Board of Teacher Education
Physics

Syllabus

Physics II and Physics Education

Course Code:	FYGL21
Course Title:	Physics II and Physics Education *Fysik II med didaktisk inriktning*
Credits:	30
Degree Level:	Undergraduate level
Progressive Specialisation:	First cycle, has at least 60 credits in first-cycle course/s as entry requirements (G2F)

Major Field of Study:
FYA (Physics)

Course Approval
The syllabus was approved by the Board of Teacher Education 2017-08-30, and is valid from the Spring semester 2018 at Karlstad University.

Prerequisites
Mathematics 1-90 ECTS with at least 60 credits completed, or equivalent, plus the course FYGL12 with at least 15 credits completed, or equivalent

Learning Outcomes
The aim of the course is that student teachers acquire good knowledge in physics and physics education. On the basis of subject knowledge and a cognitive approach to physics, students develop skills in awakening pupils' interest and wish to know more. Students are also expected to enhance their professional skills by applying evidence- and experience-based knowledge to learning and development.

The course comprises four modules.

Module 1 Physics education, 7.5 ECTS cr
Upon completion of the module, students should be able to:
1. analyse students' learning and perceptions of concepts and phenomena in the course in relation to current educational research and theories of learning,
2. plan, carry out, analyse and present experiments in relation to course content,
3. reflect on school curricula and syllabi and illustrate their relation to current textbooks, learning theories, teaching and students' interest in and attitudes to the subject,
4. suggest and give arguments for content and methods for inclusive physics teaching and evaluate teaching critically and on the basis of subject knowledge and subject-specific teaching methodology, and
5. critically review and construct valid assessment criteria on the basis of general and subject-specific

pedagogy.

Module 2 Wave physics and beam optics, 7.5 ECTS cr

Upon completion of the module, students should be able to:
1. give an account of the different models for describing light: the wave, the radiation and the foton model and their applicability,
2. identify and analyse light and sound reflection and refraction in everyday phenomena and reconstruct reflection and refraction based on the radiation model,
3. explain refraction using the wave model and apply the model in different contexts,
4. identify wave properties such as wavelength, frequency and phase and apply the properties to wave phenomena,
5. identify and mathematically describe wave phenomena such as interference and diffraction and apply to different contexts,
6. apply central wave concepts to simple physical problems, formulate the problem mathematically, calculate a result and critically assess the order of magnitude of the result,
7. apply knowledge of wave behaviour and particle behaviour to describe the wave-particle duality and estimate its consequences for physical phenomena,
8. give an account of the basic properties of sound, including noise,
9. describe the most common optical instruments and draw ray paths and perform calculations for these, and
10. plan and conduct simple laboratory experiments and present the results orally and in writing.

Module 3 Mechanics, 7.5 ECTS cr
Upon completion of the module, students should be able to:
1. give an account of the basic concepts of mechanics and their relevance in different physical contexts,
2. apply mathematical modeling of different relevant mechanical systems to the calculation of requested magnitudes for the system based on the formulated model,
3. give an account of Newton's laws and connections derived from them, and apply them in analyzing problems of equilibrium for rigid bodies and rigid body systems,
4. apply Newton's laws and connections derived from them to particles, particle systems and rigid bodies in motion, and
5. construct idealised models of concrete mechanical problems and perform validity and probability analyses of the constructed models and of the calculated magnitudes that are part of them.

Module 4 Electromagnetism 7.5 ECTS cr
Upon completion of the module, students should be able to:
1. describe electric and magnetic fields for simple systems,
2. give an account of the concepts electric field strength, polarisation and magnetic field strength and magnetization,
3. give an account of the concepts test charging, charging density, bound and free charges, conductibility and eddy current,
4. describe similarities and differences between an electric dipole and a magnetic dipole,
5. give an account of how materials are classified regarding electric and magnetic properties,
6. give the definition of the magnitudes capacitance, resistance and inductance,
7. give an account of permittivity, permeability, Coulomb's law, Ohm's law in point form, Biot-Savart's law and Faraday's induction and Lorentz' force formula,
8. give an account of Poynting's theorem, and
9. outline the physical meaning of Maxwell's equations.

Content
Module 1 Physics education 7.5 ECTS cr.
Instruction is in the form of seminars and exercises.

Students synthesise and reflect on physics-specific teaching and general theories of learning and school practice applications as well as on the organisation of learning in teaching. On the basis of research and current curricula, the module centres on teaching and learning physics as a theoretical and experimental school subject and teaching practice. The importance of planning and organising teaching, learning and formative and summative assessment in physics in secondary education is treated.

Module 2 Wave physics and beam optics, 7.5 ECTS cr
Instruction is in the form of lectures, exercises and mandatory laboratory sessions.
Short review of basic concepts in wave physics, descriptions of plane, circular and spherical waves, mechanical and electromagnetic waves. Wave properties: wavelength, frequency and phase. Reflection, superposition, standing waves, oscillation, the Dopple effect, double slit experiments, interference, diffraction grating, diffraction through single slit, refraction and dispersion. Geometric optics, optical instruments, the eye, polarisation,Fermat's principle, Huygen's principle, lens and mirror imaging (computer-based beam optics) and polarisation, coherence and introduction to lasers. Experiments in beam optics, wave optics, interference, polarisation. Project and mandatory assignments in optics.

Module 3 Mechanics, 7.5 ECTS cr
Instruction is in the form of lectures and exercises.
Statics: Forces and force system, torque in two and three dimensions, free-body diagrams of mechanical systems, Newton's first and third laws, equilibrium in two and three dimensions, potential energy, and stability. Structures, internal forces, friction, mass centre.
Kinematics: Rectilinear and plane motion, constraints.
Dynamics: Newton's second law applied to rectilinear and curvilinear motion, work and energy, momentum and impulse, angular momentum.

Module 4 Electromagnetism 7.5 ECTS cr
Instruction is in the form of lectures and exercises.
Electric charge and electric fields, electric dipole, Gauss law, electric potential, capacity and dielectricum, magnetic fields and their sources. Lorentz force, induction and inductance, electromagnetic waves, Maxwell equations, Poynting vector and Poynting's theorem.

Reading List
See separate document.

Examination
All material submitted for assessment must clearly indicate individual contributions.

Module 1:
Learning outcomes 1, 3 and 5 are assessed a written assignment.
Learning outcome 2 is assessed on the basis of a digital presentation and practical demonstration of a laboratory experiment.
Learning outcomes 4 and 5 are assessed on the basis of seminars.

Module 2:
Learning outcomes 1-8 are assessed on the basis of written exams.
Learning outcomes 9 and 10 are assessed on the basis of written lab reports.

Modules 3 and 4:
All learning outcomes are assessed on the basis of written exams.

Modules 3 and 4: Assessment is based on written exams and laboratory reports.

Grades
One of the grades Distinction (VG), Pass (G), or Fail (U) is awarded in the examination of the course.

Quality Assurance
Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

Course Certificate
A course certificate will be provided upon request.

Additional information
The local regulations for studies at the Bachelor and Master levels at Karlstad University stipulate the obligations and rights of students and staff.

Teacher Education Programme: Secondary school level