Eksempler på læringsmål (*learning objectives*) i fysikkemner ”ute og hjemme”.

Solid state physics (University of Hawaii at Hanoa)
Students should be able to:
• Describe the elementary models for bonding of atoms and molecules and the consequential classifications used in solid state physics; relate the general properties (electrical, thermal and optical) for each class, including details of the expected crystal structures, to the mechanical properties.
• Describe, and perform simple calculations involving, the hexagonal close-packed structure and various cubic structures, which are commonly found in nature.
• Explain how the problem of elastic scattering by a crystal is treated using the concept of the reciprocal lattice and how calculations separate factors which depend on the lattice and on the basis, *i.e.* yield the Laue equations and a structure factor; solve problems relating to representative solid state materials.
• Give a detailed description of the features of the vibrations of monatomic and of diatomic linear chains and explain the significance of dispersion curves in three dimensions.
• Discuss in an informed manner the scattering of phonons, and in particular the occurrence of Umklapp scattering of phonons near the Brillouin zone edge.
• Describe the free electron model and apply it in calculations involving: the dispersion relation, the effective mass, the density of states, the Fermi distribution.
• Use the nearly free electron model to account for the occurrence of energy gaps at the Brillouin zone edges, and the consequent behaviour of the group velocity and effective mass of the electrons.
• explain qualitatively band theory;
• compare the strengths and weakness of free electron and nearly free electron theories;
• state Bloch Theorem;
• draw *E*-*k* diagrams;
• describe the concepts of Brillouin zone, Density of States, Fermi energy, effective mass and holes;
• describe the basic optical transitions in semiconductors;
• describe an acceptor and donor;
• distinguish between extrinsic and intrinsic properties of semiconductors;
• define drift, diffusion and thermal conduction and the relations between them for metals, semiconductors and degenerate semiconductors;
• distinguish an insulator, semiconductor and metal
• develop the basic skills of problem solving and critical thinking.

Solid state physics (IFY, NTNU)
Introduction to solid state physics. This is the first of two courses in introductory solid state physics.

Kommentar: Den første av disse er meget omfattende, men bortsett fra det, ganske brukbar? Den ene linjen i vårt eget emne kan vel ikke egentlig sies å være noe læringsmål.

Electromagnetism 1 (Eindhoven Technical University)

To know and be able to use the SI units of electrical quantities as well as their usual symbols.
To use vector notation and calculus in the calculation of electric fields.
To set up and solve integrals for line, plane and volume charge distributions (in particular line, circle, sphere and cylinder shaped) for the calculation of electric fields and potentials.
To know and be able to perform calculations with the concept grounding.
To analyze more complex problems requiring a combination of the above skills. This includes recognition and use of symmetry in physical problems and evaluation of limiting situations.

Electricity and magnetism (IFY, NTNU)
The student is expected to:
1. Obtain, through a combined theoretical and experimental approach to the subject, a fundamental understanding of electromagnetic phenomena.
2. Learn how to analyze various problems in electromagnetism with mathematical methods involving vectors and elementary differential and integral calculus.
3. Learn experimental methods in physics.

Kommentar: Varianten fra Eindhoven TU er mer spesifikk enn vår egen.

Mesoscopic physics (TU Delft)
Reach understanding of electronic properties of meso-size conductors, appreciate/recognize the role of classical and quantum processes, being able to explain electronic transport phenomena using simple physical concepts.

Mesoscopic physics (IFY, NTNU)
The student shall, with relatively simple physical models applied to recent experimental results, learn how basic physics can be used to describe and understand the behavior of systems on the borderline between macroscopic and atomic length scales. The course will hopefully motivate for further studies in mesoscopic physics, both theoretically and experimentally.

Kommentar: En del likhetstrekk her.

Subatomic physics (Penn State)
Students will:

- make quick order-of-magnitude estimates
- make use of symmetries and conservation laws in order to easily solve complex problems
- use simple physical system as a model for understanding the behavior of a more complex system
- identify elementary particles and the type of fundamental interaction responsible for a given elementary process
- describe some particle detection techniques
- identify some applications of nuclear or particle physics processes and the environments where these might be relevant.

Subatomic physics (IFY, NTNU)
The goal of the course is to give an elementary introduction to modern subatomic physics, with a focus on theories of atomic nuclei, the interactions among elementary particles, and astroparticle physics.

Kommentar: Varianten for vårt eget emne gir vel et bra bilde av hva emnet dreier seg om, men det beskrives vel ikke egentlig noen læringsmål?

Astrophysics (Imperial College)
• Compact Objects
o Characterise the different end stages of stellar evolution
o Be familiar with the concept of electron degeneracy
o Derive the mass-radius relation and calculate mass limits for white dwarfs and neutron stars
o Explain how black holes are defined in general relativity, and describe some of the observational consequences of the existence of black holes
o Appreciate the importance of accretion in astrophysics and derive the Eddington limit and luminosity and temperature profile of an accretion disk
• Galaxies and Dark Matter
o Have an appreciation of the length scales and matter content of the Universe;
o Know basic observational properties of spiral and elliptical galaxies
o Describe the basic physical properties important in the central regions of active galactic nuclei, and appreciate their wider importance in the universe
o Explain how the distribution of dark matter can be inferred from observed galaxy rotation curves; show that dark matter is not concentrated in the disk of the Milky Way
o Derive the scalar virial theorem and apply it to illustrate the need for dark matter from observations of the stellar velocity dispersion
o Explain the evidence for dark matter from the X-ray observations of galaxy clusters
o Understand the principle of gravitational lensing, quote the lens equation and solve for simple lensing scenarios; appreciate image parity and magnification
The Interstellar Medium
o Summarize the overall distribution of gas, dust and stars in our Galaxy
o Understand the basic concepts of radiative transfer physics – how photons interact with matter – which allow us to study the ISM and stars; be able to solve the equation of radiative transfer in simple limiting cases
o Describe the main components of the ISM;
o Explain qualitatively the formation of absorption and emission lines in these components; and understand what these lines imply about the conditions in these components

• The Birth and Death of Stars
o Summarize the overall picture of how stars form out of the ISM; explain the idea of Jeans mass; understand the concepts of gravitational collapse and fragmentation; qualitatively explain the processes in the simplified picture of a collapsing isothermal sphere
o Understand why accretion disks form around young stars and their basic physical processes, leading to the formation of planets
o Explain qualitatively some of the problems with the above picture of star and planet formation, with evidence from low-mass stars and brown dwarfs; explain some of the solutions;
o Understand some of the fundamental physical processes in the atmospheres of brown dwarfs, and what implications they have for both formation and the characterization of extra-solar giant planets.
o Summarize the nuclear processes in the end-stages of stars (especially massive ones); describe the primary features of, and differences between, the 2 main types of supernovae

Astrophysics (IFY, NTNU)
Basic knowledge about the Solar system, stars, galaxies, the Universe, and understanding of relevant physical processes.

Kommentar: Disse to er ikke helt samme kurs, men illustrerer vel spennet i hvordan en kan tenke seg å formulere læringsmål på emnenivå.