# Training - Modeling as an Aid to Battery Design

EBATMOD-EN-P

Face-to-face only

**5 days**
Asynchronous part to be completed before the face-to-face part

This training aims to improve learners' skills in modeling as a tool for designing cells and battery packs in the design phase

## Level

Skilled

## Public

Engineers and technicians who wish to design, develop, model, simulate or use storage systems integrated into electric and hybrid electric vehicles, considering the technical, economic and industrial constraints of the transport sector

## Objectives

Attendees will be able to implement the following skills:

- Understand fundamental electrochemical laws,
- Understand Newman-type modeling methodologies,
- Understand and explain the design of a Li-ion cell based on a Newman-type model,
- Understand and explain the use of modeling in battery pack design,
- Be able to use the AMESIM tool.

## Pedagogical & technical resources

Teaching activities and tutorials.

## Assessment of achievements

- Trainees are assessed throughout the training through practical application phases and interactions with the trainer
- A final on-the-spot evaluation may also be carried out at the end of the course and/or at the end of each module using tests designed to verify the learners' understanding and assimilation of the knowledge linked to the training objectives

## Prerequisites

No prerequisites are necessary to follow this course.

## Responsable

IFP Training instructors, with expertise in the field and trained in modern teaching methods adapted to the specific needs of learners from the professional world

# Program

### ASYNCHRONOUS PROGRAM TO BE COMPLETED BEFORE THE SYNCHRONOUS/ FACE-TO-FACE COURSE

## VIDEOS

Video 1 - Atoms Li-ions.
Video 2 - How batteries work.
Video 3 - Introduction to Lithium.
Video 4 - Composition of Li-ion batteries.
Video 5 - How Li-ion batteries work.

## SYNCHRONOUS/FACE-TO-FACE PROGRAM

### ELECTROCHEMICAL MODELING AS AN AID TO LI-ION CELL DESIGN (LECTURES/PRACTICALS) — 3 days

Introduction:

- Main half-reactions, equilibrium potentials, and electrolyte stability window.
- Solid-state insertion and phase transition mechanisms.
- Volumetric electrodes and their characteristic parameters.
- Internal cell balancing and the unique characteristics of each technology.
- Introduction to the kinetic thermodynamics of batteries.
- Kinetic stages: double electric layer, ohmic drop, and crystallization overvoltage.
- Kinetic stage: charge transfer overvoltage.
- Kinetic stages: diffusion overvoltage.
- Battery cell in operation.
- Factors affecting battery performance.
- Battery design and voltage.

Electrochemical techniques:

- Galvanostatic cycling and measurement of capacity, coulombic efficiency, and energy efficiency.
- Constant current/constant voltage (CCCV) charging.
- Influence of current on galvanostatic charging and discharging.
- Measurement of pulse resistance and maximum power.
- Ragone diagrams.
- Peukert diagrams.
- Impedance spectroscopy.
- Measurements on half cells.
- Intermittent galvanostatic and potentiostatic measurements, incremental capacity curves.
- Battery durability and aging.
- Main aging phenomena.
- Effects of aging phenomena on cell performance (loss of capacity, power, reversible and irreversible self-discharge).
- Cell aging tests.
- Analysis of aging data using performance models (behavioral, electrochemical, etc.). Contribution of postmortem analyses.
- Aging models (empirical, physical, etc.).

Electrochemical modeling:

- Elements of thermodynamics, electrochemical kinetics, and mass transport.

- Presentation of the electrode/separator/electrode+ (Li-ion) stack model.
- Model input parameters.
- Applications: identifying limiting phenomena, cell design assistance, measurement of physical and geometric parameters.
- Other types of battery models: electrical analogy, simplified models, 3D cell model, resolved 3D microstructural models.

Tutorials:

- Tutorial analysis of a Li-ion cell design (jelly roll thickness, percolating carbon grain size, porosity of active materials, etc.) based on a Newman model.

Electrochemical modeling:

- Elements of thermodynamics, electrochemical kinetics, and mass transport.
- Presentation of the electrode/separator/electrode+ (Li-ion) stack model.
- Model input parameters.
- Applications: identifying limiting phenomena, cell design assistance, measurement of physical and geometric parameters.
- Other types of battery models: electrical analogy, simplified models, 3D cell model, resolved 3D microstructural models.

### AMESIM MODELING AS AN AID TO PACK SYSTEM DESIGN (LECTURES + WORKSHOPS) — 1,75 days

Presentation of Amesim - Tutorials on examples of battery applications for electric traction:

- Introduction to Simcenter Amesim and battery modeling - Practical.
- Identification of battery requirements - Practical.
- Creation of a cell and pack model that meets these requirements.
- Creation of a battery thermal management model.
- Impact of battery module design during thermal runaway.
- Calibration of the aging model and exploitation.

### REVIEW — 0.25 day

Verification of acquired knowledge.

## Sessions

**Rueil-Malmaison -** From 03/09/2026 to 03/13/2026 — **3040 €/HT**

To French entities : IFP Training is referenced to DataDock ; you may contact your OPCO about potential funding.
Please contact our disabled persons referent to check the accessibility of this training program : referent.handicap@ifptraining.com