CEE446: Air Quality Engineering
Final Exam

The duration of this exam is 50 min, it is worth 100 pt, and it is open book. Students should bring their textbook, lecture notes, assignments, past exams, and handouts for this semester, with your calculator and a periodic table of elements to the exam. Students can use their laptop/tablet computer to only review lecture notes and solutions to exams and assignments for the current semester. No computational capabilities are to be used with computers. The wireless network connection to all computers shall be off during exams. There shall be no access to the Internet during exams. Include solutions to questions for the first two problems in the allocated underlined areas.

Show how you were able to answer each of the calculation based problem(s). Indicate what assumptions you made to answer each question if all of the information is not provided in the problem statement. Outline how to answer the problem if time does not permit to complete your solution.

1) (20 pt) Estimating costs of air quality control devices is important to help decide the best device for the application of interest. Briefly describe capital cost and operating cost, then provide two examples for each cost category, and then describe why they are overall important in making decisions.

Describe capital cost (4 pt): __________________________

Provide two examples of capital costs for an absorber (4 pt): __________________________

Describe operating cost (4 pt): __________________________

Provide two examples of operating costs for an absorber (4 pt): __________________________

Why is it important to determine capital AND operating costs together (4 pt): __________________________
2) (20 pt) Provide brief answers to the following questions pertaining to meteorology and dispersion of pollutants in the atmosphere as we discussed during lectures.

2a) (10 pt) Assume you were given a wind speed, but no height for that wind speed.
What height would you assume for that wind speed (5 pt)? ____________________________

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Why choose that height (5 pt)? ____________________________

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2c) (10 pt) What height is wind speed determined to model dispersion of pollutants from elevated point sources.
What height is used for this application to determine the wind speed (5 pt)? __________

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Why (5 pt)? ____________________________

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3) (30 pt) An electric generating facility produces 1,000 m³/min of flue gas at 150°C and 1 atm that contains 2,000 ppmv SO₂. An absorption system was installed at the facility to remove 90% of the SO₂ from the gas stream. The absorber uses CaCO₃ in water to remove the SO₂ from the gas stream. What is the mass generation rate of dry solid waste product (CaSO₄(s)) produced by the absorber, in units of metric ton/yr?
4) (30 pt) 50 kg of NO$_2$ is rapidly released in the outdoor ambient air due to a truck accident. Wind speed, temperature and total pressure are 4 m/s, 293 K, and 1 atm, respectively. The atmosphere is neutral.

4a) (25 pt) Calculate the maximum ground-level concentration of the pollutant (in ppmv) and time of occurrence (in min) at a location 3 km downwind from the accident location.
4b) (5 pt) Is this maximum concentration of the pollutant dangerous to human health at the receptor and why?