UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

DEGREE IN ENVIRONMENTAL HEALTH SCIENCE

FINAL EXAMINATION PAPER 2016

TITLE OF PAPER	:	INDUSTRIAL WASTE MANAGEMENT II
COURSE CODE	:	EHS 554
DURATION	:	2 HOURS
MARKS	:	100
INSTRUCTIONS	:	READ THE QUESTIONS & INSTRUCTIONS CAREFULLY
	:	ANSWER **ANY FOUR** QUESTIONS
	:	EACH QUESTION **CARRIES 25** MARKS.
	:	WRITE NEATLY & CLEARLY
	:	NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM.
	:	BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR.

QUESTION ONE

(Note: each question below carries five marks)

1A. Given the formula for solids retention time below, indicate:

i. What each symbol in the formula represents

ii. How the solids retention time is increased

iii. How a constant biomass concentration in the tank is maintained

$$SRT = \frac{VX}{Q_W X_R + Q_e X_e}$$

1B. Draw a sketch of the dose vs. life time risk relationship curve for:

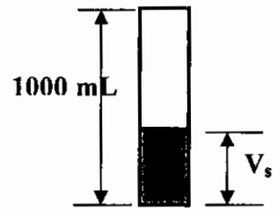
i. Non-threshold risk substance ...(1 mark)

ii. Threshold risk substance .....(1 mark)

iii. Single hit modeled risk .....(1 mark)

iv. Multi hit modeled risk .....(2 marks)

1C. A sludge settleability test indicated that the sludge volume index was 100 ml/mg. The initial MLSS concentration of the sludge before settlement was 3000 mg/L. Estimate the return sludge concentration in mg/L. Assume that all the solids occupy the settled position and that no solid is left in the supernatant water after settlement.



1D. The rate of substrate utilization r_{su} for anaerobic processes can be expressed in terms of the well-known Monod equation:

$$r_{su} = \frac{-kSX}{K_s + S}$$

Where k is the maximum specific substrate utilization rate, S is the effluent substrate concentration (COD), X is the biomass concentration and K_s is the half saturation constant.

i. Discuss the variation of the rate of substrate utilization with i) substrate concentration and ii) biomass present. .....[2 Marks]

ii. Indicate which of two (i.e. substrate concentration or biomass present) would be the limiting variable for maximum substrate utilization and state the reason. .....[2 Marks]

iii. Make an approximate sketch of the variation of the rate of substrate utilization with the substrate concentration (S) present.
.....[1 Mark]

1E. Discuss the causes and remedies to the following problems that may occur in the operation of trickling filters: i) High suspended solids in the filter effluent ii) ponding iii) odour iv) flies

QUESTION TWO (Each question below carries five marks)

2A. Describe briefly the production steps of leather tanning and finishing industries and state the nature of waste water generated from these industries.

2B. Given the chemical reaction equation for the conversion of glucose to cell mass below, compute the cell yield and chemical oxygen demand for this reaction.

$$3C_6H_{12}O_6 + 8O_2 + 2NH_3 \rightarrow 2C_5H_7NO_2 + 8CO_2 + 14H_2O$$

2C. What is the basic difference between the A/O process and the A^2O processes for the removal of phosphorus in activated sludge processes?

2D. List the five characteristics into which hazardous industrial waste may be classified.

2E. The return sludge in a certain activated sludge processes plant is being controlled on the basis of volumetric rate of flow.

i. Describe the changes in process variable that occur inside the activated sludge reactor as a result of sludge bulking problems when sludge return is being controlled by volumetric flow rate. .....[3 marks]

ii. State how the volumetric flow control of sludge return contributes to such changes in process variables. .

.....[2 marks]

QUESTION THREE (Each question below carries five marks)

3A. Indicate the limitations of currently practiced industrial wastewater effluent risk assessment methods.

3B. For sugar cane processing industries, describe briefly:

i. The steps of production ....(2 marks)

ii. The characteristics of wastewater generated ....(2 marks)

iii. Possible treatment steps. ..... (1 mark)

3C. Discuss the purpose/objective of each of the following management measures on open reservoirs used to store industrial wastewater effluents: i) copper sulfate addition ii) recirculation iii) filtration iv) wetland treatment and v) precipitation with aluminum sulphate. .....[1 marks for each item]

3D. State the two most important operational factors contributing to the failure of anaerobic process treatment of industrial wastewaters

3E. Describe with the help of a sketch contact stabilization activated sludge process and state their advantage in treating industrial wastewaters.

QUESTION FOUR (Each question below carries five marks)

The data in the table below shows measurements of solids parameters of the sludge before and after digestion of a given anaerobic sludge digester,. Using these sludge digester data provided in the table, determine:

4A. The specific gravity of the raw sludge.....[5 Marks]

4B. The specific gravity of the digested sludge digested sludge .....[5 Marks]

4C. The percentage of volatile solids after digestion. .....[5 Marks]

4D. The liquid volume before digestion. .....[5 Marks]

4E. The liquid volume after digestion. .....[5 Marks]

Parameter	Primary	Digested
Solids (%)	7	12
Volatile volume (%)	55	40
Specific gravity of fixed solids	2.65	2.65
Specific gravity of volatile solids	≈ 1.0	≈ 1.0

Use the following formulas:

$$\frac{W_s}{S_s \rho_w} = \frac{W_f}{S_f \rho_w} + \frac{W_v}{S_v \rho_w}$$

$$\frac{1}{S_{sl}} = \frac{W_s}{S_s \rho_w} + \frac{W_w}{\rho_w}$$

QUESTION FIVE (Each question below carries five marks)

5A. Compare the performance of aerobic and anaerobic treatment processes in terms of:

i. Sludge production .....(2 marks)

ii. Nutrient requirements ....(2 marks)

iii. The biological kinetics (rate of conversion of organic matter into biomass). .....(1 mark)

5B. Discuss possible methods for the treatment of liquid effluents from pesticide manufacturing processes.

5C. Determine the expected maximum Toxicity Characteristic Leaching Procedure (TCLP) value of mercury in an industrial sludge with the following characteristics:

-Concentration of mercury in liquid portion of sample = A = 0.5 mg/L
-Volume of liquid portion of the sample = B = 100 mL
-Concentration of mercury in solid portion of the sample = C = 6 mg/Kg
-Dry mass of the sludge sample = D = 100 gm

5D. Characterize the liquid wastes generated from electroplating industries and indicate possible treatment methods for the effluent from these industries.

5E. Indicate possible remedial action for the following operational problems in industrial wastewater treatment: i) Poor BOD removal in trickling filters ii) Bulking sludge in activated sludge.