NATIONAL EXAMS MAY 2016

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) Two methanol-water mixtures are contained in separate tanks. The first mixture contains 30 % by weight methanol and the second contains 70 % by weight methanol. If 100 kg of the first mixture is combined with 200 kg of the second, what are the mass and composition of the products?

(7) (ii) If the decomposition of $N_2 0_5$ into $N_2 0_4$ and O_2 were to proceed to completion in a closed volume of size V, what would be the pressure rise if the starting composition is 40 % $N_2 0_5$ and 60 % N_2?.

(7) (iii) Disinfection to inactivate microbial pathogens is an integral part of drinking water treatment. Briefly explain the significance of the following three (3) terms as they relate to disinfection: (1) indicator organism; (2) contact time and (3) log reduction.

Problem 2

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

(9) (i) The removal of particles during water treatment is crucial to produce safe potable water. Briefly outline how flocculation, coagulation and filtration may be integrated in water treatment to remove various particle types. Also, briefly explain why turbidity of the treated water is a good indicator to assess the effectiveness of filtration.

(6) (ii) The average concentrations of Ca, Mg and Fe of Lake Ontario water near a salt mine 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; Fe = 56; H = 1; C = 12 and O = 16 and indicate how you would classify this water (i.e., soft or hard).

Ca^{2+}	=	80 mg/L
Mg^{2+}	=	40 mg/L
Fe^{2+}	=	20 mg/L

(5) (iii) Sewer gas is a complex mixture of toxic and non-toxic gases produced and collected in sewage systems by the decomposition of organic and industrial wastewaters. Typical gasses include ammonia (NH_3) and hydrogen sulfide (H_2S). Briefly describe one (1) environmental or health impact from each compound and one (1) appropriate engineering strategy to reduce the environmental or health impact of each of the two (2) gasses.

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 Mobile Emissions, Wastewater Infrastructure and Water Demand 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
Mobile Emissions			
Wastewater Infrastructure			
Water Demand			

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 carried out to reduce the pollution associated with the manufacturing of coffee cups that are polyethylene coated and use solvent-based inks for coloring and printing on the cups. 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 harvesting of trees along with non-tree plant species, such as grasses, in the paper manufacturing industry. In your discussion, consider the link between environmental and economic sustainability.

Problem 5

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

(10) (i) A professional engineer is competent to make ethical and technical decisions within his/her area of expertise that could not be made correctly by the general public. Briefly discuss how to judge the competency of a professional engineer using an example (e.g., a professional engineer in charge of the implementation of a safety program at a construction site) and 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 with direct impacts on global warming and climate change . Discuss three (3) different types of pollution with direct impacts on climate change and three (3) 'soft' or 'hard' engineering solutions (**1 for each pollution type**).

Problem 6

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., PM_{10}, $PM5_{50}$) from fixed or 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. Use a matrix to organize your answer.

(10) (ii) Give three (3) main engineering approaches to control the solid waste accumulation in a landfill site whose major source is a local municipality. Prioritize these engineering approaches according to environmental benefits and cost recovery considering a 30 year life cycle for the landfill site. Use a matrix to organize your answer.

Problem 7

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

(5) (i) Compare two (2) water resource management issues associated with using a *surface water* compared to a *groundwater* source for providing potable drinking water to a small rural community.

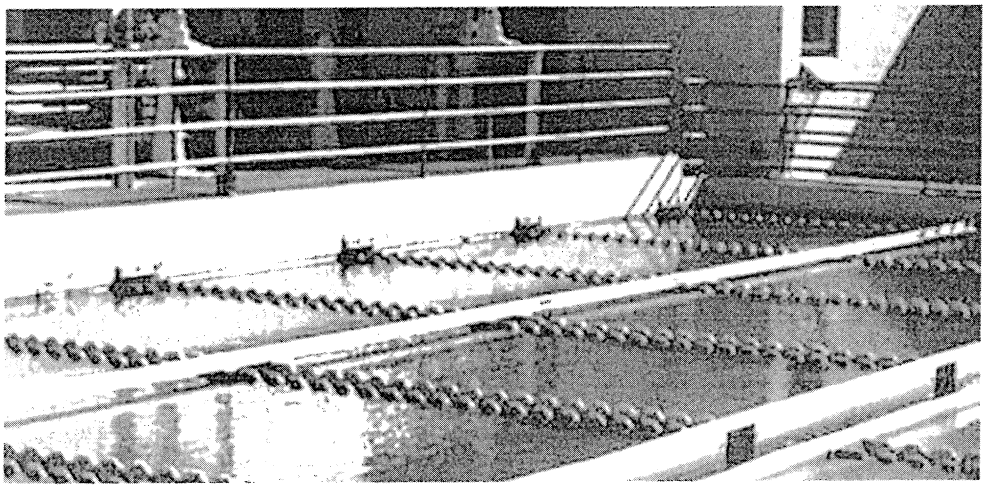
(6) (ii) Explain one (1)) different treatment method that may be used to effectively reduce suspended solids, microbial contaminants and metals during drinking water treatment. **Provide a different treatment method for each type of contaminant.**

(iii) Briefly explain three (3) main differences between the following terms:

(3) (a) Anoxic and Aerobic treatment;

(3) (b) Primary and Secondary disinfection ; and

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



Marking Scheme
98-CIV-A3 Environmental Engineering
May 2016

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