NATIONAL EXAMS DECEMBER 2019

18-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 lake has a volume of 200,000 m^3 of water and is fed by an upstream river with a flow rate of 100,000 m^3/yr (Q_u). Evaporation across the lake is 6 x 10^4 m^3/yr (Q_e). Assume that the outflow stream from the lake is flowing at 3 x 10^4 m^3/yr (Q_o), that the upstream river has a TP concentration of 15 mg/L (C_u) and that steady-state conditions apply. Calculate the concentration of the TP in the lake and outflow stream assuming a TP decay rate of 0.06/yr in the lake.

(6) (ii) Briefly explain how partitioning of an environmental contaminant between the different environmental media (e.g., benzene spill on the highway resulting in air, water and soil contamination) may be predicted and equilibrium concentration may be calculated. Use equations or diagrams to substantiate your explanation.

(7) (iii) Briefly explain three (3) key design parameters for a drinking water disinfection system at the water treatment plant. As part of your explanation, how the issue of bacterial regrowth in the water distribution system is managed.

Problem 2

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 high rate sand filter, used for total suspended solids (TSS) reduction, was hired to assess the effectiveness of the filter performance at high flows and report back to the supplier and municipality. The engineer finds that the filter reduces TSS effectively but does not meet the expected *E. coli* log-reduction at the same high flows and thus he suspects that final filtered water quality will not pass the bacteriological criteria for potable water at the high flows. Briefly explain the actions that should be taken by the engineer under contract, considering the following two (2) ethical principles:

(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) Identiy and explain three (3) key engineering design or operational principles that would need to be considered separately when designing or operating a water treatment facility that uses *surface water compared to groundwater* as a source. You may consider issues of both quality and quantity in your comparison.

Problem 3

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

(8) (i) Explain how biological treatment is used in wastewater treatment to remove some dissolved solids. Provide two (2) important required characteristics for the dissolved solids to be removed effectively by a biological system.

(7) (ii) The average analysis in terms of Ca, Mg and Cu results of Lake Superior 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 ; 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+} = 80 mg/L
Mg^{2+} = 60 mg/L
Cu^{2+} = 40 mg/L

(5) (iii) Provide three (3) design criteria or operational approaches to effectively control environmental thermal pollution from a nuclear energy plant using either a cooling tower or a cooling pond (*select only one*).

Problem 4

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 in air emissions and water demands associated with the following growth areas (**use a 2 x 3 table as provided below to complete your answer**). Assume that strict environmental requirements are to be met following further growth and industrialization:

(7) (i) Economic growth;

(7) (ii) Population growth; and

(6) (iii) Energy use.

2-Impacts & 2-Solutions	Economic Growth	Population Growth	Energy Use
Air Emissions			
Water Demand			

Problem 5

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

(8) (i) Explain how an environmental impact assessment may be applied to reduce the pollution in the development of an oil pipeline from the source in northern Alberta to the west coast of Canada (a major point of distribution). 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.

(6) (ii) Briefly discuss three (3) key principles of sustainable development and to what degree the use of wind power using wind turbine farms may achieve the principle of sustainability over a 25-year life cycle.

(6) (iii) Identify three (3) key process steps within the life cycle analysis (LCA) and how the LCA steps can be implemented to improve the sustainability in industrial food production using greenhouses. Some known enviornmental issues associated with greehnouse operation is the overuse of fertilizers and generation of nutrient rich wastewaters.

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) Air toxics are those pollutants known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects. The US EPA lists over 180 known air toxics. Give two (2) examples of different types of air toxics, two (2) treatment technologies (1 for each contaminant) and provide the key design principles necessary to ensure effective reduction of the toxic using the corresponding treatment technology.

(6) (ii) Identify and briefly discuss three (3) different strategies you would recommend in your solid waste management plan to maximize the longevity of the existing landfill site for a 25-year life cycle.

(6) (iii) Environmental controls are typically managed by the use of both environmental quality standards and guidelines. Briefly define what each is and how they can be used together to ensure a more cost effective overall environmental quality (e.g., good surface water quality of a lake used for both recreational activities and source water to supply drinking water for a large municipality).

Problem 7

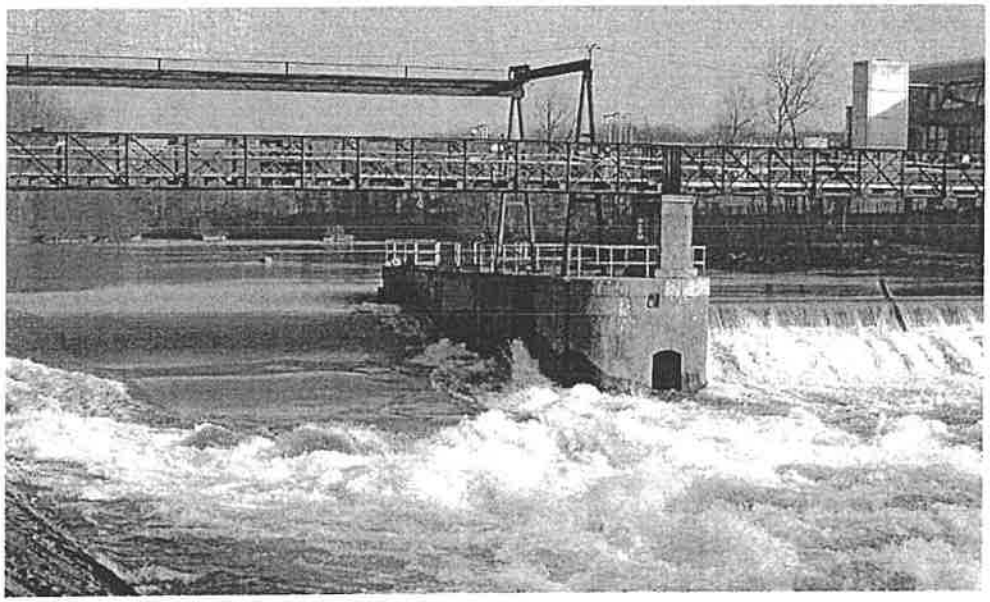
Provide answers to the following questions related to *water resource management*, *greenhouse effect*, *noise pollution* and *technical and non-technical environmental principles*:

(5) (i) A large open surface water reservoir (similar to a natural fresh water lake) used as a drinking water supply for a town is vulnerable to nutrient pollution loading (N, P) from agricultural runoff. Discuss one (1) water resource management strategy to protect the long term viability of this valuable water supply.

(5) (ii) Briefly explain two (2) main pollution issues that are made worse due to global greenhouse effect. Explain how the application of one (1) non-technical environmental principle can help reduce associated environmental impacts.

(5) (iii) Briefly explain two (2) engineering methods to reduce noise pollution from a busy airport located close to a residential community and briefly explain which is the preferred method and why.

(5) (iv) Give an example to compare the use of a technical and a non-technical environmental principle to reduce water pollution from combined sewer overflows (i.e., flow of untreated wastewater into the environment during storm events).



Marking Scheme
18-Env-A1 Principles of Environmental Engineering
December 2019

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

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

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

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

5. (i) 8, (ii) 6, (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