NATIONAL EXAMINATION, DECEMBER 2018

04-ENV-A4-Water and Wastewater Engineering

3 hours duration

**Notes:**

1. Question 1 is compulsory, attempt any three questions from the remaining four questions.
2. If doubts exist as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
3. This is a closed book exam. However, one aid sheet is allowed written on both sides.
4. One of two calculators is permitted - any Casio or Sharp approved model.
5. Marks of all questions are indicated at the end of each question.
6. Clarity and organization of answers are important.

**Q1 (25 marks)**
Define and explain the following terms in water and wastewater engineering

    i. "Population equivalent" in wastewater treatment **(5 marks)**
    ii. Oxygen sag curve in stream pollution **(5 marks)**
    iii. Return activated sludge and waste activated sludge **(5 marks)**
    iv. Disinfection by-products **(5 marks)**
    v. Turbidity in water **(5 marks)**

**Q2 (25 marks)**
    i. Describe the Phenomenon of Inter-particle bridging, sweep coagulation and ionic layer compression in coagulation-flocculation theory. **(15 marks)**
    ii. Explain the principal of ozonation for disinfection of water. Give two advantages and two disadvantages of ozonation over chlorination for disinfection **(10 marks)**

**Q3 (25 marks)**
    i. Define pH and explain its significance for water treatment with special regards to disinfection and coagulation-flocculation. **(10 marks)**
    ii. 20 mL of a water sample required 4 mL of 0.02N $H_2SO_4$ to reach the end point with phenolphthalein as indicator (pH 8.3), and 6 mL of 0.02N $H_2SO_4$ to reach the end point with Bromocresol Green (pH 4.5). Name the type of alkalinity indicated by each of these end points and determine the value of each alkalinity. Also what other type of alkalinity value can you calculate from these two observations, and what is its value? **(15)**

**Q4 (25 marks)**
    i. Define and differentiate between
        a. Anaerobic and aerobic digesters **(6 marks)**
        b. Coagulation and Flocculation **(6 marks)**
        c. TKN and Ammonia-Nitrogen **(7 marks)**
        d. HRT and SRT in Biological treatment systems **(6 marks)**

**Q5 (25 marks)**
Secondary clarifier of an activated sludge system treating an average sewage flow of 10,000 $m^3/d$ has return activated sludge pumps operating at 50% of the influent flow. The clarifier has an active volume of 2400 $m^3$ with side water depth of 4.0 m, and the MLSS concentration in the aeration tank is 3,000 mg/L. Determine:

    I. Surface overflow rate of the clarifier at average and peak flows, assuming a peaking factor of 2.5. **(9 marks)**
    II. Solids loading rate at average and peak flows. **(8 marks)**
    III. Solids concentration in the return sludge at average flow. **(8 marks)**