Pre-assignment:
Simple Vehicle Fleet Routing with SoH Cost

The **Capacitated Vehicle Routing Problem (CVRP)** is a vehicle routing problem in which vehicles with limited carrying capacity need to pick up items at various locations. The items have a quantity, such as weight or volume, and the vehicles have a maximum capacity that they can carry. The problem is to pick up the items for **the least cost** (for example, minimum total distance covered) while never exceeding the capacity of the vehicles. This pre-assignment addresses a simplistic **battery-electric vehicle (BEV)** variant of CVRP, whereby the cost is battery wear, i.e. change of battery State-of-Health (SoH), during route execution.

Your tasks in this pre-assignment are as follows:

1. Familiarize yourself with the Adaptive Large Neighbourhood Search (ALNS) meta-heuristic in Python: `https://alns.readthedocs.io/en/latest/index.html`, and especially its CVRP solution capabilities.

2. Study the standard CVRPLIB problem instance `ORTEC-n242-k12` available at `http://vrp.atd-lab.inf.puc-rio.br/index.php/en/`, and with data description at `http://comopt.ifi.uni-heidelberg.de/software/TSPLIB95/tsp95.pdf`.

3. For the `ORTEC-n242-k12` CVRP instance, assume that driving a distance d_{ij} between the customer i and j induces an affine reduction $\mathbf{\Delta SoH}_{ij}$ in battery health:

$$\mathbf{\Delta SoH}_{ij} = a \cdot d_{ij} + b, \quad \text{with } a = 8.5 \cdot 10^{-7} \text{ and } b = 0.002 \tag{1}$$

4. Use the ALNS package to solve the `ORTEC-n242-k12` CVRP instance to minimize the total reduction of battery health.

5. Provide your Python code and a written report (2-3 pages) of your results, typeset in LaTeX.