Design of EV using QSS

Project synopsis submitted in partial fulfilment

for the Award of

CERTIFICATION

in

Electric Vehicle Course

by

Pavan Srinivas Marri, September 1st batch

DATE: 14th January, 2024

CHAPTER 1

List of Figures:

CHAPTER 2

PROJECT DESCRIPTION

Objective

The main objective of the project is to design and simulate an electric vehicle using the QSS and Advisor Toolbox in MATLAB. The project aims to develop a detailed model of the EV system that encompasses the battery, power electronics, motor drive and control system. Through simulation, the project will explore different control strategies to analyse the overall performance of the EV under various operating conditions.

Expected Result

Through this project we will understand the following things:

- A model of the EV system, including all relevant components and their interconnections.
- Simulation results that demonstrate the performance of the EV under different scenarios.
- An evaluation of different control strategies including their impact on the EV system's performance and efficiency.
- A study report representing the performance comparison of different control strategies and identifying the most effective approach for maximizing the EV's performance.

Pre-requisites

To complete this project, we have some basic knowledge on:

- MATLAB environment.
- Simulation Using QSS Toolbox and Advisor Toolbox.

CHAPTER 3

REQUIRED INPUT PARAMETERS AND CALCULATIONS

Assumptions:

To perform the simulation the assumptions made in this project are,

- All the Vehicles are using NEDC driving cycle.
- The diameter of the front and rear wheel is same.
- The efficiency of Motor should be considered as same and the transmission efficiency varies.
- All vehicles having the Initial State of Charge 80% or 0.8.
- The Gear Ratio should be assumed as 2.

Let assume some parameters of some vehicles required for simulation and calculations,

Vehicle-1:

Total Mass of Vehicle = 191 kg

Frontal area = 0.875 m^2

Diameter of Wheel = 0.233 m

Coefficient of Drag = 1.5

Coefficient of Rolling Friction = 0.02

Transmission Efficiency = 0.98

Battery Capacity = 72.407 Ah or 3.7 Kwh

Maximum Power produced from the Motor = 6 KW

After simulating in the Simulink using QSS toolbox we get,

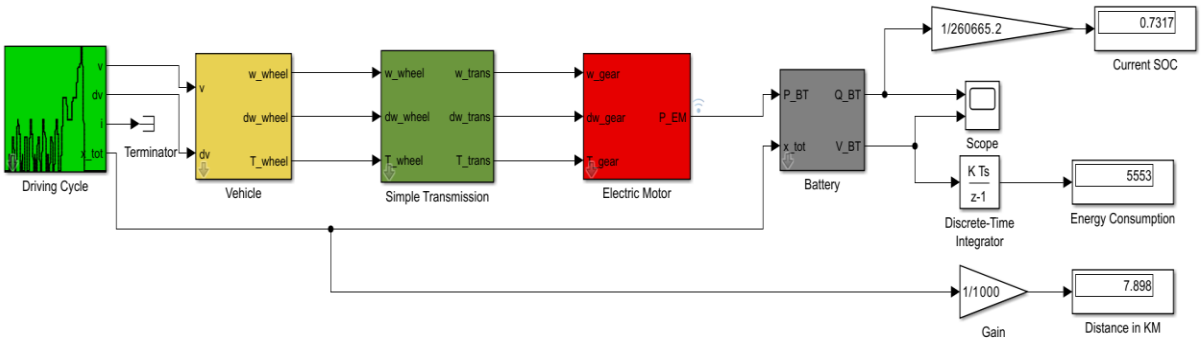

Fig-1

Current State of Charge = 73.17%

Total Distance Travelled = 7.898 KM

Energy Consumed for 7.89 KM = 5.553 KWh

Energy Consumed for a range of 1 KM = 5.553 / 7.898 = 0.703 KWh

By simulating in the advisor toolbox, we get,

Maximum Acceleration = 1.1 m/s^2

Time taken to accelerate 0 – 60 kmph = 18.2 s

Maximum Speed obtained = 103.4 kmph

Vehicle-2:

Total Mass of Vehicle = 200 kg

Frontal area = 0.926 m^2

Diameter of Wheel = 0.431 m

Coefficient of Drag = 1.3

Coefficient of Rolling Friction = 0.035

Transmission Efficiency = 0.95

Battery Capacity = 72.407 Ah or 3.7 Kwh

Maximum Power produced from the Motor = 5 KW

After simulating in the Simulink using QSS toolbox we get,

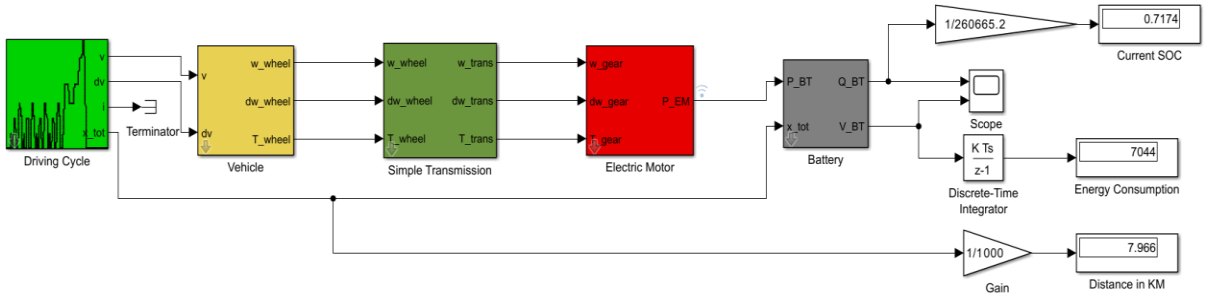

Fig-2

Current State of Charge = 71.74%

Total Distance Travelled = 7.966 KM

Energy Consumed for 7.966 KM = 7.044 KWh

Energy Consumed for a range of 1 KM = 7.044 / 7.966 = 0.884 KWh

By simulating in the advisor toolbox, we get,

Maximum Acceleration = 0.8 m/s^2

Time taken to accelerate 0 – 60 kmph = 27.5 s

Maximum Speed obtained = 89.9 kmph

Vehicle-3:

Total Mass of Vehicle = 215 kg

Frontal area = 0.825 m^2

Diameter of Wheel = 0.304 m

Coefficient of Drag = 1.2

Coefficient of Rolling Friction = 0.048

Transmission Efficiency = 0.93

Battery Capacity = 79.84 Ah or 4.08 Kwh

Maximum Power produced from the Motor = 11 KW

After simulating in the Simulink using QSS toolbox we get,

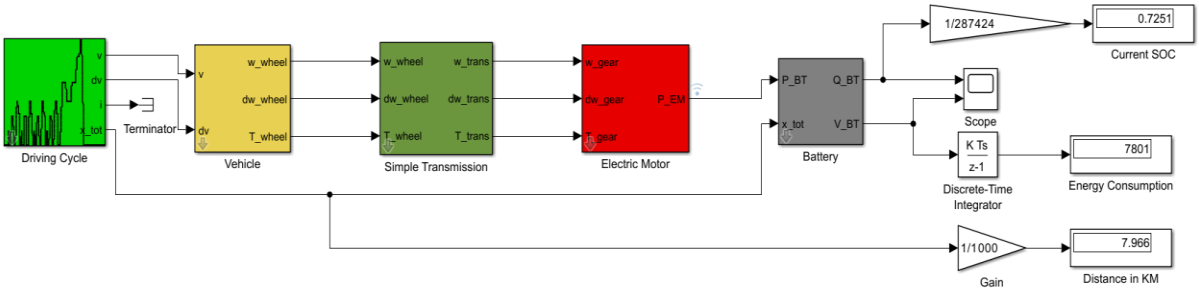

Fig-3

Current State of Charge = 72.51%

Total Distance Travelled = 7.966 KM

Energy Consumed for 7.966 KM = 7.801 KWh

Energy Consumed for a range of 1 KM = 7.801 / 7.966 = 0.98 KWh

By simulating in the advisor toolbox, we get,

Maximum Acceleration = 1.4 m/s^2

Time taken to accelerate 0 – 60 kmph = 14.5 s

Maximum Speed obtained = 105.6 kmph

Vehicle-4:

Total Mass of Vehicle = 200 kg

Frontal area = 0.762 m^2

Diameter of Wheel = 0.25 m

Coefficient of Drag = 1.0

Coefficient of Rolling Friction = 0.03

Transmission Efficiency = 0.9

Battery Capacity = 79.84 Ah or 4.08 Kwh

Maximum Power produced from the Motor = 9 KW

After simulating in the Simulink using QSS toolbox we get,

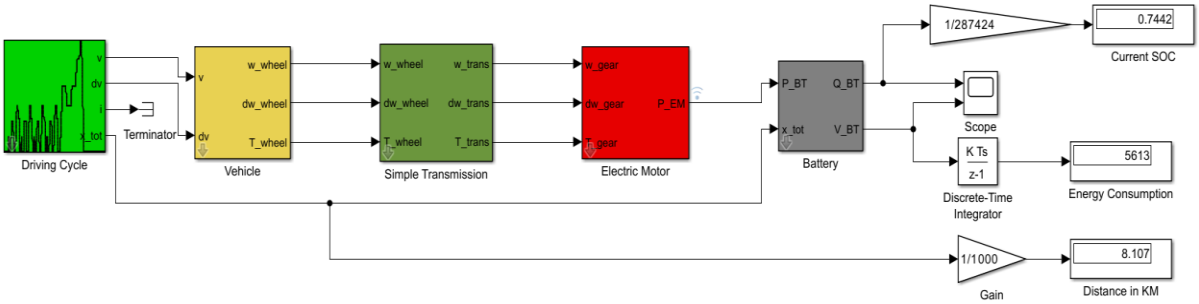

Fig-4

Current State of Charge = 74.42%

Total Distance Travelled = 8.107 KM

Energy Consumed for 8.107 KM = 5.613 KWh

Energy Consumed for a range of 1 KM = 5.613 / 8.107 =0.69 ~ 0.7 KWh

By simulating in the advisor toolbox, we get,

Maximum Acceleration = 1.2 m/s^2

Time taken to accelerate 0 – 60 kmph = 15.2 s

Maximum Speed obtained = 104.7 kmph

CHAPTER 4

OUTPUT PARAMETERS

The expected Output parameters which are found through simulation are:

- **State of Charge (SOC):**

  It can be defined as the measurement of the amount of charge available in the battery at specific point of time expressed as the percentage. It informs the user that how much long they can operate the vehicle.

- **Energy Consumption Rate:**

  It can be defined as the amount of energy consumed by the vehicle per kilometre. It informs that how much battery pack required for the vehicle to satisfy the given range.

- Understanding Modelling of an EV System using QSS toolbox in the Simulink with the all interconnections.

- Performing the different Control strategies on the parameters of the vehicle and identifying the best one.

- Simulating the vehicle using the QSS and Advisor toolbox and generating the results to estimate soc, energy consumption and also acceleration results.

CHAPTER 5

RESULT

Since we have designed a model of the EV system including all the relevant components and their interconnections and simulated the system using the different control strategies by changing the parameters as discussed above and the results are as follows:

Sl. No	Control Strategy	Current SOC (%)	Energy Consumption (kwh/km)	Maximum Acceleration (m/s^2)	Maximum Speed (kmph)
1	Vehicle-1	73.17	0.703	1.1	103.4
2	Vehicle-2	71.74	0.884	0.8	89.9
3	Vehicle-3	72.51	0.98	1.4	105.6
4	Vehicle-4	74.42	0.7	1.2	104.7

Fig-5

Plots related to the above values are given below:

For Vehicle-1 the SOC and Energy Consumption plots are

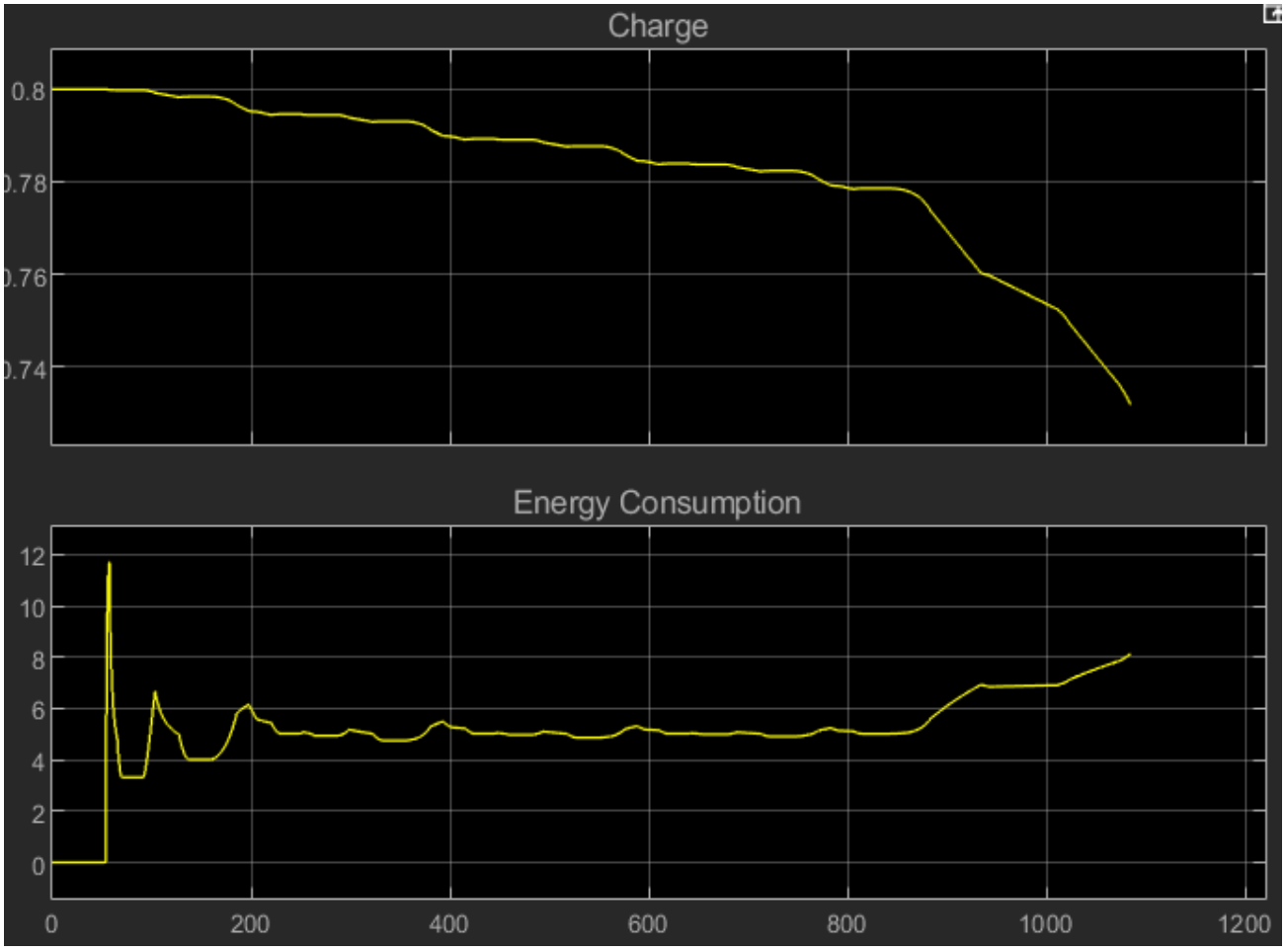

Fig-6

For Vehicle-2 the SOC and Energy Consumption plots are

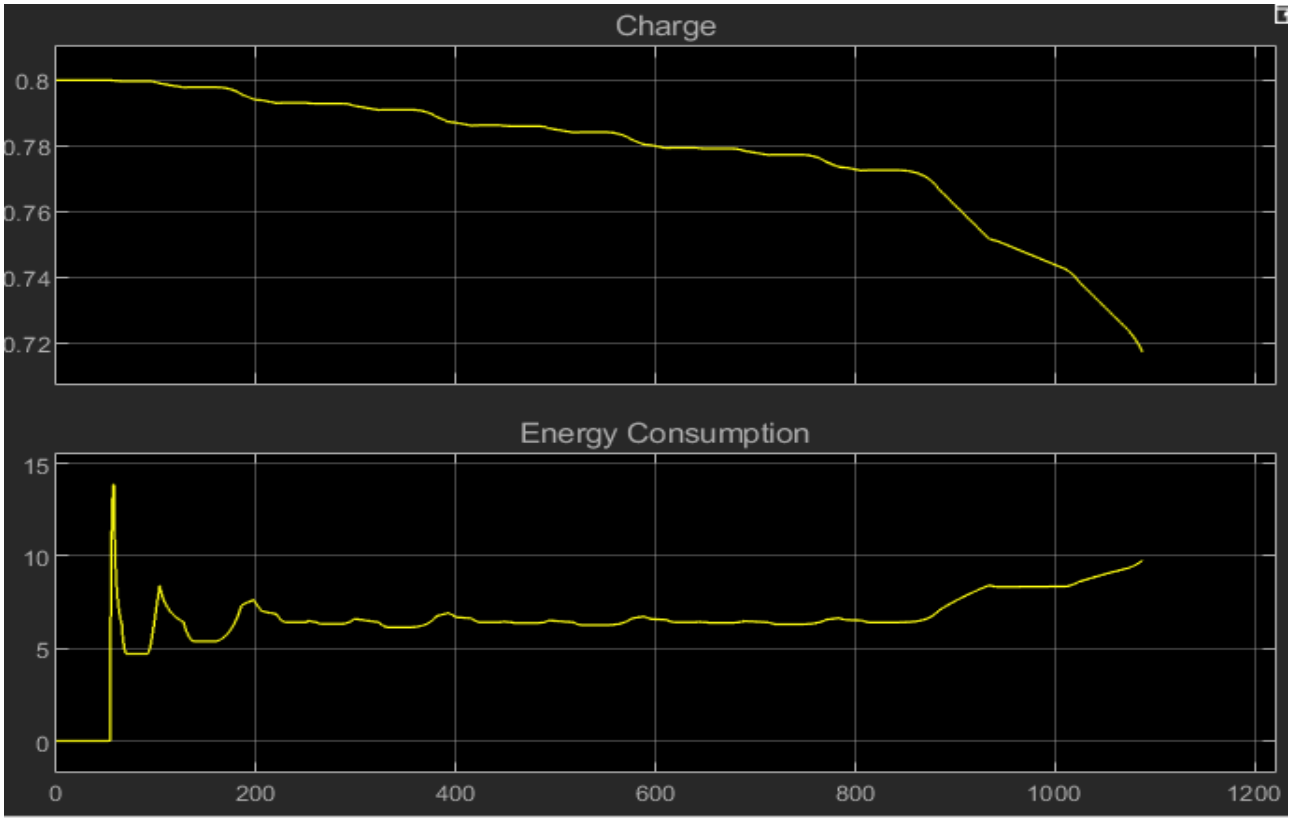

Fig-7

For Vehicle-3 the SOC and Energy Consumption plots are

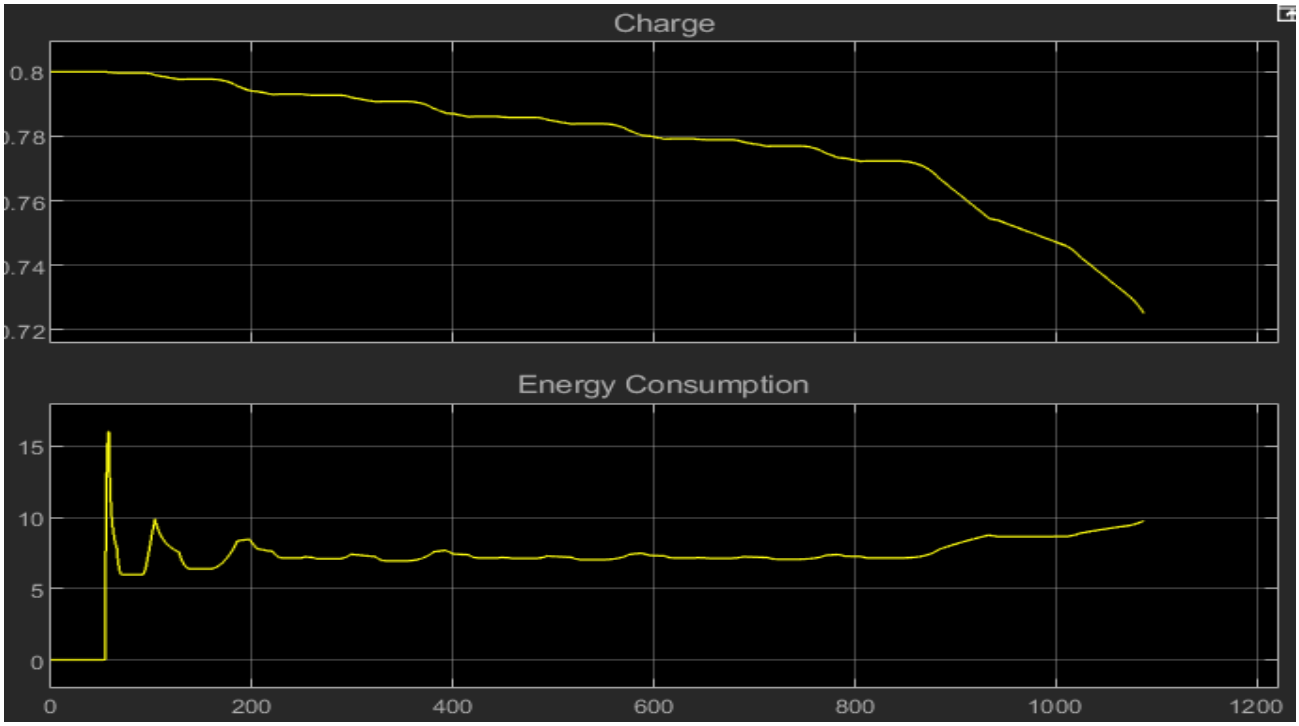

Fig-8

For Vehicle-4 the SOC and Energy Consumption plots are

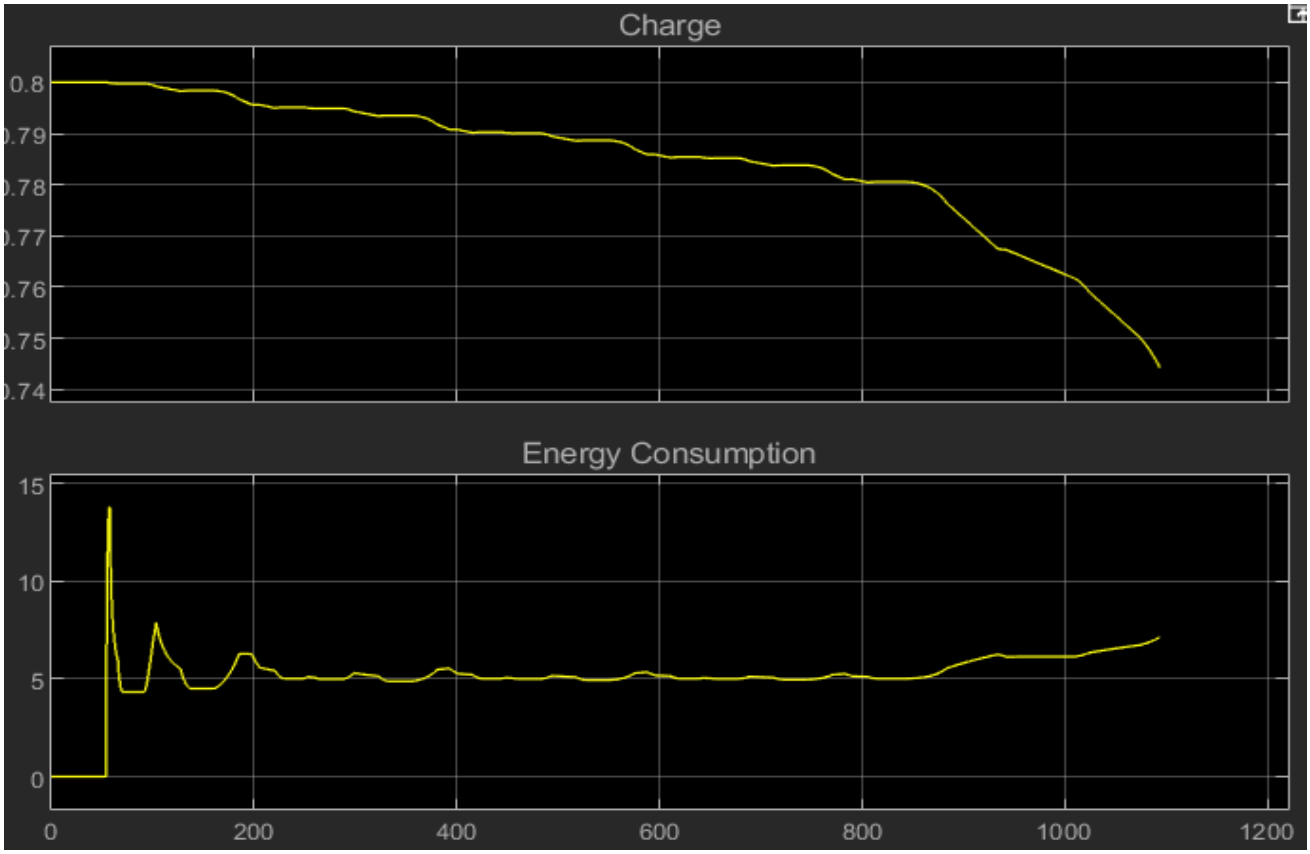

Fig-9

CHAPTER 6

OBSERVATIONS & CONCLUSION

From the Observation of the results mentioned in the above Fig-5 we can conclude that the Vehicle-1 and Vehicle-4 has least specific power consumption and travelled 7.898 and 8.107 km throughout the drive cycle. To more precise Vehicle-4 consumed less power when compared to Vehicle-1 i.e. 0.7 kwh/km whereas Vehicle-1 configuration consumes 0.703 kwh/km for same weight of 200kg.

We can also observe that the Maximum acceleration of Vehicle-4 is 1.2 m/s^2 and the top speed is 104.7 kmph. The Maximum acceleration of Vehicle-1 is 1.1 m/s^2 whereas the top speed is 103.4 kmph which is almost equal to the Vehicle-4 configuration.

By performing simulation using Simulink and advisor toolbox in the MATLAB for the vehicle parameters as we discussed above and from the results of the simulation, we can say that Vehicle-4 and Vehicle-1 configurations are more desirable ones which consumes less amount of energy and also has almost same Maximum acceleration and top speed.

References

Casavola, A., Gianfranco Gagliardi, W. Nesci, and G. Prodi. "A quasi-static simulation tool for the design and optimization of hybrid powertrains." *IAV-2012* (2012).

https://www.youtube.com/watch?v=VwJre6J6Zus&t=72s

https://www.youtube.com/watch?v=PTxkLZhaWyc

Acknowledgment: With the submission of this project report, I acknowledge that I have not copied the work/results/or text from other sources. All the used work from other sources is cited properly with the right format. In case the plagiarism is more than 20%, the instructor has the authority to cancel my project submission.