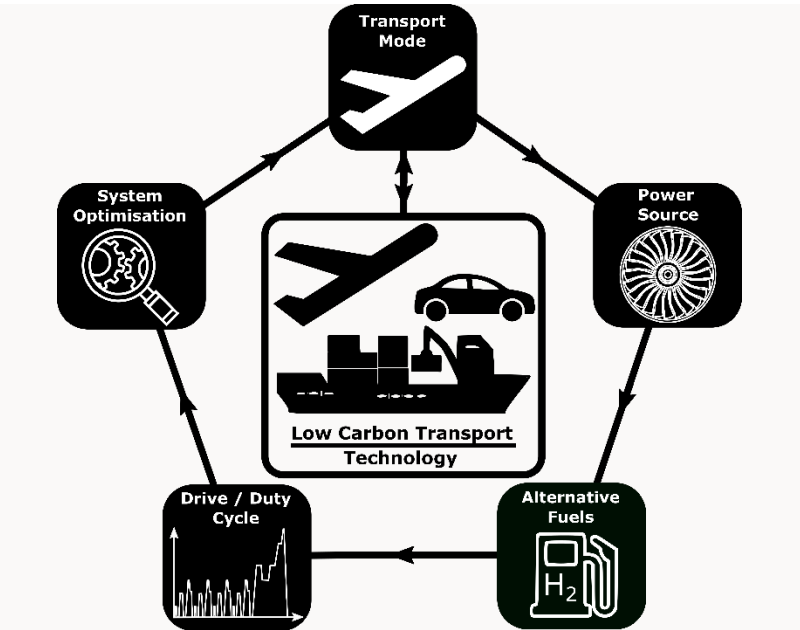


Module no. M2 (New)	Low Carbon Transport Technology
Module code and mode of delivery	MEP55B23 Delivery: Blended Learning through Blackboard VLE/LMS, face-to-face teaching and tutorial discussions as appropriate (see below).
Module ECTS Weighting	5 ECTS
Semester of delivery	Semester 2
Module Contact Hours	33 hours of lectures (hybrid synchronous online and face-to-face), 42 hours of independent student learning, 50 hours of continuous assessment in the form of class tests and student assignments which require the design and analytical modelling of low carbon propulsion systems for transport.
Module Coordinator	Charles Stuart
Module teaching staff and academic titles	Charles Stuart (Asst. Professor)
Module description—content	<p>The core topics covered as part of the Low Carbon Transport Technology Module are depicted in Figure 1, with supplementary explanation provided in the following paragraphs.</p>  <p>Figure 1: MEP55B15 core topics</p> <p>Transport Mode: Introduction to transportation of people and freight by land, sea and air. Consideration is given to the different operational and legislative requirements which ultimately govern the choice of power and propulsion system, both at an individual vehicle level and in consideration of the 2050 net-zero CO₂ target. The lack of a single “silver bullet” solution for transport decarbonisation is underlined, and it is noted that all available powertrain technologies</p>

	<p>will have a role to play in future sustainable transport. Students also learn how to develop vehicle models for each transport mode from first principles.</p> <p>Power Source: Introduction to different propulsion and power technologies. Fundamental design and modelling principles are introduced, starting with traditional combustion related thermodynamic cycles (Otto, Diesel and Brayton) through to electrification (both battery electric and fuel cell-based pathways) and hybridisation. Evaluation of different powertrain configurations for each transport mode is conducted from performance, fuel consumption and emissions perspectives (considering the full spectrum of definitions, from tank-to-wheel to complete life cycle analysis).</p> <p>Alternative Fuels: Students learn about zero carbon fuels (hydrogen and ammonia) as well as sustainable hydrocarbon fuels. Content focuses on fuel production and processing in terms of technoeconomic viability on a country wide basis, as well as resource use challenges, well-to-wheel emissions (through consideration of carbon intensity) and compatibility with existing prime movers. Dedicated sections on the concept of a “hydrogen economy” and sustainable aviation fuels (SAFs) are included, the latter of which ties directly in with the Ryanair Sustainable Aviation Research Centre.</p> <p>Drive / Duty Cycle: Students are introduced to the concept of drive / duty cycles, how these are defined, as well as their application during the design process and subsequent vehicle certification / type approval. Detailed evaluation of key modelling considerations for the automotive, aviation and maritime sectors is given, as well as the practical testing requirements which are encountered as part of the vehicle / power system certification process.</p> <p>System Optimisation: Consideration is given to optimising vehicle performance, efficiency and emissions in the context of the preceding four topics. A series of worked examples demonstrating different approaches to powertrain optimisation for an automotive vehicle are presented (single objective algorithms, design of experiments (DoE) etc), prior to giving detailed consideration to the broader implications of technical decisions. These are presented in the context of the UN Sustainable Development goals, and linked back to the technical content delivered in earlier in the course. Recognition is given to the challenge of satisfying competing requirements relating to technoeconomics and sustainability, and structured decision-making frameworks (various examples of multi-criteria decision making (MCDM) methodologies) are presented as a means of aiding in reconciling these often opposing aims.</p>
<p>Module learning aims/objectives</p>	<p>The key objectives are as follows:</p> <ul style="list-style-type: none"> • To give students sufficient fundamental understanding of a wide range of low carbon propulsion technologies for

	<p>transport to enable them to assess relevant efficiency definitions and CO₂ emissions.</p> <ul style="list-style-type: none"> • To enable students to critically judge the feasibility and sustainability of different propulsion systems considering carbon emissions, fuel sources, energy efficiency, infrastructural requirements, cost and end of life disposal. • To allow students to develop their own physics-based computational models, validate them against published information, and then deploy the models in an exploratory capacity to analyse and compare propulsion systems and vehicle designs for different transport modes. • To enable students to judge the technical, physical and economic impacts of alternative propulsion technologies for transport and present clear arguments with supporting data for choosing appropriate technologies, policy interventions and infrastructure.
<p>Module learning outcomes</p>	<p>On successful completion of this module, students should be able to:</p> <p>MLO2.1. Articulate the importance of efficient low carbon propulsion for different modes of transport.</p> <p>MLO2.2. Evaluate and compare the efficiency, sustainability and carbon impact of a range of low carbon propulsion technologies.</p> <p>MLO2.3. Use fundamental engineering science to analyse and predict the performance of various low carbon propulsion technologies.</p> <p>MLO2.4. Develop a physics-based computational model and use it to analyse the fuel efficiency and carbon emissions of vehicles representative of various transport modes.</p> <p>MLO2.5. Discuss the impacts of certain transport technologies on the long-term national investments in infrastructure.</p> <p>MLO2.6. Demonstrate an understanding of the balance between economic and environmental sustainability and the time scales of investments and benefits.</p> <p>MLO2.7. Quantitatively assess the potential for various low carbon and zero carbon propulsion technologies to complement or replace conventional propulsion systems for road, sea or air.</p>
<p>Module assessment, separate components and their weighting to be mapped into SITS</p>	<p>This module is assessed through 100 % Continuous Assessment (A single SITS component). There will be four assignments distributed across the semester. The final assignment consists of a 2500-word technical summary of a computational model and its use to evaluate and optimize different propulsion systems operating on a given drive / duty cycle.</p> <p>Students must achieve a weighted average in excess of 50% across all four assignments to pass the module.</p>