

Module Code	MEU11E16
Module Name	Materials Science
ECTS Weighting¹	5 ECTS
Semester taught	Semester 1
Module Coordinator/s	Asst. Prof. Amir Pakdel (pakdela@tcd.ie)
<u>Module Learning Outcomes</u> with reference to the <u>Graduate Attributes</u> and how they are developed in discipline	<p>Upon completion of this module, students will be able to:</p> <p>LO1. Identify the classes of materials, including metals, ceramics, polymers, composites, and semiconductors, and explain how their properties can be determined and exploited.</p> <p>LO2. Comprehend the correlation between the atomic/molecular structure of materials and their physical properties.</p> <p>LO3. Apply fundamental concepts of materials behaviour (such as deformation, failure mechanisms, and phase transformations) to solve basic engineering problems.</p> <p>LO4. Work in teams to conduct basic experimental procedures for measuring key material properties and interpreting the results. This will help develop a deeper understanding of materials behaviour, as well as enhance communication and collaboration skills.</p> <p>Graduate Attributes: levels of attainment To act responsibly - Introduced To think independently - Introduced To develop continuously - Introduced To communicate effectively - Introduced</p>

¹ [TEP Glossary](#)

Module Content

This introductory module provides a broad foundation in materials science and engineering, focusing on the fundamental principles that govern the structure, properties, and performance of materials. The topics covered include:

- Introduction to materials science and engineering: classification of materials (*metals, ceramics, polymers, composites, semiconductors, nanomaterials, natural materials*).
- Materials design and selection for different applications (e.g., *mechanical, biomedical, structural, and electronic applications*).
- Atomic bonding, binding energy, crystal structures, microstructures.
- Relationship between structure and materials properties.
- Atom movements in materials (*diffusion*).
- Defects in materials (e.g. *point defects, grain boundaries, dislocations*) and their effects on material properties.
- Principles of mechanical behaviour of materials, including concepts such as: stress and strain (*under tension, compression, shear, bending, isostatic pressure*), deformation (*elastic, plastic*), and failure (*ductile fracture, brittle fracture, creep, fatigue, wear*).
- Mechanical properties including strength, stiffness, ductility, hardness, toughness, and fracture toughness.
- Strengthening mechanisms, such as: solid solution strengthening, precipitation hardening, strain hardening, compositing, and heat treatment.
- Cold and hot deformation processes and microstructural changes.
- Introduction to phase diagrams.
- Steel types and iron-carbon phase diagram.
- Hands-on experiments to measure materials properties.

Teaching and Learning Methods

The module includes a taught component delivered through podium lectures. Regular tutorial sessions are also held to provide practice in solving problems.

An experimental component is included, where students work in teams to test the properties of materials and structures. A briefing session will be conducted beforehand to explain the required experimental procedures.

The module will require an active participation of the students. Attendance at lectures, tutorials, and lab sessions is mandatory, as is the submission of all work subject to continuous assessment. Unexcused absences will be penalised.

The module will be assessed at the end of the semester.

Assessment Details² Please include the following: <ul style="list-style-type: none"> • Assessment Component • Assessment description • Learning Outcome(s) addressed • % of total • Assessment due date 	Assessment Component	Assessment Description	LO Addressed	% of total	Week due			
	Examination	Examination	1,2,3	80	Examination Week			
	Continuous Assessment	Quizzes, reports on laboratory experiments and design challenges.	4	20	Various occasions			
Reassessment Requirements	Students must pass the examination element of the module to avoid the possibility of reassessment. Reassessment will be by examination only.							
Contact Hours and Indicative Student Workload²	<table border="1"> <tr> <td>Contact hours (lectures, analytical sessions, laboratory sessions): 44 hours</td> </tr> <tr> <td>Independent Study (preparation for course and review of materials, teamwork and group discussions): 50 hours</td> </tr> <tr> <td>Independent Study (preparation for assessment, incl. completion of assessment): 50 hours</td> </tr> </table>					Contact hours (lectures, analytical sessions, laboratory sessions): 44 hours	Independent Study (preparation for course and review of materials, teamwork and group discussions): 50 hours	Independent Study (preparation for assessment, incl. completion of assessment): 50 hours
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Recommended Reading List	<p><i>The Science and Engineering of Materials, Askeland, Fulay, Wright</i></p> <p><i>Materials Science and Engineering, William D Callister</i></p> <p><i>Engineering Materials 1&2: An Introduction to Properties, Applications and Design, Ashby and Jones</i></p> <p><i>Any other textbook covering fundamentals of “<u>materials science & engineering</u>”</i></p>							
Module Pre-requisite	N/A							
Module Co-requisite	N/A							
Module Website	https://tcd.blackboard.com/							
Are other Schools/Departments involved in the delivery of this module?	N/A							
Module Approval Date								
Approved by								
Academic Start Year	2025							
Academic Year of Date	2026/27							

² [TEP Guidelines on Workload and Assessment](#)