**BATTERY CHARGING & DISCHARGING SIMULATION**

### INFORMATION :

1. Models Li-ion battery charging/discharging behavior
2. Inputs : Capacity , current , voltage
3. Outputs : SOC (state of charge ),efficiency
4. Libraries : numpy, matplotlib
5. Application : EV battery management system

## Source code:

#Battery charging&Discharging Simulation

import numpy as np

import matplotlib.pyplot as plt

capacity\_Ah = 60.0

voltage\_nominal = 3.7

internal\_resistance = 0.05

total\_time = 3600

dt = 1

time = np.arange(0, total\_time, dt)

current = np.zeros\_like(time)

voltage = np.zeros\_like(time)

current[:1800] = 12

voltage[:1800] = voltage\_nominal + 0.1

current[1800:] = -20

voltage[1800:] = voltage\_nominal - 0.15

soc = np.zeros\_like(time, dtype=float)

efficiency = np.zeros\_like(time, dtype=float)

soc[0] = 40.0

for t in range(1, len(time)):

    I = current[t]

    V = voltage[t]

    delta\_soc = (I \* dt / 3600) / capacity\_Ah \* 100

    soc[t] = soc[t - 1] + delta\_soc

    soc[t] = np.clip(soc[t], 0, 100)

    if I > 0:

        power\_in = I \* V

        power\_stored = I \* voltage\_nominal

        eff = power\_stored / power\_in if power\_in > 0 else 1

    elif I < 0:

        power\_out = -I \* voltage\_nominal

        power\_drawn = -I \* V

        eff = power\_out / power\_drawn if power\_drawn > 0 else 1

    else:

        eff = 1.0

    efficiency[t] = np.clip(eff, 0, 1)

print("------ Battery Simulation Results ------")

print(f"Initial SOC: {soc[0]:.2f}%")

print(f"SOC after 30 minutes (charging): {soc[1800]:.2f}%")

print(f"SOC after 60 minutes (discharging): {soc[-1]:.2f}%\n")

print(f"Efficiency at 30 minutes: {efficiency[1800]:.3f}")

print(f"Efficiency at 60 minutes: {efficiency[-1]:.3f}")

print("----------------------------------------")

## output :

------ Battery Simulation Results ------

Initial SOC: 40.00%

SOC after 30 minutes (charging): 49.99%

SOC after 60 minutes (discharging): 33.33%

Efficiency at 30 minutes: 1.000

Efficiency at 60 minutes: 1.000

## Conclusion :

This program simulates how a battery charges and discharges over one hour. It starts with a battery at 40% state of charge (SOC). For the first 30 minutes, the battery is charging with a positive current, which increases the SOC. In the next 30 minutes, the battery discharges with a negative current, causing the SOC to decrease,The program also calculates the efficiency .

From the results, we see the SOC rises during charging and falls during discharging, and the efficiency values give an idea of energy losses during these processes.