NATIONAL EXAMINATION

DECEMBER 2019

16-CIV-B5-Water Supply and Wastewater Treatment

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 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 the following:

i. Temporary and permanent hardness **(5 marks)**
ii. Organic, ortho and poly phosphorus in wastewater **(5 marks)**
iii. Self-cleansing and scouring velocity in sewers **(5 marks)**
iv. Type 1 and Type 2 settling in water/wastewater treatment **(5 marks)**
v. Chloramines and Disinfection by-products **(5 marks)**

Q2 (25 marks)

a. Explain briefly with the help of chemical equations the relationship between pH and disinfection efficiency. What effect on chlorine dose do you predict if the pH of the post-filtration water in a water treatment plant was reduced from 8.5 to 7.3, and why? **(15 marks)**
b. Explain the significance and basis of selection of indicator organisms in biological testing of water. **(10 marks)**

Q3 (25 marks)

a. 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. **(12 marks)**
a. With a process flow diagram, name and briefly describe the key treatment stages in municipal wastewater treatment comprising a conventional activated sludge system and anaerobic sludge digestion. **(13 marks)**

Q4 (25 marks)

a. Describe the Phenomenon of Inter-particle bridging, sweep coagulation and ionic layer compression in coagulation-flocculation theory. **(12 marks)**
b. List the key requirements of an adequate water distribution system. Discuss the advantages and disadvantages of grid iron and dead-end system. **(13 marks)**

Q5 (25 marks)

a. The invert elevation of a 300-mm sewer drops by 0.25 m over a 100 m distance. Determine the discharge and flow velocity in the sewer when full and at a flow depth of 200 mm. Assume n = 0.013. Refer the pipe flow curves provided on the next page. **(25 marks)**

Partial Flow in Pipes
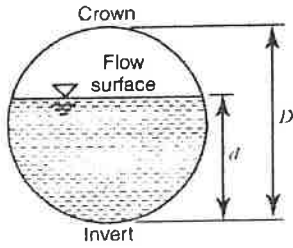
Nomenclature:
d = partial depth
D = full depth or pipe diameter
q = partial discharge
Q = full-flow discharge
v = velocity, partially full
V = velocity, full