(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF MASTERS OF SCIENCE IN WATER RESOURCES ENGINEERINTG

COURSE CODE: CWE 817

COURSE TITLE: GROUNDWATER HYDROLOGY

DATE: THURSDAY 28TH APRIL 2022 TIME: 2.00 – 5.00 PM

INSTRUCTIONS:

1. This paper contains FIVE questions
2. Answer any FOUR questions
3. Useful formulae is at the end of the question paper
4. Marks for each question are indicated in the parenthesis.
5. Examination duration is **3 Hour**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over.

QUESTION 1 (20 Marks)

(a) Derive the equation of steady radial flow in a unconfined aquifer and state the assumptions made [5marks]

(b) Three wells are sunk in a straight line to separate fully an extensive unconfined aquifer of 25m depth. The wells are equally spaced at 30m interval. When one end well was pumped at a rate of $20m^3$/day, the steady stated drawdown in the other wells was observed to be 0.90m and 0.65m

(i) What is the aquifer hydraulic conductivity? [5Marks]

(j) If all the wells are pumped at the same rate, what is the minimum drawdown between the wells, and where does it occur? [10Marks]

QUESTION 2 (20 Marks)

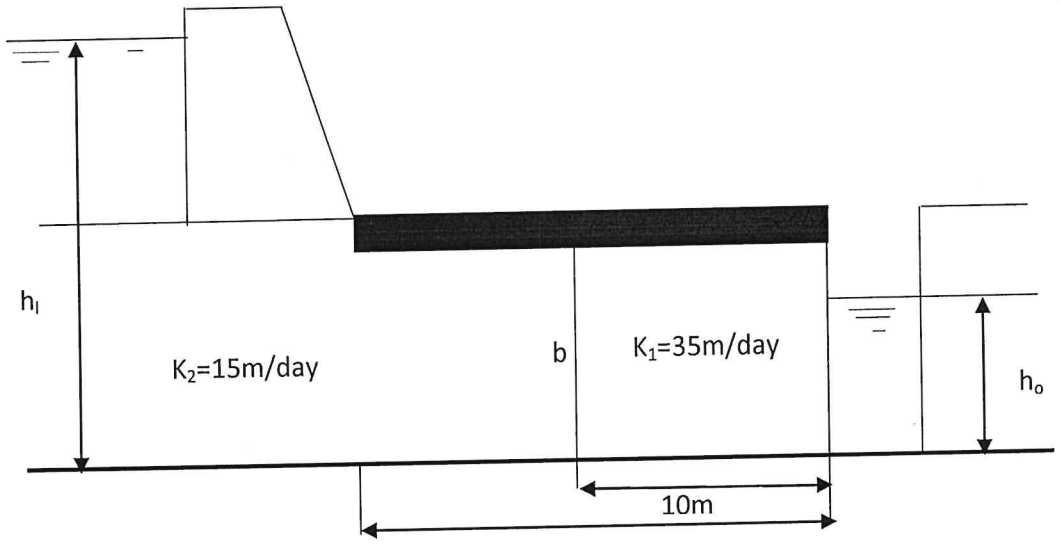
(a) Define the following terms: [8 Marks]

(i) Specific yield (ii) Fluid Potential (iii) Perched water table (iv) Cone of depression

(b) An impervious platform 110m long and 1m deep with its top at the ground level has been constructed on the downstream side of the earth dam (See Fig.1), over a 1.4m thick layer of pervious soil below which impervious clay extends up to a large depth. The sub-soil character indicates that the permeability of the layer up to 50m downstream is 15m/day and thereafter there is a sand of permeability 35m/day. At the downstream end of the platform, a seepage drain penetrating the full depth of aquifer is constructed. The water level in the drain was 260m on a day when the reservoir stood at 300m.

i. Estimate the seepage loss per meter length of the dam per day. [6 Marks]

ii. Compare the results if the permeability were only 15m/day for both layers. [6Marks]



QUESTION 3 (20 Marks)

(a) Starting from the Theis solution develop Jacob method of pumping test analysis [6Marks]

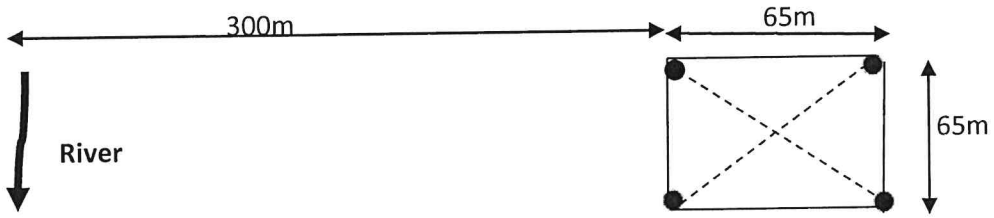
(b) A fully penetrating well in a 25-m thick confined aquifer is pumped at rate of $0.3m^3/s$ for 1200min. Drawdown is recorded versus time at an observation well located 150m away. Compute transmissivity T and storage coefficient S using the Jacobi method [14Marks]

Time (min)	S(m)	Time(min)	S(min)
1	0.10	60	1.03
2	0.25	70	1.05
3	0.31	80	1.09
4	0.34	90	1.11
6	0.40	100	1.25
8	0.49	200	1.34
10	0.54	400	1.55
20	0.71	600	1.61
30	0.82	800	1.75
40	0.85	1000	1.80
50	0.92	1200	1.97

QUESTION 4 (20 Marks)

(a) Briefly discuss the Groundwater management aspects [5 marks]

(b) The figure below shows a plan view of a proposed excavation site. It is proposed to build four equal fully penetrating wells of 0.4m radius each to lower the water table by 6m at the center of the excavation site. As an estimate, the original phreatic surface is taken horizontally at h_o=120m. The riverhead is also maintained at that value. Aquifer permeability is 1.45m/day. What is the required discharge from each well to achieve the dewatering objective? [15 marks]



QUESTION FIVE (20 Marks)

(a) Briefly discuss the occurrence of saline intrusion in aquifers and methods of controlling the intrusion in aquifer [8 marks]

(b) A confined aquifer overlying a layer of saline water is pumped by a well penetrating only the upper portion of the aquifer. The initial position of the fresh water salt interface is 30m below the bottom of the well. If the critical rise of the interface due to up-conning is limited to 14m, calculate the maximum permissible pumping rate without salt entering the well, take K=40m/day [12 marks]

Useful Formulae

$$s(r,t)=\frac{Q}{4\pi T}W(u)\ ,\quad u=\frac{r^2S}{4Tt},\quad F=\sqrt{\frac{kbB}{k_a}}\ ,\ \text{F=Leakage factor}$$

The Well Function, W(u)

u	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
X 1	0.219	0.049	0.013	0.004	0.001				
X 10^{-1}	1.82	1.22	0.91	0.70	0.56	0.45	0.37	0.31	0.26
X 10^{-2}	4.04	3.35	2.96	2.68	2.47	2.30	2.15	2.03	1.92
X 10^{-3}	6.33	5.64	5.23	4.95	4.73	4.54	4.39	4.26	4.14
X 10^{-4}	8.63	7.94	7.53	7.25	7.02	6.84	6.69	6.55	6.44
X 10^{-5}	10.94	10.24	9.84	9.55	9.33	9.14	8.99	8.86	8.74
X 10^{-6}	13.24	12.55	12.14	11.85	11.63	11.45	11.29	11.16	11.04
X 10^{-7}	15.54	14.85	14.44	14.15	13.93	13.75	13.60	13.46	13.34
X 10^{-8}	17.84	17.15	16.74	16.46	16.23	16.05	15.90	15.76	15.65
X 10^{-9}	20.15	19.45	19.05	18.76	18.54	18.35	18.20	18.07	17.95
X 10^{-10}	22.45	21.76	21.35	21.06	20.84	20.66	20.50	20.37	20.25
X 10^{-11}	24.75	24.06	23.65	23.36	23.14	22.96	22.81	22.67	22.55
X 10^{-12}	27.05	26.36	25.96	25.67	25.44	25.26	25.11	24.97	24.86
X 10^{-13}	29.36	28.66	28.26	27.97	27.75	27.56	27.41	27.28	27.16
X 10^{-14}	31.66	30.97	30.56	30.27	30.05	29.87	29.71	29.58	29.46
X 10^{-15}	33.96	33.27	32.86	32.58	32.35	32.17	32.02	31.88	31.76