

MATLS 3M03: MECHANICAL BEHAVIOUR OF MATERIALS**Instructor**

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Teaching assistants

Name	Demo labs supervised	e-mail
TBD

Course description

This course will examine how the microstructure of a material determines its mechanical behaviour. The topics covered will include elastic and plastic deformation, creep, fatigue and fracture of engineering materials. Materials selection will also be discussed.

Learning Outcomes

- Gain practical experience in measurement and quantification of mechanical properties.
- Understand the physical and microstructure basis of mechanical properties.
- Become familiar with failure mechanisms of structural materials.
- Develop ability to predict the useful lifetime of a material under specific load conditions.
- Knowledge of how to incorporate material strength limitations into engineering design.

Course structure

12 weeks: lectures 3 hrs/week, 4 lab demonstration sessions

Module 1 (week 1–3): Elasticity

- stress and strain
- Hooke's law
- nature and types of chemical bonding
- atomic structure of solids
- microscopic insight to elasticity
- modulus limited design
- Demonstration 1: Elastic modulus of composite materials

Module 2 (week 4–6): Plasticity

- tensile testing
- perfect strength, dislocations, yielding
- mechanics of plastic flow
- strengthening mechanisms
- yielding under combined stress
- yield-limited design
- Demonstration 2: Effect of microstructure on the strength of an aluminum alloy

Module 3 (week 7–8): Fracture mechanics

- energetics of fracture growth
- plasticity at the fracture tip
- measurement of fracture toughness
- damage tolerance design
- elements of fractography
- Demonstration 3: Measuring the toughness of low carbon steels

Module 4 (week 9–10): Fatigue

- low- and high-cycle fatigue
- laboratory testing in fatigue
- residual stress, surface and environmental effects
- fatigue of cracked components
- designing out fatigue failure

Module 5 (week 11–12): Creep

- stress-strain-time relationship
- creep testing
- physical mechanism of creep
- diffusion
- creep-resistant materials
- Demonstration 4: Creep and high temperature deformation of aluminum

Evaluation

Activities	Contribution to the final grade (%)
Assignments (1 per module)	15
Lab demonstrations (4 in total)	20
Midterm exam	25
Final exam	40

Prerequisites and relevance to other courses

MATLS 1M03 “Structure and Properties of Materials” AND (ENGINEER 2P04 “Engineering Mechanics A” OR registration in level 4 or above CIVENG OR registration in level 3 or above mechanical engineering).

Recommended text

- Thomas H. Courtney, *Mechanical Behavior of Materials*, 2nd ed., (Waveland Press, 2000). ISBN: 978-1-57766-425-3