

CHEM -E5100 Solid State Materials and Phenomena 2020

D.SC., UNI. LECTURER KIRSI YLINIEMI

*NOTE! If you have done course CHEM-C2450 Materiaalien ominaisuudet,
you cannot include this course to your degree*

After This Course You Can

1. **Explain electrical, thermal, dielectric and magnetic** properties from classical or quantum world viewpoint

2. **Calculate the main parameters** of the abovementioned properties for different materials

3. Describe the **working principles of smart materials** in sensors and actuators

4. **Ask critical questions** about peers' work and give constructive peer-feedback (opponenting)

Course Structure

Week 1 {
Lecture 1: Introduction to Smart Materials
Lecture 2: Kick-off Session for Group Work + Review

1. Exercise Session
3 problems

Week 2 {
Lecture 3: Electric Properties I
Lecture 4: Electric Properties II

2. Exercise Session
3 problems

Week 3 {
Lecture 5: Magnetic Properties I
Lecture 6: Magnetic Properties II

3. Exercise Session
3 problems

Week 4 {
Lecture 7: Thermal Properties
Lecture 8: Dielectrics Properties

4. Exercise Session
3 problems

Week 5 {
Lecture 9: Smart Materials: Piezoelectricity and Magnetostriction
Lecture 10: Smart Materials: Shape-Memory Alloys and Electroactive Polymers

5. Exercise Session
3 problems

Week 6 {
Lecture 11: Group Work Discussion (**Compulsory attendance, 3 h = 09-12**)
Lecture 12: Study at home

6. Exercise Session
Course Review

Lectures, Exercises and Exam

- ALL Online

Lectures

MON 10:15-12:00 (ZOOM)

WED 10:15-12:00 (ZOOM)

Exercises

THU 09:15-12:00 (ZOOM)

COURSE EXAM

21st October, 14:00-18:00

- Online Group Exam with MyCourses submission
- Choose your group in MyCourses (1-3 students)

MAKE-UP EXAM

8th December, 08:00-12:00

- Online Group Exam with MyCourses submission
- Choose your group in MyCourses (1-3 students)
- **WebOODI signing (7 days beforehand)**

About online learning:

I do my best to make online learning situations
as “lively” as possible
but I need your help too

**HIGH LECTURE ACTIVITY ↔
BETTER LEARNING**

**Do not be shy but open your mic and try to answer to my questions,
you can also write on the chat.**

**NOTE! Answering wrongly is actually an excellent thing
when it comes to learning**

- **Feel free to talk over me** and ask questions whenever
- You can also **use chat** for comments and questions
- I will divide you almost in every lecture to Breakout Rooms:
be active in discussions and if possible, have your camera* ON

**Having camera on is voluntarily but highly recommended*

Assessment

Task	Comment	Points
Activating Exercises (during lectures) / Weekly essays	Lectures 1-10: 0.5 p / lecture or essay	0-5
Exercise Sessions	Max.3 p / session	0-15
Group Work (compulsory)		
Video Review	Same for the whole group	1-9 (min. 1p)
Feedback Report		1-3 p
Answering to questions		1-3 p
		→3-15
Exam (compulsory)	Min. 7 points	0-25
TOTAL		60 points

To pass the course: min. 25 points

Course Material

1. **R.J.D. Tilley, Understanding Solids – Science of Materials, Wiley, 2nd Ed.**

- Available as *an eBook* from Aalto Library, link in MyCourses

AND

2. **K. Worden, W.A. Bullough, J. Haywood: Smart Technologies, (2003), Knovel**

- Available as *an eBook* from Aalto Library, link in MyCourses

AND

3. **Selected Publications**

- Links in MyCourses

Book / Journal Article	Chapter	Topic
R.J.D. Tilley, Understanding Solids – Science of Materials , Wiley (2013), 2 nd Ed.	Part 2	Classes of Materials <i>Lectures 1 & 2: Introduction to Smart Materials</i>
	Part 4 – Chapter 13	Electrical Solids <i>Lectures 3 & 4: Electrical Properties</i>
	Part 4 – Chapter 15	Thermal Solids <i>Lecture 7: Thermal Properties</i>
	Part 4– Chapter 11	Insulating Solids <i>Lecture 8: Dielectric Properties</i>
	Part 4 – Chapter 12	Magnetic Solids <i>Lecture 5 & 6: Magnetic Properties</i>
K. Worden, W.A. Bullough, J. Haywood: Smart Technologies , Knovel (2003)	Chapter 1	Introduction <i>Lectures 1 & 2 + 9-11: Introduction to Smart Materials</i>
	Chapters 5.1- 5.6	Shape-Memory Alloys <i>Lecture 10: Shape-Memory Alloys</i>
	Chapter 6.1	Piezoelectric Materials <i>Lecture 9: Piezoelectricity</i>
A.G. Olabi, A. Grunwald: Design and Application of Magnetostrictive Materials , <i>Materials and Design</i> 29 (2008) 469-483.	Chapters 1-4	Introduction; Magnetostriction Effect; Giant Magnetostriction Materials and Their Properties; Terfenol-D and production <i>Lecture 9: Magnetostrictive Materials</i>
E. Smela: Conjugated Polymer Actuators for Biomedical Applications , <i>Advanced Materials</i> 15 (2003) 481-494.	Chapters 1-2	Electroactive Polymers - Introduction; Background <i>Lecture 10: Electroactive Polymers</i>

**Lecture slides alone
are not enough to
UNDERSTAND
solid state physics**

Before this course you should know

- Basic of thermodynamics:

- Gibbs energy, enthalpy, entropy (1st and 2nd law of thermodynamics), heat capacity, etc.

- Basics of (modern) physics:

- Schrödinger's equation, particle-in-a-box problem, quantum numbers and electron configurations, de Broglie wavelength, harmonic oscillator, Fermi energy, density of states, etc.

Basics of material science:

- crystal structures, basics of electric, optic, magnetic, thermal and mechanical properties

Activating Exercises

*Compensation by
weekly
essays/exercises:*

DL Sunday

23:59

**During the
Lectures 1-10**

1-3 activating exercises / lecture
Max. 0.5 point / lecture

Exercise Sessions

THU 09:15-12:00 at ZOOMS

1. All exercises are published in MyCourses at the start of the course
2. In exercise session you get hints and you can ask questions
3. **Take a photo of HAND-WRITTEN answer, combine to a pdf file and submit to MyCourses after each week**
 - **DEADLINE: each week's SUNDAY, 23:59**
4. Max. 3 p / session (**TOTAL 5 x 3 p = 15 p**)
5. The answers are published in MC weekly, after the submission

All material – other than direct solutions to exercises - is allowed when solving exercises

Group Work

Max. 15 points

1. Video Review
2. Feedback Statement + 3 best questions
3. Discussions during Lecture sessions in WEEK 6

More Info on Next Lecture (THU)

All three parts of Group Work are **compulsory**

All points from Group Work are Group Grades

Group Work (max. 15 points)

APPLICATION(S) OF SMART MATERIAL TYPE "X"

1. *What is the basic principle in general?*
ONLY SHORTLY → less than 5 % of the work
2. *1-2 specific applications in one, selected field:*
 - This is what you concentrate on
 - *How the smart material works in the specific environment in question?*
 - *What are the current challenges?*
 - *Future potential?*

Group Work: Video

**Study and learn together
(even in remote learning mode)**

VIDEO (max. 15 mins)

- **Make a (fun) video with a clear, uniform story**

Making the Video

- **Visuality, movement and voice**
 - SHOW smart material(s) in action → application targets found in your surroundings...
 - Music, singing, acting, show, animations,....
- **Video can be fun too – EXTRA POINTS FROM HUMOUR**
 - Max. 15 min
 - Must contain a slide of references
- **You can use also videos from company pages etc. if and only if**
 - You provide proper reference for them
 - They are clearly a part of the story and you have own thoughts (slides etc.) embedded into your video too

Submit to MyCourses: **MONDAY 5th October**




Feedback Report: **At home, BEFORE** **Discussion Session** (as a group) 1/2

1. Watch one video carefully

- Video selected to your group by the teacher
- You may have to read also background material (references) in the video

2. Make critical but constructive questions and comments:

- Find the interesting parts of the video, find parts which could have been improved
 - Think also the science – is it all understood correctly? Are the conclusions sound?
- 

Feedback Report: **At home, BEFORE** **Discussion Session** (as a group) 2/2

3. Write a Feedback Report:

- Shows both strengths and weaknesses of the video in a constructive manner (critical but polite)
 - **Concentrate on Science**
 - Length: 1-2 pages of A4

4. Select 3-5 best questions and write them in the end of the statement

5. You will read aloud the report in Discussion session **12th October**

GRADED: 0 – 3 p



In Discussion Session

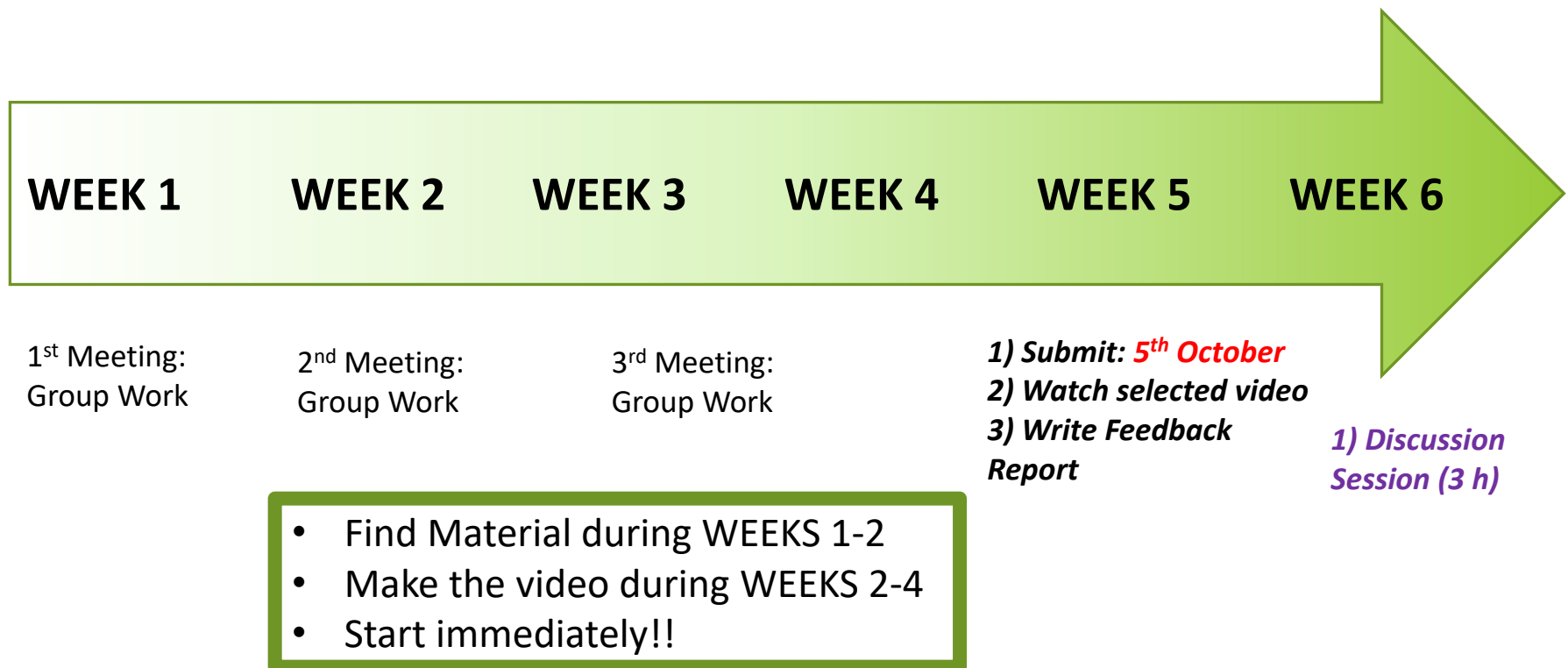
Mon 12th October 09-12

1. We will watch all videos
2. After each video, the "opponenting" group reads their Feedback Report and then asks the questions (one question at a time)
3. The group making the video defends their work, by answering to questions
 - *The opponenting group is allowed to ask even more questions during the discussion*

Defending your video is GRADED: 0 – 3 p



Timeline of Group Work



Assessment of Group Work

Task	DLINE	Points
Video	5th October	Max. 9
Feedback Reports after Discussion	Discussion: 12th October Written Reports: 14th October	Max. 3
Answering to questions	12th October	Max. 3
	TOTAL Max.	15 points

ONLINE Group Exam (max. 25 points)

COURSE EXAM

21st October, 14:00-18:00

- Choose the group in MyCourses

MAKE-UP EXAM

8th December, 08:00-12:00

- Choose the group in MyCourses

- Sign also in WebOODI

Basic Rules

- **Exam is done in groups of 1 – 3 persons**
 - You can choose the group yourself: think with whom you can work under stress and with strict timelimits
 - The whole group will get the same points
 - **The group must be chosen in MyCourses 6 days before the exam**
 - **CHOOSE THE GROUP ALSO IF YOU TAKE THE EXAM ALONE (OTHERWISE YOU CANNOT SUBMIT THE EXAM TO MYCOURSES)**
 - *If someone randomly joins your agreed group: inform Kirsi Yliniemi 4 days before the exam and the person is removed (he/she will do the exam alone)*
- **All communication is allowed within the group, but communication is NOT allowed outside the group**
- **You are allowed to use course material or google but you are NOT allowed to ask help outside your group (not even in chats, forums etc.)**

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How does this work?

- Questions are published in MyCourses at the start of the exam
- Answer to the questions as a group
- Combine answers to **ONE PDF file** and submit to MyCourses before the exam time is finished
 - For essays etc. text you may use computer (it is actually preferred)
 - Calculations you can do by hand: take a photo and embed to the Word-document on which you have written essay answers
 - Create then a pdf.

HINT! Save the last 30 mins of the exam time to combine answers, create pdf and submit to MyCourses

Despite being able to use course material
and Google during the exam

**prepare to the exam like you would do for a
traditional exam held in lecture halls**

- *You do not have time to start finding the
information during exam*

Emergencies during the exam

E.g. MyCourses is not responding... or other emergencies

- CALL Kirsi Yliniemi (+358 50 592 3690)
- You are provided a licence to submit the answers by email
 - Answers must be sent before the end of exam time
- However, you **MUST** submit exam answers **ALSO** to MyCourses **as soon as possible**
- **ONLY MYCOURSES SUBMISSIONS WILL BE GRADED**

How to Learn?

Study Gradually and Independently

→ book independent study time every week
in your calendar

≈ 2 h / week for lectures + 2 h / week for exercises

Communicate with other students also outside the class

→ email, Whatsapp, Zoom, Teams, Meet...

*Learn to know each other, help each other, have fun
together while learning...*