

NATIONAL EXAMINATION, DECEMBER 2018
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. Only an approved Casio or Sharp 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. Combined and free residual chlorine (5 marks)
- b. Coagulation-flocculation and adsorption (5 marks)
- c. TKN, Total ammonia nitrogen, and free ammonia (5 marks)
- d. $cBOD_5$ and BOD_5 (5 marks)
- e. Orthophosphates, polyphosphates, and organic phosphates (5 marks)

Q2 (25 marks)

- a. 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. (10 marks)
- b. With the help of a sketch, describe briefly the working principal and operation of a trickling filter. (15 marks)

Q3 (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 the following characteristics.

- i. TSS range of 100-500 mg/L
- ii. Turbidity of 30-100 NTU
- iii. Hardness of 50-100 mg/L
- iv. Seasonal taste and odours
- v. pH range of 6.5 to 7.0

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)

A conventional activated sludge system treating a wastewater flow of 20,000 m³/d has raw sewage BOD_5 and TSS of 150 mg/L and 200 mg/L, respectively. The primary clarifier has TSS and BOD_5 removal efficiencies of 65% and 40% respectively

- a. For a sludge TSS yield of 0.7 kg/ kg BOD_5 , calculate the solids wasted and volume of waste activated sludge per day for a secondary clarifier underflow sludge concentration of 8,000 mg/L (10 marks)
- b. Calculate the volume of the aeration tank required for an SRT of 10 days. (15 marks)