**REII 425 Lab Assignment 1 2023 (50)**

Download the file Vehicle emissions data.xlsx from the efundi site under Assignments/Lab Assignment 1. It contains the following data in different sheets:

1. SA vehicles age profile: the population of registered vehicles of different types in the provinces of South Africa and the age profiles of such vehicles
2. Emissions by vehicle type: emissions of different pollutants in g/km for different vehicle classes
3. Emission Factors over Age: emissions of different pollutants in g/kg for one vehicle class as function of vehicle age
4. VKT by age: average vehicle kilometers traveled per annum by vehicle age
5. Emissions by vehicle speed: emissions of different pollutants in g/miles for different vehicle classes and vehicle speeds.

The following additional information is provided:

1. Number of minibus taxis in South Africa: 250,000.
2. Number of buses in South Africa: 25,000 of which 19,000 is commercial.

The following questions must be answered; display tables and/or figures with the results as necessary:

1. *Data Import:* Read the data into suitable structures. Convert the text to numeric values where necessary. Fill in zeros where necessary to ensure that all columns are of the same length. Display small extracts form the structures as evidence that the data was successfully imported. (4)
2. *Data Extrapolation:*
3. Fit a polynomial curve to the VKT by age data for each of the vehicle classes, to extend this data over the same age range as the SA vehicles age profile data. Experiment with different degrees for the polynomial expressions, from 1 (linear) to at least 5. Verify if the extrapolation of the VKT and emissions by age data produces realistic values. Decide how to handle extrapolated values that become negative. Determine which polynomial degrees produces the best results for the different variables, and use the simulated results based on that polynomial expression for further calculations. Generate tables that shows the values of the polynomial coefficients. Also display tables with the simulated VKT and emissions by age results. (8)
4. Repeat this exercise for the emission factors data for each type of pollutant. (6)
5. *Vehicles age profiles:* Use the SA vehicles age profile data to calculate the total number of vehicles in SA and each province in each vehicle class:

* for all age groups combined
* in each age group. (6)

1. *Total distance travelled age profiles:*
2. Use the information above about minibus taxis and bus numbers to divide the age profile class Heavy passenger mv (12 or more persons) into Heavy Duty Passenger Vehicles (minibus taxis), Heavy-Duty Passenger Vehicles (commercial bus) and Heavy-Duty Passenger Vehicles (non-commercial bus) categories. (2)
3. Use the extrapolated VKT by age data to calculate an average VKT value for each 5-year period as used for the SA vehicles age profile data. (4)
4. Use the SA vehicles age profile and VKT by age data to calculate the total annual distance driven by each vehicle class within each age group and each province, as well as for the entire country. Assume that motorcycles drive the same annual distance as passenger vehicles. (4)
5. *Emissions age profile:*
6. Calculate the annual amount of pollution for each pollutant caused by each vehicle class and by all classes combined, in total and within each province. Use the total annual distance driven by each vehicle class and the Emissions by vehicle class data, and assume that all vehicles drove at an average speed of 22 km/h, (4)
7. Use the Emission Factors over Age data, combined with the total annual distance driven by each vehicle class per age group, to calculate the annual amount of pollution per age group. Repeat this for each pollutant caused by each vehicle class and by all classes combined, in total and within each province. Generate bar charts of the results. (6)
8. Determine the percentage contribution of each age group to total emissions in each category. Also calculate the accumulative percentage of total emission over the different age groups, starting with the youngest age groups. Comment on the usefulness of these results. Generate bar charts of the results. (6)