NATIONAL EXAMS

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 *material balance*, *reaction kinetics* and *microbiology* as related to environmental engineering:

(6) (i) A 10 m^3 storage tank is half filled with water and half filled with air at 21 ^oC. After 88 kg (1000 mol) of liquid ethyl acetate ($C_4H_8O_2$) is added, the storage tank is sealed. Determine the equilibrium concentration of ethyl acetate in water and the equilibrium partial pressure of ethyl acetate in the air space. Henrys Law Constant (K_H) for ethyl acetate at 21 ^oC is 0.30 (mol/atm).

(7) (ii) A nitrogen analysis of polluted groundwater gave the following results for ammonia, nitrite, nitrate and organic-nitrogen: 25 mg/L as NH_4^+, 5 mg/L as NO_2^-, 15 mg/L as NO_3^- and 20 mg/L as organic-N, respectively. Calculate the total nitrogen concentration in the effluent sample. Assume that all the ammonia is in the form of NH_4^+ and the following chemical atomic weights: H=1, N=14 and O=16.

(7) (iii) Briefly explain how ozone, chlorine or ultraviolet irradiation (UV) (**select one disinfectant only**) works to inactivate bacteria, cysts and viruses commonly present in surface waters used as a source for drinking water treatment plants.

Problem 2

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

(9) (i) It becomes obvious that the removal of particles from water is crucial for safe potable water production. Briefly outline two (2) key engineering principles to explain how sand filtration is effective at removing particles. Also give one (1) important reason for using the turbidity of the treated water as an indicator of effective filtration.

(6) (ii) The average concentrations of Ca, Mg and Fe of Lake Eire waters 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 and O=16 and indicate how you would classify this water (i.e., soft, moderately hard or hard).

Ca^{2+}	=	70 mg/L
Mg^{2+}	=	50 mg/L
Fe^{2+}	=	10 mg/L

(5) (iii) Two (2) types of priority and toxic atmospheric pollutants include: carbon monoxide (CO) from incomplete combustion and hydrogen sulfide (H_2S) that can occur due to anaerobic conditions in sanitary sewers. Briefly describe one (1) environmental or health impact from each compound and one (1) appropriate engineering strategy or control measure to reduce the environmental or health impact of each of the two (2) gas types.

Problem 3

Provide answers to the following questions related to *population growth*, *economic growth* and *urban sprawl* as causes of environmental pollution:

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

(7) (a) Population growth and intensification within an urban centre;

(7) (b) Economic growth and associated increase in industrial activity; and

(6) (c) Urban sprawl from the core urban centre to the city outer limits.

(Use a 3x3 matrix as provided below)

2 – Impacts & 2 – Solutions	Population Growth	Economic Growth	Urban Sprawl
Watershed			
Water Infrastructure			
Solid Waste			

Problem 4

Provide answers to the following questions related to *environmental ethics* and *energy use*.

(10) (i) A junior site structural engineer, in charge of checking the structural integrity of scaffolding each week from various construction sites, was advised by his supervisor that the scaffolding at this site was inspected last week, met code specificaitons and it's not necesary to conduct this week's inspeciton and he should move on to the next site where he is urgently needed. 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 fuel demands to meet increased energy consumption needs. Discuss three (3) different types of pollution associated with the increased burning of fossil fuels and three (3) 'soft' or 'hard' engineering solutions (**1 for each pollution type**).

Problem 5

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

(10) (i) Briefly describe three (3) different methods that can be used to control volatile organic contaminants (VOCs) (e.g., formaldehyde, toluene, benzene) from industrial fixed sources. 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.

(10) (iii) Give three (3) main strategies in controlling the solid waste generation from a municipality and prioritize these strategies according to environmental benefits and cost recovery over a 25 year period. You may use a 3 x 2 matrix to organize your answer.

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 pollution associated with the operation of a new automobile parts manufacturing plant in southern Ontario. 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 environmental impacts.

(10) (ii) Briefly discuss the key principle of sustainable development associated with maintaining our natural fish stocks with the integration of 'fish farming'. 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) A large dam is a major source of energy for the local industries and urban centers, but it is susceptible to sedimentation buildup and associated loss in energy production. It has been identified that the main causes are stormwater and agriculture runoff. Explain how you would use water resource management principles to ensure the longevity of the dam energy production.

(6) (ii) Give an example of how flocculation-coagulation is used in drinking water or wastewater treatment. In your answer, include a brief discussion of theory and associated practice.

(iii) Briefly explain the differences between the following terms:

(3) (a) Facultative and aerobic;

(3) (b) Colloidal and Dissolved solids; and

(3) (c) Secondary and tertiary wastewater treatment.

Marking Scheme
98-CIV-A3 Environmental Engineering
May 2013

1. (i) 6, (ii) 7, (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