Aalto University
School of Engineering

MEC-E1070 Selection of Engineering Materials

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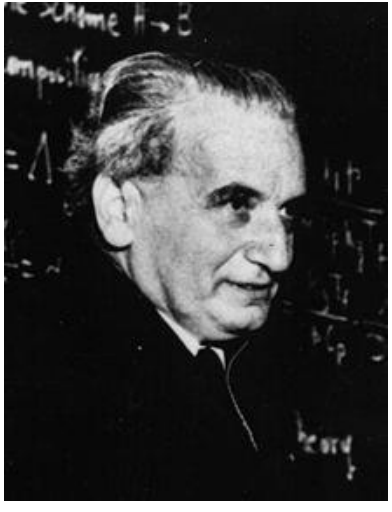
“Scientists discover the world that exists; engineers create the world that never was.”

— Theodore Von Karman



https://en.wikipedia.org/wiki/Theodore_von_K%C3%A1rm%C3%A1n

The starting point

Engineers make things.

They make them out of **materials,** using **processes.**

❑ **What do they need?**

- **Perspective** of the world of materials and processes
- **Understanding** material properties
- An ability to **select**
- **Information** and **tools** (like CAD or FE)

https://storymaps.arcgis.com/

Today's lecture structure

- ***Course introduction (35')***
  - ✓ ***Course structure and composition***
  - ✓ ***Timetable and Workload***
  - ✓ ***Course grading***
  - ✓ ***Task introduction***
- ***Break (5')***
- ***Seminar by Prof Sven Bossuyt (65')***

Purpose of this Course

The **objectives** of the course are to teach basic knowledge of **mechanical material selection**, **available structural materials**, **sources of information**, **material selection criteria,** and **systematic methods of material selection**.

During the course, students will learn to use a computer-aided material selection program, **GRANTA EduPack**, previously known as Cambridge Engineering Selector (CES).

After the course, the student can:

1. Utilize **systematic methods** for **materials selection**.
2. Compare and choose materials on the basis of the **design requirements**.
3. Criticize and compare **alternative materials solutions** for designs.
4. Examine the **product life cycle** phases.
5. Identify **major trends** in the evolution of the state of the art in engineering materials and their implications for mechanical design.

Resources

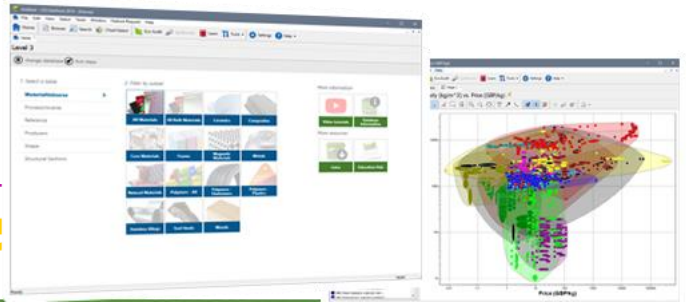
Textbook

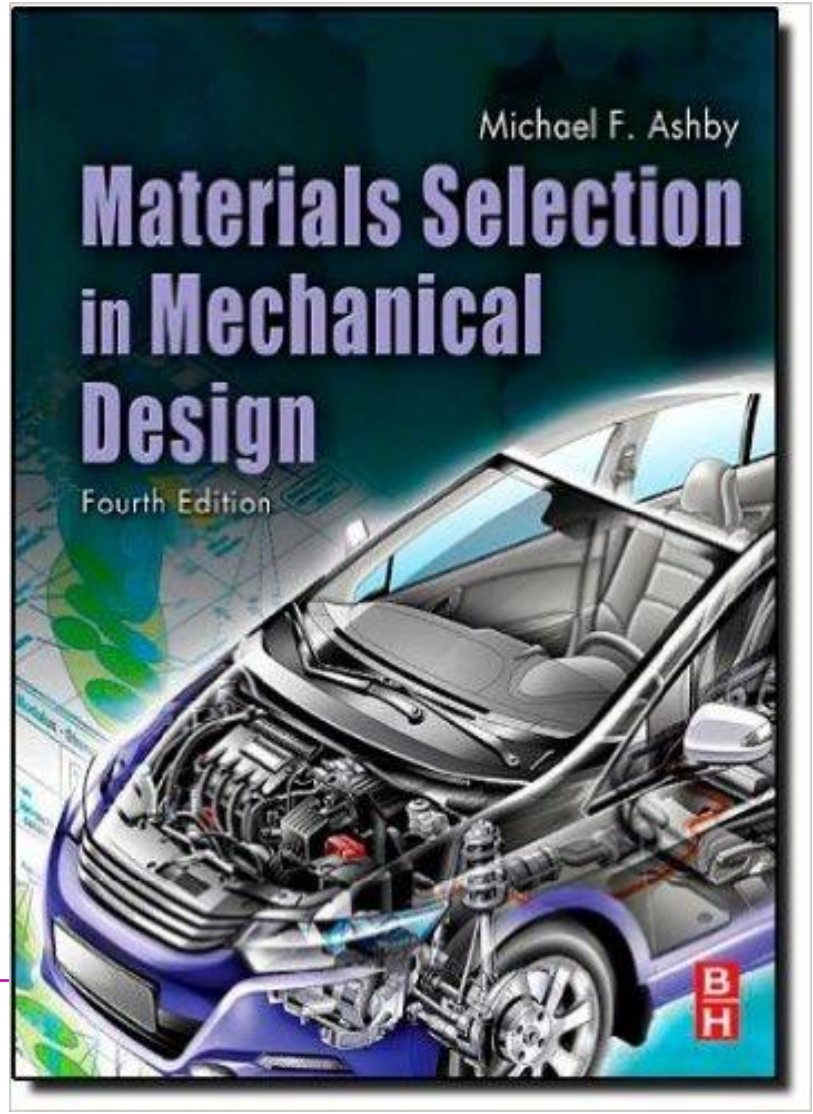
Ashby, Michael F.
Materials Selection in Mechanical Design
(recommended editions 4th or 5th).

Software

GRANTA EduPack
(was Cambridge Engineering Selector,
from Granta Design Software, now part of ANSYS)

See details in: MyCourses/Materials/
1. Textbook and Software Instruction.pdf
2. GRANTA EduPack Installation.pdf





Class structure & times

The course is **multiform teaching & problem-driven**.

Multiform teaching "Flipped classroom" (M01)
M01 Fridays 12:15-14:00, A1 - A123 & Zoom (Passcode: MEC1070)
Participation granted with 2 points for active discussion

Lecture (online)
Publishes every Friday after 14:00, available all time

Seminar (M0)
Mondays 08:15-10:00, K1, 215
3 questions worth 1 point each toward your course grade

Exercise (A0)
Mondays 16:15-18:00, Otakaari 1, U344
Exercise on software application

Q&A sessions (Hybrid: Zoom with Passcode: MEC1070)
Tuesdays 15:00-16:30, K1, 203a
Wednesdays 11:00-12:30, K1, 101 (from 6.9 to 4.10) and K1, 203a (11.10)
Task-related question and answering time

Weekly Tasks

Please watch the 1 minute video about the Flipped Classroom teaching method used in our course. Click What is a flipped class? link to open resource.

Flipped Classroom

Limited traditional lecturing

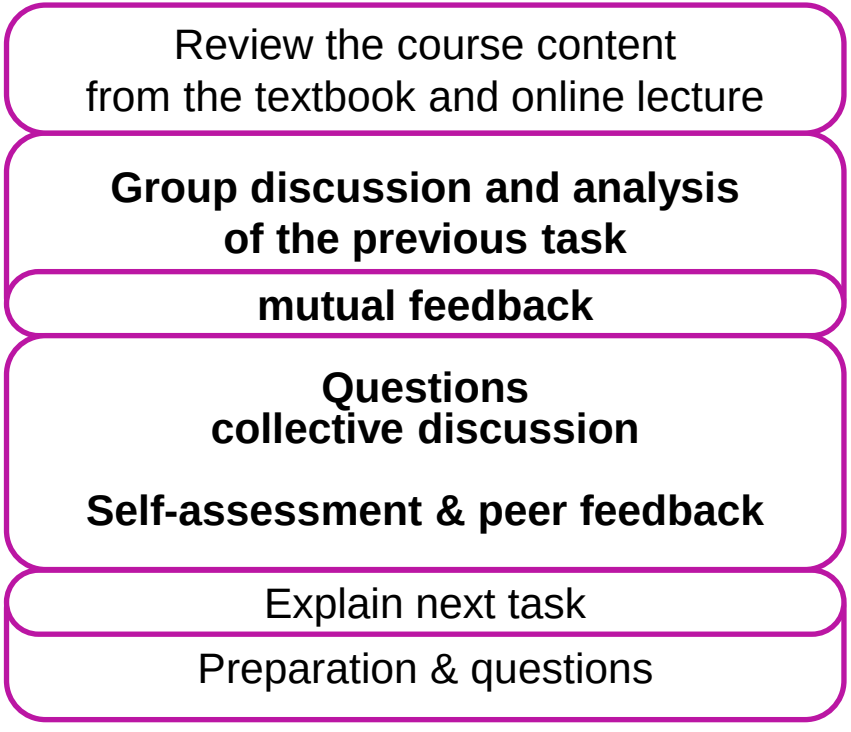
self-study using textbook

Class time is used for discussion and feedback

send questions beforehand, so teachers can prepare

Tasks to be done before each class

guidance and self-assessment for studying from textbook



Tasks

5 tasks planned and one week to solve one task

The task is a tool for guidance and self-assessment of independent study with the textbook; each task contains at least two subtasks, and your report of the task is used to discuss and compare in class how each of you did it

- 1 point: you make clear that you read the textbook and tried the subtask
- 2 points: you completed the task in a way that makes clear that you understood the textbook, or asked a good question about where you got stuck
- 3 points: a model answer, with clear & concise explanations, and exemplary language and presentation

At the end of the course, a review task gives you a second chance for the topics covered in weekly tasks

- 1 point: you completed the task in a way that makes clear that you understood the textbook
- 2 points: a model answer, with clear concise explanations, and exemplary language and presentation

Peer feedback (Task assessment)

MyCourses "Workshop" environment

At the submission deadline, it randomly allocates you three other reports to "assess" and compare with your own

You give points to your peers' reports, as well as an explanation

After the assessment deadline and evaluation by us, it shows you the assessments of your task report by your peers

Peer feedback is to be finalized soon after the session

The assessment by your peers may be overridden by the teaching group

You also receive participation points for submitting your work (or questions) on time & providing feedback during flipped classroom

Lectures and Tasks

Week 1

Task 0: Pre-assignment (Ch. 1)

Week 2

Task 1: Selection basics (Ch. 3, 4 & 5)

Week 3

Task 2: Multiple constraints (Ed. 4: Ch. 7 & 8 / Ed. 5: Ch. 8 & 9)

Week 4

Task 3: The effect of shape (Ed. 4: Ch. 9 & 10 / Ed. 5: Ch. 10 & 11)

Week 5

Task 4: Hybrid Materials (Ed. 4: Ch. 11 & 12 / Ed. 5: Ch. 12 & 13)

Week 6

Task 5: Materials and the Environment & Processes

(Ed. 4: Ch. 13, 14 & 15 / Ed.5: Ch. 14, 6 & 7)

Seminars

September 4: Materials testing and characterization (Sven Bossuyt)

September 11: Metals and alloys (Risto Ilola)

September 18: Materials modeling and machine learning (Junhe Lian)

September 25: Non-destructive testing + Welding technology (Pedro Vilaca)

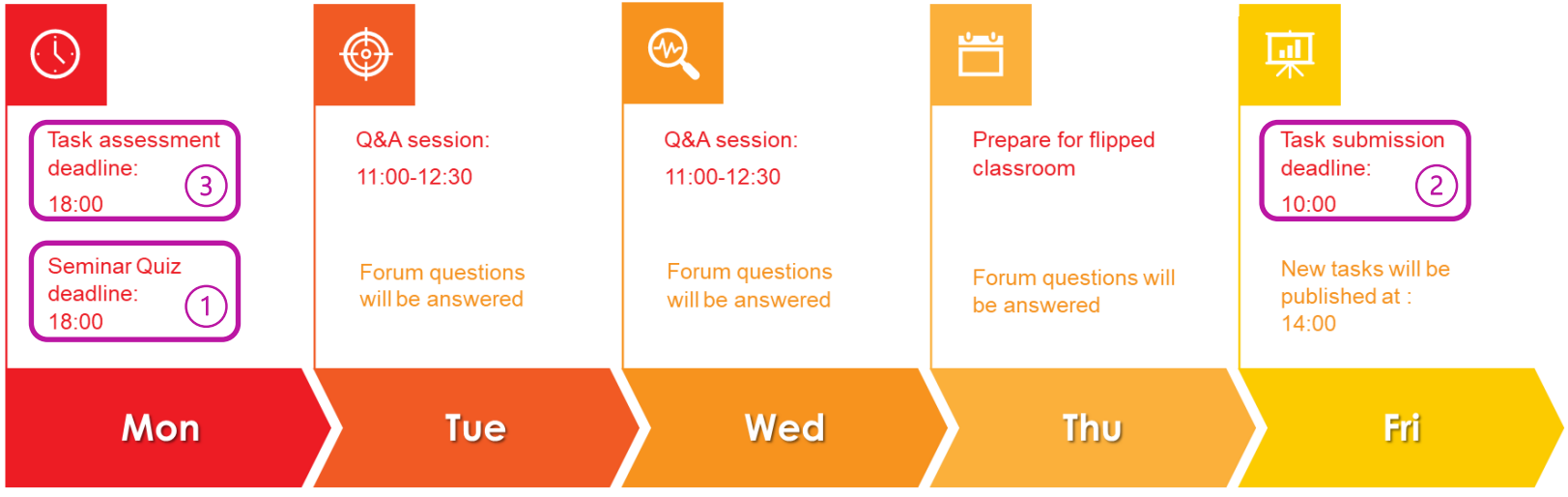
October 02: Materials safety (Iikka Virkkunen)

October 09: Casting technology (Juhani Orkas)

For each seminar, there is a quiz to be completed before 18:00 on the same day.

Timeline MEC-E1070 Selection of Engineering Materials

Weekly



Seminars

Exercises

Task-related questions Q&A sessions

*Raise a question in the **Forum**, they will be answered during the daily replying time 17:00-18:00 on weekdays*

Discussion in flipped classroom

Workload

Activities		Hours per week	Hours in total
Multiform teaching		2	12
Seminars		2	12
Exercises		2	12
Independent work	Reading	3-5	81
	Self-learning	3-5	
	Solving the tasks	4-6	
	Peer-review	1-2	
Case study		-	18
Total		-	135

Case Study (instead of exam)

Work out a materials selection problem in detail

3 options

- Part of a project or other course
- Individually, compare different materials for a case study you choose
- Groups of at least 3 students, compare your materials with each other

3 levels

- Basic case study (≤20 points)
- Detailed case study (≤30 points)
- Comparison (+ ≤10 points)

To be reported in writing, instead of an exam

Course grade

Total: 115 points

35 points: participation

- *12 flipped classrooms*
- *18 seminar questionnaires*
- *2 pre-assignment (Task 0)*
- *3 course feedback*

40 points: quality of tasks

- *6 selection basics & 2 peer assessment*
- *6 multiple constraints & 2 peer assessment*
- *6 effect of shape & 2 peer assessment*
- *6 hybrid materials & 2 peer assessment*
- *6 materials, environment and processes & 2 peer assessment*

40 points: case study

Total	Grade
≥95	5
≥85	4
≥75	3
≥65	2
≥50	1
<50	0

Task 0: Pre-assignment

- Access the course textbook and read chapter 1
- Access the software
- Check EduPack tutorials and learn the user interface
- Answer a few materials selection-related questions

See details in MEC-E1070 Task0.pdf.

Submission deadline: 10:00, Sep. 8th on MyCourses.

For task 0, maximum 1 point is credited for submission, and 1 point for assessment.

Tips

- **Join exercise and Q&A sessions**
- **Interact in the forum**
- **Ask early if you have questions about the tasks**
- **Invest enough and quality time into the course**
- **Be prepared with mechanics basics**

Questions?