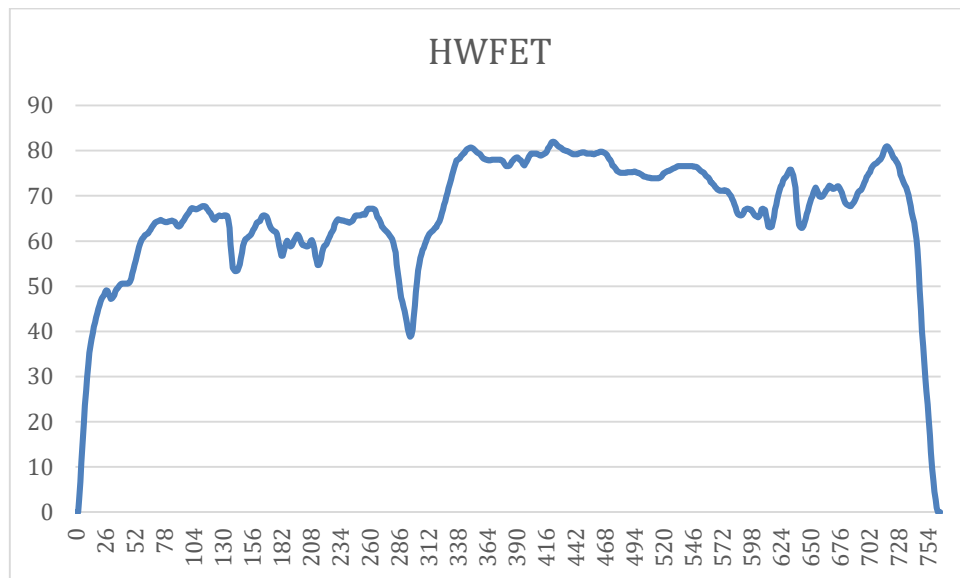


Course name	Numerical Modeling & Simulation in MATLAB-Simulink
Lesson name	Numerical Modelling of Nissan Leaf using HWFET Drive Cycle data in MATLAB-Simulink
Lesson objective	Practice blocks & acquaint to use GUI of MATLAB-Simulink
Created by	VIVEK RATHOD

**Problem statement:** Model Nissan Leaf for HWFET Drive Cycle in MATLAB Simulink to plot the Wheel Torque, Wheel Speed, Motor Torque, Motor Speed and Battery Current in Matlab Simulink.

#### Artemis Urban Drive Cycle Graph:



### Model Inputs:

SI No	Parameter	Value	Units
1.	<b>Chassis</b>		
2.	I. Coefficient of rolling resistance	0.015	
3.	II. Mass of Vehicle	1630.665	Kg
4.	III. Mass of Driver	80	Kg
5.	IV. Gravity constant	9.81	m/s
6.	V. Grade Angle	0	degree
7.	VI. Velocity	From The HWFET drive cycle	Kmph
8.	VII. Area	3.8056	m <sup>2</sup>
9.	VIII. Air Density	1.225	Kg/m <sup>3</sup>
10.	IX. Drag Coefficient	0.28	
11.	X. Radius of wheel	0.2032	m
12.	<b>Transmission</b>		
13.	I. Gear Ratio	7.9377	
14.	II. Transmission Efficiency	89	%
15.	<b>Battery</b>		
16.	I. Battery Capacity	24000	Wh
17.	II. Battery Voltage	364.8	V
18.	III. Artemis Rural drive cycle distance	14.03	Km
19.	IV. Battery Initial SOC	100	%
20.	V. Drive Cycle time or Simulation time	766	s
21.	<b>Cell</b>		
22.	I. Cell Voltage	3.8	V
23.	II. Cell Capacity	33.1	Ah

## Program:

Separately imported the file using import data.

```
M=1630.665; %Mass of vehicle (kg)
Md=80; %Mass of driver (kg)
GVM=M+Md; %Gross vehicle mass (kg)
g=9.81; %Gravity contant (m/s^2)
GVW=GVM*g; %Gross vehicle weight
A=3.8065; % frontal area (m^2)
rho=1.2250; %Air Density (kg/m^3)
Rw=0.2032; %Radius of wheel (m)
cd=0.28; %coefficient of drag
crf=0.015; %coefficient of rolling re__sistance
GR=7.9377; %Gear Ratio
Teff=0.89; %transmission efficiency
HWFET=HWFET.csv;

%Motor
ME=NissanLeafMotorEfficiency; %motor efficiency
MRE=NissanLeafMotorRegenerativeefficiency; %motor regenrative efficiency

%Motoring efficiency
ME_Speed=ME(:,1);
ME_Torque=ME(:,17);
ME_Eff=ME(:,2:16);
%surface plot of the efficiency
figure('Name','Motor Motering Efficiency')
surf(ME_Speed,ME_Torque,ME_Eff)
xlabel('motor speed (rpm)')
ylabel('motor torque (Nm)')
zlabel('motor efficiency(%)')

%regenerative efficiency
MRE_Speed=MRE(:,1);
MRE_Torque=MRE(:,17);
MRE_Eff=MRE(:,2:16);
%surface plot of the Regenerative efficiency
figure('Name','Motor Regenerative Efficiency')
surf(MRE_Speed,MRE_Torque,MRE_Eff)
xlabel('motor speed (rpm)')
ylabel('motor torque (Nm)')
zlabel('motor efficiency(%)')

%Motor Controller Efficiency
MCE=NissanLeafMotorControllerEfficiency;

%Motoring efficiency
MCE_Speed=MCE(:,1);
MCE_Torque=MCE(:,17);
MCE_Eff=MCE(:,2:16);
%surface plot of the efficiency
figure('Name','Motor Controller Efficiency')
```

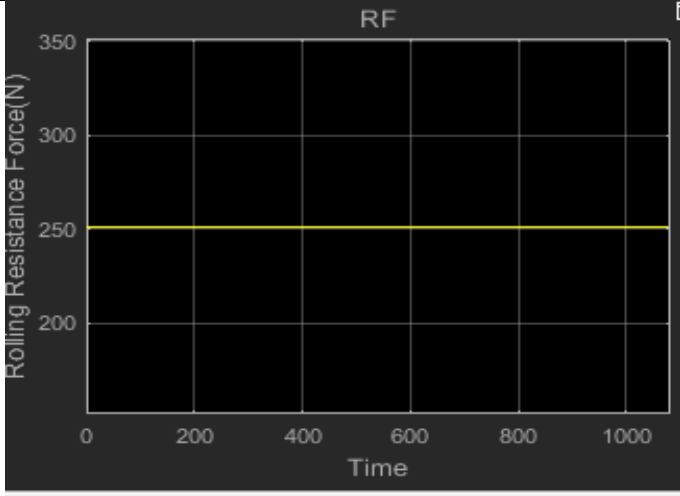
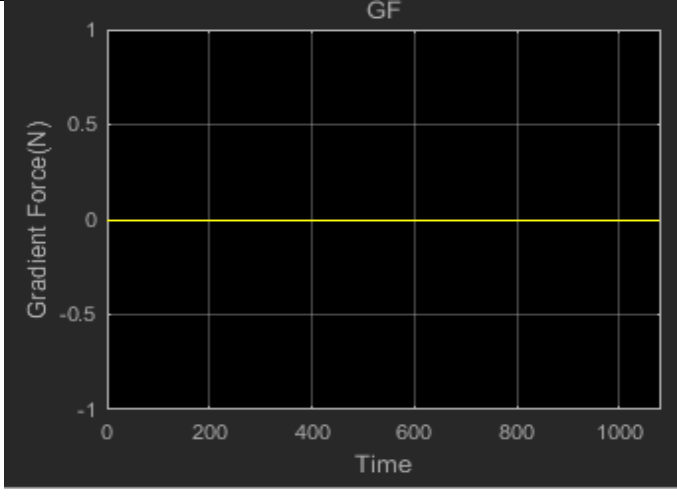
```
surf(MCE_Speed,MCE_Torque,MCE_Eff)
xlabel('motor speed (rpm)')
ylabel('motor torque (Nm)')
zlabel('motor efficiency(%)')

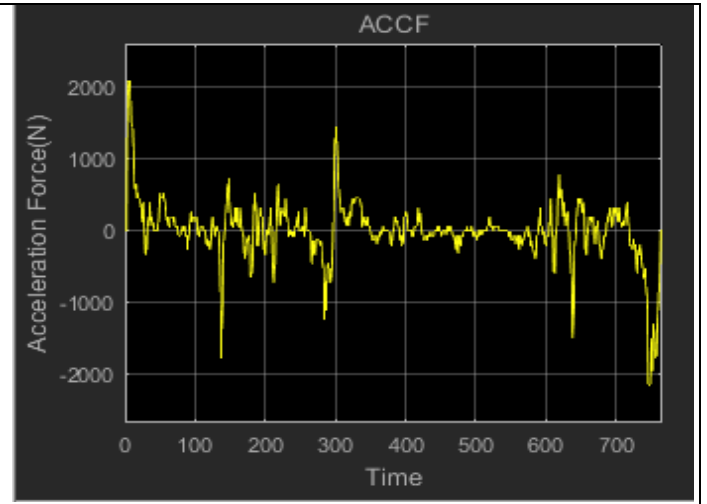
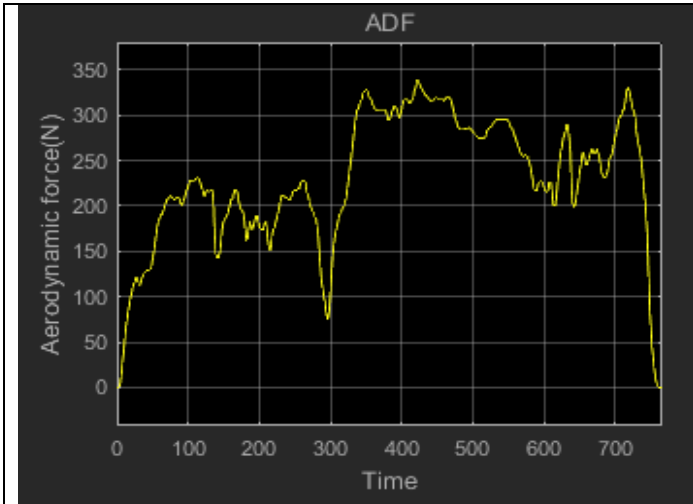
%Motor Controller Regenrative Efficiency
MCRE=Nissanleafmotorcontrollerregenerativeefficiency;

%Motoring Regenerative efficiency
MCRE_Speed=MCRE(:,1);
MCRE_Torque=MCRE(:,17);
MCRE_Eff=MCRE(:,2:16);
%surface plot of the efficiency
figure('Name','Motor Controller Regenerative Efficiency')
surf(MCRE_Speed,MCRE_Torque,MCRE_Eff)
xlabel('motor speed (rpm)')
ylabel('motor torque (Nm)')
zlabel('motor efficiency(%)')

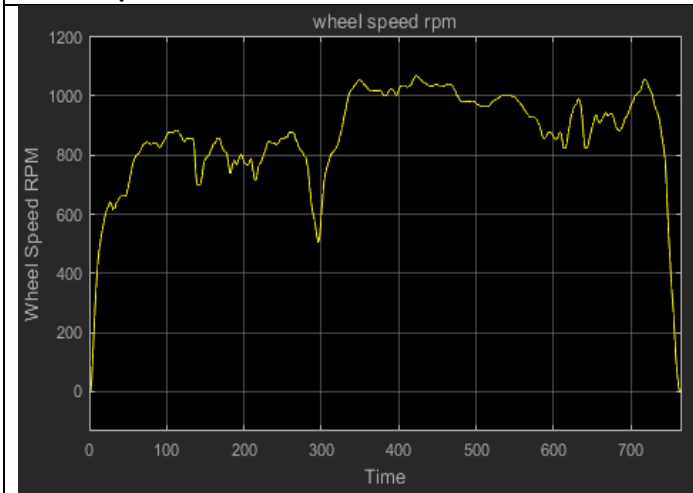
%Intial state of charge
ISOC=1;
```

#### Result:

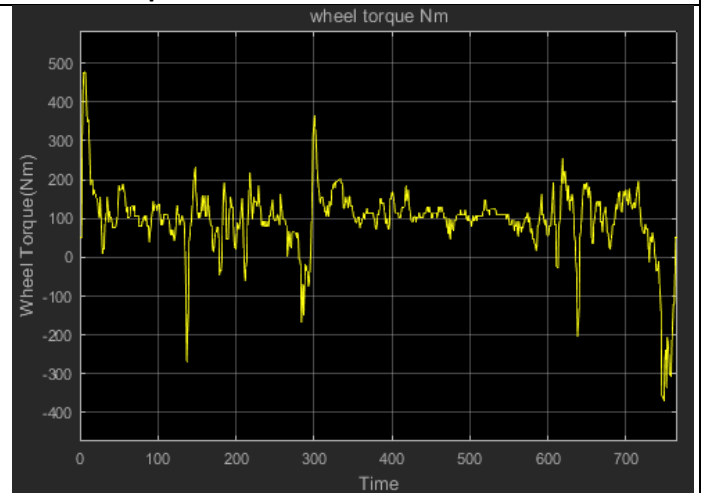
<b>Rolling Force:</b> 	<b>Gradeability Force:</b> 
<b>Aerodynamic Force:</b>	<b>Acceleration Force:</b>



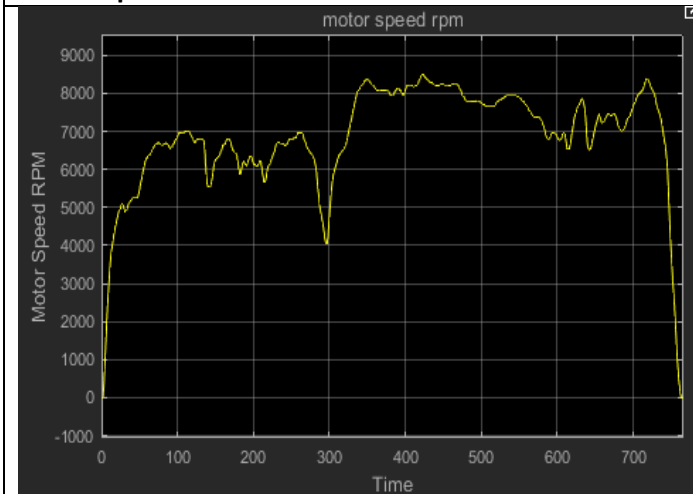
**Wheel Speed:**



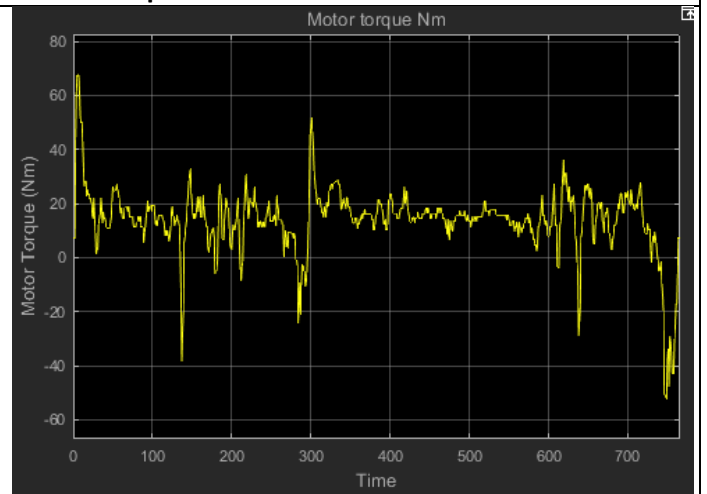
**Wheel Torque:**



**Motor Speed:**

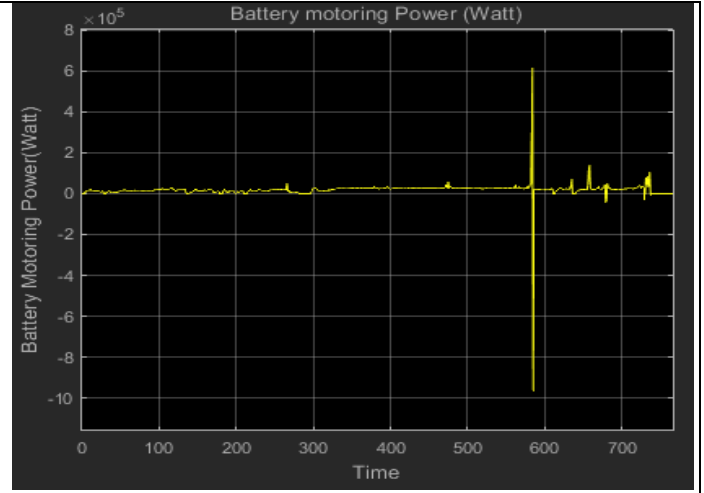
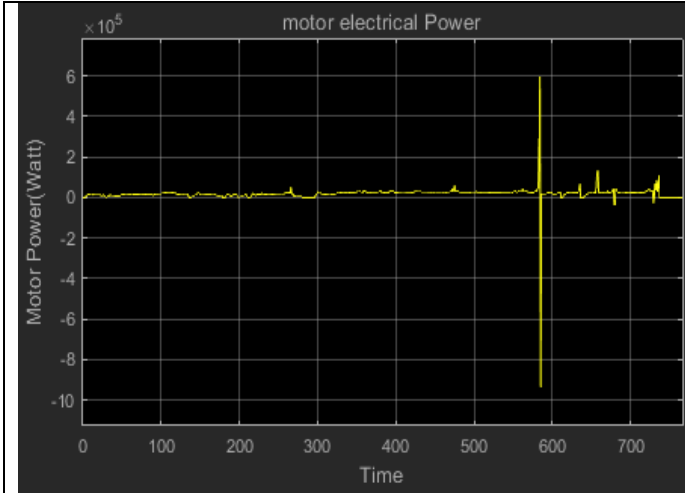


**Motor Torque:**

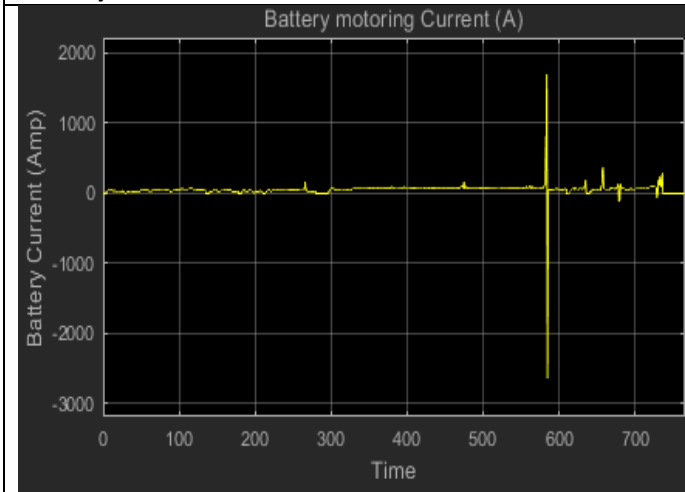


**Motor Power:**

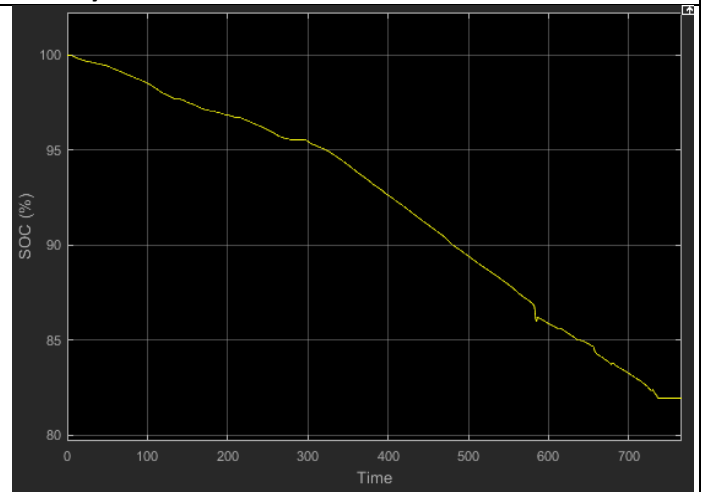
**Battery Power:**



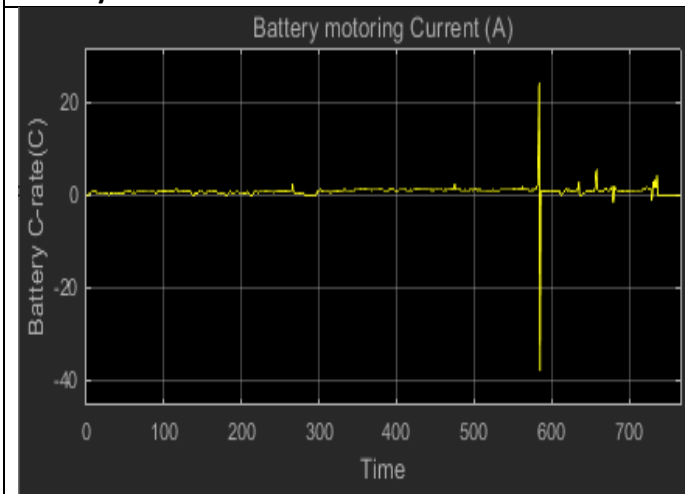
#### Battery Current:



#### Battery SOC:



#### Battery C-rate:



## Conclusion:

SI No	Parameters	Values	Units
1.	<b>Chassis</b>		
2.	• Rolling Force	250	N
3.	• Gradeability Force	0	N
4.	• Maximum Aerodynamic Force	338.1922	N
5.	• Maximum Acceleration Force	2080.1	N
6.	• Maximum Wheel Speed	1069.6	Rpm
7.	• Maximum Wheel Torque	477.8488	Nm
8.	<b>Motor</b>		
9.	• Maximum Motor Speed	8490.5	Rpm
10.	<b>Motor Torque</b>		
11.	• Nominal Motor Torque	15.1870	Nm
12.	<b>Motor Power</b>		
13.	• Nominal Motor Power	10837	W
14.	<b>Battery</b>		
15.	• Power per Km	308.9	Wh/Km
16.	• Vehicle Range	77.7	Km
17.	• Battery Capacity in Ah	65.79	Ah
18.	<b>Cell</b>		
19.	• Cell Voltage	3.8	V
20.	• Cell Capacity	33.1	Ah
21.	<b>No of cells</b>	192	
22.	<b>Battery Power</b>		
23.	• Nominal Battery Power	19743	W
24.	<b>Battery Current</b>		
25.	• Nominal Battery Current	54.1208	A
26.	<b>Battery C-rate</b>		
27.	• Nominal Battery Discharge C-rate	0.7733	C
28.	• State of Charge	81.9403	%
29.	<b>Regenerative</b>		
30.	<b>Battery Power</b>		
31.	• Nominal Battery Power	-366.997	W
32.	<b>Battery Current</b>		
33.	• Nominal Battery Current	-1.006	A
34.	<b>Battery C-rate</b>		
35.	• Nominal Battery Discharge C-rate	-0.0144	C
36.	• State of Charge	82.2703 (0.33 % of increase)	%