NATIONAL EXAMS MAY 2019

16-Civ-A3 Elementary Environmental Engineering

3 hours duration

NOTES

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is a Closed Book Exam with a candidate prepared $8\frac{1}{2}''$ x $11''$ double sided Aid-Sheet allowed.

3. Candidates may use one of two calculators, the Casio or Sharp approved models. Write the name and model designation of the calculator on the first inside left hand sheet of the exam work book.

4. Any five (5) questions constitute a complete paper. Only the first five (5) answers as they appear in your work book(s), will be marked.

5. Each question is worth a total of 20 marks with the section marks indicated in brackets ( ) at the left margin of the question. The complete Marking Scheme is also provided on the final page. A completed exam consists of five (5) answered questions with a possible maximum score of 100 marks.

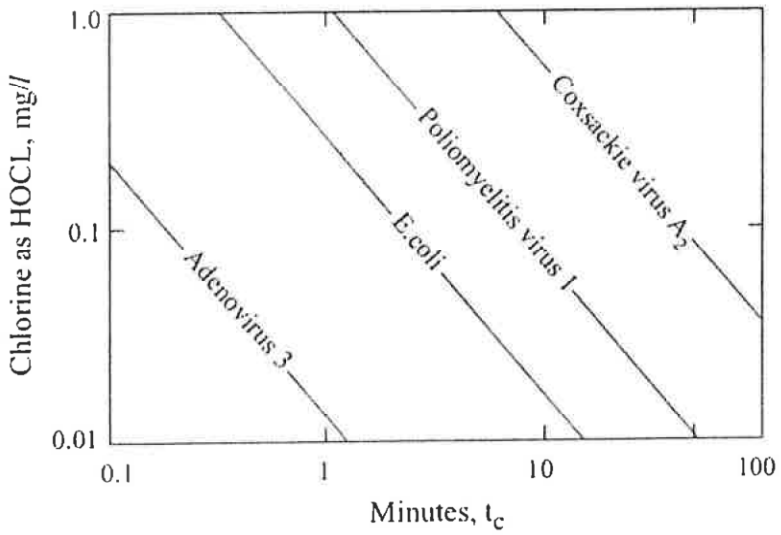
Problem 1

Provide answers to the following questions as related to environmental engineering *material balances, reaction kinetics, microbiology and ecology*:

(6) (i) A metal coating industry is located adjacent to Mudd Creek that flows at 300 L/s. The industry uses zinc cyanide $[Zn(CN)_2]$ for plating brass and discharges 100 L/s of Zn^{2+} contaminated process wastewater. Estimate the maximum concentration of Zn^{2+} in the wastewater that can be discharged in order to meet the required maximum concentration of 0.010 mg Zn^{2+}/L in the stream. Assume that the upstream Zn^{2+} concentration is 0 mg/L and that we have steady state conditions throughout.

(6) (ii) A concentrated wastewater effluent contains ammonia (NH_3) with an initial concentration of 200 mg/L. It is to be treated in an aerobic completely mixed batch reactor to convert the NH_3 to nitrates (NO_3^-). The reaction rate is assumed to be first order and the rate constant, k, is 0.1/h. Determine the time required to convert 80 % of the effluent NH_3 to NO_3^-.

(8) (iii) Consider the figure below which shows the concentration of hypochlorite ($HOCl$ mg/L) versus contact time (t_c in minutes) for 99% kill of *E. coli* and three enteric viruses at 0 to 6 ^oC. Based on the figure: (a) What is the most resistance microbe to disinfection by $HOCl$; (b) What is the least resistant microbe to disinfection by $HOCl$; (c) Would you consider *E. coli* a good indicator of virus inactivation and indicate why or why not; and (d) What would be the approximate minimum required contact time at a $HOCl$ of 0.1 mg/L to ensure 99 % inactivation of all the four microbes.



Problem 2

Provide answers to the following questions related to the application of enviornmental principles pertaining to *environmental impact assessment*, *environmental ethics* and *sustainable development*:

(7) (i) Consider the proposal to build wind farms on land near a residential communinity and a forest that provides habitats for endngered birds and bats. Briefly outline four (4) key points to show how an environmental impact assessment can evalutate and compare this proposal as a viable energy development for the expected 30-year life of the wind turbines.

(7) (ii) An engineer on contract by a construction firm is supervising the commissioning of a new water treatment plant that is overbudget and past the estimated opening date. The engineer notices what appears to be incorrect treated water quality sampling from the disinfection chamber that may compromise the safety of the final distributed drinking water. Briefly explain the actions that should be taken by the engineer, considering that inaction would place finacial interest ahead of professional engineering duties:

(a) An interest of the practitioner or another party who can benefit from the practitioner's actions; and

(b) An obligation or duty owed by the engineer to the enployer that can be adversely affected by any action taken by the practitioner to secure that interest.

(6) (iii) Consider the table below which provides a hierarchy of three levels dealing with sustainable development. The traditional discussion over sustainable development generally concentrates on Level II. Briefly explain three (3) potential negative consequences of not considering areas related to the Level I and Level III, in the implementation of a life long sustainable development project. For exmaple, consider the use of solar or wind farms compared to oil or natural gas as means of power generation over a 25-year life cycle, without considering associated ethical, technical, legal or political issues.

Level I		Ethical layer	
Level II	Ecological layer	Social layer	Economic layer
Level III	Technical layer	Legal layer	Political layer

Problem 3

Provide answers to the following questions related to *particle characteristics*, *gaseous emissions* and *chemistry of solutions* as it pertains to environmental engineering:

(8) (i) The removal of particles from municipal wastewater is critical for effective treatment. Briefly explain three (3) properties of one type of particles (e.g., suspended or colloidal particles) and explain how these properties influence the selection of appropriate treatment technologies. Give an example of two (2) treatment technologies for removal of the particle considered as part of your answer.

(5) (ii) Consider such gasses as hydrogen sulfide (H_2S), methane (CH_4) and other sulfur based volatile malodorous compounds originating from wastewater treatment. Briefly explain two (2) methods to reduce or eliminate the production of any of these gases during wastewater treatment.

(7) (iii) The average analysis in terms of Ca, Mg and Cu results of lake water near a copper refining operation is given below. Calculate the hardness of the lake water in mg/L as $CaCO_3$, assuming that the atomic weights are: Ca = 40; Mg = 24; Cu = 64; H=1; C=12 and O=16 and indicate how you would classify this water (i.e., soft, moderately hard or hard):

Ca^{2+}	=	20 mg/L
Mg^{2+}	=	30 mg/L
Cu^{2+}	=	50 mg/L

Problem 4

Provide answers to the following questions related to *population*, *economic growth*, *industrialization*, *urbanization* and *energy use* as causes of environmental pollution:

Briefly explain two (2) major environmental impacts and two (2) corresponding potential environmental engineering solutions to reduce environmental pollution from air emissions and increase in water quantity needs associated with the following growth areas (**use a 2 x 3 table as provided below**). Assume that strict environmental requirements are to be met following further economic growth, population expansion and energy-use increase:

(6) (i) Economic growth;

(7) (ii) Population expansion; and

(7) (iii) Energy-use increase.

2-Impacts & 2-Solutions	Economic Growth	Population Expansion	Energy-use Increase
Air Emissions			
Water Quantity			

Problem 5

Provide answers to the following questions related to the application of environmental principles (technical and non-technical) to *water* and *wastewater treatment*:

(10) (i) Typical source surface waters contain contaminants including dissolved organics, colloidal particulates, dissolved inorganics, pathogenic microorganisms and floatables. Provide a water treatment plant configuration to remove these water contaminants. Show the plant in a clearly labelled schematic and breifly explain one (1) key operational or monitoring approach, for each treatment unit in your plant, necessary to achieve potable water.

(10) (ii) Provide a labelled schematic which includes three (3) main treatment processes of a secondary or tertiary wastewater treatment plant (select **only one**) designed to achieve a low nitrogen (TN $<$ 10 mg/L) or phosphorous (TP $<$ 1 mg/L) in the final effluent. Provide a brief description of the engineering function of any three (3) treatment units.

Problem 6

Provide answers to the following questions associated with environmental engineering principles related to *air pollution control* and *solid waste management*:

(i) Briefly describe, using engineering principles, how each of the following three (3) systems work to control the emission of the specific air pollutants given below (e.g., equipment – contaminant):

(3) (a) Electrostatic precipitator – particulates

(3) (b) Wet scrubbing technology – SO_2

(4) (c) Adsorption technology – NO_x

(ii) Briefly provide strategies, using both technical and non-technical environmental principles, to deal with the following issues related to solid waste management:

(3) (a) Solid waste storage and collection

(3) (b) Materials recovery and recycling

(4) (c) Leachate treatment or minimization from landfill sites

Problem 7

Provide answers to the following questions related to *water resources management*, considering both technical and non-technical environmental principles:

(10) (i) Identify and discuss the application of three (3) water resource management strategies, either technical or non-technical, to protect both the short term and the long term source water in a large lake, located near a farming community. The farming operation contributes a significant nutrient loading (N and P) seasonally to the lake. The lake is the main source for a drinking water supply serving the local municipality.

(10) (ii) To address the multi-faceted nature of water management, many groups are now promoting an integrated approach to source water, water and wastewater treatment combined commonly referred to as "**One Water**". Assuming you are the municipal engineer responsible of the overall water system, provide three (3) key water resources management strategies you would apply to ensure a long-term sustainable complete water system for the local municipality.

Marking Scheme
16-CIV-A3 Elementary Environmental Engineering
December 2018

1. (i) 6, (ii) 6, (iii) 8 marks, 20 marks total

2. (i) 7, (ii) 7, (iii) 6 marks, 20 marks total

3. (i) 8, (ii) 5, (iii) 7 marks, 20 marks total

4. (i) 6, (ii) 7, (iii) 7 marks, 20 marks total

5. (i) 10, (ii) 10 marks, 20 marks total

6. (i) (a) 3, (b) 3, (c) 4, (ii) (a) 3, (b) 3, (c) 4 marks, 20 marks total

7. (i) 10, (ii) 10 marks, 20 marks total