CEE446: Air Quality Engineering
Exam No. 1

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 for this semester, handouts, calculator and a periodic table of elements to exams. Students can use their laptop 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 three 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 these problems if time does not permit to complete your solution.

1) (10 pt) Provide one example of each of the pollutants:

a) (5 pt) Primary pollutant: ____________________________

b) (5 pt) Secondary pollutant: ____________________________

2) (20 pt) The mean absolute percent error (MAPE) was discussed when comparing two independent data sets that describe the same property (e.g., modeled and measured particle size distributions).

a) (10 pt) What is the primary advantage of using MAPE when comparing the two data sets? _____

b) (10 pt) What is the primary disadvantage of using MAPE when comparing the two data sets? _____
3) (20 pt) Provide answers to the following questions pertaining to the composition of a flue gas that is generated by combustion of hydrocarbon fuel.

a) (10 pt) Why is the nitrogen (N₂) concentration lower for flue gas when compared to dry ambient air that is used to combust the fuel?

b) (10 pt) Why is the NO concentration larger for flue gas when compared to dry ambient air that is used to combust the fuel?
4) (25 pt) Visibility and optical depth were discussed for outdoor ambient aerosols and industrial aerosols during lecture.

   a) (10 pt) What is the meteorological range for particle free air at 10 °C and 0.95 atm?

   b) (10 pt) What is the meteorological range for conditions described in problem 4a above if the air also contains 15 µg/m³ of 1.12 µm diameter CaCO₃ particles?

   c) (5 pt) Provide a brief interpretation (i.e., a few sentences) of the results provided in problems 4a and 4b, explaining how they relate to CEE446.
5) (25 pt) Determine the terminal settling velocity \( (V_{tp}) \) of a 100 µm diameter \( (d_p) \) particle for sodium chloride \( (\text{NaCl}) \) in flue gas described in assignment no. 1, problem 3 for the two following conditions.

a) (5 pt) Using the correct Reynolds Number of the particle \( (R_{ep}) \).

b) (15 pt) Assuming \( R_{ep} \) is in Stokes region, without checking to see if \( R_{ep} \) is the correct value.

c) (5 pt) Calculate the percent difference in the results provided in problems 5a and 5b above and provide a brief interpretation (i.e., a few sentences) of the results for problem 5, explaining how they relate to CEE446.