

National Examination December 2010

98-Civ-B5, Water Supply and Wastewater Treatment

3 hours duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.
3. Any non-communicating calculator is permitted.
4. Answer all questions from PART A and any TWO questions from B1, B2, and B3.
5. Values of all questions are indicated.
6. Clarity and organization of the answer are important.

PART A (total 50 marks)

A1 (20 marks)

- (i) Compare and contrast slow sand filters, rapid filters and pressure filters for water or wastewater treatment. **(10 marks)**
- (ii) What average intensity must be provided in a UV system to achieve 99.99% removal of indicator microorganisms with an inactivation rate constant of $0.010 \text{ m}^2/\text{J}$ and a detention time of 2 min in the UV zone? **(10 marks)**

A2 (20 marks)

- (i) Discuss briefly the advantages of flocculation as means of water or waste water treatment. **(8 marks)**
- (ii) How much alkalinity is consumed in the form of CaCO_3 is consumed by 50 mg/L of (i) FeCl_3 and (ii) $\text{Al}_2(\text{SO}_4)_3 \cdot 14.2 \text{ H}_2\text{O}$. **(12 marks)**.

- A3** Write the half reactions for the reduction of Chlorine dioxide (ClO_2) to Cl^- and Cl_2 to Cl^- . Based on the half reactions, how many chlorine atoms will be added to water when chlorine dioxide is the disinfecting agent versus chlorine. **(10 marks)**

Part B (50 marks). Answer two of the following three.

B1 (25 marks)

- (i) What is the lagoon temperature in a 2.7 m deep aerated lagoon with a surface area of 1.1 ha. The lagoon has a detention time of 3 d and influent and ambient temperatures are 15 and 25 deg Celcius respectively. **(10 marks)**
- (ii) Calculate the COD of a microorganism with the formula $\text{C}_{106}\text{H}_{263} \text{ O}_{110} \text{ N}_{16} \text{ P}$. **(15 marks)**

B2 (25 marks) The influent of $10,000 \text{ m}^3/\text{d}$ to a secondary biological reactor has a 5 day BOD of 150 mg/L. It is desired to have an effluent total 5-day BOD of 30 mg/L with a 5 day BOD of microbial cells of 13.8 mg/L, an MLVSS of 3000 mg/L and an underflow concentration of 10,000 mg/L. Use the kinetic parameters as follows: $Y = 0.57$; $k_d = 0.06$ per day and assume $\theta_c = 10$ days. What is the volume of the reactor needed. What are the volumes and mass flow rates of sludge wasted per day?

B3 (25 marks) A waste has a COD of 4500 mg/L. The wastewater flow is $750 \text{ m}^3/\text{d}$ and 70 percent of the waste is anaerobically digested. Calculate the methane generation rate. Also calculate the maximum yield of methane in m^3 of methane per Kg of COD consumed.