**Syllabus**

**Course description**

<table>
<thead>
<tr>
<th>Course title</th>
<th>Materials science and structural mechanics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course code</td>
<td>42175</td>
</tr>
<tr>
<td>Scientific sector</td>
<td>ICAR/08 – ING-IND/22</td>
</tr>
<tr>
<td>Degree</td>
<td>Bachelor in Industrial and Mechanical Engineering</td>
</tr>
<tr>
<td>Semester</td>
<td>I</td>
</tr>
<tr>
<td>Year</td>
<td>II</td>
</tr>
<tr>
<td>Academic year</td>
<td>2021/22</td>
</tr>
<tr>
<td>Credits</td>
<td>12 (6+6)</td>
</tr>
<tr>
<td>Modular</td>
<td>yes</td>
</tr>
<tr>
<td>Total lecturing hours</td>
<td>76 (40+36)</td>
</tr>
<tr>
<td>Total lab hours</td>
<td>-</td>
</tr>
<tr>
<td>Total exercise hours</td>
<td>39 (15+24)</td>
</tr>
<tr>
<td>Attendance</td>
<td>Recommended</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>None</td>
</tr>
<tr>
<td>Course page</td>
<td><a href="https://next.unibz.it/en/faculties/sciencetechnology/bachelor-industrial-mechanical-engineering/course-offering/">https://next.unibz.it/en/faculties/sciencetechnology/bachelor-industrial-mechanical-engineering/course-offering/</a></td>
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</table>

**Specific educational objectives**
The specific educational objectives include the understanding and knowledge of the fundamentals of material science and structural mechanics. The students will learn mechanical properties of engineering materials and structural elements and how they may be analyzed. This includes modelling abstractions, solution methods and the interpretation of results of relevant engineering mechanics problems.

**Module 1**
**Mechanics of structures**
Dr. techn. Thomas Moosbrugger

**Scientific sector of the lecturer**
German

**Teaching language**
18h (by appointment: ThomasFranzXaver.Moosbrugger@unibz.it)

**Office hours**
- 

**Teaching assistant (if any)**
- 

**Office hours**
- 

**List of topics covered**
**Part I: Stereostatics – the mechanics of rigid structures**
- Statics of rigid bodies:
  - Force, force systems
- Centroids of volumes, surfaces and lines
- Structures as load-bearing assemblies
  - Structural elements
• Supports and links
• Static determinacy
• Superposition principle

• Statics of rigid bars
  • Analysis of single rigid bars
  • Analysis of rigid cables
  • Analysis of rigid trusses

• Statics of rigid beams
  • Analysis of single rigid beams
  • Analysis of rigid arches
  • Analysis of rigid frames

• Work and potential energy of rigid structures
  • Work and potential energy
  • Virtual displacement and virtual work
  • Principle of virtual work

• Friction
  • Static friction
  • Kinetic friction
  • Belt friction

**Part II: Elastostatics – the mechanics of deformable structures**

• Statics of elastic bodies
  • Stress
  • Strain
  • Constitutive law
  • Mohr’s circle
  • Principal axes and values
  • Strength hypotheses

• Statics of elastic bars
  • Thermal loading
  • Static determinacy
  • Analysis of single elastic bars
  • Analysis of elastic trusses

• Statics of elastic beams
  • Assumptions of beam theory
  • Moment of inertia
  • Deflection of beams
  • Static determinacy
  • Analysis of single elastic beams
  • Analysis of elastic frames
  • Superposition of loads

• Torsion
• Energy methods in elastostatics
  • Deformation energy
• Methods of Maxwell, Castigliano, etc.
• Stability in elastostatics
  • Buckling of elastic beams
  • Euler’s buckling cases

**Teaching format**
Frontal lectures, exercises

**Module 2**
**Material Science and Technology**
**Lecturer**
Prof. Stefano Rossi PhD stefano.rossi@unibz.it, and stefano.rossi@unitn.it, 0471-017092, https://www.unibz.it/it/faculties/sciencetechnology/academic-staff/person/1075-stefano-rossi
**Scientific sector of the lecturer**
ING IND22

**Teaching language**
Italian

**Office hours**
18 h
n.d.

**Teaching assistant (if any)**
Before lectures

**List of topics covered**
In the course the followings topics about materials will be considered.

**Introduction**: the materials and their use in the industrial production. Technological properties of materials: different type of materials and their typical properties; correlation between microstructure and mechanical properties; basis of thermodynamics and equilibrium diagrams.

**Metals**: characteristics and properties of iron alloys (steel and cast iron), copper and aluminum alloys; alloys with high performances. The mechanical workability; thermal treatments.

**Ceramics and glasses**: ceramics for building; the production and utilization of ceramic materials; materials for high temperatures; the characteristics of glass; the production of glass components.

**Polymers**: production and properties of polymeric materials; production of components in polymeric matter; utilization of polymers.

**The composite materials**: production, properties, utilization of composite materials.

**Testing standard about of materials**: the use of standard in the classification and in the properties testing of materials.

**Teaching format**
Class lectures in which topics are presented by the teacher. The lecture topics will be arguments of exercises and practical activities explained by the teacher and the teaching assistants. Generally, PowerPoint presentations will be used during the lectures.
The lessons will then be integrated with classroom exercises and video with comments. They will try to encourage students to independently perform some exercises as a self-
learning test.
The PowerPoint presentations will be given to students as material for the study track, for the preparation of the final examination.

Learning outcomes

Module I Mechanics of structures:

Knowledge and understanding:
1. Knowledge and understanding of the fundamentals of structural mechanics.

Applying knowledge and understanding:
2. Applying theoretical methods to analyze engineering structures and structural systems.

Making judgments:
3. Analyzing structural engineering devices/systems requires a deep understanding and the ability to show judgment regarding methods, results and designs.

Communication skills:
4. Communication skills to convey and transfer structural mechanics knowledge.
5. Communication skills to interpret results of structural mechanics analyses and their consequences with respect to design.

Ability to learn:
6. Learning skills to study independently the large and complex field of structural mechanics for specific applications beyond this lecture.

Module II Material Science and Technology:

Knowledge and understanding:
1. Knowledge and understanding of the different properties of materials and different technologies and production processes.

Applying knowledge and understanding:
2. Applying knowledge and understanding through the development of skills and the ability to choose the suitable materials and the technology for a particular industrial product. In addition, the students should develop the ability to apply the knowledge on the behavior of materials in the performance of laboratory technological tests.

Making judgments
3. Connect the properties of different materials with their microstructure; capacity to evaluate the experimental data obtained in laboratory tests.

**Communication skills**
4. Communication skills to present the acquired knowledge with their own lexicon of the discipline and to be able to prepare a technical report about materials tests.

**Ability to learn**
5. Acquire skills to deepen the topics covered during the course in order to apply them to simple practical cases.
6. Acquire the ability to interpret experimental test data obtained in material characterization tests.

**Assessment**

**Module I Mechanics of structures:**

<table>
<thead>
<tr>
<th>Form</th>
<th>Length /duration</th>
<th>ILOs assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exercises in the lecture hall</td>
<td>In the process of the exercises sessions</td>
<td>1-5</td>
</tr>
</tbody>
</table>

**Summative assessment**

<table>
<thead>
<tr>
<th>Form</th>
<th>%</th>
<th>Length /duration</th>
<th>ILOs assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written examination (compiling a calculation example)</td>
<td>60</td>
<td>1,5 h</td>
<td>1-5</td>
</tr>
<tr>
<td>Oral examination (in a small group)</td>
<td>40</td>
<td>30 min</td>
<td>1-5</td>
</tr>
</tbody>
</table>

**Module 2 Material Science and Technology:**

<table>
<thead>
<tr>
<th>Form</th>
<th>Length /duration</th>
<th>ILOs assessed</th>
</tr>
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<tbody>
<tr>
<td>Exercises in the lecture hall</td>
<td>In the process of the exercises sessions</td>
<td>1-5</td>
</tr>
</tbody>
</table>

**Summative assessment:**
<table>
<thead>
<tr>
<th>Form</th>
<th>Length /duration</th>
<th>ILOs assessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Written exam with questions and exercises</td>
<td>2 h</td>
<td>1,2,3,4,5</td>
</tr>
</tbody>
</table>

**Assessment language**
Module I  Structural Mechanics: German
Module II  Material Science and Technology: Italian

**Evaluation criteria and criteria for awarding marks**

**Module I Structural Mechanics:**
Written examination (in German) will include derivations and numerical examples to evaluate the ability to solve structural-mechanics problems as well as comprehension questions.

<table>
<thead>
<tr>
<th>Form</th>
<th>Evaluation criteria and weight</th>
</tr>
</thead>
</table>
| Written exam | Theoretical knowledge (30%)  
Appropriate use of methods (30%)  
Ability to solve problems (30%)  
Appropriate use of units (10%) |

**Module II Material Science and Technology:**
Written exam Theoretical knowledge of the subject (40%);
Ability to link different topics highlighting the similar peculiarities and characteristics (30%);
Ability to apply the concepts relating to materials and production technologies, for examples of objects and products (20%);
Mastery of technical language (10%).

**Final mark:**
50% Module I Structural Mechanics
50% Module II  Material Science and Technology
Note: Students must pass both modules in order to pass this course

**Required readings**
Lectures notes.
The slides, supplied during class, are a useful to follow the lectures and for the individual study. However, they are NOT sufficient for the successful exam preparation.

**Supplementary readings**
**Module I Mechanics of structures:**
German:

English:

Italian:

Further literature will be discussed during the lectures and exercises.

Module II Material Science and Technology:
Syllabus

Course description

Course title: Materials science and structural mechanics
Course code: 42175
Scientific sector: ICAR/08 – ING-IND/22
Degree: Bachelor in Industrial and Mechanical Engineering
Semester: I
Year: II
Academic year: 2021/2022
Credits: 12 (6+6)
Modular: yes

Total lecturing hours: 76 (40+36)
Total lab hours: -
Total exercise hours: 39 (15+24)
Attendance: Recommended
Prerequisites: None

Specific educational objectives

The specific educational objectives include the understanding and knowledge of the fundamentals of material science and structural mechanics. The students will learn mechanical properties of engineering materials and structural elements and how they may be analyzed. This includes modelling abstractions, solution methods and the interpretation of results of relevant engineering mechanics problems.

Modul 1

Mechanics of structures
Dr. techn. Thomas Moosbrugger

Dozent

Wissenschaftlich-disziplinärer Bereich des Dozenten

Unterrichtssprache: Deutsch
18h (nach Vereinbarung: ThomasFranzXaver.Moosbrugger@unibz.it)

Wissenschaftlicher Mitarbeiter

Sprechzeiten:

Auflistung der behandelten Themen

Teil I: Stereostatik – die Mechanik starrer Strukturen

- Statik starrer Körper:
  - Kraft, Kraftgruppen
  - Schwerpunkt von Volumen, Flächen und Linien
• Tragwerke
  ◦ Strukturelemente
  ◦ Lager und Gelenke
  ◦ Statische Bestimmtheit
  ◦ Überlagerungsprinzip
• Statik starrer Stäbe
  ◦ Analyse einzelner starrer Stäbe
  ◦ Analyse starrer Seile
  ◦ Analyse starrer Fachwerke
• Statik starrer Balken
  ◦ Analyse einzelner starrer Balken
  ◦ Analyse starrer Bögen
  ◦ Analyse starrer Rahmen
• Arbeit und potentielle Energie starrer Strukturen
  ◦ Arbeit und potentielle Energie
  ◦ Virtuelle Verrückung und Virtuelle Arbeit
  ◦ Prinzip der Virtuellen Arbeit
• Reibung
  ◦ Haftreibung
  ◦ Gleitreibung
  ◦ Seilreibung

Teil II: Elastostatik – die Mechanik verformbarer Strukturen
• Statik elastischer Körper
  ◦ Spannung
  ◦ Verzerrung
  ◦ Mohr’scher Kreis
  ◦ Hauptachsen und -werte
  ◦ Stoffgesetz
  ◦ Fettigkeitshypothesen
• Statik elastischer Stäbe
  ◦ Wärmeausdehnung
  ◦ Statische Bestimmtheit
  ◦ Analyse einzelner elastischer Stäbe
  ◦ Analyse elastischer Fachwerke
• Statik elastischer Balken
  ◦ Annahmen der Balkentheorie
  ◦ Flächenträgheitsmomente
  ◦ Biegelinie einachsiger Biegung
  ◦ Statische Bestimmtheit
  ◦ Analyse einzelner elastischer Balken
  ◦ Analyse elastischer Rahmen
  ◦ Überlagerte Belastungen
• Torsion
• Arbeitssatz in der Elastostatik
  ◦ Formänderungsenergie
  ◦ Sätze von Maxwell, Castigliano, etc.
• Stabilität in der Elastostatik
  ◦ Knickung elastischer Balken
  ◦ Eulerschen Knickfälle

Unterrichtsform
Vorlesungen, Übungen

Modulo 2
Scienza e Tecnologia dei materiali

Docente
Prof. Stefano Rossi PhD, stefano.rossi@unibz.it, e
stefano.rossi@unitn.it, 0471-017092,
https://www.unibz.it/it/faculties/sciencetechnology/academic-
staff/person/1075-stefano-rossi

Settore scientifico
ing-ind/22

disciplinare del docente

Lingua ufficiale del corso
Italiano

Orario di ricevimento
18 h - prima delle lezioni ed esercitazioni

Collaboratore didattico
n.d.
(se previsto)

Orario di ricevimento
13:00 – 14:00

Durante il corso verranno considerati i seguenti aspetti:

Introduzione: i materiali e il loro utilizzo nei prodotti industriali

Le basi delle proprietà di interesse tecnologico dei materiali: classi di materiali e loro proprietà caratterizzanti; relazioni generali fra microstruttura e proprietà; accenni di termodinamica delle trasformazioni di stato.

Il comportamento meccanico dei diversi tipi di materiali.

I materiali metallici: generalità sulle leghe ferrose; le leghe di rame ed alluminio; leghe speciali. Lavorazioni e trattamenti termici dei materiali metallici.

I materiali ceramici e vetro: ceramici per l’edilizia, loro produzione ed utilizzo; ceramic refrattari. La produzione di componenti in vetro.

I materiali polimerici: produzione e proprietà dei polimeri; lavorazione ed utilizzzi dei materiali polimerici.

I materiali compositi: produzione, proprietà ed utilizzi dei materiali compositi.

Le normative nel campo dei materiali: come si leggono e come si utilizzano

Attività didattiche
Il corso si basa su lezioni frontali in aula tenute dal docente. Le lezioni verranno quindi integrate con esercizi in aula e la proiezione di video che verranno commentati dal docente. Si cercherà di stimolare gli studenti a svolgere autonomamente alcuni esercizi e prove in modo da avere una valutazione dell’autoapprendimento.

Generalmente si utilizzeranno presentazioni PowerPoint che verranno fornite agli studenti come materiale traccia per lo studio.
Learning outcomes

Module I Mechanics of structures:

Knowledge and understanding:
1. Knowledge and understanding of the fundamentals of structural mechanics.

Applying knowledge and understanding:
2. Applying theoretical methods to analyze engineering structures and structural systems.

Making judgments:
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Ability to learn:
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Module II Material Science and Technology:

Knowledge and understanding:
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Applying knowledge and understanding:
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Making judgments
3. Connect the properties of different materials with their microstructure; capacity to evaluate the experimental data obtained in laboratory tests.

Communication skills
4. ... to present the acquired skills with their own lexicon of the discipline and to be able to prepare a technical report about material tests.

Ability to learn
5. Acquire skills to deepen the topics covered during the course in order to apply them to simple practical cases.
6. Acquire the ability to interpret experimental test data obtained in material characterization tests.

Assessment

### Module I Mechanics of structures:

**Formative assessment:**

<table>
<thead>
<tr>
<th>Form</th>
<th>Dauer</th>
<th>Nr. Lernergebnisse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Übungen im Hörsaal</td>
<td>Im Laufe der Übungseinheiten</td>
<td>1-5</td>
</tr>
</tbody>
</table>

**Summative assessment:**

<table>
<thead>
<tr>
<th>Form</th>
<th>Dauer</th>
<th>Nr. Lernergebnisse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schriftliche Prüfung (60%, Erarbeiten eines Rechenbeispiels)</td>
<td>1,5 h</td>
<td>1-5</td>
</tr>
<tr>
<td>Mündliche Prüfung (40%, In der Kleingruppe)</td>
<td>30 min</td>
<td>1-5</td>
</tr>
</tbody>
</table>

### Module 2 Material Science and Technology:

**Formative assessment:**

<table>
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<tr>
<th>Form</th>
<th>Length/duration</th>
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<tbody>
<tr>
<td>Written exam</td>
<td>2 h</td>
<td>1,2,3,4,5</td>
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Module I Structural Mechanics: German
Module II Material Science and Technology: Italian
Module I Structural Mechanics:
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<tbody>
<tr>
<td>Written exam</td>
<td>Theoretical knowledge (30%)</td>
</tr>
<tr>
<td></td>
<td>Appropriate use of methods (30%)</td>
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<tr>
<td></td>
<td>Ability to solve problems (30%)</td>
</tr>
<tr>
<td></td>
<td>Appropriate use of units (10%)</td>
</tr>
</tbody>
</table>

Module II Material Science and Technology:
Written exam (in Italian)
Theoretical knowledge of the subject (40%); Ability to link different topics highlighting the similar peculiarities and characteristics (30%); Ability to apply the concepts relating to materials and production technologies, for examples of objects and products (20%); Mastery of technical language (10%).

Final mark:
50% Module I Structural Mechanics
50% Module II Material Science and Technology
Note: Students must pass both modules in order to pass this course

Required readings
Lectures notes.
The slides, supplied during class, are a useful to follow the lectures and for the individual study. However, they are NOT sufficient for the successful exam preparation.

Supplementary readings
Module I Mechanics of structures:

German:

English:
• Gross, D., W. Hauger, J. Schröder, W. A. Wall, and

Italian:

Further literature will be discussed during the lectures and exercises.

Module II Material Science and Technology: