



# Model Curriculum

**QP Name: Automotive Battery Management System (BMS) Design Engineer**

**QP Code: ASC/Q8315**

**QP Version: 1.0**

**NSQF Level: 5.5**

**Model Curriculum Version: 1.0**

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## Training Parameters

<b>Sector</b>	Automotive
<b>Sub-Sector</b>	Research & Development
<b>Occupation</b>	Automotive Product Development
<b>Country</b>	India
<b>NSQF Level</b>	5.5
<b>Aligned to NCO/ISCO/ISIC Code</b>	NCO-2015/8212.0100, 2015/8212.0200
<b>Minimum Educational Qualification and Experience</b>	3 years Diploma (Mechanical/Automobile/ Electrical / Electronics) after class 10th from recognized regulatory body with 3 years of relevant experience OR Pursuing 4th year of B.E./B.Tech in the relevant field and continuous education OR Certificate-NSQF (Electric Vehicle Product Design Engineer/ Automotive Prototype Manufacturing Lead Technician Level 5) with 2 Years of relevant experience
<b>Pre-Requisite License or Training</b>	NA
<b>Minimum Job Entry Age</b>	22 years
<b>Last Reviewed On</b>	28/02/2023
<b>Next Review Date</b>	28/02/2026
<b>NSQC Approval Date</b>	28/02/2023
<b>QP Version</b>	1.0
<b>Model Curriculum Creation Date</b>	28/02/2023
<b>Model Curriculum Valid Up to Date</b>	28/02/2026
<b>Model Curriculum Version</b>	1.0
<b>Minimum Duration of the Course</b>	630 Hours
<b>Maximum Duration of the Course</b>	630 Hours

## Program Overview

This section summarizes the end objectives of the program along with its duration.

### Training Outcomes

At the end of the program, the learner should have acquired the listed knowledge and skills.

- Assessing targeted Electric Vehicle Architecture design, Targeted Applications & Market requirements
- Assessing vehicle battery system, cell design & its Thermal Management System design
- Review market trends for the similar applications and best practices
- Define different BMS Strategies based on vehicle applications
- Prepare hardware, software & Control system components required for BMS
- Conduct simulation modelling for verifying design options & do necessary improvements to meet specifications
- Plan for DVP requirements & support for completing validations with the testing team
- Publish technical verification / validations results, architectures options with budget requirements & propose most suitable option for decision
- Implement safety practices.
- Use resources optimally to ensure less wastage and maximum conservation.

### Compulsory Modules

The table lists the modules and their duration corresponding to the Compulsory NOS of the QP.

NOS and Module Details	Theory Duration	Practical Duration	On-the-Job Training Duration (Mandatory)	On-the-Job Training Duration (Recommended)	Total Duration
<b>Bridge Module</b>					
Module 1: Introduction to the role of an Automotive Battery Management System (BMS) Design Engineer	5:00	0:00			5:00
<b>ASC/N9818: Manage work and resources (Research &amp; Development)</b> <b>NOS Version No. – 1.0</b> <b>NSQF Level – 5</b>	<b>15:00</b>	<b>40:00</b>			<b>55:00</b>
Module 2: Manage work and resources according to safety and conservation standards	15:00	40:00			55:00
<b>DGT/VSQ/N0103- Employability Skills (90 hours)</b> <b>NOS Version No. – 1.0</b> <b>NSQF Level – 6</b>	<b>36:00</b>	<b>54:00</b>			<b>90:00</b>
Module 3: Introduction to Employability Skills	1:00	2:00			3:00
Module 4: Constitutional values - Citizenship	0.5:00	1:00			1.5:00
Module 5: Becoming a	2:00	3:00			5:00

Professional in the 21st Century					
Module 6: Basic English Skills	4:00	6:00			10:00
Module 7: Career Development & Goal Setting	1.5:00	2.5:00			4:00
Module 8: Communication Skills	4:00	6:00			10:00
Module 9: Diversity & Inclusion	1:00	1.5:00			2.5:00
Module 10: Financial and Legal Literacy	4:00	6:00			10:00
Module 11: Essential Digital Skills	8:00	12:00			20:00
Module 12: Entrepreneurship	3:00	4:00			7:00
Module 13: Customer Service	4:00	5:00			9:00
Module 14: Getting ready for apprenticeship & Jobs	3:00	5:00			8:00
<b>ASC/N8335 – Review the targeted design architecture of EV NOS Version No. –1.0 NSQF Level – 5.5</b>	<b>30:00</b>	<b>30:00</b>	<b>30:00</b>		<b>90:00</b>
Module 15: Assess the BMS requirements	15:00	15:00	15:00		45:00
Module 16: Assessing battery system, cell design & its Thermal Management System design	15:00	15:00	15:00		45:00
<b>ASC/N8336 – Develop prominent options of BMS architecture, infrastructure and solutions NOS Version No. –1.0 NSQF Level – 5.5</b>	<b>35:00</b>	<b>25:00</b>	<b>30:00</b>		<b>90:00</b>
Module 17: Prepare hardware, software & Control system components required for BMS	35:00	25:00	30:00		90:00
<b>ASC/N8337– Conduct simulation for verification &amp; validate of various architectures NOS Version No. –1.0 NSQF Level – 5.5</b>	<b>45:00</b>	<b>54:00</b>	<b>51:00</b>		<b>150:00</b>
Module 18: Verify design options and plan for Design validation and planning (DVP) requirements	40:00	44:00	41:00		125:00
Module 19: Publish technical verification / validations results and architectures options	5:00	10:00	10:00		25:00
<b>ASC/N8338 – Support manager to execute implementation of BMS system</b>	<b>45:00</b>	<b>60:00</b>	<b>45:00</b>		<b>150:00</b>

<b>NOS Version No. –1.0</b> <b>NSQF Level – 5.5</b>					
Module 20: Prepare for implementation of BMS	15:00	30:00	15:00		60:00
Module 21: Support manager & project teams to execute implementation of BMS	30:00	30:00	30:00		90:00
<b>Total Duration</b>	<b>216:00</b>	<b>258:00</b>	<b>156:00</b>		<b>630:00</b>

# Module Details

## Module 1: Introduction to the role of an Automotive Battery Management System (BMS) Design Engineer

### *Bridge module*

#### Terminal Outcomes:

- Discuss the role and responsibilities of an Automotive Battery Management System (BMS) Engineer.

<b>Duration:</b> <05:00>	<b>Duration:</b> <00:00>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• List the role and responsibilities of an Automotive Electronic Battery Management Engineer.</li> <li>• Discuss the job opportunities for an Automotive Electronic Battery Management Engineer in the automobile industry.</li> <li>• Explain about Indian automobile manufacturing market.</li> <li>• List various automobile Original Equipment Manufacturers (OEMs) and different products/ models manufactured by them.</li> <li>• Discuss electronics battery management standards and procedures followed in the company.</li> </ul>	
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 2: Manage work and resources according to safety and conservation standards

### Mapped to ASC/N9818, v1.0

#### Terminal Outcomes:

- Employ appropriate ways to maintain safe and secure working environment
- Apply material and energy conservation practices at the workplace.

Duration: <15:00>	Duration: <40:00>
Theory – Key Learning Outcomes	Practical – Key Learning Outcomes
<ul style="list-style-type: none"> <li>• Discuss organisational procedures for health, safety and security and individual role and responsibilities related to the same.</li> <li>• List the potential workplace related risks, threats and hazards, their causes and preventions.</li> <li>• List personal protective equipment like safety gloves, glasses, shoes and mask used at the workplace.</li> <li>• List various types of fire extinguisher.</li> <li>• Identify various safety boards/ signs placed on the shop floor.</li> <li>• Explain 5S standards, procedures and policies followed at workplace.</li> <li>• Discuss organisational procedures to deal with emergencies and accidents at the workplace and importance of following them.</li> <li>• State the importance of conducting safety drills or training sessions.</li> <li>• Explain the process of filling daily check sheet for reporting to the concerned authorities about improvements done and risks identified.</li> <li>• Discuss how and when to report about potential hazards identified in the workplace and limits of responsibility for dealing with them.</li> <li>• Outline the importance of keeping workplace, equipment, restrooms etc. clean and sanitised.</li> <li>• Explain the importance of following hygiene and sanitation regulations developed by organisation at the workplace.</li> <li>• Discuss the importance of maintaining the availability of running water, hand wash and alcohol-based sanitizers at the</li> </ul>	<ul style="list-style-type: none"> <li>• Apply appropriate ways to implement safety practices to ensure safety of people at the workplace.</li> <li>• Display the correct way of wearing and disposing PPE.</li> <li>• Demonstrate the use of fire extinguisher.</li> <li>• Demonstrate how to provide first aid procedure in case of emergencies.</li> <li>• Demonstrate how to evacuate the workplace in case of an emergency.</li> <li>• Employ various techniques for checking malfunctions in the machines with the support of maintenance team and as per Standard Operating Procedures (SOP).</li> <li>• Demonstrate to arrange tools/ equipment/ fasteners/ spare parts into proper trays, cabinets, lockers as mentioned in the 5S guidelines/work instructions.</li> <li>• Apply appropriate ways to organise safety drills or training sessions for others on the identified risks and safety practices.</li> <li>• Prepare a report about the health, safety and security breaches.</li> <li>• Apply appropriate ways to check that workplace, equipment, restrooms etc. are cleaned and sanitised.</li> <li>• Role play a situation to brief the team about the hygiene and sanitation regulations developed by organisation.</li> <li>• Demonstrate the correct way of washing hands using soap and water and alcohol-based hand rubs.</li> <li>• Apply appropriate methods to support the employees to cope with stress, anxiety etc.</li> <li>• Demonstrate proper waste collection and disposal mechanism depending upon types of waste.</li> </ul>



<p>workplace.</p> <ul style="list-style-type: none"> <li>• Discuss the significance of conforming to basic hygiene practices such as washing hands, using alcohol based hand sanitizers or soap.</li> <li>• Recall ways of reporting advanced hygiene and sanitation issues to the concerned authorities.</li> <li>• Elucidate various stress and anxiety management techniques.</li> <li>• Discuss the significance of greening.</li> <li>• Classify different categories of waste for the purpose of segregation.</li> <li>• Differentiate between recyclable and non-recyclable waste.</li> <li>• Discuss various methods of waste collection and disposal.</li> <li>• List the various materials used at the workplace.</li> <li>• Explain organisational recommended norms for storage of tools, equipment and material.</li> <li>• Discuss the importance of efficient utilisation of material and water.</li> <li>• Explain basics of electricity and prevalent energy efficient devices.</li> <li>• Explain the processes to optimize usage of material and energy/electricity.</li> <li>• Enlist common practices for conserving electricity at workplace.</li> </ul>	<ul style="list-style-type: none"> <li>• Perform the steps involved in storage of tools, equipment and material after completion of work.</li> <li>• Employ appropriate ways to resolve malfunctioning (fumes/ sparks/ emission/ vibration/ noise) and lapse in maintenance of equipment as per requirements.</li> <li>• Perform the steps to prepare a sample material and energy audit reports.</li> <li>• Employ practices for efficient utilization of material and energy/electricity.</li> </ul>
<p><b>Classroom Aids:</b></p>	
<p>Whiteboard, marker pen, projector</p>	
<p><b>Tools, Equipment and Other Requirements</b></p>	
<ul style="list-style-type: none"> <li>• Housekeeping material: Cleaning agents, cleaning cloth, waste container, dust pan and brush set, liquid soap, hand towel, fire extinguisher</li> <li>• Safety gears: Safety shoes, ear plug, goggles, gloves, helmet, first-aid kit</li> </ul>	

## Module 3: Introduction to Employability Skills

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Discuss about Employability Skills in meeting the job requirements

<b>Duration:</b> <1:00>	<b>Duration:</b> <2:00>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Outline the importance of Employability Skills for the current job market and future of work</li> </ul>	<ul style="list-style-type: none"> <li>• List different learning and employability related GOI and private portals and their usage</li> <li>• Research and prepare a note on different industries, trends, required skills and the available opportunities</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 4: Constitutional values - Citizenship

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Discuss about constitutional values to be followed to become a responsible citizen

<b>Duration:</b> <0.5:00>	<b>Duration:</b> <1:00>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Explain constitutional values, civic rights, duties, citizenship, responsibility towards society etc. that are required to be followed to become a responsible citizen.</li> </ul>	<ul style="list-style-type: none"> <li>• Practice different environmentally sustainable practices</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 5: Becoming a Professional in the 21st Century

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Demonstrate professional skills required in 21<sup>st</sup> century

<b>Duration: &lt;2:00&gt;</b>	<b>Duration: &lt;3:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Discuss 21st century skills required for employment</li> </ul>	<ul style="list-style-type: none"> <li>• Highlight the importance of practicing 21st century skills like Self-Awareness, Behavior Skills, time management, critical and adaptive thinking, problem-solving, creative thinking, social and cultural awareness, emotional awareness, learning to learn etc. in personal or professional life</li> <li>• Create a pathway for adopting a continuous learning mindset for personal and professional development</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 6: Basic English Skills

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Practice basic English speaking.

<b>Duration: &lt;4:00&gt;</b>	<b>Duration: &lt;6:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Describe basic communication skills</li> <li>• Discuss ways to read and interpret text written in basic English</li> </ul>	<ul style="list-style-type: none"> <li>• Show how to use basic English sentences for everyday conversation in different contexts, in person and over the telephone</li> <li>• Read and understand text written in basic English</li> <li>• Write a short note/paragraph / letter/e - mail using correct basic English</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 7: Career Development & Goal Setting

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Demonstrate Career Development & Goal Setting skills.

<b>Duration:</b> <1.5:00>	<b>Duration:</b> <2.5:00>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Identify well-defined short- and long-term goals</li> </ul>	<ul style="list-style-type: none"> <li>• Create a career development plan</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 8: Communication Skills

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Practice basic communication skills.

<b>Duration: &lt;4:00&gt;</b>	<b>Duration: &lt;6:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Explain the importance of communication etiquette including active listening for effective communication</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate how to communicate effectively using verbal and nonverbal communication etiquette</li> <li>• Write a brief note/paragraph on a familiar topic</li> <li>• Role play a situation on how to work collaboratively with others in a team</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 9: Diversity & Inclusion

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Describe PwD and gender sensitisation.

<b>Duration:</b> <1:00>	<b>Duration:</b> <1.5:00>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Discuss the significance of reporting sexual harassment issues in time</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate how to behave, communicate, and conduct oneself appropriately with all genders and PwD</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	



## Module 10: Financial and Legal Literacy

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Describe ways of managing expenses, income, and savings.

<b>Duration: &lt;4:00&gt;</b>	<b>Duration: &lt;6:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Discuss various financial institutions, products, and services</li> <li>• Explain the common components of salary such as Basic, PF, Allowances (HRA, TA, DA, etc.), tax deductions</li> <li>• Discuss the legal rights, laws, and aids</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate how to conduct offline and online financial transactions, safely and securely and check passbook/statement</li> <li>• Calculate income and expenditure for budgeting</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 11: Essential Digital Skills

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Demonstrate procedure of operating digital devices and associated applications safely.

<b>Duration: &lt;8:00&gt;</b>	<b>Duration: &lt;12:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Describe the role of digital technology in day-to-day life and the workplace</li> <li>• Discuss the significance of displaying responsible online behavior while using various social media platforms</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate how to operate digital devices and use the associated applications and features, safely and securely</li> <li>• Demonstrate how to connect devices securely to internet using different means</li> <li>• Follow the dos and don'ts of cyber security to protect against cyber crimes</li> <li>• Create an e-mail id and follow e- mail etiquette to exchange e -mails</li> <li>• Show how to create documents, spreadsheets and presentations using appropriate applications</li> <li>• Utilize virtual collaboration tools to work effectively</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 12: Entrepreneurship

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Describe opportunities as an entrepreneur.

<b>Duration: &lt;3:00&gt;</b>	<b>Duration: &lt;4:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Explain the types of entrepreneurship and enterprises</li> <li>• Discuss how to identify opportunities for potential business, sources of funding and associated financial and legal risks with its mitigation plan</li> <li>• Describe the 4Ps of Marketing-Product, Price, Place and Promotion and apply them as per requirement</li> </ul>	<ul style="list-style-type: none"> <li>• Create a sample business plan, for the selected business opportunity</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 13: Customer Service

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Describe ways of maintaining customer.

<b>Duration:</b> <4:00>	<b>Duration:</b> <5:00>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Classify different types of customers</li> <li>• Discuss various tools used to collect customer feedback</li> <li>• Discuss the significance of maintaining hygiene and dressing appropriately</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate how to identify customer needs and respond to them in a professional manner</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 14: Getting ready for apprenticeship & Jobs

### Mapped to DGT/VSQ/N0103

#### Terminal Outcomes:

- Describe ways of preparing for apprenticeship & jobs appropriately.

<b>Duration: &lt;3:00&gt;</b>	<b>Duration: &lt;5:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>Discuss the significance of maintaining hygiene and dressing appropriately for an interview</li> <li>List the steps for searching and registering for apprenticeship opportunities</li> </ul>	<ul style="list-style-type: none"> <li>Draft a professional Curriculum Vitae (CV)</li> <li>Use various offline and online job search sources to find and apply for jobs</li> <li>Role play a mock interview</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	

## Module 15: Assess the BMS requirements

### Mapped to ASC/N8335, v1.0

#### Terminal Outcomes:

- Perform steps to assess the BMS requirements

<b>Duration: &lt;15:00&gt;</b>	<b>Duration: &lt;15:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Describe 2W/3W/4W EV, its design architecture, components, and operational parameters.</li> <li>• List market trends of latest technologies, types of EVs, types of EV Batteries.</li> <li>• Illustrate E/E drawings &amp; vehicle layout architectures.</li> <li>• Discuss the information obtained from benchmarking data of previous project.</li> <li>• Describe BMS System &amp; EV basics, its components &amp; working principals.</li> <li>• List hardware &amp; software for BMS.</li> <li>• Discuss ways to prepare budget of BMS system development.</li> <li>• List best BMS suitable solutions available.</li> </ul>	<ul style="list-style-type: none"> <li>• Apply appropriate ways to evaluate the type of EV that is 2W/3W/4W for information about vehicle design architecture, its components, and operational parameters to be received from the customer/OEM for the BMS infrastructure</li> <li>• Apply appropriate ways to evaluate the targeted applications and market requirements for the current project</li> <li>• Apply appropriate ways to check the types of BSS solution to be deployed to meet the customer requirement</li> <li>• Show how to identify prominent E/E issues &amp; current leakages in the architecture</li> <li>• Show how to identify required hardware &amp; software for BMS with estimated budgeting</li> <li>• Propose the best suitable solutions to manager for the selection</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	
PCs/Laptops, Internet with Wi-Fi (Min2 Mbps Dedicated) BMS system, EV	

## Module 16: Assessing battery system, cell design & thermal management system design

*Mapped to ASC/N8335, v1.0*

### Terminal Outcomes:

- Perform steps to assess the battery system, cell design & thermal management system design of BMS.

<b>Duration: &lt;15:00&gt;</b>	<b>Duration: &lt;15:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Discuss range of standard templates and tools available and how to use them</li> <li>• Illustrate process layouts, drawings &amp; other technical details</li> <li>• Describe energy consumptions &amp; usage</li> <li>• Describe ways of energy controlling &amp; monitoring systems, its types &amp; limitations</li> <li>• Discuss updated internal and external regulations for systems design</li> <li>• Discuss impact of organisational processes &amp; products on the environment and human health safety guidelines</li> </ul>	<ul style="list-style-type: none"> <li>• Show how to prepare the outline for proposed battery swapping system and cell design packaging</li> <li>• Apply appropriate ways to evaluate proposed battery thermal management system design considering applications and vehicle architecture</li> <li>• Apply appropriate ways to evaluate E component packaging space &amp; location to check for temperature &amp; safety</li> <li>• Show how to review several market solutions and latest trends for the similar applications and best practices to carefully choose from available best solutions</li> <li>• Show how to benchmark BMS in the market comparing target vehicle</li> <li>• Show how to review SOC, SOH, Cell Chemistry &amp; cell design, Safety measurements for similar applications</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	
PCs/Laptops, Internet with Wi-Fi (Min2 Mbps Dedicated) BMS system, EV	

## Module 17: Prepare hardware, software & Control system components required for BMS

*Mapped to ASC/N8336, v1.0*

### Terminal Outcomes:

- Prepare hardware, software & Control system components required for BMS

Duration: <35:00>	Duration: <25:00>
Theory – Key Learning Outcomes	Practical – Key Learning Outcomes
<ul style="list-style-type: none"> <li>• Elaborate ways to analyse &amp; initiate concept for BMS, Hardware &amp; Software configurations</li> <li>• Describe government norms for EV, legal requirements, safety requirements per ISO 26262 &amp; compliances for designing BMS.</li> <li>• Describe basics of SOH, SOC, SOP, SOS.</li> <li>• Describe MBD approach &amp; Simulation software like Simulink, MATLAB.</li> <li>• Describe Software architecture of BMS system.</li> <li>• Describe Coulomb Counting Method or Kalman Filter Method for estimating SOC, SOH, SOP, SOS, Fault Detection code &amp; diagnostics, Battery Life Estimation, Charging &amp; Discharging monitoring &amp; Controlling mechanisms.</li> <li>• Illustrate Batter designs, cell design, cell balancing, Types of Microcontrollers, PCB Design</li> <li>• Discuss impact of Thermal &amp; external parameters on performance of BMS systems</li> <li>• Describe thermal management of Battery System &amp; its requirements,</li> <li>• List different types of Sensors, Integrations Policies, CAN Bus, J1939, J1772 Protocol,</li> <li>• Describe communication data protocols referring ISO 15118, OCPP, OCPI and other protocols</li> <li>• Describe different types of Charging Stations, connector types &amp; protocols</li> </ul>	<ul style="list-style-type: none"> <li>• Show how to analyse &amp; initiate concept for BMS, Hardware &amp; Software configurations.</li> <li>• Role play a situation on conducting core team interactions to define boundaries for BMS architectures.</li> <li>• Show how to prepare hardware requirement for BMS system configurations along with ECU &amp; Sensor integration mapping)</li> <li>• Demonstrate process of developing Software architecture using MBD approach.</li> <li>• Demonstrate use of system design software like Simulia, Ansys Medini Analyse, SCADA, etc.</li> <li>• Show how to define control system algorithms using Coulomb Counting Method or Kalman Filter Method for estimating SOC, SOH, SOP, SOS, Fault Detection code &amp; diagnostics, Battery Life Estimation, Charging &amp; Discharging monitoring &amp; Controlling mechanisms.</li> <li>• Show how to prepare estimated budget requirements</li> <li>• Demonstrate organisational procedure of submitting the budget and solution for approval to the management.</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	
PCs/Laptops, Internet with Wi-Fi (Min2 Mbps Dedicated) BMS system, EV	



## Module 18: Verify design options and plan for Design validation and planning (DVP) requirements

*Mapped to ASC/N8337, v1.0*

### Terminal Outcomes:

- Perform steps to conduct simulation modelling for verifying design options & do necessary improvements to meet specifications
- Demonstrate how to plan for DVP requirements & support for completing validations with the testing team

<b>Duration:</b> <40:00>	<b>Duration:</b> <44:00>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• List internal responsible departments and team members.</li> <li>• List leading component suppliers and competition designs.</li> <li>• Describe Coulomb counting or Kalman Filter Algorithms.</li> <li>• List testing requirements &amp; testing procedures, DVP for various components &amp; systems.</li> <li>• Describe design Validation Plan (DVP).</li> <li>• Discuss limitations of various BMS architectures &amp; its possible resolutions.</li> <li>• Describe system fault codes &amp; its Diagnostics, FMEA methodology, Predictive Cell Diagnosis &amp; Remaining Useful life estimations.</li> <li>• Discuss integrated reporting to all stakeholders.</li> </ul>	<ul style="list-style-type: none"> <li>• Demonstrate procedure of conducting design simulations using software like MATLAB or Simulink reflecting vehicle applications, loading conditions, Charging &amp; Discharging Profiles, SOC estimations based on Coulomb counting or Kalman Filter algorithms etc.</li> <li>• Show how to review simulation results for Cell Voltage, Temperature, SOC, SOH, cell balancing.</li> <li>• Demonstrate use of Simulation software like MATLAB or Simulink.</li> <li>• Role play a situation on discussing with superior &amp; perform design improvements for BMS architecture.</li> <li>• Show how to benchmark technical guidelines TGR/TGW for similar BMS.</li> <li>• Role play a situation on getting the design Validation Plan (DVP) considering design requirements, loading conditions, vehicle applications, usage patterns, Governing legal regulations &amp; Safety standards &amp; requirements, ASIC C/D Compliance, EMI/EMC requirements.</li> <li>• Show how to support testing &amp; planning team to complete testing / validations on technical topics.</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	
testing tools, simulation tools, software testing tools, hand tools, measuring tools, measuring instruments, gauges	

## Module 19: Publish technical verification / validations results and architectures options

*Mapped to ASC/N8337 v1.0*

### Terminal Outcomes:

- Perform steps to publish technical verification / validations results and architectures options.

<b>Duration: &lt;5:00&gt;</b>	<b>Duration: &lt;10:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Discuss integrated reporting to all stakeholders.</li> </ul>	<ul style="list-style-type: none"> <li>• Show how to prepare comparison study with verification &amp; testing results outcomes.</li> <li>• Apply appropriate ways to prepare most suitable BMS architecture option recommendation considering design parameters, adaption complexity, cost etc.</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	
testing tools, simulation tools, software testing tools, hand tools, measuring tools, measuring instruments, gauges	

## Module 20: Prepare for implementation of BMS

### Mapped to ASC/N8338, v1.0

#### Terminal Outcomes:

- Perform preparatory steps for BMS implementation.

<b>Duration: &lt;15:00&gt;</b>	<b>Duration: &lt;30:00&gt;</b>
<b>Theory – Key Learning Outcomes</b>	<b>Practical – Key Learning Outcomes</b>
<ul style="list-style-type: none"> <li>• Illustrate electrical connection layout, energy maps, energy costs.</li> <li>• List various materials used in BMS and their environmental impacts.</li> <li>• List battery power cycles and prevalent energy efficient devices.</li> <li>• Describe types of Batteries used in EV, Loading cycles and its impacts on battery life, Safety requirements for selected battery types.</li> <li>• Discuss ways to communicating with internal &amp; external stakeholders.</li> <li>• Illustrate design &amp; drawings for system and various components, Conventions used in E/E drawings, Product design management &amp; release.</li> <li>• List EMI/EMC requirements.</li> <li>• Discuss updated internal and external regulations for system and component designs.</li> </ul>	<ul style="list-style-type: none"> <li>• Show how to prepare detailed design for H/W &amp; Software Interfaces, UI/UX interfaces.</li> <li>• Show how to prepare control system detailed design with defined architecture &amp; strategies.</li> <li>• Demonstrate organisational procedure of releasing detail design, architecture Drawings for development.</li> <li>• Show how to prepare &amp; release specification book for various components &amp; system.</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	
testing tools, simulation tools, software testing tools, hand tools, measuring tools, measuring instruments, gauges	

## Module 21: Support manager & project teams to execute implementation of BMS

### Mapped to ASC/N8338, v1.0

#### Terminal Outcomes:

- Perform steps to support manager & project teams to execute implementation of BMS.

Duration: <30:00>	Duration: <30:00>
Theory – Key Learning Outcomes	Practical – Key Learning Outcomes
<ul style="list-style-type: none"> <li>• List latest technology discussion forums and future technology study.</li> <li>• List field issues, its relationship with BMS system &amp; its resolutions.</li> <li>• Discuss need of team working &amp; communications.</li> <li>• List latest Automotive trends &amp; development strategies.</li> </ul>	<ul style="list-style-type: none"> <li>• Role play a situation in participating in design reviews with the team internally &amp; externally.</li> <li>• Show how to support the core team for necessary technical clarifications &amp; resolutions from R&amp;D network.</li> <li>• Show how to support for vehicle integration &amp; series implementation.</li> <li>• Role play a situation in participating quality meetings &amp; receive BMS performance feedback.</li> <li>• Apply appropriate ways to identify field issues regarding BMS related to various architecture, durability or control system issues.</li> <li>• Apply appropriate ways to propose &amp; provide necessary technical resolution for the issues during deployment.</li> </ul>
<b>Classroom Aids:</b>	
Whiteboard, marker pen, projector	
<b>Tools, Equipment and Other Requirements</b>	
testing tools, simulation tools, software testing tools, hand tools, measuring tools, measuring instruments, gauges	

# Annexure

## Trainer Requirements

Trainer Prerequisites						
Minimum Educational Qualification	Specialization	Relevant Industry Experience		Training Experience		Remarks
		Years	Specialization	Years	Specialization	
B.E/B.Tech	Mechanical/Automobile/ Electrical/ Electronics	4	Mechanical/ Automobile/ Electronics/ Instrumentation	1	Mechanical/ Automobile/ Electronics/ Instrumentation	NA
B.E/B.Tech	Mechanical/Automobile/ Electrical/ Electronics	5	Mechanical/ Automobile/ Electronics/ Instrumentation	0	Mechanical/ Automobile/ Electronics/ Instrumentation	NA
Diploma	Mechanical/Automobile/ Electrical/ Electronics	3	Mechanical/ Automobile/ Electronics	1	Mechanical/ Automobile/ Electronics	NA
Diploma	Mechanical/Automobile/ Electrical/ Electronics	4	Mechanical/ Automobile/ Electronics	0	Mechanical/ Automobile/ Electronics	NA
M.E/M.Tech	Mechanical/Automobile/ Electrical/ Electronics	2	Mechanical/Automobile/ Electrical/ Electronics	1	Mechanical/Automobile/ Electrical/ Electronics	NA
M.E/M.Tech	Mechanical/Automobile/ Electrical/ Electronics	3	Mechanical/Automobile/ Electrical/ Electronics	0	Mechanical/Automobile/ Electrical/ Electronics	NA

Trainer Certification	
Domain Certification	Platform Certification
“Automotive Battery Management System (BMS) Design Engineer, ASC/Q8315, version 1.0”. Minimum accepted score is 80%.	Trainer is certified for the job role “Trainer” (VET and Skills); mapped to QP: “MEP/Q2601, V2.0” with minimum score of 80%.

## Assessor Requirements

Assessor Prerequisites						
Minimum Educational Qualification	Specialization	Relevant Industry Experience		Training Experience		Remarks
		Years	Specialization	Years	Specialization	
B.E/B.Tech	Mechanical/Automobile/ Electrical/ Electronics	5	Mechanical/ Automobile/ Electronics/ Instrumentation	1	Mechanical/ Automobile/ Electronics/ Instrumentation	NA
B.E/B.Tech	Mechanical/Automobile/ Electrical/ Electronics	6	Mechanical/ Automobile/ Electronics/ Instrumentation	0	Mechanical/ Automobile/ Electronics/ Instrumentation	NA
Diploma	Mechanical/Automobile/ Electrical/ Electronics	4	Mechanical/ Automobile/ Electronics	1	Mechanical/ Automobile/ Electronics	NA
Diploma	Mechanical/Automobile/ Electrical/ Electronics	5	Mechanical/ Automobile/ Electronics	0	Mechanical/ Automobile/ Electronics	NA
M.E/M.Tech	Mechanical/Automobile/ Electrical/ Electronics	3	Mechanical/Automobile/ Electrical/ Electronics	1	Mechanical/Automobile/ Electrical/ Electronics	NA
M.E/M.Tech	Mechanical/Automobile/ Electrical/ Electronics	4	Mechanical/Automobile/ Electrical/ Electronics	0	Mechanical/Automobile/ Electrical/ Electronics	NA

Assessor Certification	
Domain Certification	Platform Certification
“Automotive Battery Management System (BMS) Design Engineer, ASC/Q8315, version 1.0”. Minimum accepted score is 80%.	Assessor is certified for the job role “Assessor” (VET and Skills); mapped to QP: “MEP/Q2701, V2.0” with minimum score of 80%.

## Assessment Strategy

1. Assessment System Overview:
  - Batches assigned to the assessment agencies for conducting the assessment on SDMS/SIP or email
  - Assessment agencies send the assessment confirmation to VTP/TC looping SSC
  - Assessment agency deploys the ToA certified Assessor for executing the assessment
  - SSC monitors the assessment process & records
2. Testing Environment:
  - Confirm that the centre is available at the same address as mentioned on SDMS or SIP
  - Check the duration of the training.
  - Check the Assessment Start and End time to be as 10 a.m. and 5 p.m.
  - If the batch size is more than 30, then there should be 2 Assessors.
  - Check that the allotted time to the candidates to complete Theory & Practical Assessment is correct.
  - Check the mode of assessment—Online (TAB/Computer) or Offline (OMR/PP).
  - Confirm the number of TABs on the ground are correct to execute the Assessment smoothly.
  - Check the availability of the Lab Equipment for the particular Job Role.
3. Assessment Quality Assurance levels / Framework:
  - Question papers created by the Subject Matter Experts (SME)
  - Question papers created by the SME verified by the other subject Matter Experts
  - Questions are mapped with NOS and PC
  - Question papers are prepared considering that level 1 to 3 are for the unskilled & semi-skilled individuals, and level 4 and above are for the skilled, supervisor & higher management
  - Assessor must be ToA certified & trainer must be ToT Certified
  - Assessment agency must follow the assessment guidelines to conduct the assessment
4. Types of evidence or evidence-gathering protocol:
  - Time-stamped & geotagged reporting of the assessor from assessment location
  - Centre photographs with signboards and scheme specific branding
  - Biometric or manual attendance sheet (stamped by TP) of the trainees during the training period
  - Time-stamped & geotagged assessment (Theory + Viva + Practical) photographs & videos
5. Method of verification or validation:
  - Surprise visit to the assessment location
  - Random audit of the batch
  - Random audit of any candidate
6. Method for assessment documentation, archiving, and access
  - Hard copies of the documents are stored
  - Soft copies of the documents & photographs of the assessment are uploaded / accessed from Cloud Storage

- Soft copies of the documents & photographs of the assessment are stored in the Hard Drives

## References

## Glossary

Term	Description
<b>Declarative Knowledge</b>	Declarative knowledge refers to facts, concepts and principles that need to be known and/or understood in order to accomplish a task or to solve a problem.
<b>Key Learning Outcome</b>	Key learning outcome is the statement of what a learner needs to know, understand and be able to do in order to achieve the terminal outcomes. A set of key learning outcomes will make up the training outcomes. Training outcome is specified in terms of knowledge, understanding (theory) and skills (practical application).
<b>OJT (M)</b>	On-the-job training (Mandatory); trainees are mandated to complete specified hours of training on site
<b>OJT (R)</b>	On-the-job training (Recommended); trainees are recommended the specified hours of training on site
<b>Procedural Knowledge</b>	Procedural knowledge addresses how to do something, or how to perform a task. It is the ability to work, or produce a tangible work output by applying cognitive, affective or psychomotor skills.
<b>Training Outcome</b>	Training outcome is a statement of what a learner will know, understand and be able to do upon the completion of the training.
<b>Terminal Outcome</b>	Terminal outcome is a statement of what a learner will know, understand and be able to do upon the completion of a module. A set of terminal outcomes help to achieve the training outcome.



## Acronyms and Abbreviations

<b>NOS</b>	National Occupational Standard(s)
<b>NSQF</b>	National Skills Qualifications Framework
<b>QP</b>	Qualifications Pack
<b>TVET</b>	Technical and Vocational Education and Training
<b>SOP</b>	Standard Operating Procedure
<b>WI</b>	Work Instructions
<b>PPE</b>	Personal Protective equipment