

NATIONAL EXAMS December 2018
18-Env-A5, Air Quality and Pollution Control Engineering

3 hours duration

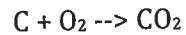
NOTES

1. If doubt exists as to the interpretation of any questions, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN Book Exam.
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. Question 2 must be attempted and other three (3) for a total of four (4) questions constitute a complete paper. Only the first four (4) answers as they appear in your work book(s), will be marked.
5. Each question is worth a total of 25 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 four (4) answered questions with a possible maximum score of 100 marks.

Problem 1

Provide answers to the following questions related to *source and classifications of atmospheric pollutants, indoor and outdoor air pollutants and health and ecological impacts*.

- (20) (i) List five (5) different types of outdoor air pollutants then describe:
- their source of origin;
 - their potential health impacts; and
 - briefly explain engineering methods, one per pollutant, to reduce their potential health impacts.
- (5) (ii) For a typical plant 4, 500 MW which consumes approximately 55,000 US tons of coal per day calculate air required for combustion due to energy generation. State all assumptions.



Problem 2

Provide answers to the following questions related to influence of *solar radiation and wind fields on stack plumes, dispersion and deposition modelling of atmospheric pollutants and Eddy and Gaussian diffusion models.*

- (10) (i) Consider the Gaussian Plume model used to determine pollutant concentration.
- a) write simplified equation;
 - b) explain significance of effective stack height, provide one (1) factors that contribute to it.
 - c) describe how does the temperature and velocity impact the height of the plume.
- (10) (ii) chose four (4) distinct type of plume behavior and for each draw a simple diagram (i.e. side view), describe the behavior in terms of distance away from the stack and dispersion. Describe potential problems with the dispersion. Assume, for prevailing wind speed $u \gg 0$ m/s.

Distinct type of plume behaviors: Fumigation, Trapping, Lofting, Fanning, Coning, Looping

- (5) (iii) list and describe differences in how dispersion modelling of atmospheric pollutants is handled by Gaussian and Lagrangian models.

Problem 3

Provide answers to the following questions related to *measurement techniques of air pollutants, characteristics of various air pollutant particulates and health and aesthetic considerations of PM_{2.5} and PM₁₀*.

- (10) (i) consider a tall stack servicing coal fired kiln which emits particulates.
- List two (2) industry that would use a kiln.
 - Discuss what type of control(s) would apply on such a source, discuss and explain significance of particle size distribution.
- (10) (ii) Describe two (2) measurement methods for particulate matter, for each discuss merits and disadvantages.
- (5) (iii) Describe two (2) key differences in the health effects and aesthetics between the PM_{2.5} and PM₁₀ categories of particulate pollutants.

Problem 4

Provide answers to the following questions related to *air toxics, mobile sources of air pollutants, noxious pollutants and odour control*.

- (10) (i) Define air toxics? list five (5) air toxics and describe their sources.
- (10) (ii) Describe an industry which is expected to release odour. Describe the type of technology that can be used for the control of emissions from this industry. List three (3) fundamental principles of the design.
- (5) (iii) Define noxious pollutants ? list 2 noxious pollutants and their source of emission?

Problem 5

Provide answers to the following questions related to *control of sulphur oxides and oxides of nitrogen, desulphurization and kinetics of NO_x formation and the role of nitrogen and hydrocarbons in photochemical reactions.*

- (5) (i) What is smog? Describe how is it formed and from what? List sources which emit chemicals that cause smog.
- (5) (ii) What is photochemical reaction? describe the roles of nitrogen and hydrocarbons in photochemical reactions.
- (10) (iii) Provide a simple schematic and briefly describe how a commonly used Flue Gas Desulfurization plant works.
- (5) (iv) select one and describe: adsorption, absorption, combustion and incineration. Provide example when the mechanisms would be applied.

Marking Scheme

1. (i) 20, (ii) 5, 25 marks total
2. (i) 10, (ii) 10, (iii) 5, 25 marks total
3. (i) 10, (ii) 10, (iii) 5, 25 marks total
4. (i) 10, (ii) 10, (iii) 5, 25 marks total
5. (i) 5, (ii) 5, (iii) 10, (iv) 5, 25 marks total