UNIVERSITY OF SWAZILAND

Faculty of Health Science

Department of Environmental Health Sciences

Final Examination 2009

Title of paper: HYDROLOGY

Course code: EHS 545

Time allowed: 3 hours

Marks allocation: 100 Marks

Instructions:

1) Read the questions and instructions carefully
2) Answer ANY FOUR (4) questions
3) Each question is weighted 25 marks
4) Write neatly and clearly
5) Begin each question on a separate sheet of paper

This paper is not to be opened until the invigilator has granted permission

QUESTION 1

I.

Multiple choice: Write True or False against each letter corresponding to the following statements as they apply to hydrology.

(a) Infiltration capacity is the minimum rate at which water may enter the upper soil horizons.

(b) Precipitation is measured on the basis of the vertical depth of water that would accumulate on a level surface if the precipitation remains where it falls.

(c) For precipitation to occur there must be some mechanism to cool the vapor, there must be a condensation nuclei and lifting of air to achieve large scale precipitation.

(d) Double mass analysis tests the consistency of the record at a station by comparing its accumulated precipitation with the concurrent accumulated values of precipitation for a group of surround stations.

(e) Depth-Area duration curves determine the minimum amount of precipitation within various durations over areas of various sizes.

(f) Cyclonic rainfall is velocity difference induced precipitation

g) In non-frontal precipitation, low pressure occurs in an area and air flows from the surrounding areas lifts the air in low pressure area until it reaches heights where it condenses and precipitates falling as rainfall.

h) Permeability is the ability of a porous medium to transmit water.

i) Mass curves are not useful in reservoir design studies since they do not provide a ready means of determining storage capacity.

j) In warm air-front precipitation, warm air is forced upwards more rapidly.

II.

a. What is the information required in pumping tests?

(5 marks)

QUESTION 2

(a) Using the data provided, calculate the storage capacity required. The water demand (D) is $0.405 \times 10^6 m^3$/month and the available water flows at a flow rate, Q, of $10^6 m^3$/month. Use the arithmetic method.

Arithmetic Method and Storage

Month	Q ($10^6 m^3$)	D ($10^6 m^3$)
January	0.18	0.405
February	1.02	0.405
March	1.32	0.405
April	0.51	0.405
May	0.87	0.405
June	0.67	0.405
July	0.19	0.405
August	0.08	0.405
September	0.07	0.405
October	0.04	0.405
November	0.10	0.405
December	0.26	0.405
January	0.20	0.405
February	1.10	0.405
March	1.01	0.405

(16 marks)

b) During the water-year 1994/95, a catchment's area of 2500km^2 received 1300mm of precipitation. The average discharge at the catchment's outlet was 30m^3/s. Estimate the amount of water lost due to the combined effects of evaporation, transpiration and percolation to ground water. Compute the volumetric run off coefficient for the catchment in the water-year.

(9 marks)

QUESTION 3

(a) Describe the Thiessen method and the Isohyetal method of estimating precipitation.

(12 marks)

(b) Describe the hydrologic cycle

(13 marks)

QUESTION 4

(a) An evaporation pan is maintained near a small lake in order to determine daily evaporation. The water level in the pan is observed every day, and water is added if the water level falls below about 17.5 cm. Estimate the daily pan evaporation for the 14-day period for which readings are summarized in the following table.

Day	Rainfall, mm during the day	Water level, mm during the day
1.	5.1	199.0
2.	3.8	198.0
3.	6.2	196.7
4.	2.3	196.2

5.	0.2	193.9
6.	0	189.3
7.	0.5	185.5
8.	0.4	182.7
9.	0	180.9
10.	0.2	179.4
11.	0.3	176.6
12.	0.2	197.7
13.	0	196.4
14.	0.5	194.9

NB: The pan was filled to a depth of 200mm at the beginning of both day 1 and day 12.

(9 marks)

(b) Stream flow Records Listing the Lowest Mean Discharge for Seven Consecutive Days for Each year from 1961 to 1982.

The average annual discharge for this period was 178 m^3/s.

Year	Lowest Mean Flow in Cubic Meter per Second for 7 Consecutive days
1961	19.6
1962	28.6
1963	18.1
1964	34.3
1965	29.3
1966	35.7
1967	35.0
1968	27.0
1969	35.0
1970	36.9
1971	90.3
1972	50.6
1973	35.3
1974	59.4
1975	26.3
1976	30.1
1977	29.4
1978	29.7
1979	30.4
1980	49.6
1981	36.6
1982	59.1

(16 marks)

QUESTION 5

(a) A clear lake has a surface area of 740,000m^2. For the month of March, this lake had an inflow of 1.5m^3/s and an outflow of 1.4m^3/s. A storage change of +740,000m^3 was recorded. If the total depth of rainfall recorded at the local rain gauge was 230 mm for the month, estimate the evaporation loss from the lake. State any assumptions that you make in your calculations.

(16 marks)

b) Describe the siting of a rain gauge

(9 marks)

FORMULARS

1. $Cd = 0.61$ and $T = \int dt = \frac{ZA\,(H_1^{1/2} - H_2^{1/2})}{Cda\sqrt{2g}}$

2. $Q = 2/3\ Cd\ \sqrt{2g}\ \ b(H_1^{3/2} - H_2^{3/2})$

3. $Y_i = Y_S/2\ (\sqrt{1+8\beta f_S^2} - 1)$

4. $F_S = V_S/\sqrt{gY_S}$

5. $(Y + V/2g) - (Y + V/2g)$

6. $\rho g y^2/2 + \rho q(V_1 - V_2) - \rho g Y_2^2/ F_X = 0$

7. $Y_G = Y_s\ \sqrt{1+2F_s^2}\ (1 - Y_S/ Y_2)$

8. $Q = AV$

9. $Q = A/n\ R^{2/3}\ S_0^{1/2}$

10. $Y_i = Y_S/2\ (\sqrt{1+8\beta f_S^2} - 1)$

11. $F_S = V_S/\sqrt{gY_S}$

12. $p_1/\rho g + v_1^2/2g = p_2/\rho g + v_2^2/2g + 0.03\ (p_1/\rho g - p_2/\rho g)$

13. $Q = 1.84BH^{3/2}\ [(1+ \alpha\ v^2/2g\ H)^{3/2} - (\alpha\ v^2/2g\ H)^{3/2}]$

14. $k=[(1+ \alpha\ v^2/2g\ H)^{3/2} - (\alpha\ v^2/2g\ H)^{3/2}]$

15. $h= (v^2/2g)(1+ A_1/A_2)^2 = v^2/2g\ (A_1/A_2 - 1)^2$

16. $W = \Sigma_{i=1} \frac{p^{2rms(1)} S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

17. $S.I.L = 10 \log_{10} (I) + 120$

18. $L_p = 10 \log (p_1/p_0)^2$ or $(p_1/p_0)^2 = 10^{Lp/10}$

19. $L_p(total) = 10 \log (p_{total}/p_0)^2$

20. $I = W/A$

21. $L_W = 10 \log W/W_0$

22. $Q_1 = 1.84\ BH^{3/2}$

23. $Q = Cd\ 8/15\ \sqrt{(2g)}(\tan \square/2)H^{5/2}$

24. $\Delta Q = \dfrac{-\sum h}{2\sum h/Q}$