



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

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

FINAL EXAMINATION PAPER 2016

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 (Each question below carries 5 marks)

1A. From the point of view of wastewater treatment objectives, comment on the merits of the following approaches to wastewater design by a wastewater manager.

A designer of wastewater treatment plant found a suitable site for wastewater treatment. However, the wastewater needs to be pumped from the sewer outfall to the treatment site since the treatment site is located at a higher elevation. S/he found out that diesel pumps are cheaper and opted for these pumps. S/he adopted conventional treatment that incorporated screening, grit removal, primary settlement tank followed by activated sludge reactor, secondary settlement tank and finally disinfection. S/e decided to use surface aerator to supply oxygen to the activated sludge reactor. The sludge is to be dewatered, dried in lagoons and eventually disposed on land fill.

1B. Give examples of treatment processes for the removal of:

- i. Colloidal solids
- ii. Dissolved solids
- iii. Volatile organic compounds
- iv. Odours

1C. State whether the following statements are true or false:

- i. Lime stabilization can lead to reduction of pathogens
- ii. Lime stabilization can achieve reduction of the mobile fraction of metals
- iii. Lime stabilization helps in dewatering of sludge
- iv. Heating of sludge achieves dewatering
- v. Heating of sludge reduces pathogens
- vi. Anaerobic digestion reduces pathogens
- vii. Anaerobic digestion achieves sludge dewatering
- viii. Anaerobic digestion saves energy compared to aerobic digestion
- ix. Composting reduces pathogens
- x. Composting leads to dewatering
- xi. Composting reduces the mobile fraction of metals.

1D. A typical biological reactor in the batch mode involves a sequence of four steps. Draw the sequence diagram of these four steps in the correct order.

1E. Compare packed bed reactor and fluidized bed reactor in terms of:

- a. Need for backwashing
- b. Solids storage capacity
- c. Dissolved air storage capacity
- d. Requirement for secondary settlement tank
- e. Danger of solids carryover.

QUESTION TWO (Each question below carries 5 marks)

2A. State whether each of the following reactions are homogenous or heterogeneous reactions. Give reasons for your choice.

- i. Fluidized bed reactor
- ii. Packed bed reactor
- iii. Ammonia stripping
- iv. Chemical precipitation
- v. Ion exchange

2B. Differentiate between the total Kjeldahl nitrogen and organic nitrogen.

2C. For a given wastewater parameter, the method detection limit was determined to be $3S$ while the limit of quantification (LOQ) was $10S$ where S is the standard deviation of the blank measurement. Suppose the blank measurement series was the following:

Blank sample number	1	2	3	4	5
Parameter value (mg/L)	0.001	0.005	0.1	0.003	0.002

- i. Determine the method detection limit in mg/L
- ii. Determine the limit of quantification
- iii. If a given sample analysis for the said parameter gave a value of 0.1 mg/L determine if this measurement is significant.

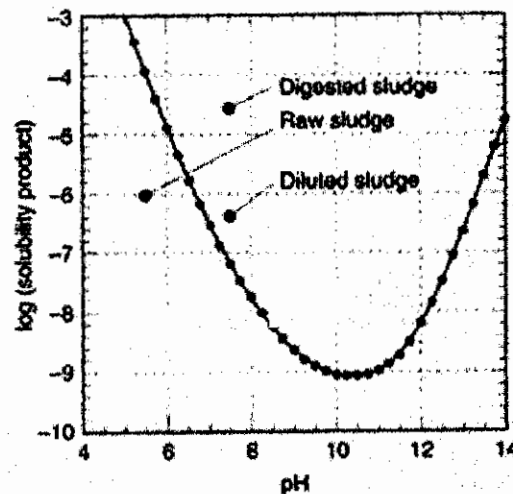
2D. The Henry's law constants for ammonia, hydrogen and carbon dioxide are respectively: 0.75, 68300 and 1420. Which of these three compounds is:

- i. Most soluble in water
- ii. Least soluble in water

2E. If a given sample were diluted 4 times in a 1:1 dilution ration after which 25 mL of the sample was taken and diluted eventually to 200 mL to give the just detectable odour, what will be the threshold Odour Number (TON).

QUESTION THREE (Each question below carries 5 marks)

- 3A.** Describe with the help of a sketch the following methods of equalization:
- i. Flow equalization
 - ii. Constituent equalization
- 3B.** Describe how the following factors may influence the settlement of solids in wastewater
- i. Wastewater temperature
 - ii. Solids density
 - iii. Solids size
 - iv. Horizontal velocity of flow
- 3C.** Describe the effect of using pumps on the removal of fat, oil and grease in wastewater
- 3D.** List three techniques applicable to each of the following sludge processing activities.
- i. Sludge thickening
 - ii. Sludge stabilization
 - iii. Sludge dewatering
- 3E.** The solubility products for struvite precipitation of three different types of wastewater sludge are shown in the figure below. Comment on the extent of formation of struvite in each of the sludge types.



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
- 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.** What operational control can be employed in order to maintain a desirable level of MLSS in activated sludge?
- 5B.** Describe the advantages of extended aeration units compared to the conventional activated sludge processes.
- 5C.** Differentiate between activated sludge and percolating filters in terms of the biological species present.
- 5D.** Describe the factors that affect the efficiency of performance of percolating filters.
- 5E.** Describe the effect of the presence of sulphate on the performance of anaerobic processes