NATIONAL EXAMS DECEMBER 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. A completed exam consists of five (5) answered questions with a possible maximum score of 100 marks.

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

Problem 1

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

(6) (i) A sewage pipe from a wastewater treatment plant discharges 1.0 m^3/s of effluent containing 5.0 mg/L of phosphorus compounds (reported as mg P/L) into a river with an upstream flow rate of 20 m^3/s and a phosphorus concentration of 0.05 mg P/L. What is the resulting concentration of phosphorus in the river downstream of the sewage discharge, in units of mg/L?

(7) (ii) A completely stirred tank reactor (CSRT) at steady state is used to treat an industrial waste, using a reaction which destroys the waste according to first-order kinetics: $dC/dt = -kC$ where $k = 0.25\ d^{-1}$. The reactor volume is 100 m^3, the volumetric flow rate of the single inlet and exit is 30 m^3/d, and the inlet waste concentration is 80 mg/L. What is the outlet waste concentration in mg/L?

(7) (iii) Briefly explain how chorine works to inactivate microbial pathogens and why the total residual chlorine in the final disinfected wastewater effluent, is a good indirect indicator to determine the effectiveness of disinfection.

Problem 2

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

(9) (i) The removal of particles during wastewater treatment is crucial to achieve a treated final effluent. Briefly outline how the sedimentation and filtration processes may be integrated to remove various particle types. Also, briefly explain why turbidity of the final effluent is a good indicator to assess the effectiveness of the treatment process.

(6) (ii) The average concentrations of Ca, Mg and Fe of Lake Erie waters 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+}	=	50 mg/L
Mg^{2+}	=	20 mg/L
Fe^{2+}	=	30 mg/L

(5) (iii) Leachate under acidic conditions may be very corrosive, include various metals and other contaminants, that require pH adjustment as part of the treatment process. Assuming that the pH of the leachate is 3.0, calculate both the $[H_3O^+]$ and $[OH^-]$ concentration in moles/L.

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 Industrial Air Emissions Abatement, Solid Waste Management and Wastewater Treatment 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 table as provided below)

2-Impacts & 2-Solutions	Population Growth	Economic Growth	Urban Sprawl
Industrial Air Emissions Abatement			
Solid Waste Management			
Wastewater Treatment			

Problem 4

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

(10) (i) Briefly describe three (3) different common air pollution control devices that can be used to control particulate emissions (e.g., PM_{10}, $PM5_{50}$), VOCs and odorous organic compounds. Identify one (1) control device for each type of pollutant. Also, provide an example of a stationary source for each of the pollutant types (three (3) different sources). Use a matrix to organize your answer.

(10) (ii) Describe the "3R" solid waste management hierarchy which describes the preferred strategy towards waste minimization. Give a simple example using the described "3R" hierarchy in dealing with solid waste.

Problem 5

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

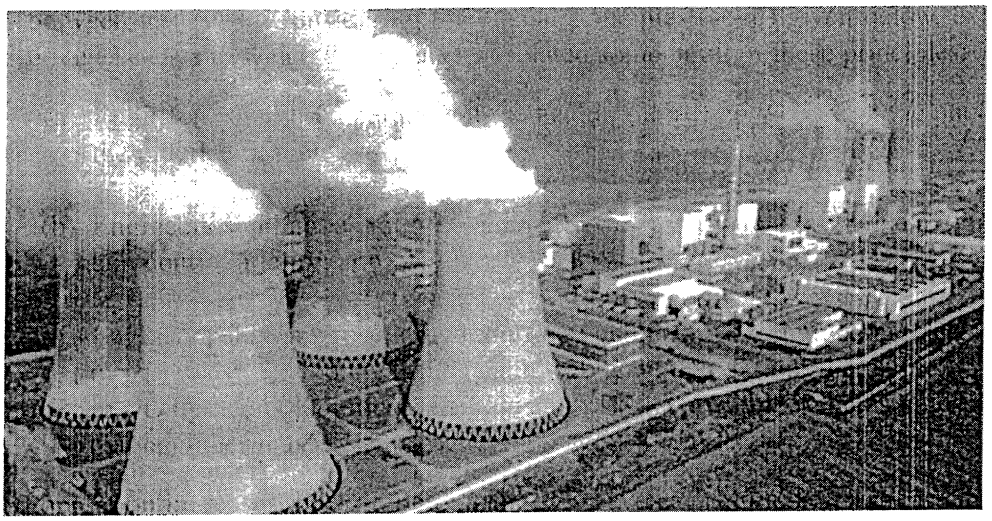
(10) (i) In 1975 the Aviation Corporation won a contract for the design of brakes for the AL7 Carrier Aircraft of the National Air Force, with an innovative two-rotor brake design. However, testing showed that the two-rotor system would not function in accordance with the regulatory specifications. The engineer managers tried to show that the brakes met the standards by allowing the brakes to be cooled and remachined between test runs. Considering the ethical principles (a - c) given below, explain three (3) ways in which the managers violated some or all of these 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 (a different solution for each pollution type).

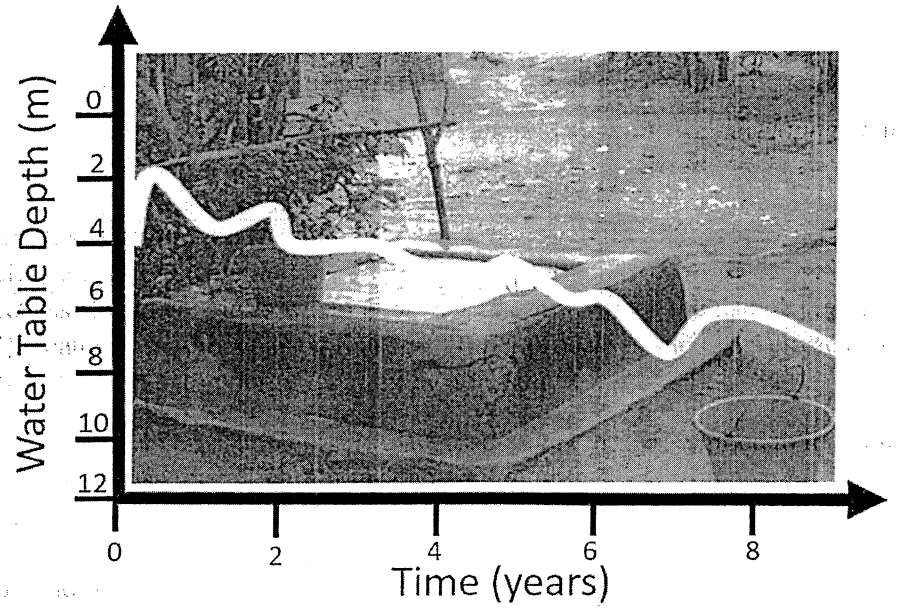


Problem 6

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

(10) (i) Give an example of a manufacturing process, with three (3) key methods, of how to achieve a truly sustainable life cycle for a product. Recall that a truly sustainable process would: (1) uses waste materials and minimizes the use of virgin materials; (2) creates output that can be reused by other processes and (3) uses the least amount of energy and uses energy from renewable sources.

(10) (ii) Explain how an environmental impact assessment may be applied to increase the water quantity associated with a groundwater aquifer used as a drinking water source in a rural area. Consider the baseline condition, the normal variability and current trends shown in the figure below. 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 of a low water table.



Problem 7

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

(5) (i) Agriculture is the largest user of the world's freshwater and similarly the largest potential sector user of treated wastewater effluent as a water resource management strategy. Briefly explain two (2) benefits and two (2) challenges associated with wastewater reuse in agriculture that a technical water resource manager needs to consider.

(6) (ii) Explain one (1) different treatment method that may be used to effectively reduce color, unpleasant odours and water pathogens during drinking water treatment from a surface water source (provide a different treatment method for each type of contaminant).

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

(3) (a) Anaerobic and Aerobic treatment;

(3) (b) Extended Aeration and Conventional Activated Sludge treatment; and

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