Module Code	MEU33B04
Module Name	Mechanical Engineering Materials
ECTS Weighting	5 ECTS
Semester taught	Semester 1
Module Coordinator	Prof. Kevin O'Kelly
Module Learning Outcomes (LOs) with reference to the Graduate Attributes and how they are developed in the discipline	LO1. Describe the structure and mechanical properties of different engineering materials including metals, polymers, ceramics and composites. LO2. Understand different mechanism of material deformation and failure and perform calculations relating the atomic structure and microstructure of materials to deformation behaviour. LO3. To quantify the effects of time, temperature and environment on material properties of metals, ceramics, polymers and composites. LO4. Predict how material properties are affected by alloy compositions and thermo-mechanical treatment. LO5. Apply knowledge to selection of suitable materials for specific engineering applications. LO6. Understand failure in engineering components, especially its social and ethical consequences. LO7. Carry out a technical report on material selection and performance in engineering applications. **Graduate Attributes: levels of attainment** • To act responsibly - Enhanced • To think independently - Enhanced • To develop continuously - Enhanced • To communicate effectively - Enhanced
Module Content	This module develops essential concepts in the selection and use of engineering materials for mechanical and biomedical applications. Various modes of failure including yield, fracture, fatigue, creep, corrosion and wear will be examined. Different types of materials (including metal alloys, polymers, ceramics and composites) and their mechanical behaviour will be explored. Material processes and environmental conditions that alter the mechanical characteristics of the materials shall be considered. This information will then be

	used to select suitable materials for specific applications and determine why some materials fail under certain conditions.
Detailed Syllabus	This module further develops material structures introduced on 1st year Chemistry and static properties covered in the 1st year Introduction to Materials. It introduces transient properties and material selection in design. Specifically: *Elastic behaviour* • **Review** of tensile, compressive, shear and bulk moduli • Rule of mixtures for composite materials including effects of fibre characteristics • Material selection (Ashby charts) *Plastic behaviour* • **Review** of yield, tensile and ultimate strengths • Metal and ceramic crystal structures, • point defects, dislocations • grain boundaries, solid solution strengthening • binary phase diagrams • transient diffusion (Fick's 2nd Law) • heat treatments of steel • Material selection (Ashby charts) *Fracture* • Mictrostructural mechanisms • LEFM • EPFM (CTOD, J-integral) • Experimental techniques (Charpy, nano-indentation) Fatigue • Microstructural mechanisms • S-N curves & uncertainty • Paris Law • Linear and non-linear damage accumulation models • Mean loads (Goodman, Gerber, Soderberg lines) • Surface effects (polishing, grinding, shot peening) • Forensic fatigue analyses *Creep* • Microstructural mechanisms • Temperature and stress models • Design considerations • Displacement, rupture, bucking) • Stress relaxation in polymers Wear

<table>
<tr><td></td><td>Corrosion
Wet and dry oxidation mechanisms (linear & non linear)
Temperature effects
Stability (Pilling-Bedworth ratio)
Reduction potentials
Oxidation rates (CPR, current density models)
Design considerations (sacrificial anodes)
Types (uniform, Galvanic, crevice, intergranular, erosion corrosion.</td></tr>
<tr><td>Teaching and Learning Methods</td><td>This module is taught using a combination of lectures and tutorial sessions. The tutorial sessions are overseen by Teaching Assistants where students work in groups to develop their technical, communication and teamwork skills.

Learning is achieved using both summative and formative methods.</td></tr>
<tr><td>Assessment Details</td><td>
<table>
<tr><th>Assessment Component</th><th>Assessment Description</th><th>% of total</th><th>Week due</th></tr>
<tr><td>A. Written examination</td><td>2 in-class exams</td><td>50% (25% each)</td><td>Week 6, Week 12</td></tr>
<tr><td>B. Continuous assessment</td><td>Long technical report</td><td>50%</td><td>Week 10</td></tr>
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IMPORTANT: Students must pass both the A and B assessment components to pass the module.</td></tr>
<tr><td>Reassessment</td><td>Written Examination (100%)</td></tr>
<tr><td>Contact Hours and Indicative Student Workload</td><td>Contact hours: 44 (33 lectures + 11 tutorials)

Independent Study (preparation for and review of lecture material): 22

Independent Study (preparation for and completion of assessments): 54</td></tr>
<tr><td>Recommended Reading List</td><td>Engineering Materials 1 & 2,
MF Ashby & DRH Jones (Butterworth- Heinemann)</td></tr>
<tr><td>Module Pre-requisites</td><td>MEU11E12 Materials or equivalent module</td></tr>
<tr><td>Module Co-requisite</td><td>None</td></tr>
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