NATIONAL EXAMS DECEMBER 2012

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 *population*, *economic growth* and *urbanization* as causes of environmental pollution:

(i) Explain three (3) major environmental impacts and corresponding potential environmental engineering solutions to reduce impacts associated with the following:

(7) (a) Population increase specifically associated with immigration;

(7) (b) Economic growth due to increase in industrial production; and

(6) (c) Urbanization associated with movement of people from rural to urban communities.

For impacts, consider emmission of pollutants to the atmosphere, hydrosphere or lithosphere. For engineering solutions, consider both 'hard' or 'soft' engineering approaches. A matrix may be used to organize your answer.

Problem 2

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 particulate emissions (e.g., PM10, PM2.5) from industrial fixed sources and mobile 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) The existing landfill site for the city's solid waste will reach capacity in five (5) years at the current rate of solid waste production. You have been hired to recommend an engineering plan for the next 25 years by the city to assist in managing their solid waste. Identify and briefly discuss four (4) strategies you would recommend in your solid waste management plan and prioritize these strategies according to environmental endpoints and long term (over the 25 year period) reduced cost. You may use a matrix to organize your answer.

Problem 3

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

(9) (i) In wastewater and water treatment process control it is important to know the concentration levels of total suspended solids (TSS), total colloidal solids (TCS) and total dissolved solids (TDS). Briefly explain the key engineering principle of three (3) different engineering processes and one technology type for each particle range, to reduce their concentration in the effluent of a sewage treatment plant (STP) or finished treated water in a drinking water treatment plant (WTP). Consider either a STP or WTP, **not both**.

(6) (ii) The average analysis results of Lake Huron waters near a fish farm shows the following characteristics. Calculate the alkalinity 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.

CO_3^{2-}	=	20 mg/L
HCO_3^-	=	100 mg/L
pH	=	10

(5) (iii) Two (2) types of priority atmospheric pollutants include: nitrogen oxides (NO_x) and sulphur oxides (SO_x). Briefly describe one (1) environmental impact from each compound and one (1) appropriate engineering strategy or control measure to reduce the environmental impact of each of the two (2) gas types.

Problem 4

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 in the development of a pipeline from the Alberta Oil Sands across to British Columbia or into the United States. You may use a matrix to identify the key process steps, the issues and considerations and actions necessary to address the issues.

(10) (ii) Briefly discuss the key principle of sustainable development and to what degree the use of solar power, wind power or tidal power (**choose only one**) may achieve the principle of sustainability. In your discussion, consider the link between environmental and economic sustainability.

Problem 5

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

(6) (i) A 1000 L storage tank is half filled with water and half filled with air at 25 ^{o}C. After 92 kg (1000 mol) of liquid toluene (C_7H_8) is added, the storage tank is sealed. Determine the equilibrium concentration of toluene in water and the equilibrium partial pressure of toluene in the air space. Henrys Law Constant (K_H) for toluene at 25 ^{o}C is 0.20 (mol/atm).

(7) (ii) A nitrogen analysis of sewage effluent gave the following results for ammonia, nitrite, nitrate and organic-nitrogen: 20 mg/L as NH_4^+, 6 mg/L as NO_2^-, 10 mg/L as NO_3^- and 15 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 discuss three (3) different disinfection process strategies to disinfect effluent discharges to surface waters that contain either bacteria, cists or viruses. Select **one** strategy for each type of microorganism.

Problem 6

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

(5) (i) A large open surface water reservoir (similar to a natural fresh water lake) used as a drinking water supply for a local town is vulnerable to point source subsurface wastewater plumes from septic systems that treat wastewater from local cottages and small local industries. Provide two (2) water resource management principles or strategies that can be applied to protect the long term viability of this valuable resource.

(6) (ii) Explain the process of disinfection using ozone or chlorine as related to drinking water or wastewater treatment. In your answer, include a brief discussion of contact time, dosage, pathogen inactivation and reactivation. Select only **one** disinfection method and **one** type of treatment.

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

(3) (a) Aerobic and anoxic reactors;

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

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

Problem 7

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

(10) (i) A chemical engineer on contract by a city is supervising the effluent sampling of the city's sewage treatment plant conducted by city staff on the final week of a summer month. The supervising engineer notices what appears to her to be selective sampling from the effluent channel where the effluent total suspended solids (TSS) appear lower. A very low effluent TSS, *E. coli*, and BOD compliance is required in the summer months due to a busy beach area downstream of the effluent discharge. Briefly explain the actions that should be taken by the supervising engineer, considering the following ethical 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 has caused a direct increase in fuel demands to meet increased energy consumption needs. Discuss three (3) main energy uses within an urban setting and three (3) examples of engineering technologies which have reduced the pollution sources through improved energy conversion efficiencies or the application of innovative pollution control devices.

Marking Scheme
98-CIV-A3 Environmental Engineering
December 2012

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

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

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

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

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

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

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