NATIONAL EXAMINATION, DECEMBER 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 differentiate between

a. TKN, Total ammonia nitrogen, and free ammonia **(5 marks)**
b. COD and BOD_5 **(5 marks)**
c. Orthophosphates, polyphosphates, and organic phosphates **(5 marks)**
d. Return activated sludge and waste activated sludge **(5 marks)**
e. Hydraulic retention time and solids retention time**(5 marks)**

Q2 (25 marks)

i. Explain mathematically that the settling of discrete particle in a primary sedimentation tank is a function of the surface area and not the depth of the tank. **(15 marks)**
ii. What is an indicator organism in the biological examination of water? List the characteristics required of an organism to be selected as an indicator. **(10 marks)**

Q3 (25 marks)

i. 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 the following characteristics.
    a. Turbidity of 30-50 NTU
    b. Hardness of 200-250 mg/L
    c. Seasonal taste and odours
    d. pH range of 6.5 to 7.0

Q4 (25 marks)

i. With the help of a general chlorination curve, explain Chlorine demand, formation of chloramines and organochlorines, and, breakpoint chlorination **(15 marks)**
ii. Define and explain the following terms in water treatment:
    a. Charge neutralization and ionic layer compression in coagulation **(5 marks)**
    b. Schmutzdecke in rapid sand filtration **(5 marks)**

Q5 (25 marks)

An activated sludge system treating a wastewater flow of 10,000 m^3/d has primary effluent BOD_5 of 120 mg/L

i. For a sludge TSS yield of 0.75 kg/ kg BOD_5, calculate the volume of waste activated sludge per day for a secondary clarifier underflow sludge concentration of 8,000 mg/L **(10 marks)**
ii. Calculate the volume of the aeration tank required for an SRT of 10 days. **(15 marks)**