NATIONAL EXAMINATION, MAY 2017

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. An approved calculator is permitted.
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. MLSS and MLVSS **(5 marks)**
iv. Disinfection by-products **(5 marks)**
v. Turbidity in water **(5 marks)**

Q2 (25 marks)

Labeling all unit processes, process streams and chemical injection points; draw a detailed process schematic of a water treatment plant that has raw water with following characteristics.

i. Turbidity of 30-50 NTU
ii. Hardness of 200-250 mg/L
iii. Seasonal taste and odours
iv. pH range of 7.0 to 8.7

Q3 (25 marks)

i. Define pH and explain its significance for water treatment with special regards to disinfection and coagulation-flocculation. **(10 marks)**
ii. 50 mL of a water sample required 5 mL of 0.02N H_2SO_4 to reach the end point with phenolphthalein as indicator (pH 8.3) , and 8 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)

Define and differentiate between

a. Aerated and facultative lagoons **(6 marks)**
b. Organic, Poly and Ortho Phosphorus **(6 marks)**
c. Total Nitrogen, TKN and Ammonia-Nitrogen **(7 marks)**
d. HRT and SRT in Biological treatment systems **(6 marks)**

Q5 (25 marks)

Primary clarifier of an activated sludge system treats an average day flow of 10,000 m^3/d with TSS, VSS and BOD_5 of 250 mg/L, 200 mg/L and 200 mg/L respectively. If the TSS removal efficiency of the clarifier is 60%, calculate the following;

I. TSS, VSS and BOD_5 loads in primary effluent. Assume appropriate BOD_5 removal for the given TSS removal in the clarifier. **(7 marks)**

II. Volume of primary sludge produced per day, assuming a solids concentration of 4% and specific gravity of 1.03. **(6 marks)**

III. Surface area of the primary clarifier for a surface overflow rate of 60 m^3/m^2-d at peak day flow, assuming a flow peaking factor of 2.25. **(6 marks)**

IV. HRT at average day flow if the side water depth of the clarifier is 3.0 m. **(6 marks)**