UNIT REF: BT3	UNIT TITLE: Familiarisation of battery manufacturing module and pack design

Level: 4	**Credit value:** 2	**Guided Learning:** 12
Unit Mapping:		
Unit Overview:	This unit will enable the learner to become familiar with design methods and considerations when manufacturing Lithium-ion battery modules and packs	
Assessment Method:	1. Multiple-choice examination 2. Assignment	
Assessment Detail:	1. Multiple-choice examination comprising of 30 questions (45 minutes) 2. Assignment – design a module and pack for a specified use (e.g. high performance road vehicle) and explain the reasoning behind the design (Learning Outcome 6)	

LEARNING OUTCOMES The Learner will:	ASSESSMENT CRITERIA The Learner can:	INDICATIVE CONTENT
1. Define what a battery module and pack is	1.1 Describe what a battery module is 1.2 Describe what a battery pack is 1.3 Identify different battery pack layouts for at least one application 1.4 Explain the battery manufacturing process 1.5 Identify the different power and current outputs 1.6 Explain the main considerations when designing a battery	a. A battery module is a combination of components of a battery system that includes at least the following components: i. a battery cell ii. battery management electronics for Battery Cell balancing iii. voltage and temperature measurement iv. connectors b. A battery pack is: i. a series of individual modules and protection systems organised in a shape that will be installed into a unit – e.g. an electric vehicle or static storage c. Applications include: i. Electric vehicle ii. Marine iii. Static storage iv. Air v. Drones

		d. Manufacturing process includes: i. Electrode a. Dosing b. Mixing c. Coating d. Winding e. Calendering f. Slitting ii. Cell assembly a. Slitting b. Winding c. Cell assembly d. Cell filling e. Electrolyte dosing f. Sealing g. Washing and marking iii. FA&T a. Soaking b. Formation c. Aging d. Testing e. Final charge f. Grading g. Sorting h. Discharge iv. Module and pack e. Provide examples of power and current outputs f. Considerations include: i. Purpose ii. Location

2. Understand the main components and organisation of a battery module and pack	2.1 Identify the components of a battery module on an engineering drawing or CAD image 2.2 Identify the components of a battery pack on an engineering drawing or a CAD image 2.3 List all the required components of a battery module 2.4 List all the required components of a battery pack 2.5 Identify from an engineering drawing or CAD image any component incorrectly located in a battery module or pack	a. Battery module and pack components include: i. Cells a. Cylindrical b. Pouch c. Prismatic ii. Busbar and high voltage front end (HVFE) iii. Connectors iv. Cooling v. Thermal management system vi. Battery management system vii. Manual service disconnects
3. Recognise potential issues with battery modules and packs	3.1 List the key battery module and pack systems where issues can arise 3.2 Explain the risks associated with a lack of battery module and pack cooling 3.3 Describe how form and function can impact battery module and pack issues	a. Main systems include: i. Cooling ii. Thermal management iii. Battery management iv. Connectors v. Busbar and high voltage front end (HVFE) b. Risks associated with a lack of cooling include: i. Thermal ii. Performance c. Form and function impacts include: i. Cooling ii. Maintenance iii. Reliability iv. Performance

4. Understand the processes relating to battery module and pack design	4.1 Identify operational requirements of a battery module and pack design 4.2 Identify physical requirements of a battery module and pack design 4.3 List the process steps of designing a battery module or pack	a. Operational requirements include: i. Charge time ii. Range iii. Current/voltage input iv. Current/voltage output v. Working temperatures b. Physical requirements include: i. Size ii. Shape iii. Location iv. Weight c. Process steps include: i. Requirement/specification ii. Choice of cells (electrochemistry) iii. Identity required components: a. Battery management system b. Connectors c. Fuses d. Thermal management e. Cooling iv. Create CAD drawing(s) v. Create BOM and source materials vi. Build prototype vii. Streamline the manufacturing process viii. Bench testing ix. Regulation requirement testing: a. Shaker test b. EMC testing c. Crash testing d. R100 regulations e. Any other required tests

5. Identify the main design points of a battery module and pack	5.1 Explain the main considerations whilst designing battery module 5.2 Explain the main considerations whilst designing battery pack	a. Main considerations of a battery module or pack include: i. Size ii. Weight iii. Power iv. Cooling v. Output
6. Design and evaluate a battery module and pack based on specific requirements	6.1 Design a battery module and pack based on specific requirements 6.2 Assess the final battery module and pack design based on the original requirements 6.3 Produce a detailed report of the design process and final evaluation	a. Specific requirements must: i. Be for an electric vehicle application ii. Fit in a pre-defined space iii. Deliver a pre-defined amount of power iv. Be air cooled v. Not weigh more than a pre-defined weight b. Final assessment includes: i. Operating parameters a. Thermal b. Power c. Cooling ii. Size iii. Weight c. Evaluation report includes: i. Initial specifications ii. Step by step design process iii. Methods of assessment iv. Assessment outcome vs original specification v. Lessons learnt vi. Future improvements vii. Environmental impact

Total Qualification Time Calculations

- Theory GLH:
  - Introduction – 40 minutes
  - Define what a battery module and pack is – 2 hours + 1 hour for activities and group discussions
  - Understand the main components and organisation of a battery module and pack – 2 hours + 1 hour for activities and group discussions
  - Recognise potential issues with battery modules and packs – 2 hours + 1 hour for activities and group discussions
  - Identify the main design points of a battery module and pack – 2 hours + 1 hour for activities and group discussions
- Tutorial and feedback – 1 hour

Total GLH = 13 hours 40 minutes

- Assessment time:
  - 45 minute multiple choice assessment covering learning outcomes 1 to 5
  - 4 hours for design and evaluate assessment activity (Design and evaluate a battery module and pack based on specific requirements)

Total Assessment Time = 4 hours 45 minutes

Self-Study Time = 1 hour
Directed Study Time = n/a

Total qualification time: 19 hours 25 minutes

Credit value: 2