NATIONAL EXAMS DECEMBER 2014

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.

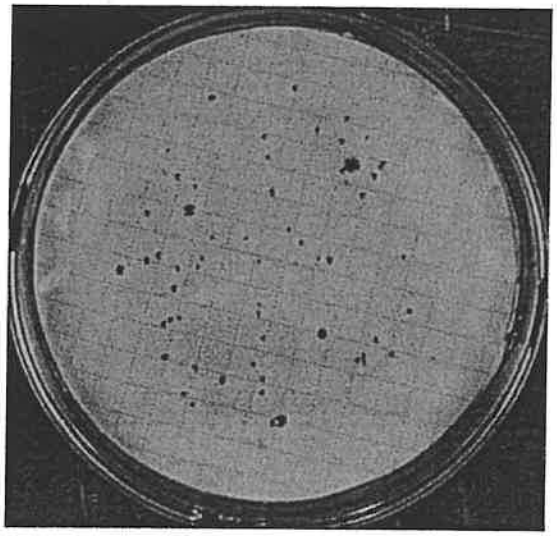
Problem 1

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

(6) (i) A 30 m^3 storage tank is half filled with water and half filled with air at 21 ^oC. After 76 kg (1000 mol) of liquid dipropylene glycol ($C_3H_8O_2$) is added, the storage tank is sealed. Determine the equilibrium concentration of dipropylene glycol in water and the equilibrium partial pressure of dipropylene glycol in the air space. Henry's Law Constant (K_H) for dipropylene glycol at 21 ^oC is 10^6 mol/(L·atm).

(7) (ii) A nitrogen analysis of a contaminated water sample gave the following results for ammonium, nitrite, nitrate and organic-nitrogen: 40 mg/L as NH_3, 2 mg/L as NO_2^-, 10 mg/L as NO_3^- and 20 mg/L as organic-N, respectively. Calculate the total nitrogen concentration in the water 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.

(7) (iii) Two different methods, the most probable number (MPN) and colony-forming unit (CFU), are commonly used to enumerate fecal indicator bacteria in 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. The image below shows Enterococci colonies growing on a selective agar after membrane filtration.



Problem 2

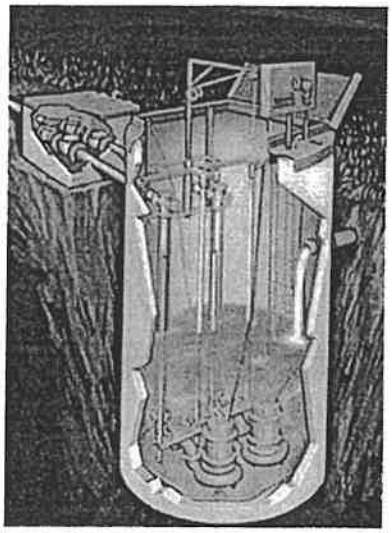
Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *gases*:

(9) (i) The removal of particles from water is crucial for safe potable water production. Briefly outline two (2) key engineering principles to explain how colloidal (non-settleable) particles are effectively removed in a drinking water treatment plant. Also give one (1) important reason why particle counters may be an improvement over turbidity measurements to assess the effectiveness of treatment.

(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, O=16, Mg=24 and Fe=56 and indicate how you would classify this water (i.e., soft, moderately hard or hard).

Ca^{2+}	=	100 mg/L
Mg^{2+}	=	80 mg/L
Fe^{2+}	=	30 mg/L

(5) (iii) Identity two (2) toxic atmospheric pollutants that can occur under anaerobic conditions similar to what you may find in sanitary sewers and sewage pumping stations. 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) gases. A 2x2 matrix may be used to organize your answers. The image below shows a typical sewage pumping station cross section.



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) Urban expansion and intensification;

(7) (b) Increasing energy use per capita; and

(6) (c) Industrial parks intensification.

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

2-Impacts & 2-Solutions	Urban Expansion	Increased Energy Use	Industrial Intensifiation
Atmospheric Emissions			
Water and Wastewater Infrastructure			
Solid Waste Management			

Problem 4

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

(10) (i) A junior site municipal engineer, was assigned the responsibility to conduct weekly checks of the hydraulic integrity of pressure relief valves (PRVs) at the five main water pumping stations (PS1 to PS5) serving the municipality. During the summer months, the juniour engineer, was advised by his superior that the PRVs at PS2 needed to be checked more thoroughly and that he could periodically skip checking PS1 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 wastewater generation and treatment demands. Identify and briefly discuss two (2) different ways of addressing both these issues considereing a 'soft' and a 'hard' engineering solution. Use a matrix like the one below to organize your answer.

Engineering Solutions	'Soft' Engineering	'Hard' Engineering
Wastewater Generation		
Treatment Demands		

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 mobile source 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 control the solid waste generation rate and conserve landfill space needs in a municipality that is restricted in land availability. 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
Generation Rate			
Conserve Landfill 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 pollution associated with the operation of a new gold mine and smelting operation located in northern British Columbia. 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 maintaining our natural forests with the integration of 'tree plantations'. 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 underground shallow aquifer has been identified as the main water supply source for a large town. It has been identified that agriculture runoff is a major source of contamination due to the aquifer being under the influence of surface water. Explain how you would use water resource management principles to minimize the contamination of this aquifer.

(6) (ii) Give an example of how chlorination is used in wastewater treatment and briefly explain why dechlorination is a typical requirement for the treatment of the final effluent before being discharged into the natural waterways.

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

(3) (a) Sedimentation and sand filtration;

(3) (b) turbidity meters and particle counters; and

(3) (c) colloidal and settleable solids.

Marking Scheme
98-CIV-A3 Environmental Engineering
December 2014

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