Module no. M2 (New)	Low Carbon Transport Technology
Module code and mode of delivery	MEP55B15 Delivery: Blended Learning through Blackboard VLE/LMS, face-to-face teaching and tutorial discussions as appropriate (see below).
Module ECTS Weighting	10ECTS
Semester of delivery	S1 + S2
Module Contact Hours	60 hours lectures (hybrid synchronous online and face-to-face), 84 hours independent student learning, 12 hours tutorials (face-to-face as appropriate), 100 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	Decarbonising transport is particularly challenging because the high energy density of existing hydrocarbon fuels cannot readily be matched by carbon free alternatives. Alternative solutions incur significant weight, space and cost penalties in vehicles, which customers are reluctant to accept. This course will review the current state of technology in road, marine and air transport, calculate typical carbon levels and highlight relevant emissions legislation and future targets. Basic thermodynamics cycles for reciprocating engines and aircraft propulsion will be presented, enabling the student to undertake basic analysis and calculate efficiency. Students will learn about the different low carbon technology options for road transport, including electrification, batteries, fuel cells, different forms of energy recovery, various configurations of hybrid power trains and down-sized engines. The fundamental science of these propulsion systems will be presented, enabling students to analyse each and compare efficiency and carbon emissions. Alternative fuels for transport applications will be presented and compared in terms of carbon emissions, cost and availability. Fuels include bio-fuels, compressed natural gas, synthetic fuels and hydrogen. Students will learn about the fundamental principles of fuel cells relevant to transport applications and the challenges of precious metal use.

	The potential importance of hydrogen as an energy vector will be presented, along with the challenges of clean production, safety, transport and storage. This will include consideration of drive cycles, the infrastructure investment and also the flexibility of hydrogen for use in reciprocating engines and gas turbines. The course will present the unique challenges of decarbonising air travel. Students will analyse the impact of using lower energy density fuels or batteries on the viability of air travel. Alternative fuels, hydrogen and electrification for aircraft propulsion will be studied and the impact of hydrogen storage on air frame design. Students will learn about propulsion systems and fuels for international shipping, and their carbon emissions. The alternatives will be presented, including assistive technologies, with supporting analysis and consideration of the varied availability of alternative fuels in different international regions. The use of different renewables to supplement existing power sources will be considered and also the impact of changing speeds and routes to save energy. As part of a staged series of assignments, students will develop a basic computational model using Excel or MatLab (or similar software) to simulate a vehicle powertrain with different configurations and predict fuel consumption and carbon emissions on a well-to-wheel basis.
Module learning aims/objectives	The key objectives are as follows: • To give students sufficient fundamental understanding of a wide range of low carbon propulsion technologies for transport to enable them to undertake efficiency and carbon analysis of such systems. • To enable students to critically judge the feasibility and sustainability of different propulsion systems considering carbon emissions, fuel sources, energy efficiency, cost and end of life disposal. • To allow students to develop and use their own basic computational models to analyse and compare propulsion systems for different transport applications and quantify carbon emissions. • 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 and infrastructure.

Module learning outcomes	On successful completion of this module, students should be able to: MLO2.1. Articulate the importance of efficient low carbon propulsion for different modes of transport. MLO2.2. Evaluate and compare the efficiency, sustainability and carbon impact of a range of low carbon propulsion technologies. MLO2.3. Use fundamental engineering science to analyse and predict the performance of various low carbon propulsion technologies. MLO2.4. Develop a basic computational model and use it to analyse the fuel efficiency and carbon emissions of propulsion systems for transport. MLO2.5. Discuss the impacts of certain transport technologies on the long-term national investments in infrastructure. MLO2.6. Demonstrate an understanding of the balance between economic and environmental sustainability and the time scales of investments and benefits. 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.
Module assessment, separate components and their weighting to be mapped into SITS	This module is assessed through 100 % Continuous Assessment (A single SITS component). There will be one assignment to be assessed approximately every 4 weeks in the two semesters (hence 3 assignments per semester for 2 semesters in total). 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. Students must achieve a weighted average in excess of 50% across all six assignments to pass the module.