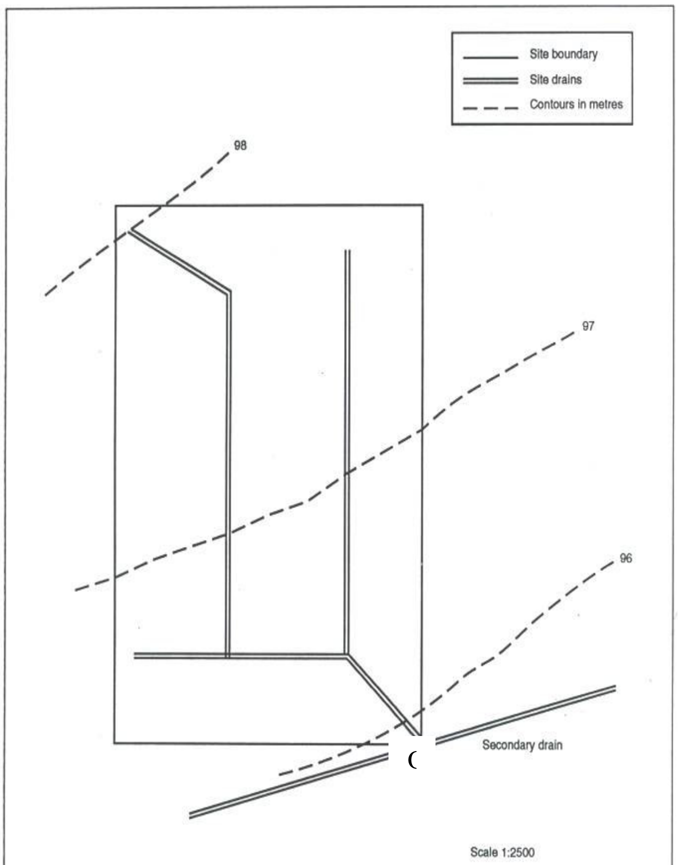


Fig. Q4.1

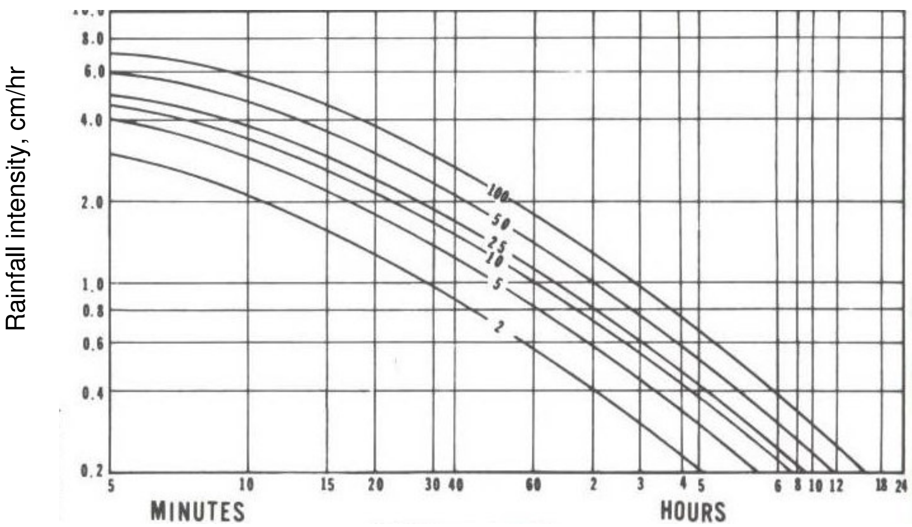


Fig. 4.1

Table 5.1

Time (hrs)	Discharge (m^3/s)	Time (hrs)	Discharge (m^3/s)
0	6	8	50
1	6	9	40
2	20	10	30
3	50	11	25
4	70	12	21
5	80	13	15
6	74	14	10
7	60	15	8

QUESTION 6

The inflow and outflow hydrographs for a river reach are given Table Q6.1. Determine the Muskingum coefficients, K and X for the reach. [25 marks]

Table Q6.1

Time, hr	0	12	24	36	48	60	72	84	96	108
Inflow, m^3/s	30	120	570	740	450	240	140	90	60	50
Outflow, m^3/s	40	50	280	620	630	390	230	140	90	60

Useful formula

$$S = \frac{2.3Q}{4\pi T}\log\frac{2.25Tt}{r^2 S_c} \qquad T = \frac{2.3Q}{4\pi\Delta s} \qquad S = \frac{2.25Tt_o}{r^2} \qquad T = \frac{2.3Q}{2\pi\Delta s}$$

$$C_o = \frac{-KX + 0.5\Delta t}{K - KX + 0.5\Delta T} \qquad C_1 = \frac{KX + 0.5\Delta t}{K - KX + 0.5\Delta T} \qquad C_2 = \frac{K - KX - 0.5\Delta t}{K - KX + 0.5\Delta T}$$

$$S = K[XI + (1 - X)O] \qquad O_2 = C_O I_2 + C_1 I_1 + C_2 O_1$$