(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 MASTER OF SCIENCE IN WATER RESOURCES ENGINEERING

COURSE CODE: CWE 812

COURSE TITLE: WATER AND WASTEWATER TREATMENT

DATE: THURSDAY 28TH APRIL 2022 **TIME: 8.00 – 11.00 AM**

INSTRUCTIONS:

1. This paper contains **FIVE** Questions
2. Answer questions any **FOUR (4)** questions.
3. Answer each question on a separate page.
4. This is an Open Book Exam
5. Mobile phones and Tablets are prohibited in Examination room
6. Examination duration is **3 Hours**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 3 Printed Pages. Please Turn Over.

QUESTION ONE [25 Marks]

You are required to design a circular sedimentation tank to achieve a 60% reduction in TSS with a daily peak flow factor of 2.5. Also determine the BOD removal rate.

Design information

Service area = 2500 ha.
Residential area = 60% of the total area
Commercial area = 30% of total area
Industrial area = 10% of the total area
Residential area composition = 40% are large lots, 55% are small single-family lots and 5% multistory apartments.
The wastewater from the residential area is estimated to be 800 Lpcd.
The sewage from commercial area = 25,000 L/ha/d
Sewage from industrial area = 40,000 L/ha/d, respectively.

Type of Area	Density (persons/ha)
Large lots	5-7
Small lots, single family	75
Small lots, two family	125
Multistory apartments	2500

QUESTION TWO [25 Marks]

a) A wastewater treatment plant serves a population equivalent of 30 000, a per capita flow rate of 230 l/day and influent TSS concentration of 350 mg/ l and has a TSS removal efficiency of 60%. Calculate the flow to the plant, and the quantity and volume of sludge produced each day [10 marks]

b) Wastewater can be used in the production of biogas. You have designed Up-flow Anaerobic Sludge Blanket (UASB) reactor for biogas production. Discuss the need for reactor optimization and describe the parameters which can be optimized [15 marks]

QUESTION THREE [25 Marks]

a) Calculate the aeration basin volume (V), the HRT (φ), the volume of sludge wasted each day (Q_w), the mass of sludge wasted each day ($Q_w X_w$), the fraction of sludge recycled Q_r/Q_0 and the f/m ratio for a completely mixed activated sludge system. [15 marks]

Design information

Population equivalent served = 60,000
Per capita water use = 225 l/day
Influent BOD (S_0) = 280 mg/ l
Required effluent BOD = 20 mg l/l
Yield coefficient (Y) = 0.6
Decay rate (k_d) = 0.06/day
Assumed optimum operational factors are

1) aeration tank MLSS (X) = 3500 mg l/l
2) WAS MLSS (X_w) = 14 000 mg l/l
3) MCRT (φ_c) = 10/day

Note: Express values in m^3, kg and per day

b) Describe the key treatment mechanisms in a facultative pond and design a facultative pond for an influent wastewater BOD of 550 mg/l and a flow rate of 120 m^3/ day where the average temperature is 20 ° C. [10 marks]

QUESTION FOUR [25 Marks]

a) Activated Rice husk Ash (RHA) was tested for its ability to remove pesticide organic compounds (POC) from water. Different masses of RHA were added to 1 litre of water (initial POC concentration = 0.9 mg/l) and contacted for 2 hours at 20°C and pH of 7.5. Using the data given in the table below determine whether the adsorption data fits Langmuir or Freundlich isotherm and determine the isotherm constants [15 marks]

Mass of RHA added (g)	Concentration of POC (mg/l)
0.2	0.77
0.5	0.65
2.0	0.32
5.0	0.19
10	0.14
20	0.09
50	0.06

b) Describe optimization parameters in adsorption water treatment units [10 marks]

QUESTION FIVE [25 Marks]

a) The ABC well water has bicarbonate hardness equal to 100 mg/L as $CaCO_3$. Calculate amounts of lime and soda ash required during the lime-soda ash process (Given: Daily flow rate: 10,000 m^3/day [10 marks]

b) The adoption of membrane processes in developing countries is low. Discuss [15 marks]

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