

**NATIONAL EXAMINATION, MAY 2015**

**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. TKN and Total Ammonia Nitrogen (5 marks)
- ii. TSS, VSS and Inert Suspended Solids in wastewater (5 marks)
- iii. Oxygen sag curve in stream pollution (5 marks)
- iv. Free and combined residual chlorine (5 marks)
- v. Mercaptans in wastewater (5 marks)

**Q2 (25 marks)**

- a. Explain the significance of alkalinity and temperature in wastewater treatment with special reference to nitrification. Explain the principle of measuring alkalinity in water. (15 marks)
- b. Explain the importance of organic compounds and ammonia on chlorination based disinfection of water. Give two advantages and two disadvantages of UV disinfection over chlorination for disinfection (10 marks)

**Q3 (25 marks)**

- a. Define pH and explain its significance for water treatment with special regards to disinfection and coagulation-flocculation. (10 marks)
- b. 5 ml of a raw sewage sample diluted to 300 mL in a BOD bottle had an initial DO of 7.5 mg/L. After 3 days of incubation at 20°C, the DO in the sample was measured at 4.3 mg/L. Assuming 5% of the oxygen demand over this 3 day period being contributed by the seed in the sample, determine the 3 day, 5 day and ultimate BOD of the sample. (15)

**Q4 (25 marks)**

Give a brief description of the following in water and wastewater treatment:

- a. Jar tests for optimum coagulant dose (6 marks)
- b. Filter headloss, Shmutzdecke and filter backwash (6 marks)
- c. Discrete settling and flocculent settling (7 marks)
- d. HRT and SRT in biological treatment systems (6 marks)

**Q5 (25 marks)**

An activated sludge system based WWTP treats an average day flow of 20,000 m<sup>3</sup>/d with TSS, BOD<sub>5</sub>, TKN and TP of 200 mg/L, 170 mg/L, 35 mg/L and 4.5 mg/L respectively. The effluent limits for the WWTP are 10 mg/L, 10 mg/L, 3 mg/L and 0.2 mg/L for cBOD<sub>5</sub>, TSS, total ammonia nitrogen and total phosphorus, and 200 CFU/100 mL for E-Coli. Sketch a process flow diagram for the WWTP with the following details:

1. All unit operations and processes with liquid and solids streams;
2. Approximate influent and effluent characteristics from primary and secondary clarifiers and tertiary treatment units;
3. Sludge processing facility with digestion and dewatering processes;
4. Sludge streams with approximate volumes, % solids and/or concentrations; and
5. Chemical used and injection points.