

**NATIONAL EXAMINATION, December 2015**  
**98-CIV-B5-Water Supply and Wastewater Engineering**

**3 hours duration**

**Notes:**

1. Question 1 is compulsory, attempt any five questions from the remaining six 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.

1. In a water treatment plant, the raw water is drawn from a lake and has high TSS, turbidity, and hardness along with seasonal taste and odour issues. With a neat process flow diagram, propose a treatment process for the plant briefly describing the key processes in the liquid and solids/residues train. Name the chemicals used and injection points for the same, and give reactions in coagulation and chlorine disinfection processes. **(25 marks)**
2. 20 mL of a sludge sample was filtered through a standard filter paper weighing 1.2345 g and dried at 105°C in an oven. The weight of the filter paper after drying in the oven was 1.3456 g. The filter paper was then ignited in a muffle furnace at 550°C and the weight of the residue after ignition was 0.0234 mg/L.
  - a. Determine the TSS, VSS and Inorganic suspended solid in the sample in mg/L. **(12 marks)**
  - b. Comment on the impact on the test results if the muffle furnace temperature was set at 900°C by mistake. **(3 marks)**
3. What is the significance of ammonia in treated wastewater effluents discharged into surface water bodies? Name the forms of ammonia that are usually determined and reported in the effluent analysis. Which of these forms will be important and why, if the receiver has (a) high DO but an endangered species sensitive to toxicity (b) low DO but no concerns with toxicity (c) both low DO as well as toxicity concerns. Also comment on the impact of the pH values on the ammonia toxicity and how it can be controlled. **(15 marks)**
4. Describe the Phenomenon of Inter-particle bridging, sweep coagulation and ionic layer compression in coagulation-flocculation theory. **(15 marks)**
5.  $cBOD_5$  of a wastewater is 300 mg/L. If the organic matter in the wastewater sample has a non-biodegradable fraction of 0.35, determine the biodegradable and total COD values of the sample. Make suitable assumptions where required. **(15 marks)**
6. Explain mathematically that the TSS removal efficiency in a sedimentation tank is a function of its surface area and not the depth of the tank. **(15 marks)**
7. Name and briefly describe the four keys biochemical stages in anaerobic sludge digestion process. Which one of these is the rate limiting out of these and why? **(15 marks)**