Electric & Hybrid Vehicles

Course Objectives	• Gain the fundamentals of the engineering principles behind electric vehicles. • Examine key design considerations in EV development. • Explore various energy sources used in electric vehicles. • Explore different types of motors and drive systems used in EVs. • Comprehend the role and functioning of power converters and controllers in EVs. • Gain insight into hybrid and electric vehicle technologies. • Explore potential career opportunities in the electric vehicle industry
Course Outcomes	• Design and development of powertrain components for EV application • Progression of Li ion Battery pack and integration with BMS • Selection of traction motor for EV application • Development of Power Electronic converter for EV applications • Analysis of different powertrain architecture

Course Duration: 45 Hours

Course Content:

Unit 1: Design considerations for EV

Comparative study of petrol, diesel, hybrid and EV, Design requirements of EV, Range Estimation, maximum velocity, acceleration, power requirement of an EV.

Unit 2: Energy Sources

Lead-acid, Li-ion, NMC, sodium-based metal air batteries, battery charging, equivalent circuit, fuel cell, ultra capacitor, BMS

Unit 3: Motor and Drives

Different types of motors, AC, DC, PMSM, BLDC, SRM, construction, working and characteristics

Unit 4: Power Converters and controllers

Power semiconductor devices, BJT, MOSFET, IGBT, Converters, Inverters, Motor Drives for AC, DC and PMSM, BLDC and control strategies

Unit 5: Hybrid and Electric Vehicles

Components and working of HEV, different architecture, power split device, operating modes and control strategies

USE CASES:

INDUSTRY USE CASE 1: Power and Energy Optimization for Lightweight 2-Wheeler EV. To design and implement a lightweight 2-wheeler EV by estimating power and energy requirements to optimize for maximum efficiency and performance.

Specifications:

- Vehicle Weight: <100 kg
- Motor Power: 2 kW
- Battery Capacity: 1.5 kWh
- Range: 50 km
- Top Speed: 50 km/h
- Charging Time: 2 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 2: High-Performance Sports EV

To design and implement the electrical wiring of a high-performance 2-wheeler sports EV, focusing on power and energy requirements to achieve high acceleration and top speed.

Specifications:

- Vehicle Weight: 120 kg
- Motor Power: 10 kW
- Battery Capacity: 5 kWh
- Range: 100 km
- Top Speed: 120 km/h
- Acceleration: 0-60 km/h in 3 seconds
- Charging Time: 4 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 3: Long-Range Touring EV

To design and implement the electrical wiring of a long-range 2-wheeler touring EV, estimating power and energy requirements for extended travel distances with minimal charging stops.

Specifications:

- Vehicle Weight: 150 kg Motor Power: 5 kW
- Battery Capacity: 8 kWh Range: 200 km
- Top Speed: 80 km/h
- Charging Time: 6 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i. Energy consumption
ii. Power Requirements
iii. Speed and Energy Consumption relationship
iv. Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 4: Urban Commuter EV

To design and implement the electrical wiring of an urban commuter 2-wheeler EV, focusing on power and energy requirements for stop-and-go traffic and short trips.

Specifications:

- Vehicle Weight: 100 kg
- Motor Power: 3 Kw
- Battery Capacity: 2 kWh
- Range: 60 km
- Top Speed: 60 km/h
- Charging Time: 3 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 5: Off-Road Adventure EV

To design and implement the electrical wiring of an off-road 2-wheeler EV, estimating power and energy requirements for rugged terrain and variable driving conditions.

Specifications:

- Vehicle Weight: 140 kg Motor
- Power: 7 kW
- Battery Capacity: 6 kWh Range: 80 km
- Top Speed: 70 km/h
- Suspension: Enhanced off-road suspension Charging
- Time: 5 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i. Energy consumption
ii. Power Requirements
iii. Speed and Energy Consumption relationship
iv. Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.
Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i. Battery Pack Voltage and Configuration
ii. Current measurement
iii. Temperature Management
iv. Cell balancing
v. State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 6: Economical Budget EV

To design and implement the electrical wiring of an economical 2-wheeler EV, focusing on cost-effective power and energy solutions to make electric transportation affordable.

Specifications:

- Vehicle Weight: 90 kg
- Motor Power: 1.5 kW
- Battery Capacity: 1 kWh
- Range: 40 km
- Top Speed: 45 km/h
- Charging Time: 1.5 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i. Energy consumption
ii. Power Requirements
iii. Speed and Energy Consumption relationship
iv. Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i. Battery Pack Voltage
ii. Number of batteries in series and parallel
iii. Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i. Battery Pack Voltage and Configuration
ii. Current measurement
iii. Temperature Management
iv. Cell balancing
v. State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 7: Cargo Carrier EV

To design and implement the electrical wiring of a cargo-carrying 2-wheeler EV, estimating power and energy requirements to handle heavy loads and maintain performance.

Specifications:

- Vehicle Weight: 160 kg
- Motor Power: 4 kW
- Battery Capacity: 4 kWh
- Range: 70 km
- Top Speed: 55 km/h
- Cargo Capacity: 50 kg
- Charging Time: 4 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.
Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i. Battery Pack Voltage and Configuration
ii. Current measurement
iii. Temperature Management
iv. Cell balancing
v. State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 8: Compact Foldable EV

To design and implement the electrical wiring of a compact foldable 2-wheeler EV, focusing on power and energy requirements for portability and convenience.

Specifications:

- Vehicle Weight: 30 kg
- Motor Power: 0.75 kW
- Battery Capacity: 0.5 kWh
- Range: 20 km
- Top Speed: 25 km/h
- Folded Dimensions: 0.5m x 0.3m x 0.8m
- Charging Time: 1 hour

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task 2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i. Battery Pack Voltage and Configuration
ii. Current measurement
iii. Temperature Management
iv. Cell balancing
v. State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 9: High-Efficiency Solar-Assisted EV

To design and implement the electrical wiring of a high-efficiency solar-assisted 2-wheeler EV, incorporating solar panels to supplement power and energy requirements.

Specifications:

- Vehicle Weight: 110 kg
- Motor Power: 2.5 kW
- Battery Capacity: 3 kWh
- Range: 100 km
- Top Speed: 60 km/h
- Solar Panel Capacity: 200W
- Charging Time: 3.5 hours (excluding solar)

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

- Battery Pack Voltage and Configuration
- Current measurement
- Temperature Management
- Cell balancing
- State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 10: Autonomous Delivery EV

To design and implement the electrical wiring of an autonomous delivery 2-wheeler EV, estimating power and energy requirements for autonomous navigation and operation.

Specifications:

- Vehicle Weight: 140 kg Motor Power: 4 kW
- Battery Capacity: 4 kWh Range: 80 km
- Top Speed: 50 km/h
- Autonomy: Full autonomous navigation
- Cargo Capacity: 30 kg
- Charging Time: 4 hours.

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i. Energy consumption
ii. Power Requirements
iii. Speed and Energy Consumption relationship
iv. Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i. Battery Pack Voltage
ii. Number of batteries in series and parallel
iii. Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i. Battery Pack Voltage and Configuration
ii. Current measurement
iii. Temperature Management
iv. Cell balancing
v. State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 11: High-Speed Racing EV

To design and implement the electrical wiring of a high-speed racing 2-wheeler EV, focusing on power and energy requirements for competitive racing performance.

Specifications:

- Vehicle Weight: 130 kg
- Motor Power: 12 kW
- Battery Capacity: 6 kWh
- Range: 60 km
- Top Speed: 150 km/h
- Acceleration: 0-100 km/h in 4 seconds
- Charging Time: 3.5 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i. Energy consumption
ii. Power Requirements
iii. Speed and Energy Consumption relationship
iv. Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 12: Low-Emission Eco-Friendly EV

To design and implement the electrical wiring of a low-emission 2-wheeler EV, estimating power and energy requirements to minimize environmental impact.

Specifications:

- Vehicle Weight: 110 kg
- Motor Power: 2 kW
- Battery Capacity: 2 kWh
- Range: 50 km
- Top Speed: 50 km/h
- Eco-Friendly Materials: Recycled and biodegradable components
- Charging Time: 2 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i. Energy consumption
ii. Power Requirements
iii. Speed and Energy Consumption relationship
iv. Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 13: Vintage-Style EV

To design and implement the electrical wiring of a vintage-style 2-wheeler EV, focusing on power and energy requirements while maintaining a classic aesthetic.

Specifications:

- Vehicle Weight: 120 kg
- Motor Power: 2.5 kW
- Battery Capacity: 3 kWh
- Range: 60 km
- Top Speed: 50 km/h
- Design Aesthetic: Vintage styling with modern tech
- Charging Time: 2.5 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clark ansformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management l
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 14: Heavy-Duty Industrial EV

To design and implement the electrical wiring of a heavy-duty industrial 2-wheeler EV, estimating power and energy requirements for industrial applications and heavy usage.

Specifications:

- Vehicle Weight: 180 kg
- Motor Power: 6 Kw
- Battery Capacity: 7 kWh
- Range: 70 km
- Top Speed: 50 km/h
- Durability: Enhanced for industrial use
- Charging Time: 5 hour

Determine the capacity and voltage of the battery pack to meet the energy requirements.

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 15: Versatile Hybrid EV

To design and implement the electrical wiring of a versatile hybrid 2-wheeler EV, combining electric and auxiliary power sources to optimize energy requirements.

Specifications:

- Vehicle Weight: 130 kg
- Motor Power: 3 kW (electric) + 2 kW (auxiliary) Battery Capacity: 3.5 kWh
- Range: 100 km (combined) Top Speed: 60 km/h
- Hybrid System: Electric and auxiliary power source
- Charging Time: 3 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using

MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 16: Luxury Comfort EV

To design and implement the electrical wiring of a luxury comfort 2-wheeler EV, focusing on power and energy requirements for enhanced comfort and advanced features.

Specifications:

- Vehicle Weight: 140 kg
- Motor Power: 4 kW
- Battery Capacity: 5 kWh
- Range: 80 km
- Top Speed: 70 km/h
- Features: Advanced comfort features like heated seats, Bluetooth, etc.
- Charging Time: 4 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage

(inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 17: Youth-Friendly EV

To design and implement the electrical wiring of a youth-friendly 2-wheeler EV, estimating power and energy requirements for safe, easy handling, and appeal to younger riders.

Specifications:

- Vehicle Weight: 90 kg
- Motor Power: 1.5 kW
- Battery Capacity: 1.5 kWh
- Range: 50 km
- Top Speed: 45 km/h
- Safety Features: Enhanced safety for younger riders
- Charging Time: 2 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed

characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage

ii) Number of batteries in series and parallel l

iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following: Battery Pack Voltage and Configuration

i) Current measurement
ii) Temperature Management
iii) Cell balancing
iv) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 18: High-Torque Hill Climber EV

To design and implement the electrical wiring of a high-torque hill climber 2-wheeler EV, focusing on power and energy requirements for steep inclines and hilly terrain.

Specifications:

- Vehicle Weight: 130 kg
- Motor Power: 5 kW
- Battery Capacity: 4 kWh
- Range: 60 km
- Top Speed: 55 km/h
- Torque: High torque for steep inclines
- Charging Time: 3.5 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration

ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 19: Water-Resistant All-Weather EV

To design and implement the electrical wiring of a water-resistant all-weather 2-wheeler EV, estimating power and energy requirements to perform reliably in various weather conditions.

Specifications:

- Vehicle Weight: 140 kg
- Motor Power: 3.5 kW
- Battery Capacity: 4 kWh
- Range: 70 km
- Top Speed: 60 km/h
- Water Resistance: IP67 r

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship
iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel l
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and

examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration Current measurement
ii) Temperature Management
iii) Cell balancing
iv) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation

INDUSTRY USE CASE 20: Customizable Modular EV

To design and implement the electrical wiring of a customizable modular 2-wheeler EV, focusing on power and energy requirements for various interchangeable components and configurations.

Specifications:

- Vehicle Weight: 120 kg
- Motor Power: 3 kW
- Battery Capacity: 3 kWh
- Range: 60 km
- Top Speed: 55 km/h
- Modularity: Interchangeable components
- Charging Time: 3 hours

Task 1:

Perform the calculations for design of EV motor with specifications given and compute the following for motor

i) Energy consumption
ii) Power Requirements
iii) Speed and Energy Consumption relationship

iv) Average Power and Speed for desired range

Build a suitable MATLAB/Simulink block diagram and examine the torque – speed characteristics. Validate the simulation results with the available hardware model of BLDC motor.

Task -2:

Perform the calculations for battery pack sizing with given vehicle / load specifications and compute the following

i) Battery Pack Voltage
ii) Number of batteries in series and parallel
iii) Current requirements

Build a suitable MATLAB/Simulink block diagram for the battery pack design and examine characteristics. Validate the simulation results with the available hardware model of battery pack.

Task - 3:

Develop the MATLAB/Simulink model for a suitable motor controller and power stage (inverter) in the proposed EV system model to achieve smooth torque and speed control. Design the controller parameters by applying suitable control strategy.

Hint: Use Park and Clarke transformation

Task - 4:

For the given BMS hardware kit, determine the following:

i) Battery Pack Voltage and Configuration
ii) Current measurement
iii) Temperature Management
iv) Cell balancing
v) State of Charge and State of Health Monitoring

Task - 5:

From the given EV kit Outline the integration plan for assembling the powertrain module for an electric bicycle / scooter model intended for daily commuting. Validate the performance of integrated model with calculated design parameters using MATLAB Simulink. Compare the hardware results with MATLAB simulation