NATIONAL EXAMS DECEMBER 2015

98-CIV-A3, 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.

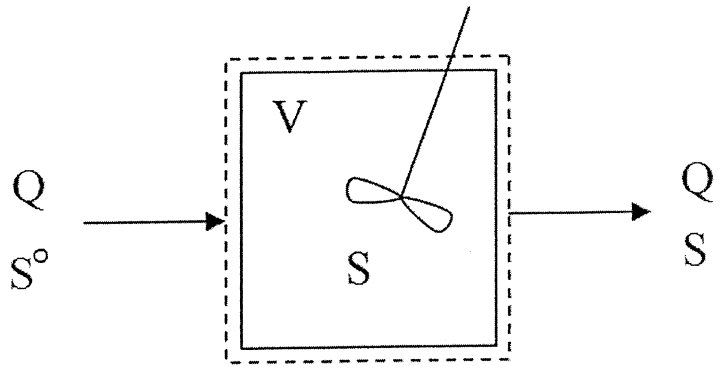
Problem 1

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

(7) (i) Two different methods, the most probable number (MPN) and colony-forming unit (CFU), are commonly used to enumerate fecal indicator bacteria in surface water samples for environmental compliance. Briefly explain each method and two (2) important differences to be considered when interpreting reported data from the microbiology lab.

(7) (ii) A nitrogen analysis of a wastewater sample gave the following results for ammonia, nitrite, nitrate and organic-nitrogen: 30 mg/L as NH_3, 5 mg/L as NO_2^-, 15 mg/L as NO_3^- and 10 mg/L as organic-N, respectively. Calculate the total nitrogen concentration in the wastewater sample. Assume that all the ammonia is in the form of NH_3 and the following chemical atomic weights: H=1, N=14 and O=16 apply.

(6) (iii) Consider the figure of a continuous-stirred tank reactor (CSTR) below, write the mass balance equation and solve for the steady state concentration of S in the discharge of the reactor. Assume $Q = 1\ (m^3/s)$, $S^o = 1\ (kg/m^3)$, $V = 10\ (m^3)$ and the rate of depletion is first order given by $r_s = -0.1S\ (s^{-1})$.



Problem 2

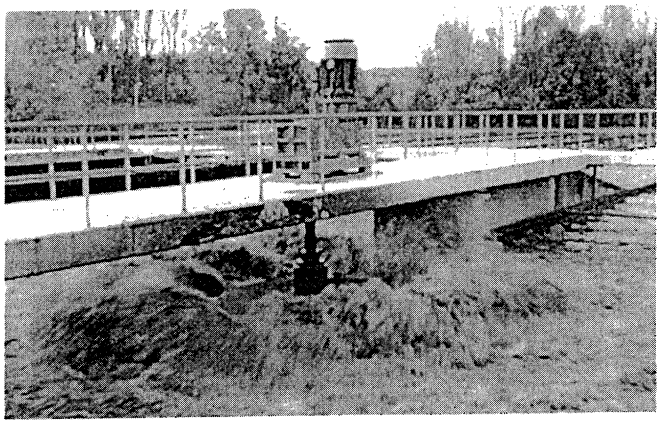
Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *gases*:

(9) (i) The removal of particles from wastewater is crucial for effective treatment and disinfection. Briefly outline two (2) key engineering principles for each process to explain: (1) how settleable particles are effectively removed in a wastewater treatment plant and (2) how disinfection may be compromised by the presence of suspended particles in the final effluent prior to disinfection.

(6) (ii) The average concentrations of Ca^{2+}, Mg^{2+} and Fe^{2+} of Lake Ontario water near a rock quarry is given below. Calculate the hardness of the lake water in mg/L as $CaCO_3$, assuming that the atomic weights are: Ca = 40, H=1, C=12, O=16, Mg=24 and Fe=56 and indicate how you would classify this water (i.e., soft, moderately hard or hard).

Ca^{2+}	=	80 mg/L
Mg^{2+}	=	70 mg/L
Fe^{2+}	=	20 mg/L

(5) (iii) Explain the use of aeration in the activated sludge treatment system and how temperature influences the proper number or size of blowers or surface aerators. You may use equations or labelled diagrams to provide an engineering explanation.



Problem 3

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

(i) Briefly explain two (2) major environmental impacts and two (2) corresponding potential engineering solutions associated with the Atmospheric Emissions, Water and Wastewater Infrastructure and Solid Waste Management with respect to:

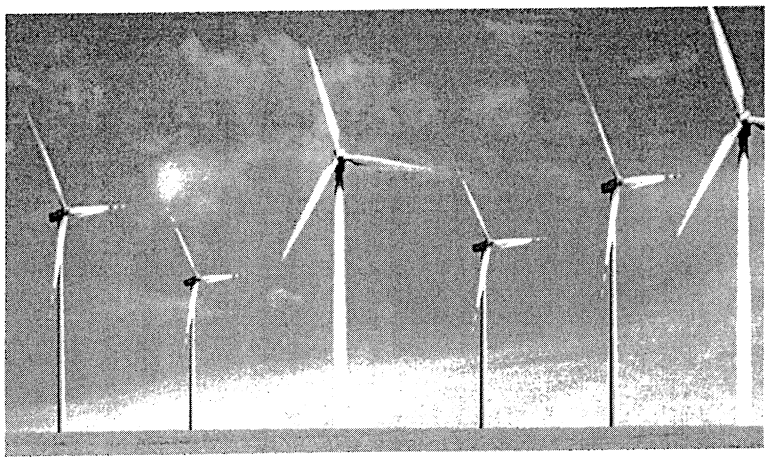
(7) (a) Economic growth;

(7) (b) Increasing population; and

(6) (c) Urban intensification.

(Use a 3x3 matrix as provided below to organize your answer)

2-Impacts & 2-Solutions	Economic Growth	Increased Population	Urban Intensification
Atmospheric Emissions			
Water and Wastewater Infrastructure			
Solid Waste Management			



Problem 4

Provide answers to the following questions related to *environmental ethics* and *surface water treatment*.

(10) (i) A junior structural engineer, was assigned the responsibility to conduct weekly checks on 3 birdges for their structural integrity by assessing the growth of several fractures on main pillars supporting the main structure. During the summer months, the juniour engineer, was advised by his superior that 2 of the bridges needed to be checked more thoroughly and that he could periodically skip checking the 3rd bridge to make up for lost time. Explain what the junior engineer should do considering the following three principles:

(a) Engineers shall hold paramount the health, safety and welfare of the public in the practice of their profession;

(b) Engineers shall act as faithful agents for their employers or clients and maintain confidentiality; and

(c) Engineers shall appropriately report any public works, engineering decisions, or practices that endanger the health, safety and welfare of the public. When, in an engineer's judgment, a significant risk to the public remains unresolved, that engineer may ethically make the concerns known publicly.

(10) (ii) Population increases, in developing countries have caused a direct increase in dinking water demands and water treatment. Identify and briefly discuss two (2) different ways of addressing both these issues considereing a 'soft' and a 'hard' engineering solutions. Use a matrix like the one below to organize your answer.

Engineering Solutions	'Soft' Engineering	'Hard' Engineering
Water Demands		
Water Treatment		

Problem 5

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

(10) (i) Briefly describe three (3) different engineering methods that can be used to control two (2) different air toxics associated with industrial air emissions. For each method, briefly provide one (1) advantage and one (1) limitation of the method and an example of where it is most appropriate to use that particular method. You may use a matrix to organize your answer as below.

Air Toxics	Advantage and Limitation		
	Method 1	Method 2	Method 3
Air Toxic 1			
Air Toxic 2			

(10) (ii) Give three (3) engineering strategies to reclaim the solid waste for resource recovery and to reduce transportation needs. Prioritize the 3-strategies according to environmental benefits and cost recovery over a 25 year period. You may use a matrix to organize your answer as below.

Solid Waste	Engineering Strategies		
	Strategy 1	Strategy 2	Strategy 3
Resource Recovery			
Reduce Transportation Needs			

Problem 6

Provide answers to the following questions related to *environmental impact assessment* and *sustainable development*:

(10) (i) Explain how an environmental impact assessment may be applied to reduce the impacts of the construction of a new northern access road to a proposed new oil well in northern Alberta. You may use a matrix to organize your explanation and to identify the key process steps, the main issues and actions necessary to address the potential environmental impacts.

(10) (ii) Briefly discuss the key principle of sustainable development associated with harnessing of wind energy or solar energy. In your discussion, consider the link between environmental and economic sustainability.

Problem 7

Provide answers to the following questions related to *water resource management*, *water treatment* and *wastewater treatment*:

(5) (i) Water conservation priorities are becoming an important part of water resource management that impacts the complete water use cycle. Give an example showing how engineering principles are used to reuse or recycle wastewater.

(6) (ii) Explain three key engineering principles in the operation of a sand filter in a water filtration plant having surface water as its source water.

(iii) Briefly explain two (2) main differences between the following terms:

(3) (a) Coagulation and flocculation;

(3) (b) Anoxic and aerobic treatment; and

(3) (c) Municipal wastewater and sludge.

Marking Scheme
98-CIV-A3 Environmental Engineering
December 2015

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

2. (i) 9, (ii) 6, (iii) 5 marks, 20 marks total

3. (i) (a) 7, (b) 7, (c) 6 marks, 20 marks total

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

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

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

7. (i) 5, (ii) 6, (iii) (a) 3 (b) 3 (c) 3 marks, 20 marks total