NATIONAL EXAMS MAY 2018

04-Env-A1 Principles of 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 *mass and energy balance*, *physical properties of homogeneous and heterogeneous mixtures* and *ecology* as related to environmental engineering:

(7) (i) A completely stirred tank reactor (CSTR) in steady state is used to treat an industrial contaminant which converts the waste product according to the first-order kinetics $dC/dt = -kC$, where $k = 0.5$ day^{-1}. The reactor volume is 2000 m^3, the inflow rate to the reactor is 200 m^3/d and the inlet contaminant concentration is 500 mg/L. Calculate the outlet concentration of the contaminant in mg/L.

(7) (ii) Briefly describe two (2) key differences between physical properties of a homogeneous and a heterogeneous mixture important to environmental engineering. As part of your description, give an example of each type of mixture that can be found in the environment due to natural or industrial activities.

(6) (iii) Mitsch and Jorgensen were the first to define ecological engineering as designing societal services such that they benefit society and nature and the design should be systems based, sustainable and integrate society with its natural environment. Based on the above definition provide two (2) environmental engineering examples that show the application of the above ecological principles for the benefit of humanity.

Problem 2

Provide answers to the following questions related to *environmental impact assessment* and *acid precipitation*:

(10) (i) Explain how an environmental impact assessment may be applied to reduce the pollution in the development of a gold mining operation in a heavily forested area. Use a table to identify three (3) key process steps, three (3) key issues and the actions necessary to address the issues in each of the processes.

(10) (ii) Briefly explain three (3) principle causes of acid precipitation in a developed country and two (2) different types of potential engineering solutions that can be impletmented at the root cause of the problem.

Problem 3

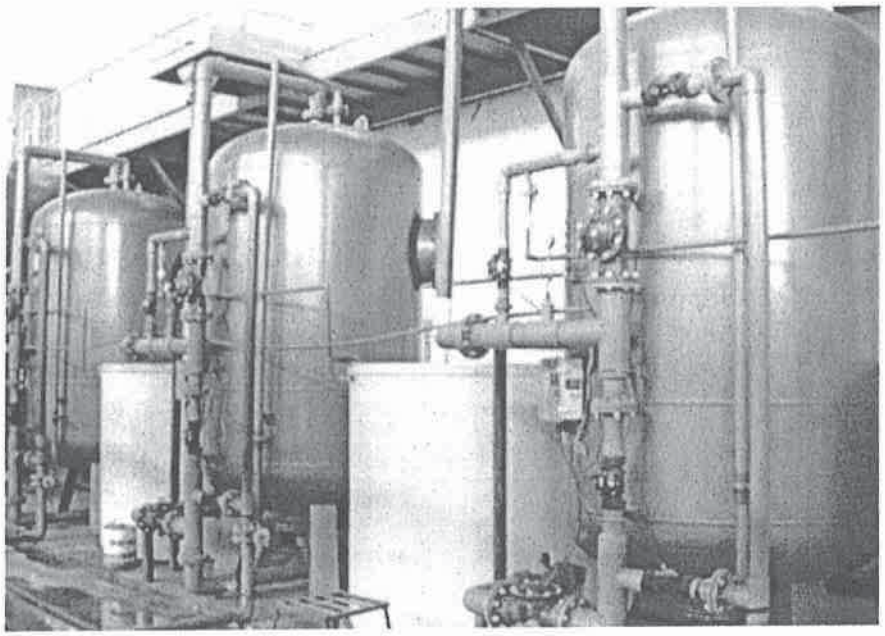
Provide answers to the following questions related to *environmental ethics* and *water treatment*:

(10) (i) An environmental engineer working for the local bottling water plant drives past a residential area and notices that a storage tank full of chlorine gas is located dangerously close to residential homes. Upon further investigation, he finds that the tank belongs to a local, privately owned company. When he discusses this problem with the local provincial authorities, they tell him that there is nothing they can do. Considering the two (2) ethical principles of good engineering practice provided below, briefly explain the proper ethical course of action for the engineer.

(a) Engineers shall hold paramount the health, safety and welfare of the public in the practice of their profession; and

(b) 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) Briefly identify and discuss four (4) key design or operational strategies to ensure a water treatment plant, using a surface water supply (e.g., lake water) as the source water will consistently produce a potable drinking water supply.



Problem 4

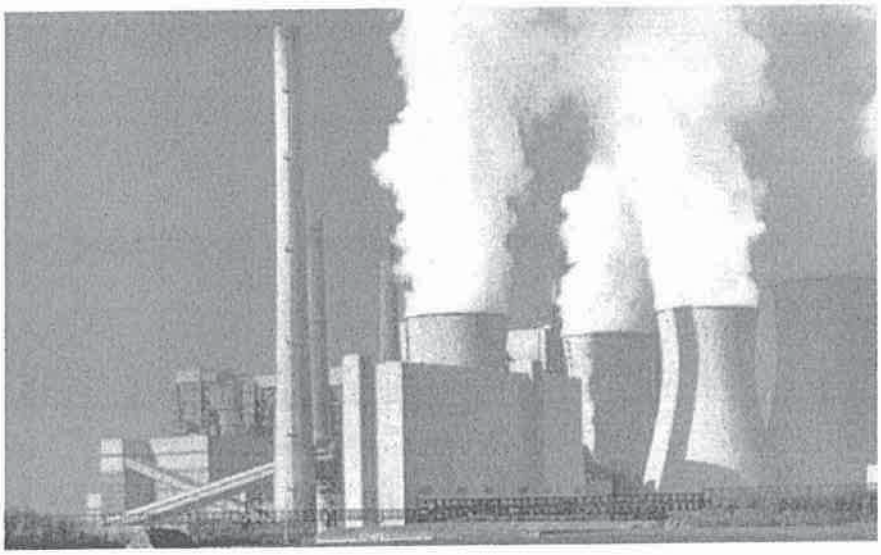
Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *thermal pollution*:

(8) (i) Briefly explain the role of two (2) physical-chemical treatment processes in the effective reduction of two (2) types of particulates found in municipal wastewater.

(7) (ii) The average analysis in terms of Ca, Mg and Cu results of Lake Erie 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; Mg= 24; Cu = 64; H = 1; C = 12 and O = 16 and indicate how you would classify this water (i.e., soft, moderately hard or hard):

Ca^{2+}	=	30 mg/L
Mg^{2+}	=	40 mg/L
Cu^{2+}	=	20 mg/L

(5) (iii) A power plant cooling tower discharges to an area with a cold water fishery downstream of the plant. Briefly explain two (2) potential thermal impacts and two (2) engineering methods that may be used to reduce the thermal environmental impacts on the river habitat from the cooling tower discharge.



Problem 5

Provide answers to the following questions related to *urbanization*, *energy use* and *industrialization* as causes of environmental pollution:

Briefly explain two (2) major environmental impacts and two (2) corresponding potential environmental engineering solutions to reduce impacts in noise pollution, water demands and wastewater treatment associated with the following growth areas (**use a 3 x 3 table as provided below**). Assume that strict environmental requirements are to be met following increases in energy use, urbanization and industrialization:

(7) (i) Urbanization growth;

(7) (ii) Energy use increase; and

(6) (iii) Industrialization growth.

2-Impacts & 2-Solutions	Urbanization Growth	Energy Use Increase	Industrialization Growth
Noise Pollution			
Water Demand			
Wastewater Treatment			

Problem 6

Provide answers to the following questions associated with *air pollution control of air toxics*, *solid waste management* and *environmental quality objectives, standards and guidelines* :

(8) (i) Particulate matter from diesel-fuelled engines (diesel PM) contributes over 70 % of the known risk from air toxics within large cities. Identify two (2) air pollution control measures that regulators may impose on existing and potential emitters to reduce or eliminate the risk from diesel PM.

(6) (ii) Identify three (3) major sources of solid waste in a large municipality and describe two (2) methods for effective solid waste management to be implemented urgently to reduce the reliance on a landfill fast approaching its storage capacity limit.

(6) (iii) Briefly describe a key difference between quality standards and guidelines; provide an example of an environmental guideline and a standard; and finally comment on why you think one regulatory method may be more effective at protecting the environment.

Problem 7

Provide answers to the following questions related to *water resource management*, *greenhouse effect* and *technical and non-technical environmental principles*:

(7) (i) On-site stormwater controls and treatment facilities are commonly used to protect off-site surface water and groundwater. Give an example of an on-site stormwater control measure and two (2) basic design features that can improve the quality or reduce the quantity of stormwater discharged off-site.

(7) (ii) Briefly explain two (2) different greeenhouse gas emission control strategies and compare their relative effectiveness from both an environmental and economic perspective.

(6) (iii) Give an example of a technical and a non-technical environmental regulatory approach to reduce the VOC emissions from an industrial park located near a residential community.

Marking Scheme
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1. (i) 7, (ii) 7, (iii) 6 marks, 20 marks total

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

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

4. (i) 8, (ii) 7, (iii) 5 marks, 20 marks total

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

6. (i) 8, (ii) 6, (iii) 6 marks, 20 marks total

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