NATIONAL EXAMS MAY 2016

04-Env-A1 Principles of Environmental Engineering

3 hours dnration

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 qnestion 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 10^4 m^3 of water and is fed by an upstream river with a flow rate of 10^3 m^3/yr (Q_u). Evaporation across the lake is 4 x 10^4 m^3/yr (Q_e). Assume that the outflow stream from the lake is flowing at 2 x 10^4 m^3/yr (Q_o), that the upstream river has a TP concentration of 25 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 0.05/yr in the lake.

(6) (ii) The equilibrium partitioning of dilute concentrations of polyaromatic hydrocarbons (PAHs) in groundwater-soil mixtures are often well characterized by the Freundlich isotherm given as $q = KC^{\frac{1}{n}}$. Briefly explain the significance of each term in the Freundlich isotherm.

(7) (iii) Different types of pathogens are present in source waters used for drinking water. Explain two (2) different types of pathogens and two (2) parameters commonly varied to ensure adequate inactivation of the different types of pathogens.

Problem 2

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

(10) (i) In a highly competitive construction industry, there are frequent cases of buildings collapsing because in part due to unethical engineering practices. Identify three (3) actions and conduct of a professional engineer, responsible for inspecting the quality of materials and workmanship on a construction site, that would be considered unprofessional, negligent or incompetent, 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

(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) Considering a drinking water or wastewater treatment facility (**select only one**) identify four (4) important treatment design approaches to ensure that the treated water or the final effluent is in compliance with typical regulatory limits. As part of your answer, provide a clearly labelled schematic of the process train.

Problem 3

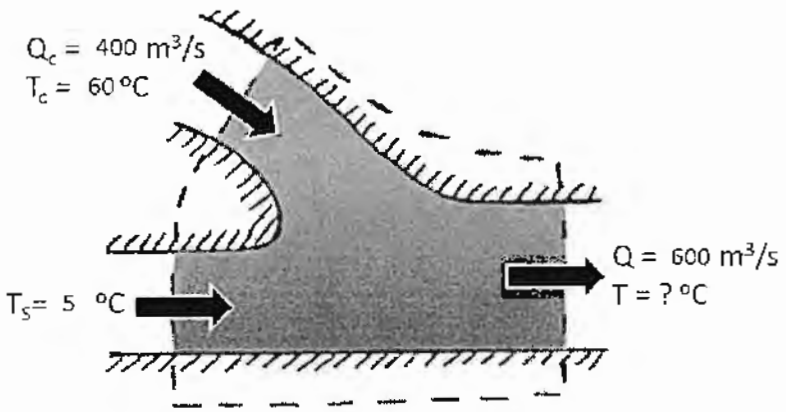
Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *thermal pollution*:

(8) (i) The removal of particles from surface water or wastewater is crucial for effective treatment. Briefly explain three (3) different types of particles and how each is removed using a different treatment method. Consider either a drinking water or wastewater treatment facility (**select only one**).

(7) (ii) The average analysis in terms of Ca, Mg and Fe results of Lake Ontario 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; Fe = 56 ; 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+} = 70 mg/L
Fe^{2+} = 40 mg/L

(5) (iii) Calculate the temperature of the downstream river (T) in degree Celsius (^oC) (use data provided in diagram below) discharging into a cold water spawning area. Give two (2) possible engineering solutions to further reduce the downstream water temperature or reduce the upstream temperature assumed to be discharged at 60 ^oC from a cooling tower.



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 on wastewater generation, water treatment and mobile source emissions 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) Urban growth;

(7) (ii) Water use; and

(6) (iii) Industrial expansion.

2-Impacts & 2-Solutions	Urban Growth	Water Use	Industrial Expansion
Wastewater Gencration			
Water Treatment			
Mobile Source Emissions			

Problem 5

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 gold mine in northern Ontario. 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 the key principle of sustainable development and to what degree the use of biogas from waste, solar energy or geo-thermal energy (**choose only one**) may achieve the principle of sustainability. In your discussion, consider the principles of life cycle analysis to help answer the question.

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) Briefly describe two (2) different methods that can be used to reduce air pollution from air toxics (e.g., VOCs, PM_{10}) from an industrial fixed source. For each method, briefly provide one (1) design and one (1) operational approach and explain where the method is most appropriate. Use a table to organize your answer.

(6) (ii) The existing landfill site for a city's solid waste will reach capacity in six (6) years at the current rate of solid waste production. You have been hired to recommend an engineering plan for the next 25 years by the city to assist in managing its solid waste. Identify and briefly discuss three (3) methods you would recommend in your solid waste management plan. Use a table to organize your answer.

(6) (iii) Environmental controls are typically managed by the use of environmental objectives or standards. Briefly explain a two (2) key differences between an environmental objective and a standard. As part of your explanation, indicate when each type of environmental control would be better at controlling environmental impacts.

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 fresh water lake used as a drinking water source is vulnerable to pollution from stormwater runoff from the local town. Propose one (1) water resource management engineered system that can be used to protect this valuable water resource and discuss two (2) issues to ensure the proper operation and maintenance of the system.

(5) (ii) Briefly explain two (2) global environmental impacts associated with the greenhouse effect and one (1) technical solution to help reduce each global environmental impact.

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

(5) (iv) Propose a technical and non-technical environmental principle that can be used to control air emissions from a large industrial operation with large emissions of air contaminants. Briefly explain which principle would be more effective in the long term.

Marking Scheme
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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) 10, (ii) 10 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