



**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**FACULTY OF INDUSTRIAL TECHNOLOGY**

**DEPARTMENT OF CIVIL AND WATER ENGINEERING**

**WASTEWATER ENGINEERING**

**TCW 3104**

**Main Examination Paper**

**DECEMBER 2015**

This examination paper consists of 4 pages

**Time Allowed: 3 hours**

**Total Marks: 100**

**Special Requirements: NONE**

**Examiner's Name: Eng. A Chinyama**

**INSTRUCTIONS**

1. Answer any Four (4) questions
2. Each question carries 25 marks
3. Use of calculators is permissible

**MARK ALLOCATION**

<b>QUESTION</b>	<b>MARKS</b>
1.	25
2.	25
3.	25
4.	25
5.	25
6.	25
<b>TOTAL</b>	<b>100</b>

### **QUESTION 1**

- a. A BOD test is run using 100ml of treated wastewater mixed with 200ml of pure water. The initial DO of the mix is 9.0mg/l. After 5 days the DO is 4.0mg/l. After a long period of time, the DO is 2.0mg/l and it no longer seems to be dropping.
- What is the 5 day BOD of the wastewater? (5 marks)
  - Estimate the ultimate BOD, neglecting the effects of nitrification. (5 marks)
  - What would be the remaining BOD after 5 days? (5 marks)
- b. Describe the biochemical processes that take place in nutrient removal in a treatment plant. (10 marks)

### **QUESTION 2**

- a. An activated sludge system processes 12000m<sup>3</sup>/d of municipal sewage. After PST the soluble BOD<sub>5</sub> is 150mg/l and is desired to have not more than 5mg/l of soluble BOD<sub>5</sub> in the effluent. A completely mixed reactor is to be used and the wasting of activated sludge is from the recycle line. Given the following:
- $Y=0.5\text{kg/kg}$ ,  $k_d=0.06\text{d}^{-1}$
  - Sludge age = 6 days
  - $F/M = 0.8$
  - $MLVSS=3600\text{mg/l}$
  - $RAS= 10000\text{mg/l}$

Determine:

- The volume of the aeration basin (7 marks)
  - The quantity of activated sludge wasted each day (8 marks)
- b. Draw a cross-section of a biological filter and briefly explain the attached growth process of wastewater treatment. (10 marks)



### **QUESTION 6**

- a. Describe what would be termed “tertiary treatment” in wastewater treatment citing examples. (5 marks)
- b. With the aid of neat sketches, describe the various processes of removing nitrogen and phosphorus compounds from wastewater. (20 marks)

### **USEFUL FORMULAE**

$$\lambda_v = 20T - 100$$

$$K_{(T)} = K_{(20)} [1.04^{(T-20)}]$$