

NATIONAL EXAMINATION DECEMBER 2019

18-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:

- a. Grit removal in wastewater treatment (5 marks)
- b. Oxygen sag curve in stream pollution (5 marks)
- c. Indicator organism in water quality analysis (5 marks)
- d. Solids retention time and hydraulic retention time (5 marks)
- e. cBOD₅ and BOD₅ (5 marks)

Q2 (25 marks)

- a. Describe briefly the aerobic and anaerobic sludge digestion processes, and list two major advantages of anaerobic over aerobic digestion. (15 marks)
- b. Name and describe the various species of Nitrogen in municipal wastewater treatment. Explain the two key mechanisms of Nitrogen removal in wastewater treatment. (10 marks)

Q3 (25 marks)

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

- i. TSS 250 mg/L
- ii. BOD₅ 220 mg/L
- iii. Alkalinity 100 mg/L, and
- iv. TKN 40 mg/L

The treated effluent is required to meet effluent limits of 10 mg/L, 10 mg/L, 0.3 mg/L and 3.0 mg/L for cBOD₅, TSS, total phosphorus and ammonia nitrogen respectively, and a coliform limit of 150 CFU/100 mL.

Q4 (25 marks)

- a. With the help of a general chlorination curve, explain Chlorine demand, formation of chloramines and organochlorines, and, breakpoint chlorination (15 marks)
- b. A drinking water sample in a City was found to have sulfates, nitrate and chloride concentrations of 150 mg/L, 10 mg/L, and 100 mg/L respectively. What would be your comments and recommendations as a consulting engineer for suitability of this water for its intended use and why? (10 marks)

Q5 (25 marks)

Give a brief description of the following in water treatment:

- a. Jar tests for optimum coagulant dose. (5 marks)
- b. Filter headloss, Schmutzdecke and filter backwash. (5 marks)
- c. Discrete settling and flocculent settling. (5 marks)
- d. Importance of organic compounds and ammonia on chlorination based disinfection. (5 marks)
- e. Two advantages and two disadvantages of UV disinfection over chlorination. (5 marks)