NATIONAL EXAMS DECEMBER 2017

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.

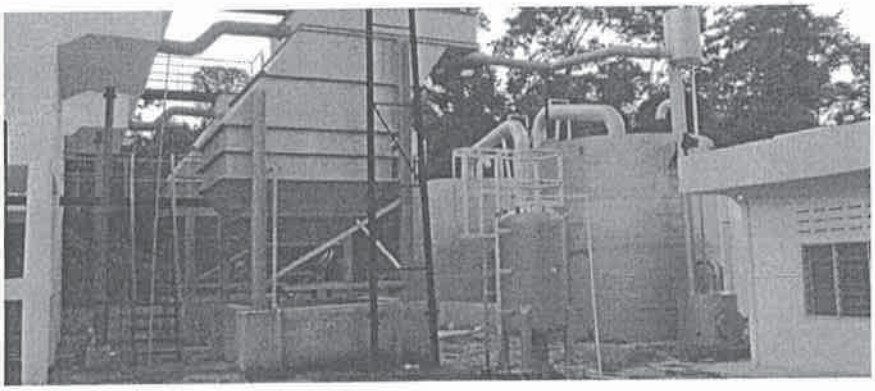
Problem 1

Provide answers to the following questions related to *mass and energy balance*, *contaminant partitioning* and *microbiology* 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 $k = 0.25$ day^{-1}. The reactor volume is 1000 m^3, the inflow rate to the reactor is 100 m^3/d and the inlet contaminant concentration is 200 mg/L. Calculate the outlet concentration of the contaminant in mg/L.

(7) (ii) Use the partition coefficient (K_d) concept to briefly explain the fate of a contaminant with a high octanol-water partition coefficient ($K_{OW} \geq 4$) emitted into the atmosphere and depositing into a fresh water lake with fish. Consider three (3) compartments air-water-fish as the final sink for the contaminant.

(6) (iii) Briefly explain the purpose of using bacterial indicator organisms to determine how effective a drinking water disinfection is. In your explanation, provide two (2) advantages and two (2) limitations of using bacterial indicators alone to assess potability.



Problem 2

Provide answers to the following questions related to *environmental impact assessment*, *sustainable development* and *life cycle analysis*:

(10) (i) Explain how an environmental impact assessment may be applied to reduce pollution in the development of a coal power generation station. 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 discuss three (3) key principles of sustainable development and to what degree the use of nuclear power, geothermal power or natural gas (**choose only one**) may achieve the principle of sustainability. In your discussion, consider the principles of life cycle analysis to help with answering the question.

Problem 3

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

(10) (i) An engineer on contract by the supplier of a package-plant wastewater treatment technology was required to oversee and report back to the regulator upon final commissioning sheduled to last 5-weeks. The technology would be required to meet a monthly average effluent limit for total nitrogen (TN) of 5 mg/L based on a minimum of 4-weekly samples of the final effluent. Due to time constraints, the supplier requested that the engineer complete the commissioning in only 3-weeks and take a total of 10 samples during the 3-week period. The engineer agreed and then reported back to supplier that of the 10 samples only 5 samples were below the TN results and the other 5 samples were significantly higher. Under the request of the supplier the engineer reported the 5 high TN values as outliers and based on the other 5-samples reported that the technology complies with the regulatory monthly average limit. Briefly explain how the actions of the engineer met his contractual obligations to the supplier and how his final report may have violated the following two (2) ethical principles of good engineering practice:

(a) Engineers shall hold paramount the health, safety and welfare of the public in the practice of their profession; 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) Briefly identify and discuss four (4) key operational and maintenance strategies for a water or wastewater treatment facility (**select only one**) to ensure potable drinking water or effluent complinace with prescribed regulatory limits, respectively.

Problem 4

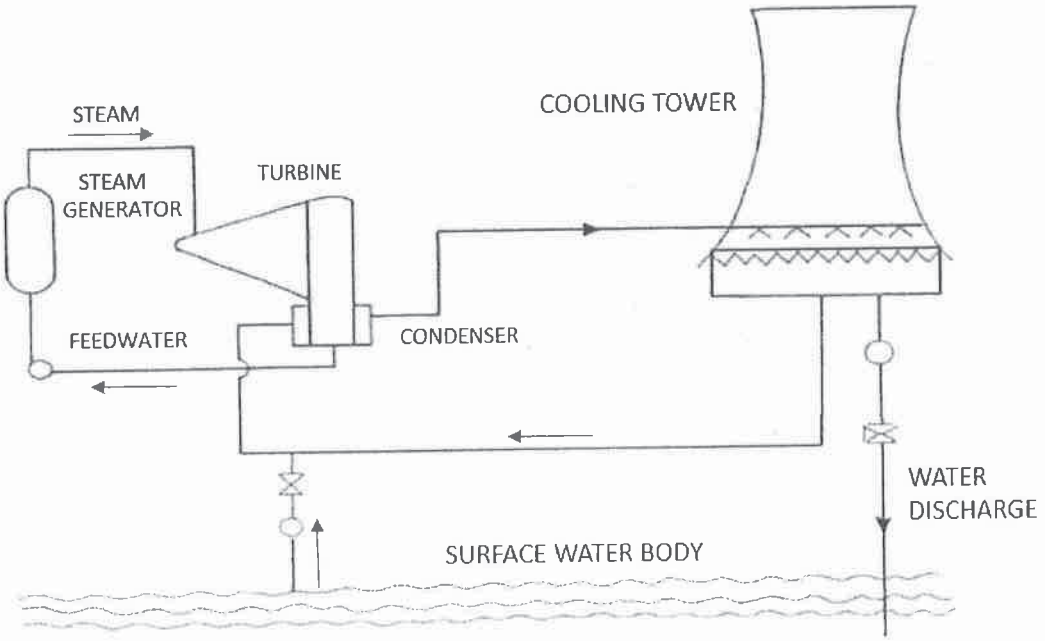
Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *thermal pollution*:

(8) (i) Briefly explain the role of biological treatment and any pretreatment in the effective removal of colloidal and dissolved particulates. As part of your explanation provide a labelled schematic of a typical engineering process that includes both the pretreatment and biological treatment for either a water or wastewater system (**select only one**).

(7) (ii) The average analysis results for Ca, Mg and Cu results of Lake Ontario waters near a gold mine are 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 = 63; H=1; C=12 and O=16 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
Cu^{2+}	=	40 mg/L

(5) (iii) Consider the schematic (below) of a nuclear power plant hot water discharge to a surface water body. Briefly explain three (3) engineering methods that may be used to reduce the thermal environmental impacts on the biota living in the water.



Problem 5

Provide answers to the following questions related to *population*, *economic growth* 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 related to air emissions, 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 further growth and industrialization:

(7) (i) Population growth;

(7) (ii) Economic growth; and

(6) (iii) Increase in energy use.

2-Impacts & 2-Solutions	Population Growth	Economic Growth	Increase in Energy Use
Air Emissions			
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) Regulators commonly mandate using best available control technology economically achievable (BACTEA) to control air toxics (e.g., VOCs, PM_{10}) emissions below target levels. Give examples of two (2) technologies considered to meet the BACTEA criteria, one for VOCs and another for PM_{10} and briefly explain any contingencies that would need to be included to ensure emission compliance.

(6) (ii) Briefly explain three (3) long term waste management and reduction engineering strategies to reduce solid waste produced by a large municipality like Toronto by 50% from its current rate over the next 20-year period. For each strategy, provide an advantage and a challenge with an estimate of the relative cost (low, moderate or high) to implement. Use a table to answer this question.

(6) (iii) Different regulatory measures are generally used by regulatory agencies depending on the ultimate enviornmental goal to be achieved. Briefly define and give an example of the usage of an environmental Guideline and a Standard. As part of your example, briefly explain why you think, in each case, one regulatory measure was used rather than the other.

Problem 7

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

(5) (i) End-of-pipe stormwater control and treatment facilities are commonly used to protect surface and groundwater resources. Give an example of an end-of-pipe stormwater control measure and two (2) basic design features to ensure downstream quantity or quality control.

(5) (ii) Briefly explain two (2) main engineering approaches to control the production of greenhouse gases and how each approach may be implemented in the short term and long term with the maximum environmental benefit.

(5) (iii) Briefly explain two (2) engineering methods to reduce noise pollution from a busy highway traffic adjacent to a residential community and briefly explain the preferred method and why.

(5) (iv) Give an example to compare the use of a technical and a non-technical environmental principle in the control of fugitive air emissions from a petroleum refinery.

Marking Scheme
04-Env-A1 Principles of Environmental Engineering
December 2017

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) 5, (ii) 5, (iii) 5, (iv) 5 marks, 20 marks total