NATIONAL EXAMS DECEMBER 2014

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 lake has a volume of 10^7 m^3 of water and is fed by an upstream river with a discharge rate of $9 \cdot 10^4$ m^3/d (Q_u). Evaporation across the lake is $2 \cdot 10^3$ m^3/d (Q_e). Assume that the outflow stream from the lake is flowing at $6 \cdot 10^4$ m^3/d (Q_o), that the upstream river has a TP concentration of 20 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 0.01/d in the lake.

(6) (ii) Briefly identify and explain the significance of two (2) environmentally important contaminant partition coefficients (e.g., these partition coefficient may explain why certain contaminants associate more with the solids or lipid layers found in fish rather than the aqueous phases).

(7) (iii) Briefly explain three (3) key design parameters in the design of an effective disinfection system used to treat surface or groundwater for the effective elimination of microbial contaminants.

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 the environmental impacts on a surface water reservoir, used as a source for drinking water by the nearby town, located downstream from a proposed redevelopment of an old silver and copper mine in British Columbia. You may use a matrix to identify the key process steps, the issues, considerations and actions necessary to address the issues.

(10) (ii) Briefly discuss the key principle of sustainable development and to what degree the use of solar, tidal-wave or wind power, used on-site or at centralized locations (**choose only one**), may be used to achieve energy self-sufficiency. In your discussion, also consider the principles of life cycle analysis to help with answering the question.

Problem 3

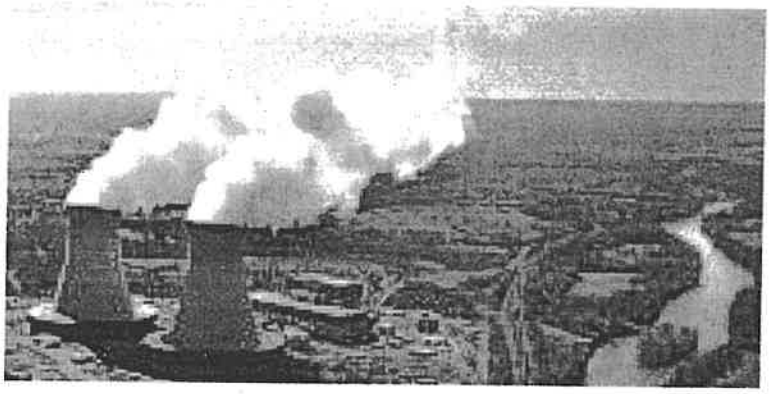
Provide answers to the following questions related to *particle characteristics*, *chemistry of solutions* and *thermal pollution*:

(8) (i) Many environmental contaminants associate with dissolved, colloidal or suspended solids and engineered systems focus on removing these contaminants to reduce environmental pollution. Briefly explain a conceptual engineered design that can handle *all three* types of contaminants. As part of your explanation provide a simple labeled schematic of the system.

(7) (ii) The average analysis in terms of Ca, Mg and Fe results of Lake Ontario waters near a copper 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; H=1; C=12 and O=16 and indicate how you would classify this water (i.e., soft, moderately hard or hard):

Ca^{2+}	=	50 mg/L
Mg^{2+}	=	200 mg/L
Cu^{2+}	=	200 mg/L

(5) (iii) Some of the effects of thermal pollution are direct thermal shock, changes in dissolved oxygen and the redistribution of organisms in the local community. Describe an engineered system, conceptually, that can reduce these potential effects assuming you have to deal with the discharge of cooling water from a power plant into a nearly lake. Make any reasonable assumptions necessary.



Problem 4

Provide answers to the following questions related to *population intensification* 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 associated with the Air Shed, Water Resources and Solid Waste Impacts associated with the following (**use a 3 x 2 table as provided below**):

(10) (i) Population intensification in urban areas; and

(10) (ii) Industrial growth in rural areas.

2-Impacts & 2-Solutions	Population Intensification	Industrial Growth
Air Shed		
Water Resources		
Solid Waste Impacts		

Problem 5

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

(7) (i) Briefly describe two (2) different methods that can be used to control air toxics (e.g., Benzene, Acetone, $PM_{2.5}$) from industrial fixed sources. For each method, briefly provide one (1) advantage and one (1) limitation of the method and an example of where the method is most appropriate.

(7) (ii) The existing landfill site for the city's solid waste will reach capacity in five (5) years at the current rate of solid waste production. Identify three (3) engineering strategies you would recommend to the city that would allow them to potentially extend the landfill life another 5-years.

(6) (iii) Give an environmental example that clearly distinguishes the significance of quality objectives, standards and guidelines as applied to environmental engineering designs.

Problem 6

Provide answers to the following questions related to *environmental ethics*, *water and wastewater treatment* and *technical and non-technical environmental principles*.

(10) (i) A recent graduate civil engineer on contract by the municipality has been hired to supervise the commissioning of a new water treatment filtration plant. The supervising civil engineer notices, what appears to her to be, an indirect flow from the back-flush waste holding tank into the final filtered treated water reservoir prior to disinfection. Briefly explain the actions that should be taken by the supervising engineer, 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) Briefly explain the conceptual design of a water or wastewater treatment facility (**select only one**). In your explanation, provide a simple labelled schematic of the key treatment processes and briefly explain how you considered both technical and non-technial environmental principles in your final conceptual design.

Problem 7

Provide answers to the following questions related to *water resource management*, *greenhouse effect* and *noise pollution*:

(6) (i) A large subsurface groundwater recharge zone supplying a groundwater reservoir used as a drinking water supply for a local town is vulnerable to runoff pollution associated with intensive farming. Provide two (2) water resource management strategies that can be used to protect the long term viability of this valuable groundwater source.

(6) (ii) Briefly explain one (1) primary and one (1) secondary cause for the greenhouse effect and two (2) technical solutions to help reduce associated environmental impacts.

(8) (iii) Briefly explain three (3) engineering methods to reduce noise pollution from a busy rail line approximately 20 meters to the nearest house in a residential community and identify the preferred method and explain why.

Marking Scheme
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December 2014

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) 10, (ii) 10 marks, 20 marks total

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

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

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