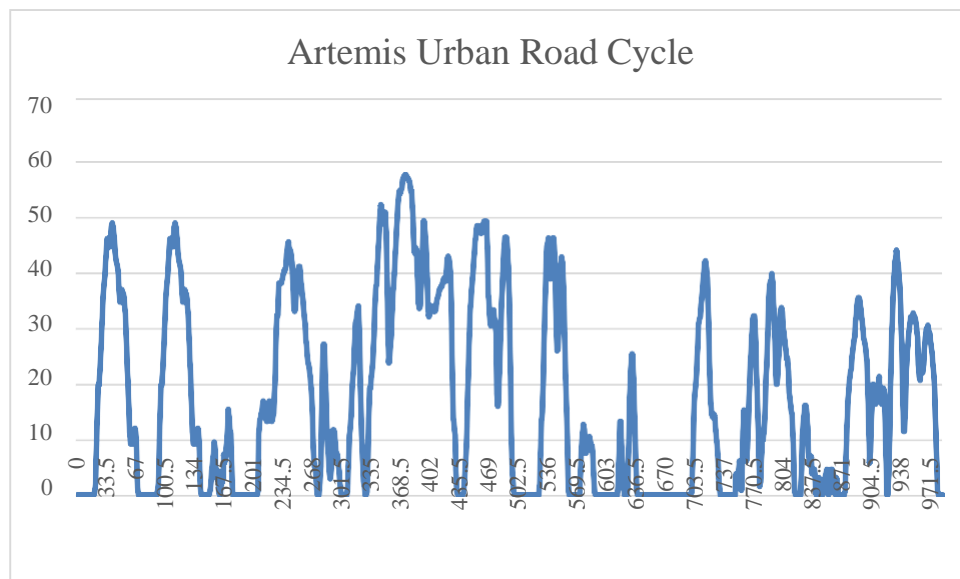| Course name	Numerical Modeling & Simulation in MATLAB-Simulink
Lesson name	**Numerical Modelling of Nissan Leaf using Artemis Rural Drive Cycle data in** MATLAB-Simulink
Lesson objective	**Practice blocks & acquaint to use GUI of MATLAB-Simulink**
Created by	VIVEK RATHOD

Problem statement: Model Nissan Leaf for Artemis Rural 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:

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Model Inputs:

SI No	Parameter		Value	Units
1.	**Chassis**			
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 Artemis rural drive cycle	Kmph
8.	VII.	Area	3.8056	m^2
9.	VIII.	Air Density	1.225	Kg/m^3
10.	IX.	Drag Coefficient	0.28	
11.	X.	Radius of wheel	0.2032	m
12.	**Transmission**			
13.	I.	Gear Ratio	7.9377	
14.	II.	Transmission Efficiency	89	%
15.	**Battery**			
16.	I.	Battery Capacity	24000	Wh
17.	II.	Battery Voltage	364.8	V
18.	III.	Artemis Rural drive cycle distance	14.68	Km
19.	IV.	Battery Initial SOC	100	%
20.	V.	Drive Cycle time or Simulation time	1082	s
21.	**Cell**			
22.	I.	Cell Voltage	3.8	V
23.	II.	Cell Capacity	33.1	Ah

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Program:

Separately imported the file using import data.

```matlab
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
ARDC=ArtemisRuralDriveCycle;

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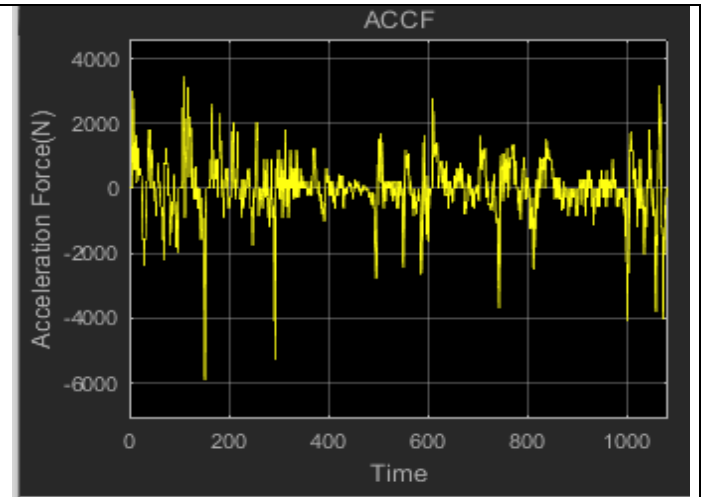
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```matlab
surf(MCE_Speed,MCE_Torque,MCE_Eff)
xlabel('motor speed (rpm)')
ylabel('motor torque (Nm)')
zlabel('motor efficiency(%)')

%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;
```
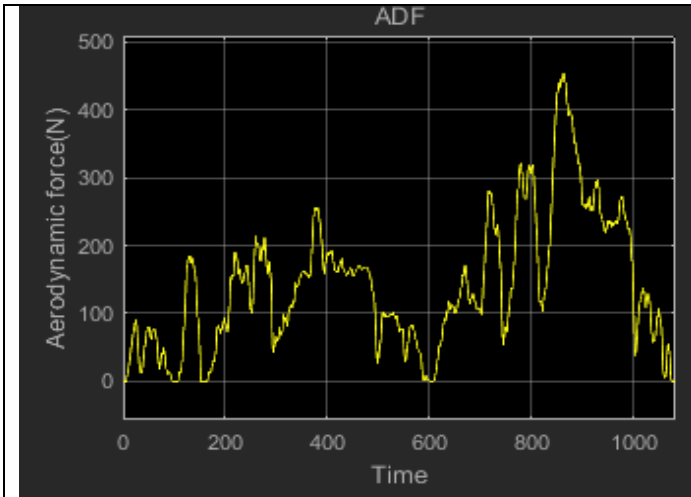
Result:

Rolling Force:	Gradeability Force:
Aerodynamic Force:	Acceleration Force:

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ADF

ACCF

Wheel Speed:

wheel speed rpm

Wheel Torque:

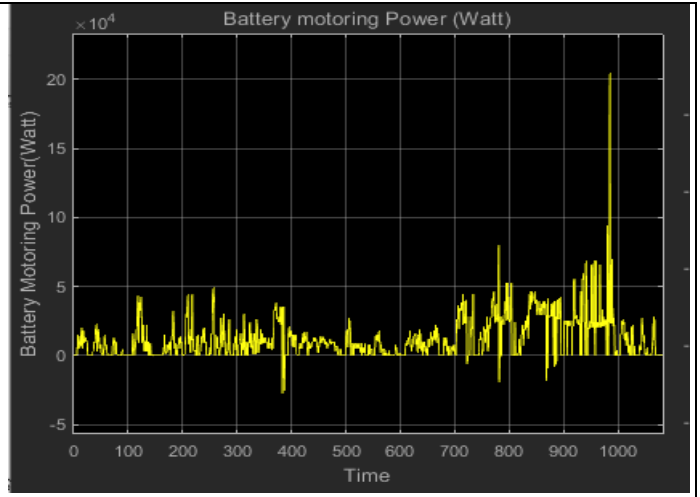wheel torque Nm
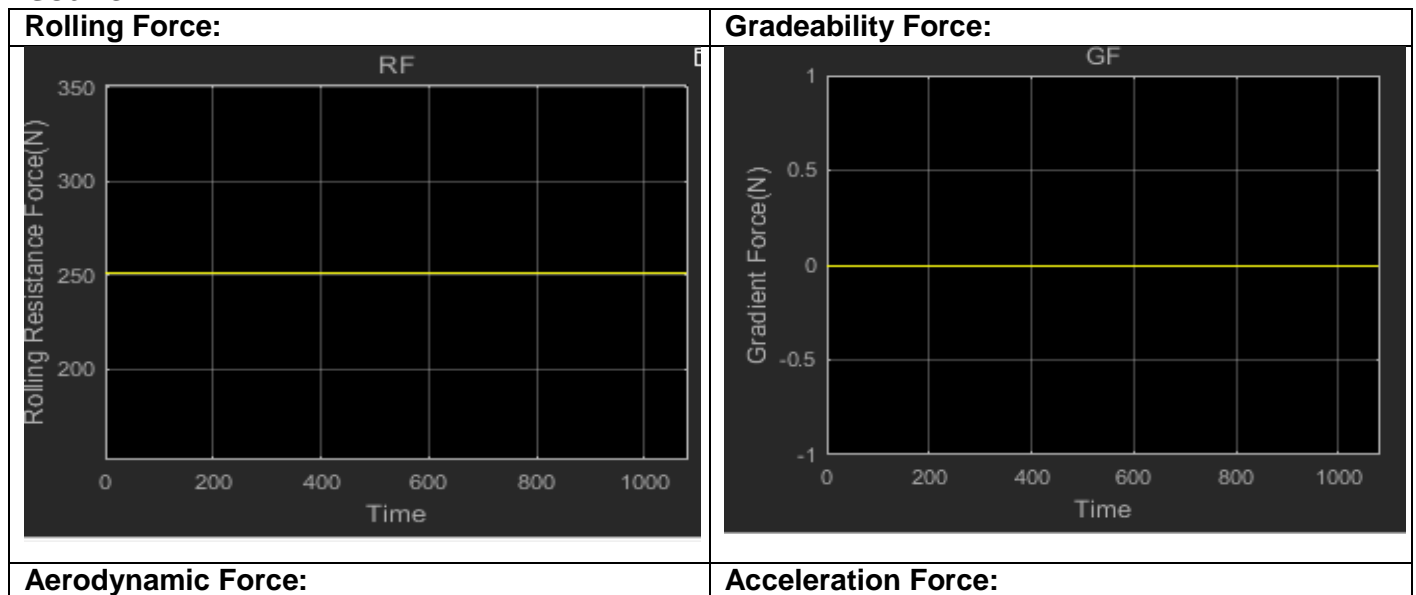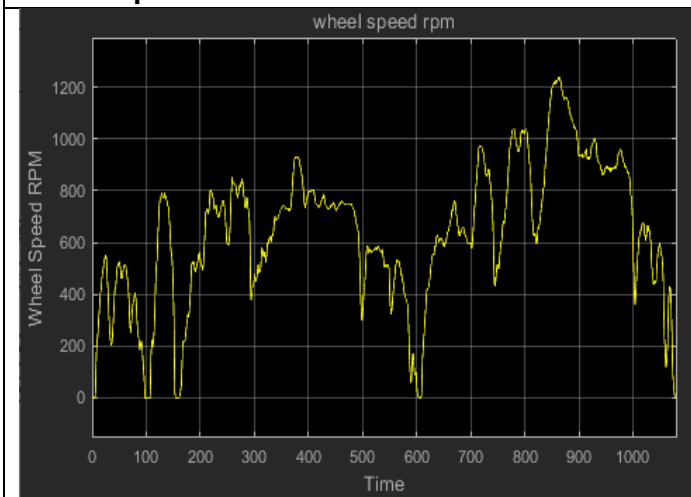
Motor Speed:
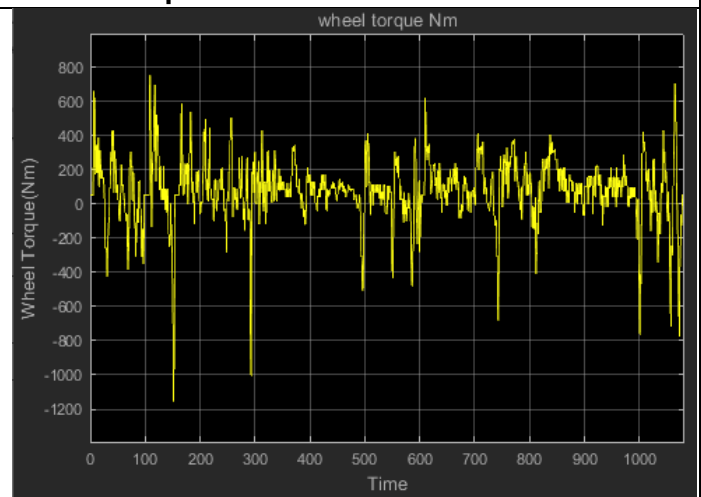
motor speed rpm
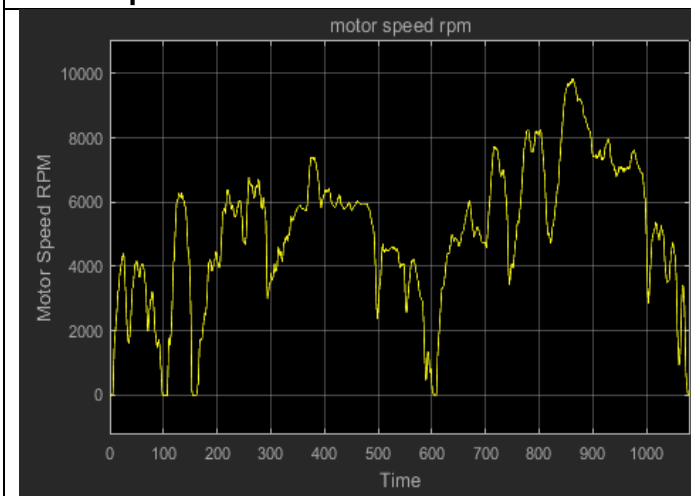
Motor Torque:

Motor torque Nm
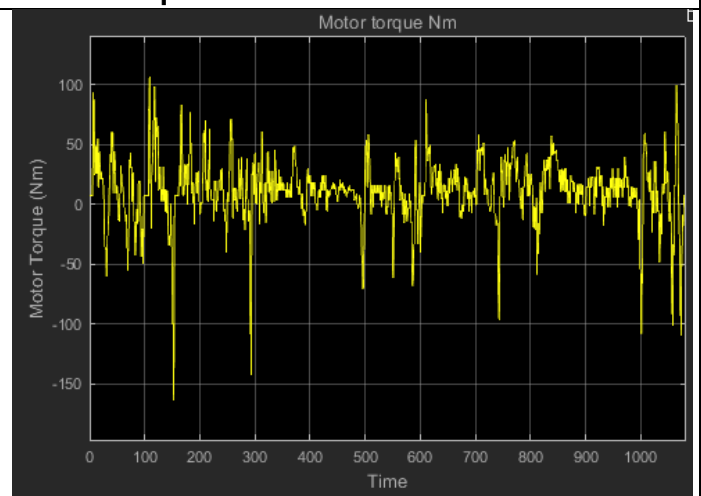
Motor Power:

Battery Power:

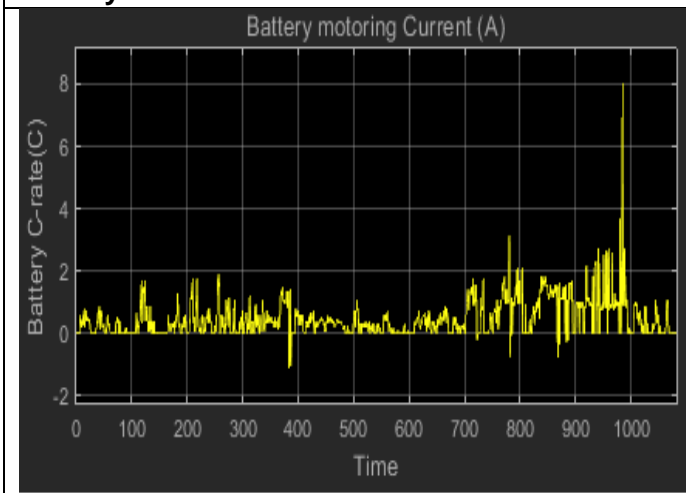Decibels Lab Private Limited CIN:
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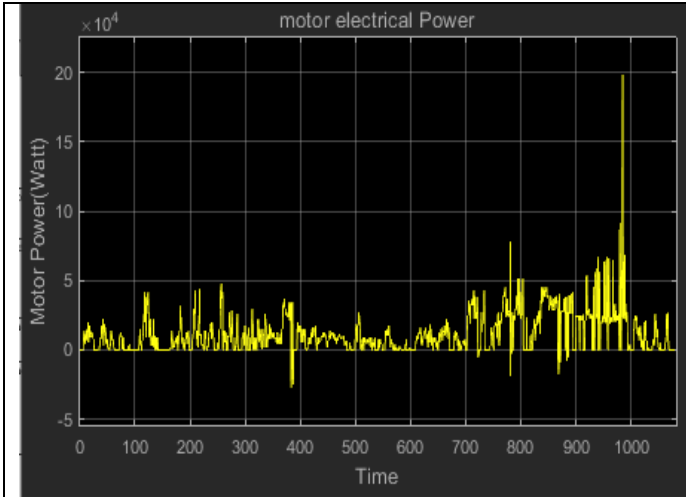
Battery Current:
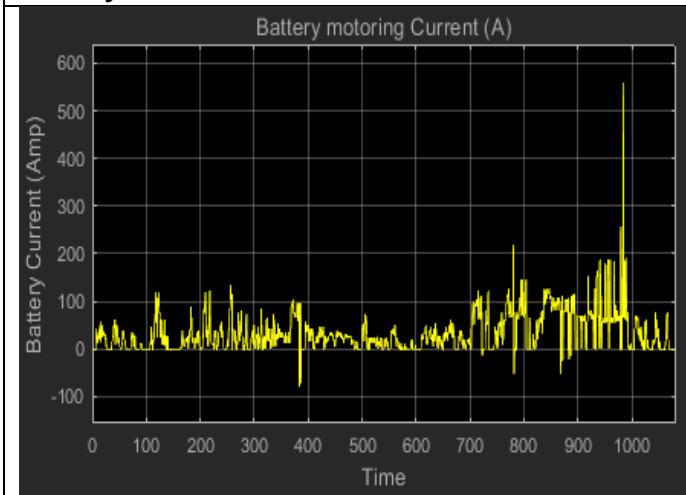
Battery SOC:

Battery C-rate:

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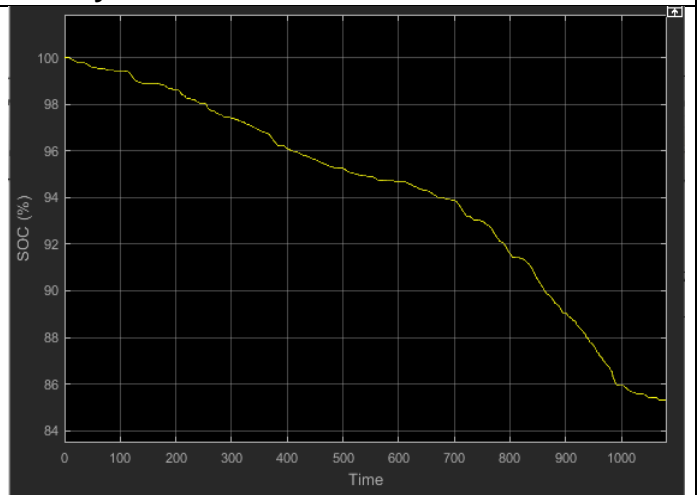
Conclusion:

SI No	Parameters	Values	Units
1.	**Chassis**		
2.	• Rolling Force	250	N
3.	• Gradeability Force	0	N
4.	• Maximum Aerodynamic Force	452.4520	N
5.	• Maximum Acceleration Force	3433.2	N
6.	• Maximum Wheel Speed	1237.2	Rpm
7.	• Maximum Wheel Torque	750.3766	Nm
8.	**Motor**		
9.	• Maximum Motor Speed	9820.5	Rpm
10.	**Motor Torque**		
11.	• Nominal Motor Torque	32.1853	Nm
12.	**Motor Power**		
13.	• Nominal Motor Power	8549.7	W
14.	**Battery**		
15.	• Power per Km	249.9	Wh/Km
16.	• Vehicle Range	96.04	Km
17.	• Battery Capacity in Ah	65.79	Ah
18.	**Cell**		
19.	• Cell Voltage	3.8	V
20.	• Cell Capacity	33.1	Ah
21.	**No of cells**	192	
22.	**Battery Power**		
23.	• Nominal Battery Power	12251	W
24.	**Battery Current**		
25.	• Nominal Battery Current	33.5831	A
26.	**Battery C-rate**		
27.	• Nominal Battery Discharge C-rate	0.4798	C
28.	• State of Charge	85.3178	%
29.	**Regenerative**		
30.	**Battery Power**		
31.	• Nominal Battery Power	-1136.1	W
32.	**Battery Current**		
33.	• Nominal Battery Current	.3.1143	A
34.	**Battery C-rate**		
35.	• Nominal Battery Discharge C-rate	-0.0445	C
36.	• State of Charge	86.7097 (1.3919 % of increase)	%