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

B.Sc. DEGREE IN: ENVIRONMENTAL MANAGEMENT & OCCUPATIONAL SAFETY AND HEALTH
- ENVIRONMENTAL MANAGEMENT AND WATER RESOURCES

MAIN EXAMINATION PAPER 2018

TITLE OF PAPER	:	WASTEWATER MANAGEMENT
COURSE CODE	:	EHM 418
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 (25 Marks)

1A. What is the importance of grit chambers in waste water treatment? ...[4 Marks]

1B. Describe the cause of short circuiting in sedimentation tanks and the methods employed to prevent them.....[4 Marks]

1C. Differentiate between the following oil suspension in wastewater and indicate the methods for their removal from wastewater:

i) Free oil
ii) Physical emulsion
iii) Chemical emulsion
iv) Dissolved oil. .....[7 Marks]

1D. State the preferred position of adding precipitating chemicals for phosphorous removal in wastewater treatment plant. Choose from i) dosage at primary settlement tanks ii) dosage at secondary settlement tanks. State the reason for your choice. .....[5 Marks]

1E. Discuss the drawback of using hydrogen peroxide /UV combination treatment for disinfection of wastewater. .....[5 Marks]

QUESTION TWO (Each question below carries 5 marks)

2A. 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

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

2B. 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)

2C. 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.

2D. 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. .....[3 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]

2E. 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

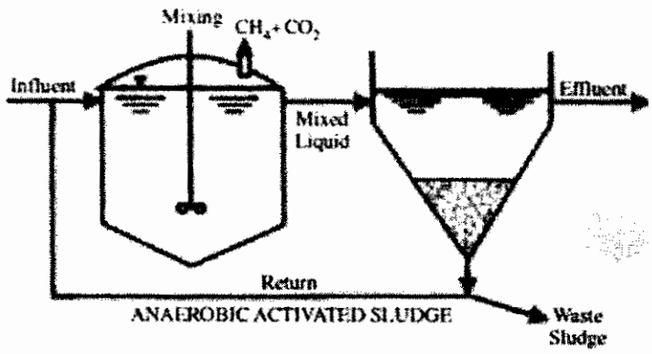
QUESTION THREE (Each question below carries 5 marks)

3A. How do you characterize the settling characteristics of sludge from extended aeration units and what is the particular requirement of settling tanks for extended aeration units?

3B. The diagram below shows anaerobic activated sludge process with sludge recirculation. A designer decided to remove the sludge recirculation. In relation to this decision answer the following questions.

i. What will happen to the hydraulic retention time and solids retention time as a result?

ii. How will the performance of the reactor change?



3C. Give five examples of physical unit processes in wastewater treatment.

3D. Discuss mechanism of disposal of sludge screenings and methods of stabilization that may be needed.

3E. Discuss the role of the following factors in the settlement of particles by gravity in wastewater i) particle size ii) particle shape iii) particle density iv) water temperature v) concentration of particles.

QUESTION FOUR (Each question below carries 5 marks)

4A. Describe the purposes for which conventional oxidation may be applied as treatment alternative in wastewaters.

4B. Compare the potentials of the following oxidation processes for treating wastewater

i. Ozone/UV

ii. UV/Hydrogen peroxide

iii. Ozone/Hydrogen peroxide

4C. What type of wastewater treatment may be suitable to eliminate interfering compounds so that photolysis treatment of wastewater becomes effective?

4D. Develop expression for the rate of substrate utilization for the following conditions:

i. When there is excess substrate available
ii. When the substrate available is limited.

$$r_{su} = \frac{-kXS}{K_s - S}$$

4E. Describe with the help of a diagram the following processes of denitrification in activated sludge:

i. The pre-anoxic process

ii. Post-anoxic process

QUESTION FIVE (Each question below carries 5 marks)

5A. 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.

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

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$$

5B. What is the basic difference between the A/O process and the A^2O processes for the removal of phosphorus in activated sludge processes?

5C. State the two most important operational factors contributing to the failure of anaerobic process treatment of wastewaters

5D. Describe with the help of a sketch contact stabilization activated sludge process and state their advantage in treating industrial wastewaters.

5E. 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)