



Decibels Lab Private Limited
#2362, 24th main road
1st sector, HSR layout
Bangalore, Karnataka, 560102

CIN: U80904KA2019PTC126675
+91 7411019255
contact@decibelslab.com

Course name	Battery Electric Vehicle Technology & BEV Powertrain Modeling
Course duration	3 months
Course delivery mode	Online + 1 week offline classes
Software tool used	Scilab & Xcos (Model based design)
Course approach	Project based (70% practical with software based & 30% theory)
Created Authors	<ol style="list-style-type: none">1. Suraj S D, 8 years of industry experience with Mercedes & FCA USA, CEO at Decibels Lab2. Krishna H, Senior Simulations Engineer, Decibels3. Bharath P, Senior Simulations Engineer, Decibels

Decibels Certification courses are created by mapping the industry demanding skills, tools & domains, learning during the courses will give an opportunity to find the practical application of subjects in the curriculum and will help to gain, hands-on experience by building the projects.

During the certification course students will get the access to Decibels software platform (LMS), Live classes from experienced professionals, recordings of the live classes if they miss the session, additional content for learning, projects & assessments. Individual students should have the computer, internet connectivity and installed software to take part in learning & build projects. Students will be assessed every week on their progress with tests & assessments. Student who complies to complete all the learning, projects & assessments will be awarded with certificate.

Benefits of taking the certification program are

1. Participants will be able to build the real world projects and applications
2. Practical content & projects are created by experts with years of experience in industry
3. Model Based Design will be taught using Scilab Xcos
4. Students will get mentorship & doubt clarification sessions
5. Gamification approach in learning & challenges will help students to think creatively & build analytical ability

Assessments, intelligent analytics, tracking systems built by Decibels will ensure the certification for students who have worked put efforts to complete the course.

Course content

Module 1: Electric Vehicle Technology Foundation

Outcomes: This module brings the deeper insights to understand the electric vehicle technologies and gain appreciable command over the systems. By the end of course, participants will have will have the theoretical understanding of the system, visualization of real vehicle components, numerical calculations, analytical understanding of system sizing and build the motivation to learn further.

Well to Wheel energy & emission analysis
E&E hand calculations for
Case 1 Ather 450 & Active Honda
Case 2 Tata Nexon Petrol & Tata Nexon EV

Subsystems of EV in detail
Traction battery
Battery Management System
Traction motor & controller
EV charger
Safety & control

Auxiliary Component in detail
HVAC systems
Motor cooling
Battery cooling / Heating
Steering & braking system
Lighting & other Auxiliary systems
DC-DC converter

EV Powertrain Architecture
Native & non native EV configurations
Motor arrangements
Battery arrangements
Voltage architecture

Resistive force calculations
Motor sizing calculations
Battery sizing calculations

Module 2: Electric Vehicle Powertrain Modeling

Outcomes: Individual students will learn the Model Based Design Engineering (MBD) with real time projects and further to develop the EV powertrain model of Nissan Leaf, Ather 450 & formula student race car to study the influence of varying parameters on the powertrain design using Scialb & Xcos or Scilab Xcos software. By the end of this module, participant will have full confidence to perform below tasks in his/her job role.

1. Motor peak & continues torque & current demands
2. Motor RPM
3. Motor power rating
4. Motor efficiency & operating points analysis
5. Battery & Cell discharge rating (C-rating)
6. Energy consumption analysis (Wh/km)
7. Range estimation
8. Ns & Np configuration for pack
9. Battery pack sizing (Kw) based on different drivers
10. Influence of motor efficiency on energy consumption
11. Influence of motor regeneration energy on battery sizing
12. Cell selection for racing applications
13. Motor selection for racing applications
14. Optimisation of powertrain

Model Based Design (MBD)

Need for MBD, Application of MBD in various industries & Career opportunities in MBD
 Overview of dynamic systems, system modelling & Component modelling

MBD in Scilab Xcos

Intro to the User Interface of Sci notes (Programming Language), Defining a variable and a matrix. Example (Area of a square, rectangle and circle) based learning Scilab programming.

Xcos with practical case studies

Introduction to model-based design using Xcos.
 Intro to the UI (User Interface) of Xcos (A graphical editor). Performing Simulation of Summation, Multiplication and Division of numbers. Case study on Aerodynamic Force analysis of a vehicle.

NI_MH Battery Modeling – Minor Project 1

Review on battery (Voltage, Current and Capacity).
 Explanation on State of Charge (% of battery charge) and Battery voltage.
 Utilizing the SCIALB & Xcos software to create NI-MH battery modeling based on the discharge current to estimate SOC and battery voltage.

Thermal modeling of a house – Minor Project 2
<p>Explanation of the physics behind working of thermal modeling of a house. Derivation of equation for modeling heater (mass flowrate, specific heat capacity and Heater temperatures) and the house (Thermal resistance of house). Discussion on house temperature controller (ON or OFF controller)</p>
Analysis of Aerodynamic force on car – Minor Project 3
<p>Analysis on aerodynamic force acting on a vehicle at a constant vehicle velocity, acceleration of the vehicle and based on how the vehicle is driven on the road (Drive Cycle). Analysis on the NI-MH battery discharge current, SOC and battery voltage results obtained. Analysis on thermal model of a house temperature variation based on the control logic, thermal resistance of the house and environmental temperature.</p>
Need for simulation
Understanding the system complexity, dynamic behavior, parameters influencing the powertrain sizing & setting project goals
Drive Cycle and their importance
Understanding the drive cycle, comparison of drive cycles, example cases such as NEDC, FTP-75, WLTP Drive Cycle, how to create a drive cycle & activity to plot the drive cycles
Modeling the vehicle Resistive Force
Modeling the Rolling Resistance, Gradient Resistance, Aerodynamic Force, Acceleration Force & Inertia forces. Studying the influence of each forces on vehicle performance
Modeling the single speed transmission
Understanding the need of transmission in EV, Pros & Cons of transmission, Hand calculations for gear ratio selection, wheel torque & wheel speed & transmission efficiency influences
Modeling the Electric Traction Motor
Approach to model the motor, calculations for Motor Torque & RPM, Nominal & Peak torque estimations, Motor power estimations, studying the influence of motor efficiency & motor controller efficiency, estimation of motor regenerative power, analysis of motor operating points & understanding the motor selection
Modeling the Traction Battery

Performing hand calculations for pack parameter estimations, understanding the cell data sheet & modeling the pack for evaluation of Battery Power, Battery Current (Peak & Nominal), Cell operational C-rate, Regenerative Power & Current estimation at battery, Charge C Rate during Regen, Energy consumed per Km, Total energy consumption for drive cycle or required range, SoC estimations, NS & NP cell configurations

Results and Discussion

Advance topics

- Implementation of motor controller efficiency to study the accurate energy consumption
- Modeling of regenerative energy from motor during breaking

Individual student projects

- Modeling & Simulation of Ather 450 electric scooter
- Modeling & Simulation of electric formula student race car
- Studying the influence of various drive cycles on energy consumption of EV powertrain

Module 3: Practical & hands-on session on Electric vehicles & subsystems

Outcomes: This module brings the opportunity to get hands on experience with real time hardware components on EV such as BMS, Battery, Motor, controller, Electric vehicle, 2W chargers, DC-DC converter, software & hardware overview.

Day 1	Session 1 (10 AM to 1 PM)	Session 2 (2 PM to 5 PM)
	Electric Vehicle Subsystems & component sizing	Cell Technology for EV Applications
	Electric 2W tear down, Visualize the components in EV such as Cell, Battery, BMS, Motor, Motor Controller, DC-DC converter, Contactors, Charger, Throttle, Wiring & more	Cell formats, Li-ion Cell chemistries, Cell Properties, Perform a cell cut section, Visualize the cell construction (Anode, Cathode, Active materials, Separator, Electrolyte)
	Perform calculations for motor & battery sizing	Read a cell data sheet & Evaluation for different cell chemistries for EV application
	Assignment: Case studies for battery & motor sizing	Assignment: Make report on cell dissection and identify the alternative materials for Li-ion cell technology
Day 2	Session 1 (10 AM to 1 PM)	Session 2 (2 PM to 5 PM)
	Cell testing & Characterisation	EV Battery Pack
	Overview of cell testing & characterisation, Understand the usage & application of cell testing equipments, Different	Perform hand calculations & Advanced Excel based calculation for cell selection for battery

	functionalities & Modes of cell analyser, Perform different test cases on given cells like, Charging and discharging cells with different C rates, Obtain CC-CV curve, Obtain Discharge characteristic curve (Li ion technology), Software interface with instrument, Data logging,	pack design (Based on cell Voltage, Power, Energy, Mass, Volume, Energy densities etc). Build a battery pack for various voltage configurations.
	Estimation of Cell energy, Charge/Discharge efficiency	Understand comparison matrices of different constructional feature, Procedure, Materials requirement
	Assignment: Make overview report on cell testing equipment & its functionalities, perform charging/ discharging of different cells for given conditions, analyse the logged data & estimate the possible cell parameters	Assignment: Make report on hand calculation/ simulation for given cells data & construct battery for 13s-1p, 13-2p / 48 V & 72 V
Day 3	Session 1 (10 AM to 1 PM)	Session 2 (2 PM to 5 PM)
	Traction Motor, Motor controller & Throttle	Battery Management System hardware & software
	BLDC Hub & Non Hub motor tear down, Visualize the components & arrangement of Stator, Rotor, Winding & Hall sensors. Motor controller tear down, visualize the components such as driver circuit, 48V/5V I/O's, controller IC's & peripheral circuits. Motor controller interfacing with ignition key, battery, motor, hall sensor, throttle, brake, instrument cluster.	Types of BMS & their functionality, BMS architecture, BMS tear down, Visualize the BMS hardware components, Practical implementation of BMS on Battery pack, BMS data communication, BMS interfacing with battery pack, charger & PC.
	Overview of configurable motor controller such as Kelly KBX, it's software features, advanced features such as throttle response, regen, diagnostics, Under/over voltage setting, Max current limit, Max and Min speed setting & more. Approach to select right motor controller for vehicle needs	Configurable BMS software features and functionalities demonstration Cell voltage & pack current, Cell balancing, cell & pack protection. Approach to select right BMS for vehicle needs.
	Assignment: Perform programming as per instruction & Demonstration as per given parametric settings	Assignment: Install/integrate BMS on battery pack, Interface BMS software, Program as per given conditions & Make report on it
Day 4	Session 1 (10 AM to 1 PM)	Session 2 (2 PM to 5 PM)
	EV charger, DC-DC converter & other peripherals	Electric 2W assembly
	DC-DC converter tear down & Visualize its components. Charger tear down, Visualize its components. Contactors, Precharge circuits, VCU/BCM, Telematics,	Understand procedure, Safety precautions, Placing & Positioning of EV components
Day 5	Session 1 (10 AM to 1 PM)	Session 2 (2 PM to 5 PM)
	Project reviews	Certification
	Assignment evaluation	

All the needful communication can be shared to suraj@decibelslab.com & 7411019255.