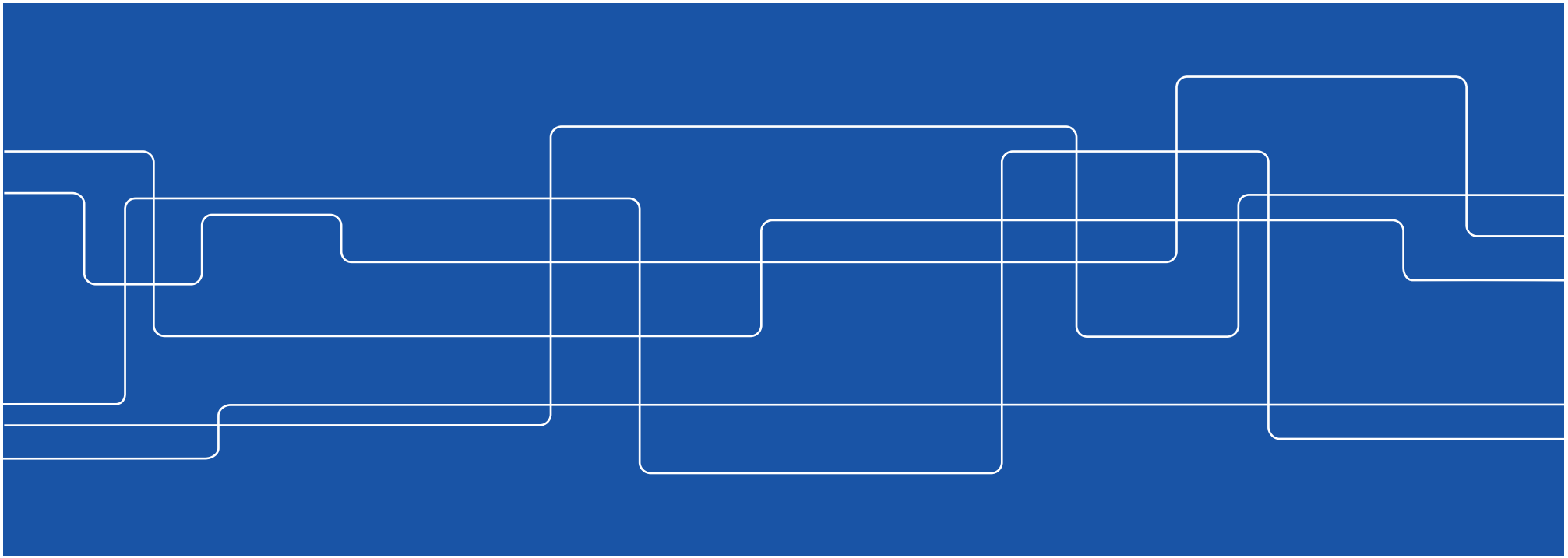
Welcome to ED2210 (6 credits)

Electromagnetic processes in dispersive media

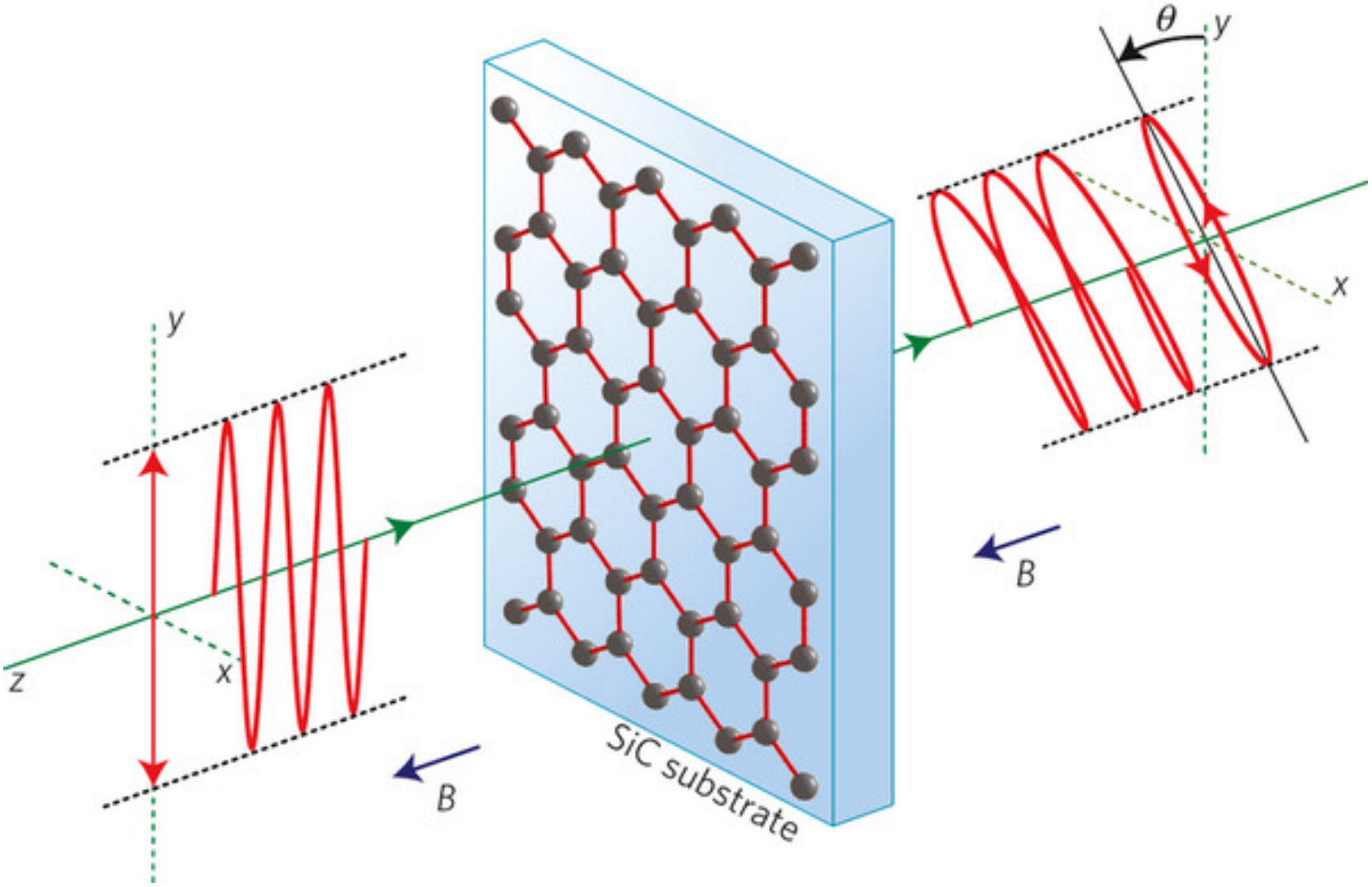
Lecturer: Thomas Johnson



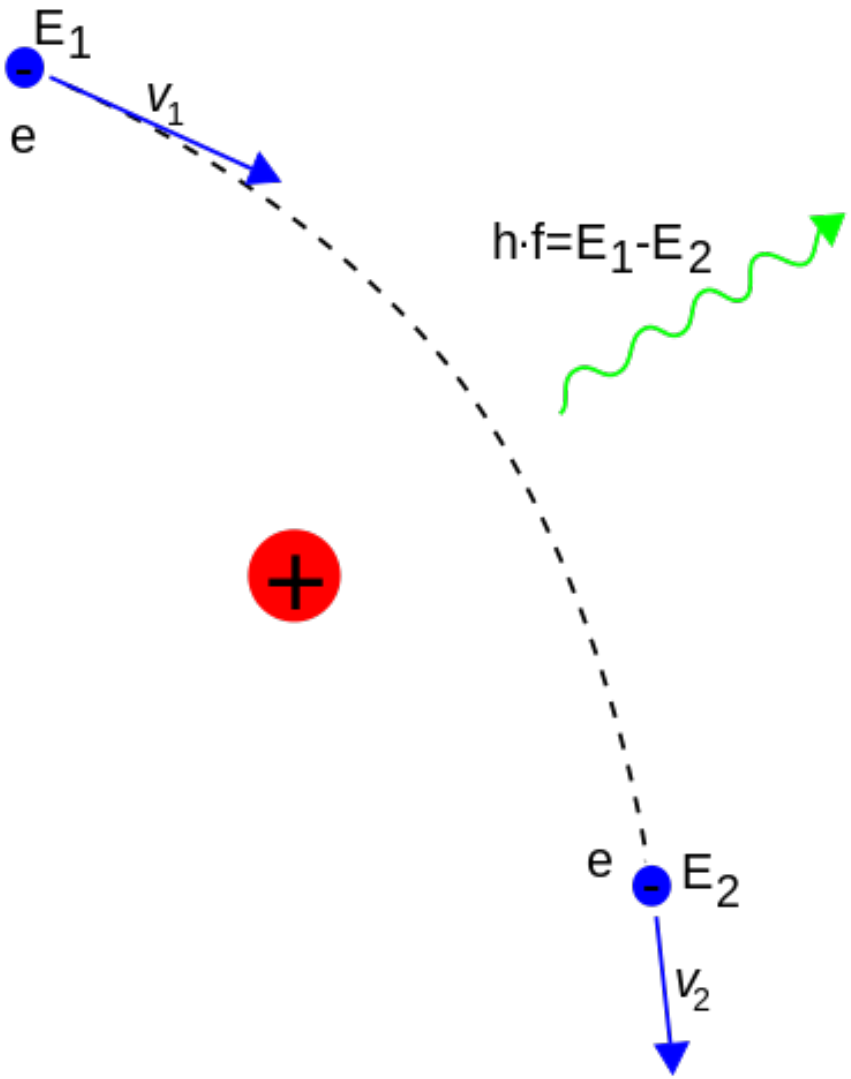
Dispersive media…

Why do the light split in different colors?

Dispersive media: Wave polarisation can be altered by crystals or plasmas



Dispersive media: Radiation processes



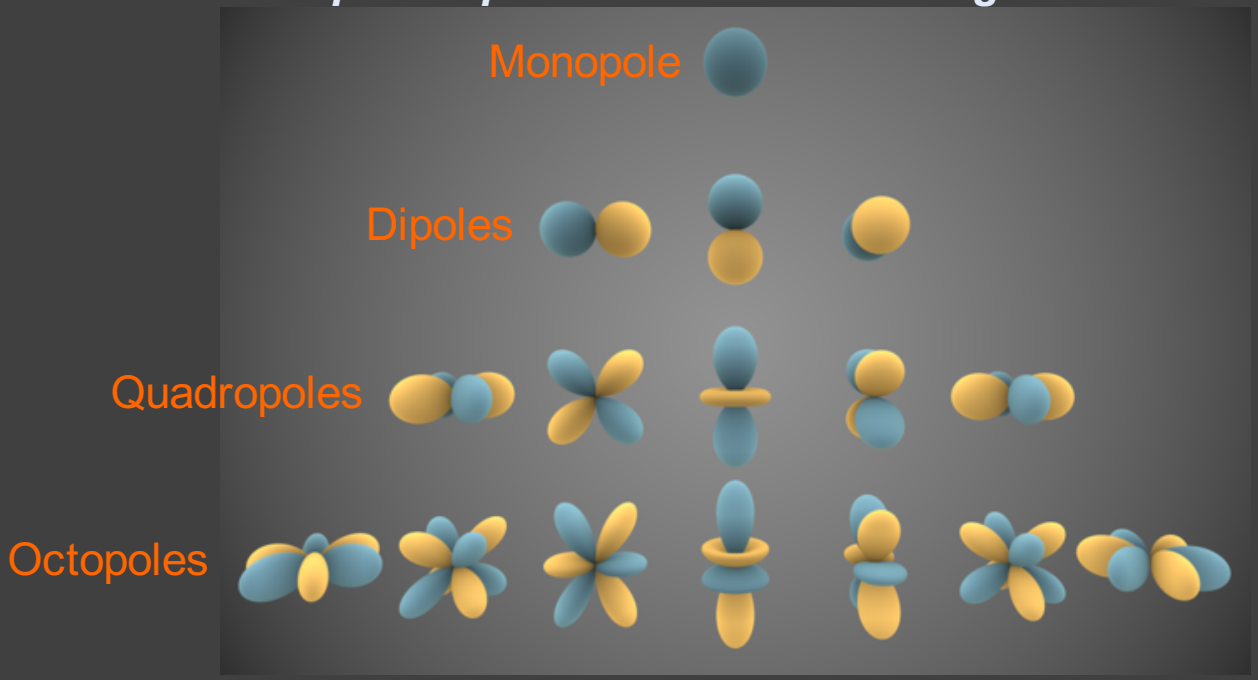
Course content

Part 1: Electromagnetic waves and mathematical representations

a) Maxwell's equations, its properties and representations

b) Mathematical tools: plane waves, Fourier analysis and tensor representations

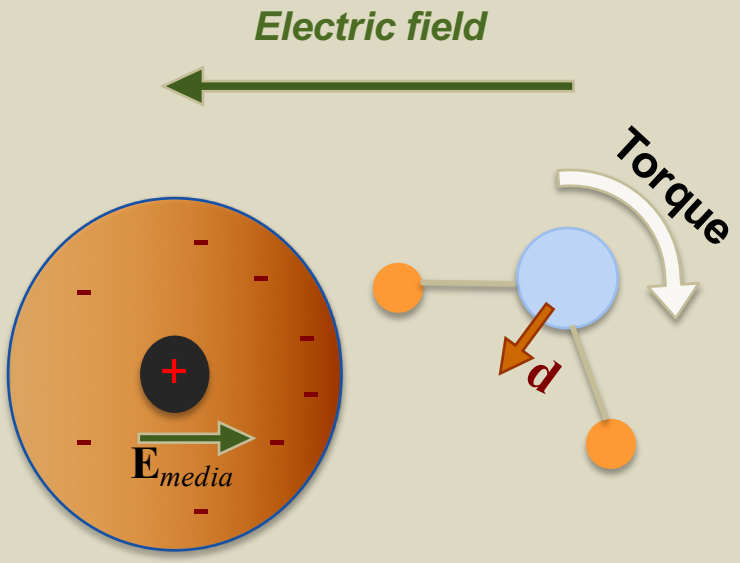
Multipole expansions of electro-magnetic fields



Course content

Part 2: What happens when an electromagnetic wave pass through a **media**?

- Mechanical properties of the media
- Concepts like grope velocity, dispersion, birefringence, …



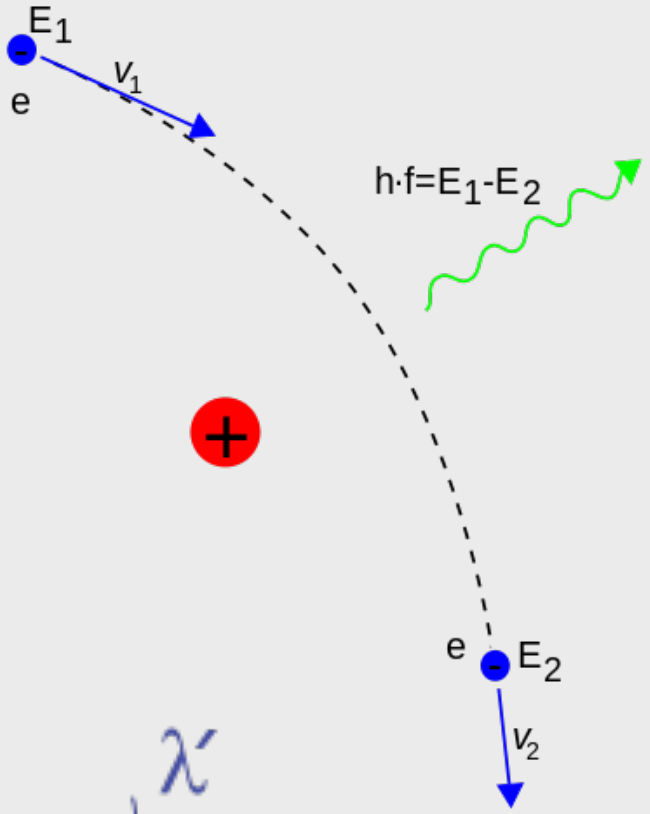
Looking through a birefringent Calcite crystal, the blue lines appear twice!

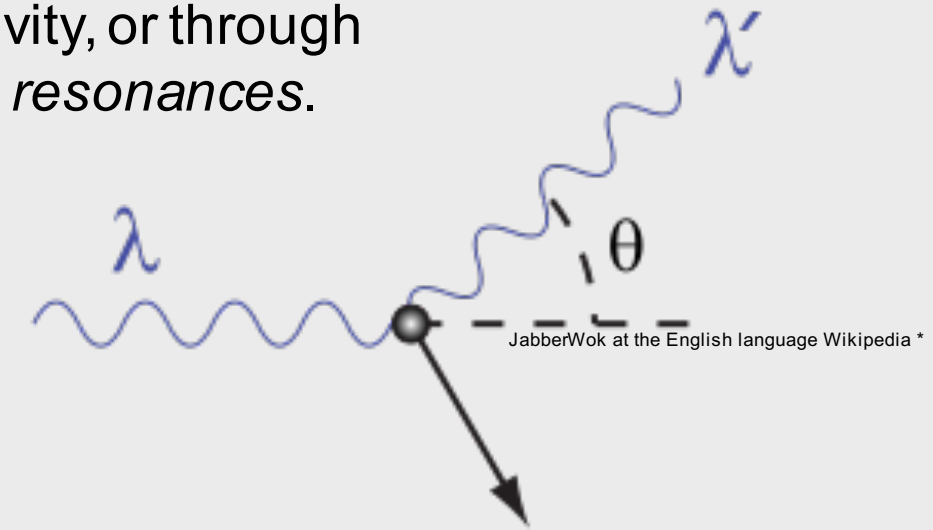
Course content

Part 3: Emission and **absorption** of electromagnetic waves

a) Electrons, ions, atoms, molecules can emit electromagnetic waves; like tiny antennas!

b) A media can absorb wave energy though resistivity, or through *wave-particle resonances*.





Examples

Ideal crystals:

- Anisotropic (produce birefringence)
- We only treat idealised crystal;
  - Use experimentally measured electromagnetic properties
  - Quantum solutions of crystal structure outside this course.

A crystal of amethyst quartz

Plasmas (we'll describe what is a plasma later on):

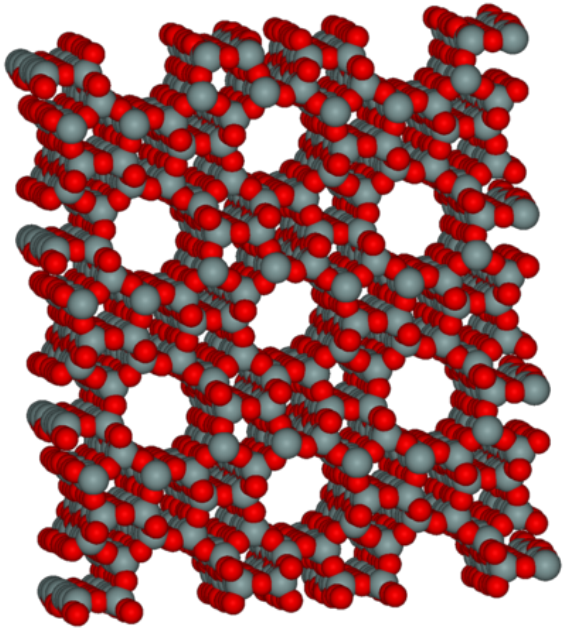
- Anisotropic, dispersive (temporal and spatially dispersive), intrinsic resonances…
  - Plasma have a very rich phenomenology!
- Plasmas often follow classical mechanics; first principle derivation of electromagnetic properties are possible!

Applications

The course concerns fundamental physics with applications in many fields of physics and engineering.

Examples:

- **Plasma physics**: fundamental in almost all plasma physics, particularly for diagnostics, wave heating, instabilities etc.
- **Astrophysics**: all observations rely on interpretations of emitted waves.
- **Optics**: dispersive/birefringent optical component.
- **X-rays applications**: CAT scanner, airport luggage scanner, crystallography…



Crystal structures can be measure X-ray crystallography

Practical details (January-March 2016)

The course will be taught Thomas Jonsson with assistance from Torbjörn Hellsten and Pablo Vallejos.

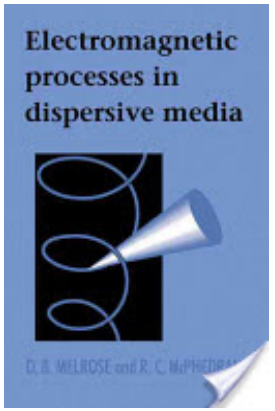
The course includes12 Lectures and exercise classes, while there are 14 scheduled meeting. I will get back to you about which two meeting to skip. It will *not* be during the coming two weeks.

Examination:

- Home assignments; 5 assignment
- Written exam (date to be decided)

Final grade is given from a weighted sum;
2/3 from written exam and 1/3 from home assignments.

Literature



- D.B. Melrose and R.C. McPhedran, "*Electromagnetic processes in dispersive media*" E-book downloadable using KTH account from : http://libris.kb.se/bib/5018804
- The lecture notes.

The lecture notes from Thomas will be on the web after the lecture, while the ones from Torbjörn will be handed out at the lectures.

Warning! *Lecture notes may include e.g. sign errors; please use the book to look up formulas.*

What is the examination like?

The home assignments in this course will test your ability to use mathematic to solve a physics problem.

As a complement, the written exam aim to test that you understand the physics. Of course, it still require some mathematical skills.

Note: Mathematical derivations are very useful,
but you are usually not required to be able to repeat them.

Later in the course we will hand out examples similar to the questions in the written exam.