NATIONAL EXAMS DECEMBER 2015

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*, *water treatment* and *contaminant partitioning* as related to environmental engineering:

(7) (i) A lake has a volume of 10^5 m^3 (V) and is fed by an industrial waste stream from a mine operation with a flow of 10^5 m^3/yr (Q_u). Assume that the outflow stream from the lake is flowing at 10^5 m^3/yr (Q_o) and has an ammonia [NH_3 (aq)] concentration of 50 mg/L (C_o) and that steady-state conditions apply. Calculate the concentration of the NH_3 in the industrial stream (C_u) assuming an NH_3 decay rate of 0.2/yr in the lake.

(7) (ii) Briefly explain the main difference between primary and secondary disinfectants and how they are used in water treatment of surface water and in water distribution of potable water.

(6) (iii) A confined aquifer is contaminated with 1,4-dichlorobenzene (Log K_{ow} = 3.6) at an average concentration of 1 mg/L. The soil organic carbon content (f_{oc}) in the aquifer is 0.2 percent and the pore water occupies 50% of the aquifer's volume. Calculate the contaminants distribution between the aqueous and solid phases. The following equations for the carbon sorption coefficient (K_{oc}) and sorption coefficient (K_p) may be used:

$$Log(K_{oc}) = 0.69 \cdot K_{ow} + 0.22$$
$$K_p = K_{oc} \cdot f_{oc}$$

Problem 2

Provide answers to the following questions related to *environmental impact assessment*, *sustainable development* and *noise pollution*:

(10) (i) Explain how an environmental impact assessment may be applied to reduce pollution in the development of landfill site for the life duration assumed to be 25-years. You may use a matrix to organize your answer.

(10) (ii) Briefly discuss three (3) key principles of sustainable development and to what degree the use of wind turbines may help achieve energy sustainability. In your discussion, consider the turbine noise pollution and how it may be addressed based on good environmental engineering practice.

Problem 3

Provide answers to the following questions related to *particle characteristics*, *wastewater treatment*, *greenhouse effect* and *photochemical smog*:

(7) (i) Explain how particle size and density characteristics are used in two (2) wastewater treatment processes. Provide a simple labelled schematic of each process. In your explanation, give the key engineering principle involved in the effective use of each process.

(7) (ii) Briefly explain how any three (3) of the following gases help to moderate the earth's tempearture through the greenhouse effect: water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (NO_2).

(6) (iii) Briefly explain under what environmental conditions photochemical smog ("smog") develops and give two (2) environmental actions (one (1) soft and one (1) hard engineering approaches) that may be used to reduce smog.

Problem 4

Provide answers to the following questions related to *population*, *urbanization* and *energy use* as they impact the environment:

Briefly explain two (2) major environmental impacts and two (2) corresponding potential environmental engineering solutions to reduce impacts associated with the following (**use a 3 x 3 table to organize your answer**):

(7) (i) Population growth;

(7) (ii) Urban intensification; and

(6) (iii) Increased energy use.

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* :

(10) (i) Briefly describe two (2) different methods that can be used to reduce or eliminate air toxics (e.g., Benzene, Acetone, PM_{10}) 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. It is recommended that you use a table to organize your answer.

(10) (ii) Noise, dust and heavy truck traffic congestion are the three (3) major issues the local municipal council is in desperate need of resolving using engineering solutions. You have been hired to recommend an engineering plan to address these 3-problems based on the next 25-years life of the landfill. Identify and briefly discuss two (2) strategies for each of the 3-issues you would recommend as a solution in your solid waste management plan. Briefly explain how your strategies relate to environmental quality standards or guidelines set by the local regulators. It is recommended that you use a table to organize your answer.

Problem 6

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

(6) (i) A large open surface water reservoir (similar to a natural fresh water lake) 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 water source.

(7) (ii) Briefly explain two (2) main causes for the greenhouse effect and two (2) technical solutions to help reduce associated environmental impacts.

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

Problem 7

Provide answers to the following questions related to *environmental ethics*, *air pollution controls* and *technical and non-technical environmental principles*.

(10) (i) An industrial safety engineer, with limited experience, is hired on contract by an auto company to conduct daily inspections of the primary bearings and belts controlling the safe operation of the assembly line system. The safety engineer is to report directly to the health and safety inspector from the "Ministry of Industrial Health and Saftey" that has the power to shut down unsafe assembly lines. Briefly explain two (2) fundamental problems with this safety-control framework and propose two (2) potential improvements that may result in safer conditions for the workers and better productivity for the industry. Your answer should consider 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 identify and discuss three (3) key air pollution control approaches that may be used for three (3) different mobile or fixed air contaminant emissions. In your answer, identify the source, the contaminant and the control approach. For each control approach, explain the use of one (1) technical and one (1) non-technial environmental principle that may be applied to improve the emission controls. Use a table to organize your answer.

Marking Scheme

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

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

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

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