UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEGREE IN ENVIRONMENTAL HEALTH SCIENCES

(FINAL EXAMINATION)

TITLE OF PAPER : **HYDROLOGY**

COURSE CODE : **EHS 545**

TIME : **3HOURS**

TOTAL MARKS : **100**

INSTRUCTIONS:

- **QUESTION 1 IS COMPULSORY**
- **ANSWER ANY OTHER THREE QUESTIONS**
- **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
- **FORMULAE AND OTHER DATA IS PROVIDED**
- **NO FORM OF PAPER SHOULD BE BROUGHT IN OR OUT OF THE EXAMINATION ROOM**
- **BEGIN THE ANSWER TO EACH QUESTION IN A SEPARATE SHEET OF PAPER.**

DO NO OPEN THIS EXAMINATION PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR.

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) 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.

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

(d) The simplest method for determining reservoir capacity from stream flow data is by means of a mass curve.

(e) When a well fully penetrates a horizontal confined aquifer, the flow to the well is also horizontal from all directions.

(f) When fluid particles move in smooth paths without lateral mixing, the flow is said to be turbulent.

(g) Over the cross-section of an open channel, the velocity distribution depends on the character of the river banks and of the bed and in the shape of the channel.

(h) 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.

(16 marks)

II.

(a) What is the information required in pumping tests?

(6 marks)

(b) Name three things that determine the amount of runoff.

(3 marks)

QUESTION 2

(a) A well in a confined aquifer was pumped at a steady state rate of 0.0311 m^3/s. when the level remained constant at 85.48 m, the observation well level at a distance of 10.4 m was 86.52 m. Calculate the transmissibility (T).

(5 marks)

c) Use the data provided to determine T and S, when Q is 80 m^3/hr and r = 30 m; Δs = 2.84 m; t_0= 4.8 hrs

Time (hours)	2	4	7	12	20	30	50	70	100
Drawdown (m)	0.16	0.43	0.74	1.15	1.74	2.25	2.87	3.3	3.75

(6 marks)

(b) Using the data provided, calculate the storage capacity required. The water demand (D) is 0.250 x $10^6 m^3$/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 ($10^6 m^3$)**
January	0.8
February	1.22
March	1.02
April	0.41
May	0.77
June	0.37
July	0.09
August	0.18
September	0.07
October	0.14
November	0.10
December	0.16
January	0.20
February	1.20
March	1.31

(14 marks)

QUESTION 3

(a) A clear lake has a surface area of 708,000m^2. For the month of March, this lake had an inflow of 1.5 m^3/s and an outflow of 1.35 m^3/s. A storage change of +708,000m^3 was recorded. If the total depth of rainfall recorded at the local rain gauge was 225 mm for the month, estimate the evaporation loss from the lake. State any assumptions that you make in your calculations.

(13 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)

(c) State Darcy's law on ground water flow.

(3 marks)

QUESTION 4

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

(12 marks)

(b) Describe the hydrologic cycle

(13 marks)

QUESTION 5

(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.	4.1	199.0
2.	3.8	198.0
3.	4.2	196.7
4.	1.3	196.2
5.	0.2	193.9
6.	0	189.3
7.	0.5	185.5
8.	0.2	182.7
9.	0	180.9
10.	0	179.4
11.	0	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) Describe the siting of a rain gauge

(7 marks)

c) Describe the factors affecting evaporation

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

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. $W = \sum_{i=1} \frac{p^{2rms(1)} S_i}{\rho C}$, 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. $I = W/A$

22. $n = \frac{2\delta \cos\theta}{R\rho g}$

23. $\frac{p_1}{\rho g} + \frac{v_1^2}{2g} = \frac{p_2}{\rho g} + \frac{v_2^2}{2g}$

24. $W = \rho g Q h_p$,

25. Turbine output = $\eta_t \rho g Q h_p$,

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

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

28. $Q = a_1 v_1 = a_1 v_2$

29. $h_L = (1/C_c-1)^2 V_1^2/2g$

30. $A = (b + Ny)y$

31. $P = b + 2 y \sqrt{(1+N^2)}$

32. $\Delta Q = \frac{-\Sigma h}{2 \Sigma h/Q}$

33. $SRI = 10 \log_{10} \frac{I_t}{I_t} = 10 \log_{10} \frac{1}{T} = T.L$