

Module Title:	3B4 Mechanical Engineering Materials
Code:	ME3B4
Level:	Junior Sophister
Credits:	5
Lecturer(s):	Assistant Prof. Mark Ahearne (ahearnm@tcd.ie); Associate Prof. Bruce Murphy (murphb17@tcd.ie)

Module Organisation

The module runs for 12 weeks of the academic year and comprises three lectures per week. A tutorial is given every week. Total contact time is 44 hours.

Semester	Start Week	End Week	Lectures per week	Lectures total	Tutorials per week	Tutorials total
1	1	12	3	33	1	11

Module description, aims and contribution to programme

This module introduces the student to essential concepts in the selection and use of engineering materials. This includes a study of the mechanical properties of materials and their structure at the atomic and microscopic scales. Material processing is also discussed, allowing the student to obtain an overview of the various considerations necessary when selecting materials as part of the design process. Failure modes are described, including short-term and long-term types of failure, which are related to their underlying causes such as cracks and dislocations. This is a key module in the study of mechanical engineering, which builds on work established in the second year curriculum.

Learning outcomes

On completion of this module the student will be able to:

- describe and conduct tests to measure mechanical properties, making use of data collection and analysis systems;
- perform calculations relating deformation under load to atomic structure and microstructure;
- predict the failure loads and times for simple structures, appreciate how these predictions can be made for complex engineering components and how they can be used to ensure safe life in conjunction with maintenance;
- describe the assumptions and approximations that must be made in predicting deformation and failure and the likely errors that will arise as a result;
- describe the microstructures and phases that will occur in material alloys in general and in steels and aluminium alloys in particular;
- predict how microstructure will be affected by alloy composition and thermo-mechanical treatment;
- describe the structure and processing of some typical engineering ceramic materials; to compare the mechanical properties of these materials to those of

- metals, explaining under what circumstances ceramics might be used in industry;
- describe the structure, processing and mechanical properties of polymers and composites; to compare the mechanical properties of these materials with those of metals and to explain under what circumstances these materials might be used in industry; to estimate the mechanical properties of a composite material knowing the properties of its constituents;
- appreciate the considerations involved in materials selection: to use a systematic approach to the selection of the optimum material for a given application, including considerations of material price and availability;
- be aware of the importance of preventing failure in engineering components, especially its social and ethical consequences;

Module content

- elastic and plastic deformation: stiffness and strength;
- fracture: toughness;
- fatigue, creep and wear;
- phase diagrams: phase changes;
- metallic alloys;
- ceramic materials;
- polymers;
- composites;
- structure/property relationships;
- case studies in materials selection and design.

Teaching strategies

This module is taught using a combination of lectures, laboratory classes and tutorial sessions. The tutorial sessions are overseen by a Teaching assistant where students work in groups to develop their communication and teamwork skills.

Assessment

This module is assessed by means of a formal two-hour written examination (worth 80% of the final marks) and laboratory assignment and report (worth 20% of the final marks). Examination questions are designed to test students' ability to use the knowledge gained in lectures to solve practical problems, bringing together different aspects of the module and of other modules, such as mechanics of solids and manufacturing technology.

Recommended text

- Engineering Materials Books 1 and 2, Ashby and Jones, Pergamon
- Selection and Use of Engineering Materials, Crane and Charles
- Introduction to Engineering Materials, John
- Materials Science and Engineering, Callister
- The New Science of Strong Materials, Gordon

Laboratories

- Lead Creep