Competence coverage matrix

GHENT UNIVERSITY
Bachelor of Science in Engineering

Engineering Physics

Academic year 2021-2022

Legend:
T=teaching methods
E=evaluation methods

			General Courses																				Courses Related to the Main Subject																							
			E001142 Basic Mathematics	E070080 Chemical Thermodynamics	E003043 Probability and Statistics	E066012 Materials Technology	E098512 Sustainability, Entrepreneurship and Ethics	E020061 Physics I	E001132 Mathematical Analysis I	E001460 Discrete Mathematics I	E070070 Chemistry: the Structure of Matter	E098513 Modelling, Making and Measuring	E015041 Informatics	E001222 Mathematical Analysis II	E000662 Geometry and Linear Algebra	E090320 Electrical Circuits and Networks	E020220 Physics II	E045120 Transport Phenomena	E001321 Mathematical Analysis III	E005020 Analysis of Systems and Signals	E007120 Modelling and Control of Dynamic Systems	E076040 Sustainable Business Operations	E040050 Theoretical Mechanics I	E023060 Quantum Mechanics II	E022110 Electromagnetism I	E032010 Electronic Systems and Instrumentation	E024620 Solid-state Physics and Semiconductors II	E030610 Photonics	E022210 Electromagnetism II	E099030 Cross-Course Project	E001810 Mathematical Tools in Engineering: Linear Algebra	E020310 Physics III	E021110 Materials and Fields	E023010 Quantum Mechanics I	E099131 Engineering Project	E040060 Theoretical Mechanics II	E024610 Solid-state Physics and Semiconductors I	E001820 Mathematical Tools in Engineering: Complex Analysis
Competences in one/more scientific discipline(s)	Have a clear understanding of the basic sciences and basic engineering sciences, and have the ability to apply them in a creative and purposeful way in the chosen specific engineering discipline.	T 33 E 33	T E	T E		T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E		T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E	T E
	Employ the basic sciences and techniques (statistics, ICT, CAD) in a creative and purposeful way.	T 13 E 13							T E	T E		T E	T E		T E			T E			T E				T E		T E	T E	T E			T E		T E				
	Possess the scientific knowledge, insight, and skills to analyse, model analytically and numerically, specify, design, control, and test experimentally, systems that are a direct application of the fundaments of physics.	T 12 E 13														T E						T E		T E			T E	T E	T E	E	T E	T E		T E			T E		T E
	Have a thorough understanding of the basis of quantum mechanics, the composition of matter, the states of matter, semiconductors, and their applications.	T 8 E 8																					T E		T E	T E	T E				T E	T E	T E			T E		
	Have a clear insight in fields (electric, magnetic) and wave phenomena (electromagnetic, acoustic, optic) and the competence to creatively apply it in systems.	T 5 E 5																							T E		T E	T E				T E				T E		
Scientific competences	Research and process technical and scientific information in a purposeful way.	T 9 E 7				T E	T E					T E	T E									T					T E		T E					T	T E				
	Employ standard models, methods and techniques in assignments.	T 25 E 25	T E		T E	T E			T E			T E	T E	T E	T E	T E			T E	T E	T E		T E	T E	T E	T E	T E	T E	T E	T E		T E	T E	T E		T E	T E	
	Schematize and model phenomena, processes, and systems.	T 19 E 18			T E			T E	T E	T E				T E	T E	T E	T E			T E	T E	T	T E	T E	T E		T E	T E	T E		T E					T E		
	Justify decision-making processes on rational grounds.	T 12 E 11		T E	T	T E	T E				T E	T E		T E						T E		T E						T E	T E	T E								
Intellectual competences	Understand and structure learning experiences.	T 17 E 15	T E		T E	T E			T E				T E	T E	T E				T E	T E	T	T E				T E	T E	T E	T E			T E				T	
	Think in a conceptual, analytical, system-oriented, problem-solving and synthesizing way at different levels of abstraction.	T 29 E 27	T E		T E	T E	T E	T	T E	T E			T E	T E	T E	T E	T E	T E	T E	T E	T E	T		T E	T E	T E	T E	T E	T E	T E	T E		T E		T E		T E	T E	
	Show precision, perseverance and critical reflection.	T 25 E 24	T E		T E	T E	T E		T E	T E				T E	T E	T E		T E	T E	T E	T		T E	T E		T E		T E	T E	T E	T E	T E		T E		T E	T E		T E
	Show scientific curiosity.	T 15 E 12		T E		T	T E	T			T E	T E		T E			T E			T E			T E					T E		T E				T	T E			
	Justify further studies or professional opportunities on rational grounds.	T 2 E 1				T														T E																		
Competences in cooperation and communication	Master scientific and discipline-specific technical terminology (also in English).	T 22 E 19	T E	T E	T E	T E	T E	T	T E		T	T E		T E	T E		T E	T E	T E		T		T E					T E	T E	T E					T E	T E	T E	
	Carry out concrete assignments systematically.	T 8 E 7					T E					T E												T E	T E			T E	T E	T E							T	
	Work as part of a team.	T 8 E 7					T E					T E													T E	T E		T E		T E					T E		T	
	Report results verbally, in writing, and graphically.	T 12 E 12				T E	T E					T E									T E			T E	T E		T E	T E	T E					T E		T E	
Societal competences	Act in an ethical and social way.	T 4 E 4				T E	T E															T E					T E											
	Be aware of the business aspects of the engineering discipline.	T 4 E 4					T E															T E					T E		T E									
			W 6 E 6	W 4 E 4	W 7 E 6	W 12 E 10	W 12 E 12	W 5 E 2	W 8 E 8	W 5 E 5	W 4 E 3	W 11 E 11	W 6 E 6	W 9 E 9	W 8 E 8	W 6 E 6	W 5 E 5	W 5 E 5	W 8 E 8	W 8 E 8	W 12 E 6	W 5 E 5	W 7 E 7	W 8 E 8	W 8 E 8	W 9 E 9	W 6 E 6	W 19 E 19	W 13 E 13	W 15 E 16	W 3 E 3	W 7 E 7	W 5 E 5	W 8 E 6	W 8 E 8	W 7 E 7	W 10 E 7	W 3 E 3

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E001142 Basic Mathematics	lecture seminar: coached exercises lecture: plenary exercises	written examination	Being able to perform basic calculations quickly and efficiently by hand. Being able to formulate correctly and with mathematical precision. Being able to make a correct reasoning and to write it down in a structured way. To have a thorough knowledge of the topics matrices, complex numbers, elementary functions and vectors.
E070080 Chemical Thermodynamics	guided self-study seminar: coached exercises lecture	written examination open book examination	Application of the laws of thermodynamics on chemical systems. Calculation of the solubility of ionic compounds in aqueous solutions. Calculation of the pH of aqueous solutions. Understand and apply chemical equilibrium.
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E098512 Sustainability, Entrepreneurship and Ethics	lecture project	participation assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E020061 Physics I	demonstration lecture	written examination	To understand the physical laws and concepts of the covered chapters. To be able to solve problems by applying these laws and concepts.
E001132 Mathematical Analysis I	guided self-study lecture: plenary exercises seminar lecture	written examination open book examination	Being able to assess the convergence of numerical series and series of functions. To have acquired insight in the mathematical, geometric and physical interpretation of notions of primitive function, integral, improper integral and integrability. To know the structure of the general solution of a linear differential equation, as well as the lack of a general solution of a non-linear differential equation, to be able to solve specific differential equations and to check the existence and uniqueness conditions for the corresponding initial value problems. Being able to use Fourier series for solving partial differential equation by separation of variables. Being able to perform integral transforms, having acquired insight in their respective properties and being able to use them for solving initial value problems. Being able to construct and manipulate power series and Fourier series. Being able to use power series for solving ordinary differential equations.
E001460 Discrete Mathematics I	guided self-study seminar: coached exercises practicum lecture	written examination open book examination	Distinguishing and applying fundamental algebraic and discrete structures. Being fluent in graph algorithms and applying them to real problem situations. Deploying deductively correct reasonings in an independent way. Evaluating logical reasonings with respect to correctness / identifying errors. Deploying mathematical reasoning and proof argumentation. Using basic concepts from set theory, group theory, combinatorics and graph theory.
E070070 Chemistry: the Structure of Matter	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform stoichiometric calculations. Identify and describe the different types of intermolecular interactions. Being able to determine the molecular geometry of covalent compounds. Identify and describe the different types of chemical bonding. Being able to order atoms and ions based on their periodic properties Being able to write the electron configuration of atoms and ions.
E098513 Modelling, Making and Measuring	project	report	Concepts: working collaboration in a group, scientific techniques, use of scientific language.
E015041 Informatics	lecture seminar: practical PC room classes	written examination open book examination	To master the structured programming paradigm and to realize a Python program, using this structured programming paradigm . To design an algorithm solving a given problem, and to assess the complexity of this solution. To master the basic concepts of objectorientation and to realize an objectoriented program in Python.
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E000662 Geometry and Linear Algebra	guided self-study lecture: plenary exercises seminar lecture	open book examination	Having acquired insight in the notions rank, image, kernel, invertability, and determinant of a linear transform. Having acquired skills in the manipulation of vectors. Being able to write down vector representations of curves and surfaces, and to perform chains of active and passive transforms on them. Being able to construct an orthogonal basis by means of the Gram-Schmidt-procedure, to project a vector orthogonally onto a subspace and to perform a least squares algorithm. Being able to give the matrix representation and the corresponding formulae of an affine or co-ordinate transform in threedimensional space, or of a linear transform between abstract vector spaces. Having acquired insight in the notions vector space, linear dependence and independence, basis and dimension. Being able to write down the respective reduced forms of a matrix and use them for solving systems of linear equations. Having acquired insight in the mathematical, physical and geometric meaning of eigenvalues and eigenvectors.
E090320 Electrical Circuits and Networks	lecture seminar: coached exercises	written examination	Draw amplitude and phase Bode diagrams for transfer functions and determine the poles and zeros. Analyze basic electrical circuits containing diodes, bipolar transistors and MOSFETs. Determine the balance of active and reactive electrical power in a three-phase electrical network. Analyze linear circuits with resistors, (coupled) inductors and capacitors in dc, in the periodic regime and during transients.
E020220 Physics II	demonstration lecture	written examination participation	To be able to solve physics problems by applying these laws and concepts. To understand the physical laws and concepts of the covered chapters.
E045120 Transport Phenomena	lecture seminar: practical PC room classes seminar	open book examination	To understand the properties of fluids. To understand the similarities between transport of impulse, heat and mass. To solve problems of stationary heat transport. To know the basic laws of stationary heat transport and to be able to apply them. To understand the law of energy in open and closed systems and to be able to apply it. To master the laws of statics and dynamics and to be able to apply them.

E001321	Mathematical Analysis III	lecture seminar: coached exercises lecture: plenary exercises	written examination	To master the basic theory of curves. To apply the residue theorem in a variety of situations. To calculate complex line integrals both directly and by means of theoretical results. To have insight in the meaning of holomorphic functions and to be able to apply their properties. To calculate line and surface integrals both directly and by means of theoretical results. To have insight in the meaning of the notions line and surface integral and in the theorems of Green, Gauss and Stokes. To have acquired insight in the meaning of the notions scalar and vector potential, rotation and divergence free vector fields, conservative and solenoidal vector fields. To have acquired skills in calculations with the nabla operator.
E005020	Analysis of Systems and Signals	lecture seminar: coached exercises	written examination with multiple choice questions	To identify systems and signals; to describe them in continuous time and discrete time. To be able to execute the Laplace transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To be able to execute the Z-transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To have understood the sampling theorem and its applications. To have gained insight in the various Fourier transforms. To have gained insight in the impulse response , the frequency response and the transfer function as an alternative description of a linear system, as well as in their mutual relationships. To have gained insight in Fourier series as a basis for the decription of signals and as a basis for transforming signals. To describe linear systems by means of the state model. (exclusively for the 6 credit points course.)
E007120	Modelling and Control of Dynamic Systems	lecture seminar: coached exercises	written examination	Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems. To implement modeling and control on small scale setups by using personal laptop To design of controllers based on the application of root-locus techniques and frequency-response techniques such as Bode, Nyquist. Being able to analyse feedback control systems using several stability criteria. To evaluate in a correct way the results of computer simulations and numerical techniques when designing feedback control systems. To have insight regarding the static and dynamic behaviour of systems and to apply this insight when designing feedback loops. To derive transfer-function models and state-space models of physical systems and comprehend linear and nonlinear behavior.
E040050	Theoretical Mechanics I	lecture seminar: coached exercises	written examination with open questions open book examination	To have insight in the Newtonian formulation of classical mechanics of point masses. To be able to set up the Lagrange and the Hamilton equations in concrete applications. To have insight in the Lagrangian and the Hamiltonian formalism for point masses. To be able to analyse and solve simple problems in mechanics and to be able to interpret their solution.
E023060	Quantum Mechanics II	lecture seminar: coached exercises	written examination oral examination	Have detailed knowledge of Perturbation theory (stationary and time-dependent) and scattering theory and being able to apply it to relevant problems. Have the skills for analyzing and applying two-level systems. Understand solution methods for Schrodinger equation in a spherical potential and being able to communicate about them. Possess detailed knowledge of concepts related to angular momentum and spin and have the ability to explain them.
E022110	Electromagnetism I	lecture seminar: coached exercises project	written examination with open questions report written examination	To be able to describe, understand and discuss wave propagation in free space and in waveguides. To understand and to be able to obtain Green's functions for general free space current sources and for 2D problems. To understand, calculate and determine voltage and current behaviour on transmission lines. To be able to program a numerical technique as applied to a "simple" wave problem.
E032010	Electronic Systems and Instrumentation	lecture practicum	written examination skills test	Being able to build and experimentally evaluate analog and digital electronic circuits at breadboard level with sufficient accuracy, perseverance and critical reflection. Have the skill to communicate about own design of electronic systems in writing and in graphics. Have the skills to perform numerical simulations of electronic circuits by means of standard models and methods, in particular PSpice. Analyse basic analog and digital electronic circuits and think in a conceptual, analytical, system-oriented way about them. Understand the operation of the basic electronic components
E024620	Solid-state Physics and Semiconductors II	lecture seminar practicum	written examination	Using concepts from semiconductor physics to explain the operation of electronic components (p-n junction, heterojunction, metal/semiconductor contact, MOS structure). Knowing key concepts related to crystal growth and epitaxial growth. Knowing key concepts related to defects in solids (vacancies, interstitials, color center, dislocations, stacking fault, surface, work function). Knowing key concepts related to superconductivity (e.g. Meissner effect, Cooper pair, Josephson junction) and possess the scientific curiosity to explore them further. Understanding the relationship between size and electronic properties of nanostructures and possess the scientific curiosity to explore them further.
E030610	Photonics	group work seminar: coached exercises practicum lecture	written examination skills test assignment oral examination open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210	Electromagnetism II	lecture seminar: coached exercises	written examination open book examination	Explain and apply concepts related to antennas and 3D radiations. Understand and apply the principles and methods of electrodynamics of moving sources and materials and apply these concepts (such as Doppler effect) in the framework of special relativity. Describe and apply acustic phenomena.
E099030	Cross-Course Project	project	oral examination report	Make links between different knowledge domains.
E001810	Mathematical Tools in Engineering: Linear Algebra	lecture seminar	written examination with open questions	Have insight into linear analysis and apply it creatively and purposefully within one's own engineering discipline. Use current models, methods and techniques of linear algebra in assignments.

E020310	Physics III	lecture seminar: coached exercises	written examination oral examination	Application of basic concepts of thermodynamics and statistical physics. Knowledge of thermodynamical concepts and the application on a broad variety of thermodynamical systems. Application of the various statistical distribution functions on systems with a lot of degrees of freedom. Derivation of partition functions for simple and complicated systems. Understand the relation between macroscopic and microscopic description of matter.
E023010	Quantum Mechanics I	lecture lecture: plenary exercises	written examination	Explaining quantisation of observables and the postulates of quantum mechanics. Describing and applying the operator concept in quantum mechanics. Explaining and elucidating wave-particle duality.
E099131	Engineering Project	lecture project	report	Being able to accurately perform physical experiments in group, to analyze the obtained data and to interpret the results in a critical way with the application of appropriate error analysis. Being able to write an accurate, succinct and clear report of the experimental physical project based on a scientific paper (state of the art, objectives, experimental methods, results and conclusions). Learning specific ICT skills for word processing in Latex and data processing (graphs and tables).
E040060	Theoretical Mechanics II	lecture seminar: coached exercises	written examination open book examination	To have a thorough command of the basic concepts and techniques concerning the statics and dynamics of rigid bodies, and to be able to apply them to simple engineering problems. To be able to solve simple problems of small oscillations. To have insight in the technique of small oscillations in the neighbourhood of a stable equilibrium. To be able to apply the Lagrangian and Hamiltonian formulation to the mechanics of rigid bodies. To be able to give a mathematical formulation of problems from mechanics of rigid bodies, and to solve them analytically in simple cases.
E024610	Solid-state Physics and Semiconductors I	lecture seminar: coached exercises online discussion group	written examination with open questions oral examination open book examination	Understand the basic theoretical concepts of solid state and semiconductor physics (direct and reciprocal lattice, phonons, electronic band structure, Fermi level, effective mass, holes) and being able to apply these concepts to materials with a highly symmetric crystal structure. Being able to derive, schematize, and explain the relation between the internal structure of a solid and its macroscopic (elastic, thermal, electric and optical) properties.
E001820	Mathematical Tools in Engineering: Complex Analysis	lecture seminar	written examination with open questions	Have insight into complex analysis and apply it creatively and purposefully within one's own engineering discipline. Use current models, methods and techniques of complex analysis in assignments. Use the terminology of complex analysis correctly.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E001132 Mathematical Analysis I	lecture lecture: plenary exercises seminar	written examination	Being able to assess the convergence of numerical series and series of functions. To know the structure of the general solution of a linear differential equation, as well as the lack of a general solution of a non-linear differential equation, to be able to solve specific differential equations and to check the existence and uniqueness conditions for the corresponding initial value problems. Being able to use Fourier series for solving partial differential equation by separation of variables. Being able to perform integral transforms, having acquired insight in their respective properties and being able to use them for solving initial value problems. Being able to construct and manipulate power series and Fourier series. Being able to use power series for solving ordinary differential equations.
E001460 Discrete Mathematics I	practicum	written examination	Distinguishing and applying fundamental algebraic and discrete structures. Being fluent in graph algorithms and applying them to real problem situations. Deploying deductively correct reasonings in an independent way. Evaluating logical reasonings with respect to correctness / identifying errors. Deploying mathematical reasoning and proof argumentation. Using basic concepts from set theory, group theory, combinatorics and graph theory.
E098513 Modelling, Making and Measuring	project	participation report	Use of software tools to make simulations and diagrams
E015041 Informatics	lecture seminar: practical PC room classes	written examination open book examination	To master the structured programming paradigm and to realize a Python program, using this structured programming paradigm . To master the basic concepts of objectorientation and to realize an objectoriented program in Python.
E000662 Geometry and Linear Algebra	guided self-study lecture: plenary exercises seminar lecture	written examination	Being able to write down the respective reduced forms of a matrix and use them for solving systems of linear equations. Having acquired skills in the manipulation of vectors. Being able to write down vector representations of curves and surfaces, and to perform chains of active and passive transforms on them. Being able to construct an orthogonal basis by means of the Gram-Schmidt-procedure, to project a vector orthogonally onto a subspace and to perform a least squares algorithm. Being able to give the matrix representation and the corresponding formulae of an affine or co-ordinate transform in threedimensional space, or of a linear transform between abstract vector spaces.
E045120 Transport Phenomena	seminar: practical PC room classes	open book examination	To solve problems of stationary heat transport.
E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises	written examination	To evaluate in a correct way the results of computer simulations and numerical techniques when designing feedback control systems.
E032010 Electronic Systems and Instrumentation	practicum	skills test	Being able to build and experimentally evaluate analog and digital electronic circuits at breadboard level with sufficient accuracy, perseverance and critical reflection. Have the skills to perform numerical simulations of electronic circuits by means of standard models and methods, in particular PSpice.
E030610 Photonics	group work	assignment	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	project	report	Computer-aided design simple wire antennas. Analyse and calculate the most important antenna characteristics.
E099030 Cross-Course Project	project	oral examination report	Make links between different knowledge domains.
E021110 Materials and Fields	self-reliant study activities	assignment	Solving elementary electromagnetic field problems. Good knowledge of the fundamentals of quasi-stationary electromagnetic fields. Turning a quasi-stationary electromagnetic field problem into a boundary value problem.
E099131 Engineering Project	lecture project	report	Being able to write an accurate, succinct and clear report of the experimental physical project based on a scientific paper (state of the art, objectives, experimental methods, results and conclusions). Learning specific ICT skills for word processing in Latex and data processing (graphs and tables).

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E090320 Electrical Circuits and Networks	lecture seminar: coached exercises	written examination	Analyze basic electrical circuits containing diodes, bipolar transistors and MOSFETs.
E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises	written examination	Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems.
E040050 Theoretical Mechanics I	lecture seminar: coached exercises	written examination with open questions open book examination	To have insight in the Newtonian formulation of classical mechanics of point masses. To have a general insight in the construction and the meaning of a mathematical model for a physical theory. To have insight in the Lagrangian and the Hamiltonian formalism for point masses.
E032010 Electronic Systems and Instrumentation	lecture practicum	written examination skills test	Being able to build and experimentally evaluate analog and digital electronic circuits at breadboard level with sufficient accuracy, perseverance and critical reflection. Have the skill to communicate about own design of electronic systems in writing and in graphics. Have the skills to perform numerical simulations of electronic circuits by means of standard models and methods, in particular PSpice. Analyse basic analog and digital electronic circuits and think in a conceptual, analytical, system-oriented way about them. Understand the operation of the basic electronic components
E024620 Solid-state Physics and Semiconductors II	practicum	skills test	Possess the practical skills for performing electrical measurements on semiconductor components.
E030610 Photonics	group work seminar: coached exercises practicum lecture	written examination skills test assignment oral examination open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	lecture seminar: coached exercises project	written examination report open book examination	Explain and apply concepts related to antennas and 3D radiations. Analyse and calculate the most important antenna characteristics. Understand and apply the principles and methods of electrodynamics of moving sources and materials and apply these concepts (such as Doppler effect) in the framework of special relativity. Describe and apply acustic phenomena. Computer-aided design simple wire antennas.
E099030 Cross-Course Project	Het vakoverschreidend project toetst of deze competentie aanwezig is en stimuleert de student door peerleren ze verder te actualiseren, maar deze competentie wordt niet expliciet aangebracht in dit opleidingsonderdeel.	oral examination report	Make links between different knowledge domains.
E001810 Mathematical Tools in Engineering: Linear Algebra	lecture seminar	written examination with open questions	Use the terminology of linear algebra correctly. Use current models, methods and techniques of linear algebra in assignments. Have insight into linear analysis and apply it creatively and purposefully within one's own engineering discipline.
E020310 Physics III	lecture seminar: coached exercises	written examination oral examination	Application of basic concepts of thermodynamics and statistical physics. Knowledge of thermodynamical concepts and the application on a broad variety of thermodynamical systems. Application of the various statistical distribution functions on systems with a lot of degrees of freedom. Derivation of partition functions for simple and complicated systems. Understand the relation between macroscopic and microscopic description of matter.
E023010 Quantum Mechanics I	lecture lecture: plenary exercises	written examination	Explaining quantisation of observables and the postulates of quantum mechanics. Describing and applying the operator concept in quantum mechanics. Explaining and elucidating wave-particle duality.
E040060 Theoretical Mechanics II	lecture seminar: coached exercises	written examination open book examination	To have a thorough command of the basic concepts and techniques concerning the statics and dynamics of rigid bodies, and to be able to apply them to simple engineering problems. To have insight in the technique of small oscillations in the neighbourhood of a stable equilibrium. To be able to apply the Lagrangian and Hamiltonian formulation to the mechanics of rigid bodies. To be able to give a mathematical formulation of problems from mechanics of rigid bodies, and to solve them analytically in simple cases.
E001820 Mathematical Tools in Engineering: Complex Analysis	lecture seminar	written examination with open questions	Have insight into complex analysis and apply it creatively and purposefully within one's own engineering discipline. Use current models, methods and techniques of complex analysis in assignments.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E023060 Quantum Mechanics II	lecture seminar: coached exercises	written examination oral examination	Have detailed knowledge of Perturbation theory (stationary and time-dependent) and scattering theory and being able to apply it to relevant problems. Have the skills for analyzing and applying two-level systems. Understand solution methods for Schrodinger equation in a spherical potential and being able to communicate about them. Possess detailed knowledge of concepts related to angular momentum and spin and have the ability to explain them.
E032010 Electronic Systems and Instrumentation	lecture	written examination	Understand the operation of the basic electronic components
E024620 Solid-state Physics and Semiconductors II	lecture seminar practicum	written examination	Understanding the effect of electric fields and concentration gradients on the band structure in semiconductors. Knowing key concepts related to crystal growth and epitaxial growth. Knowing key concepts related to defects in solids (vacancies, interstitials, color center, dislocations, stacking fault, surface, work function). Knowing key concepts related to superconductivity (e.g. Meissner effect, Cooper pair, Josephson junction) and possess the scientific curiosity to explore them further. Understanding the relationship between size and electronic properties of nanostructures and possess the scientific curiosity to explore them further. Using concepts from semiconductor physics to explain the operation of electronic components (p-n junction, heterojunction, metal/semiconductor contact, MOS structure). Being able to draw and interpret energy band diagrams.
E030610 Photonics	group work seminar: coached exercises practicum lecture	written examination skills test assignment oral examination open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E020310 Physics III	lecture seminar: coached exercises	written examination oral examination	Application of basic concepts of thermodynamics and statistical physics. Knowledge of thermodynamical concepts and the application on a broad variety of thermodynamical systems. Application of the various statistical distribution functions on systems with a lot of degrees of freedom. Derivation of partition functions for simple and complicated systems. Understand the relation between macroscopic and microscopic description of matter.
E021110 Materials and Fields	lecture	written examination with open questions	Good knowledge of elementary models for modeling mechanisms of polarization and magnetization in materials. Insight into the relation between microscopic and macroscopic fields and forces.
E023010 Quantum Mechanics I	lecture lecture: plenary exercises	written examination	Having developed a scientific curiosity for quantum mechanics and its applications. Describing and applying the operator concept in quantum mechanics. Explaining and elucidating wave-particle duality. Explaining quantisation of observables and the postulates of quantum mechanics.
E024610 Solid-state Physics and Semiconductors I	lecture seminar: coached exercises practicum online discussion group	written examination with open questions report oral examination open book examination	Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Being able to derive, schematize, and explain the relation between the internal structure of a solid and its macroscopic (elastic, thermal, electric and optical) properties. Recognize doping as a method to control the electronic properties of semiconductors. Understand the basic theoretical concepts of solid state and semiconductor physics (direct and reciprocal lattice, phonons, electronic band structure, Fermi level, effective mass, holes) and being able to apply these concepts to materials with a highly symmetric crystal structure. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E022110 Electromagnetism I	lecture seminar: coached exercises project	written examination with open questions report written examination	To be able to describe, understand and discuss wave propagation in free space and in waveguides. To understand and to be able to obtain Green's functions for general free space current sources and for 2D problems. To understand, calculate and determine voltage and current behaviour on transmission lines. To be able to program a numerical technique as applied to a "simple" wave problem.
E030610 Photonics	group work seminar: coached exercises practicum lecture	written examination skills test assignment oral examination open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	lecture seminar: coached exercises project	written examination report open book examination	Explain and apply concepts related to antennas and 3D radiations. Analyse and calculate the most important antenna characteristics. Understand and apply the principles and methods of electrodynamics of moving sources and materials and apply these concepts (such as Doppler effect) in the framework of special relativity. Describe and apply acustic phenomena. Computer-aided design simple wire antennas.
E021110 Materials and Fields	lecture seminar: coached exercises	written examination with open questions	Solving elementary electromagnetic field problems. Good knowledge of the fundamentals of quasi-stationary electromagnetic fields. Turning a quasi-stationary electromagnetic field problem into a boundary value problem.
E024610 Solid-state Physics and Semiconductors I	lecture seminar: coached exercises practicum online discussion group	written examination with open questions report oral examination open book examination	Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Being able to derive, schematize, and explain the relation between the internal structure of a solid and its macroscopic (elastic, thermal, electric and optical) properties. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E098512 Sustainability, Entrepreneurship and Ethics	project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E098513 Modelling, Making and Measuring	project	report	Concepts: working collaboration in a group, scientific techniques, use of scientific language.
E015041 Informatics	seminar: practical PC room classes	written examination open book examination	To master the structured programming paradigm and to realize a Python program, using this structured programming paradigm . To master the basic concepts of objectorientation and to realize an objectoriented program in Python.
E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises		Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems. To evaluate in a correct way the results of computer simulations and numerical techniques when designing feedback control systems.
E030610 Photonics	group work	oral examination assignment	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E099030 Cross-Course Project	guided self-study project	oral examination report	Find information in the literature.
E023010 Quantum Mechanics I	lecture lecture: plenary exercises		Having developed a scientific curiosity for quantum mechanics and its applications.
E099131 Engineering Project	lecture project	report	Being able to look for information in scientific papers to solve specific research questions. Being able to write an accurate, succinct and clear report of the experimental physical project based on a scientific paper (state of the art, objectives, experimental methods, results and conclusions). Learning specific ICT skills for word processing in Latex and data processing (graphs and tables).

Course	Teaching methods	Evaluation methods	Course learning outcome
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E001142 Basic Mathematics	lecture: plenary exercises seminar: coached exercises	written examination	Being able to perform basic calculations quickly and efficiently by hand. To have a thorough knowledge of the topics matrices, complex numbers, elementary functions and vectors.
E003043 Probability and Statistics	guided self-study seminar: coached exercises lecture	written examination with multiple choice questions open book examination	To reason and to work with multi-dimensional random variables To identify an appropriate probabilistic model for the analysis of an event or experiment
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E001132 Mathematical Analysis I	seminar	written examination open book examination	Being able to assess the convergence of numerical series and series of functions. To know the structure of the general solution of a linear differential equation, as well as the lack of a general solution of a non-linear differential equation, to be able to solve specific differential equations and to check the existence and uniqueness conditions for the corresponding initial value problems. Being able to use Fourier series for solving partial differential equation by separation of variables. Being able to perform integral transforms, having acquired insight in their respective properties and being able to use them for solving initial value problems. Being able to construct and manipulate power series and Fourier series. Being able to use power series for solving ordinary differential equations.
E098513 Modelling, Making and Measuring	project	report	Concepts: working collaboration in a group, scientific techniques, use of scientific language. Use of software tools to make simulations and diagrams
E015041 Informatics	lecture seminar: practical PC room classes	written examination open book examination	To master the structured programming paradigm and to realize a Python program, using this structured programming paradigm . To design an algorithm solving a given problem, and to assess the complexity of this solution. To master the basic concepts of objectorientation and to realize an objectoriented program in Python.
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E000662 Geometry and Linear Algebra	seminar	written examination open book examination	Being able to write down the respective reduced forms of a matrix and use them for solving systems of linear equations. Having acquired skills in the manipulation of vectors. Being able to write down vector representations of curves and surfaces, and to perform chains of active and passive transforms on them. Being able to construct an orthogonal basis by means of the Gram-Schmidt-procedure, to project a vector orthogonally onto a subspace and to perform a least squares algorithm. Being able to give the matrix representation and the corresponding formulae of an affine or co-ordinate transform in threedimensional space, or of a linear transform between abstract vector spaces.
E090320 Electrical Circuits and Networks	seminar: coached exercises	written examination	Analyze linear circuits with resistors, (coupled) inductors and capacitors in dc, in the periodic regime and during transients.
E001321 Mathematical Analysis III	lecture seminar: coached exercises lecture: plenary exercises	written examination	To master the basic theory of curves. To apply the residue theorem in a variety of situations. To calculate complex line integrals both directly and by means of theoretical results. To have insight in the meaning of holomorphic functions and to be able to apply their properties. To calculate line and surface integrals both directly and by means of theoretical results. To have insight in the meaning of the notions line and surface integral and in the theorems of Green, Gauss and Stokes. To have acquired insight in the meaning of the notions scalar and vector potential, rotation and divergence free vector fields, conservative and solenoidal vector fields. To have acquired skills in calculations with the nabla operator.
E005020 Analysis of Systems and Signals	lecture seminar: coached exercises	written examination with multiple choice questions	To identify systems and signals; to describe them in continuous time and discrete time. To be able to execute the Laplace transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To be able to execute the Z-transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To have understood the sampling theorem and its applications. To have gained insight in the various Fourier transforms. To have gained insight in the impulse response , the frequency response and the transfer function as an alternative description of a linear system, as well as in their mutual relationships. To have gained insight in Fourier series as a basis for the decription of signals and as a basis for transforming signals. To describe linear systems by means of the state model. (exclusively for the 6 credit points course.)
E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises practicum	report	Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems. To implement modeling and control on small scale setups by using personal laptop
E040050 Theoretical Mechanics I	lecture seminar: coached exercises	written examination with open questions open book examination	To be able to analyse and solve simple problems in mechanics and to be able to interpret their solution. To be able to set up the Lagrange and the Hamilton equations in concrete applications.
E023060 Quantum Mechanics II	lecture seminar: coached exercises	written examination oral examination	Have detailed knowledge of Perturbation theory (stationary and time-dependent) and scattering theory and being able to apply it to relevant problems. Have the skills for analyzing and applying two-level systems. Understand solution methods for Schrodinger equation in a spherical potential and being able to communicate about them. Possess detailed knowledge of concepts related to angular momentum and spin and have the ability to explain them.
E022110 Electromagnetism I	project	report	To be able to program a numerical technique as applied to a "simple" wave problem.

E032010 Electronic Systems and Instrumentation	lecture practicum	written examination skills test	Being able to build and experimentally evaluate analog and digital electronic circuits at breadboard level with sufficient accuracy, perseverance and critical reflection. Have the skills to perform numerical simulations of electronic circuits by means of standard models and methods, in particular PSpice. Analyse basic analog and digital electronic circuits and think in a conceptual, analytical, system-oriented way about them.
E024620 Solid-state Physics and Semiconductors II	seminar	written examination	Being able to draw and interpret energy band diagrams. Have the skills for solving exercises related to concepts in solid-state physics. Using concepts from semiconductor physics to explain the operation of electronic components (p-n junction, heterojunction, metal/semiconductor contact, MOS structure).
E030610 Photonics	group work seminar: coached exercises practicum	open book examination assignment	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	project seminar: coached exercises	written examination report open book examination	Computer-aided design simple wire antennas. Understand and apply the principles and methods of electrodynamics of moving sources and materials and apply these concepts (such as Doppler effect) in the framework of special relativity.
E099030 Cross-Course Project	guided self-study project	oral examination report	Make links between different knowledge domains. Work in a team, plan and execute tasks in a project.
E020310 Physics III	lecture seminar: coached exercises	written examination oral examination	Derivation of partition functions for simple and complicated systems.
E021110 Materials and Fields	seminar: coached exercises	written examination with open questions	Turning a quasi-stationary electromagnetic field problem into a boundary value problem.
E023010 Quantum Mechanics I	lecture lecture: plenary exercises	written examination	Explaining quantisation of observables and the postulates of quantum mechanics. Describing and applying the operator concept in quantum mechanics. Explaining and elucidating wave-particle duality.
E040060 Theoretical Mechanics II	lecture seminar: coached exercises	written examination open book examination	To have a thorough command of the basic concepts and techniques concerning the statics and dynamics of rigid bodies, and to be able to apply them to simple engineering problems. To have insight in the technique of small oscillations in the neighbourhood of a stable equilibrium. To be able to apply the Lagrangian and Hamiltonian formulation to the mechanics of rigid bodies.
E024610 Solid-state Physics and Semiconductors I	lecture seminar: coached exercises practicum online discussion group	written examination with open questions report oral examination open book examination	Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Being able to derive, schematize, and explain the relation between the internal structure of a solid and its macroscopic (elastic, thermal, electric and optical) properties. Recognize doping as a method to control the electronic properties of semiconductors. Understand the basic theoretical concepts of solid state and semiconductor physics (direct and reciprocal lattice, phonons, electronic band structure, Fermi level, effective mass, holes) and being able to apply these concepts to materials with a highly symmetric crystal structure. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E003043 Probability and Statistics	guided self-study seminar: coached exercises lecture	written examination with multiple choice questions open book examination	To reason and to work with multi-dimensional random variables To identify an appropriate probabilistic model for the analysis of an event or experiment
E020061 Physics I	demonstration lecture	written examination	To understand the physical laws and concepts of the covered chapters. To be able to solve problems by applying these laws and concepts.
E001132 Mathematical Analysis I	lecture lecture: plenary exercises seminar	written examination	To know the structure of the general solution of a linear differential equation, as well as the lack of a general solution of a non-linear differential equation, to be able to solve specific differential equations and to check the existence and uniqueness conditions for the corresponding initial value problems.
E001460 Discrete Mathematics I	guided self-study seminar: coached exercises practicum lecture	written examination open book examination	Distinguishing and applying fundamental algebraic and discrete structures. Being fluent in graph algorithms and applying them to real problem situations. Deploying deductively correct reasonings in an independent way. Evaluating logical reasonings with respect to correctness / identifying errors. Deploying mathematical reasoning and proof argumentation. Using basic concepts from set theory, group theory, combinatorics and graph theory.
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E000662 Geometry and Linear Algebra	lecture lecture: plenary exercises seminar	written examination open book examination	Being able to give the matrix representation and the corresponding formulae of an affine or co-ordinate transform in threedimensional space, or of a linear transform between abstract vector spaces. Being able to write down vector representations of curves and surfaces, and to perform chains of active and passive transforms on them.
E090320 Electrical Circuits and Networks	lecture seminar: coached exercises	written examination	Draw amplitude and phase Bode diagrams for transfer functions and determine the poles and zeros. Analyze basic electrical circuits containing diodes, bipolar transistors and MOSFETs. Determine the balance of active and reactive electrical power in a three-phase electrical network. Analyze linear circuits with resistors, (coupled) inductors and capacitors in dc, in the periodic regime and during transients.
E020220 Physics II	demonstration lecture	written examination participation	To be able to solve physics problems by applying these laws and concepts. To understand the physical laws and concepts of the covered chapters.
E001321 Mathematical Analysis III	lecture seminar: coached exercises lecture: plenary exercises	written examination	To master the basic theory of curves. To apply the residue theorem in a variety of situations. To calculate complex line integrals both directly and by means of theoretical results. To have insight in the meaning of holomorphic functions and to be able to apply their properties. To calculate line and surface integrals both directly and by means of theoretical results. To have insight in the meaning of the notions line and surface integral and in the theorems of Green, Gauss and Stokes. To have acquired insight in the meaning of the notions scalar and vector potential, rotation and divergence free vector fields, conservative and solenoidal vector fields. To have acquired skills in calculations with the nabla operator.
E005020 Analysis of Systems and Signals	lecture seminar: coached exercises	written examination with multiple choice questions	To identify systems and signals; to describe them in continuous time and discrete time. To be able to execute the Laplace transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To be able to execute the Z-transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To have understood the sampling theorem and its applications. To have gained insight in the various Fourier transforms. To have gained insight in the impulse response , the frequency response and the transfer function as an alternative description of a linear system, as well as in their mutual relationships. To have gained insight in Fourier series as a basis for the decription of signals and as a basis for transforming signals. To describe linear systems by means of the state model. (exclusively for the 6 credit points course.)
E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises		Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems. To derive transfer-function models and state-space models of physical systems and comprehend linear and nonlinear behavior.
E076040 Sustainable Business Operations	lecture	written examination with open questions written examination with multiple choice questions	Understand the technique of financial balance sheet reading and be able to apply it practically in simple accounting exercises
E040050 Theoretical Mechanics I	lecture seminar: coached exercises	written examination with open questions open book examination	To have insight in the Newtonian formulation of classical mechanics of point masses. To have a general insight in the construction and the meaning of a mathematical model for a physical theory. To have insight in the Lagrangian and the Hamiltonian formalism for point masses.
E022110 Electromagnetism I	lecture seminar: coached exercises	written examination with open questions written examination	To be able to describe, understand and discuss wave propagation in free space and in waveguides. To understand and to be able to obtain Green's functions for general free space current sources and for 2D problems. To understand, calculate and determine voltage and current behaviour on transmission lines.
E030610 Photonics	group work seminar: coached exercises practicum lecture	written examination skills test assignment oral examination open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays

E022210 Electromagnetism II	lecture seminar: coached exercises project	written examination report open book examination	Explain and apply concepts related to antennas and 3D radiations. Analyse and calculate the most important antenna characteristics. Understand and apply the principles and methods of electrodynamics of moving sources and materials and apply these concepts (such as Doppler effect) in the framework of special relativity. Describe and apply acustic phenomena. Computer-aided design simple wire antennas.
E099030 Cross-Course Project	guided self-study project	oral examination report	Make links between different knowledge domains. Work in a team, plan and execute tasks in a project.
E020310 Physics III	lecture seminar: coached exercises	written examination oral examination	Derivation of partition functions for simple and complicated systems. Application of the various statistical distribution functions on systems with a lot of degrees of freedom.
E040060 Theoretical Mechanics II	lecture seminar: coached exercises	written examination open book examination	To be able to give a mathematical formulation of problems from mechanics of rigid bodies, and to solve them analytically in simple cases. To be able to solve simple problems of small oscillations. To be able to apply the Lagrangian and Hamiltonian formulation to the mechanics of rigid bodies.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E070080 Chemical Thermodynamics	guided self-study seminar: coached exercises lecture	written examination open book examination	Application of the laws of thermodynamics on chemical systems. Calculation of the solubility of ionic compounds in aqueous solutions. Calculation of the pH of aqueous solutions. Understand and apply chemical equilibrium.
E003043 Probability and Statistics	lecture		To calculate probabilities of events and expectations of random variables
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E098512 Sustainability, Entrepreneurship and Ethics	project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E070070 Chemistry: the Structure of Matter	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform stoichiometric calculations. Identify and describe the different types of intermolecular interactions. Being able to determine the molecular geometry of covalent compounds. Identify and describe the different types of chemical bonding. Being able to order atoms and ions based on their periodic properties Being able to write the electron configuration of atoms and ions.
E098513 Modelling, Making and Measuring	project	report	Writing reports Oral presentation
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E001321 Mathematical Analysis III	lecture seminar: coached exercises lecture: plenary exercises	written examination	To master the basic theory of curves. To apply the residue theorem in a variety of situations. To calculate complex line integrals both directly and by means of theoretical results. To have insight in the meaning of holomorphic functions and to be able to apply their properties. To calculate line and surface integrals both directly and by means of theoretical results. To have insight in the meaning of the notions line and surface integral and in the theorems of Green, Gauss and Stokes. To have acquired insight in the meaning of the notions scalar and vector potential, rotation and divergence free vector fields, conservative and solenoidal vector fields. To have acquired skills in calculations with the nabla operator.
E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises practicum	written examination report	To have insight regarding the static and dynamic behaviour of systems and to apply this insight when designing feedback loops. To implement modeling and control on small scale setups by using personal laptop To evaluate in a correct way the results of computer simulations and numerical techniques when designing feedback control systems.
E030610 Photonics	seminar: coached exercises	open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	project	report	Computer-aided design simple wire antennas.
E099030 Cross-Course Project	project	oral examination report	Write the goal, background, results and conclusions of a project in a written report. Present the results of a project in a scientific and captivating way.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E001142 Basic Mathematics	seminar: coached exercises	written examination	To have a thorough knowledge of the topics matrices, complex numbers, elementary functions and vectors. Being able to formulate correctly and with mathematical precision. Being able to make a correct reasoning and to write it down in a structured way.
E003043 Probability and Statistics	guided self-study seminar: coached exercises lecture	written examination with multiple choice questions open book examination	To reason and to work with multi-dimensional random variables To perform a linear regression and to interpret its results To understand and to apply methods for hypothesis testing To understand and to apply methods for (parameter) estimation To interpret and to judge the results of statistical sampling, and to represent them in an appropriate form To identify an appropriate probabilistic model for the analysis of an event or experiment To calculate probabilities of events and expectations of random variables
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E001132 Mathematical Analysis I	guided self-study	written examination open book examination	Being able to assess the convergence of numerical series and series of functions. To have acquired insight in the mathematical, geometric and physical interpretation of notions of primitive function, integral, improper integral and integrability. To know the structure of the general solution of a linear differential equation, as well as the lack of a general solution of a non-linear differential equation, to be able to solve specific differential equations and to check the existence and uniqueness conditions for the corresponding initial value problems. Being able to use Fourier series for solving partial differential equation by separation of variables. Being able to perform integral transforms, having acquired insight in their respective properties and being able to use them for solving initial value problems. Being able to construct and manipulate power series and Fourier series. Being able to use power series for solving ordinary differential equations.
E015041 Informatics	guided self-study seminar: practical PC room classes lecture	written examination open book examination	To master the structured programming paradigm and to realize a Python program, using this structured programming paradigm . To design an algorithm solving a given problem, and to assess the complexity of this solution. To master the basic concepts of objectorientation and to realize an objectoriented program in Python.
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E000662 Geometry and Linear Algebra	guided self-study	written examination open book examination	Having acquired skills in the manipulation of vectors.
E001321 Mathematical Analysis III	lecture seminar: coached exercises lecture: plenary exercises	written examination	To master the basic theory of curves. To apply the residue theorem in a variety of situations. To calculate complex line integrals both directly and by means of theoretical results. To have insight in the meaning of holomorphic functions and to be able to apply their properties. To calculate line and surface integrals both directly and by means of theoretical results. To have insight in the meaning of the notions line and surface integral and in the theorems of Green, Gauss and Stokes. To have acquired insight in the meaning of the notions scalar and vector potential, rotation and divergence free vector fields, conservative and solenoidal vector fields. To have acquired skills in calculations with the nabla operator.
E005020 Analysis of Systems and Signals	lecture seminar: coached exercises	written examination with multiple choice questions	To identify systems and signals; to describe them in continuous time and discrete time. To be able to execute the Laplace transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To be able to execute the Z-transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To have understood the sampling theorem and its applications. To have gained insight in the various Fourier transforms. To have gained insight in the impulse response , the frequency response and the transfer function as an alternative description of a linear system, as well as in their mutual relationships. To have gained insight in Fourier series as a basis for the decription of signals and as a basis for transforming signals. To describe linear systems by means of the state model. (exclusively for the 6 credit points course.)
E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises		Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems.
E076040 Sustainable Business Operations	lecture	written examination with open questions written examination with multiple choice questions	Critical, creative thinking and scientific reasoning Be able to think carefully about social, scientific and ethical problems and possible solutions to these problems
E024620 Solid-state Physics and Semiconductors II	seminar	written examination	Have the skills for solving exercises related to concepts in solid-state physics.

E030610 Photonics	group work seminar: coached exercises practicum lecture	written examination skills test assignment oral examination open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	project seminar: coached exercises	written examination report open book examination	Explain and apply concepts related to antennas and 3D radiations. Analyse and calculate the most important antenna characteristics. Understand and apply the principles and methods of electrodynamics of moving sources and materials and apply these concepts (such as Doppler effect) in the framework of special relativity. Describe and apply acustic phenomena. Computer-aided design simple wire antennas.
E099030 Cross-Course Project	guided self-study project	oral examination report	Write the goal, background, results and conclusions of a project in a written report. Work in a team, plan and execute tasks in a project. Make links between different knowledge domains. Present the results of a project in a scientific and captivating way.
E021110 Materials and Fields	lecture	written examination with open questions	Good knowledge of the fundamentals of quasi-stationary electromagnetic fields.
E024610 Solid-state Physics and Semiconductors I	lecture seminar: coached exercises practicum		Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Being able to derive, schematize, and explain the relation between the internal structure of a solid and its macroscopic (elastic, thermal, electric and optical) properties. Understand the basic theoretical concepts of solid state and semiconductor physics (direct and reciprocal lattice, phonons, electronic band structure, Fermi level, effective mass, holes) and being able to apply these concepts to materials with a highly symmetric crystal structure. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E001142 Basic Mathematics	lecture seminar: coached exercises lecture: plenary exercises	written examination	Being able to make a correct reasoning and to write it down in a structured way.
E003043 Probability and Statistics	guided self-study seminar: coached exercises lecture	written examination with multiple choice questions open book examination	To reason and to work with multi-dimensional random variables To identify an appropriate probabilistic model for the analysis of an event or experiment To calculate probabilities of events and expectations of random variables
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E098512 Sustainability, Entrepreneurship and Ethics	project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E020061 Physics I	demonstration lecture		To understand the physical laws and concepts of the covered chapters. To be able to solve problems by applying these laws and concepts.
E001132 Mathematical Analysis I	guided self-study lecture: plenary exercises seminar lecture	written examination open book examination	Being able to assess the convergence of numerical series and series of functions. To have acquired insight in the mathematical, geometric and physical interpretation of notions of primitive function, integral, improper integral and integrability. To know the structure of the general solution of a linear differential equation, as well as the lack of a general solution of a non-linear differential equation, to be able to solve specific differential equations and to check the existence and uniqueness conditions for the corresponding initial value problems. Being able to use Fourier series for solving partial differential equation by separation of variables. Being able to perform integral transforms, having acquired insight in their respective properties and being able to use them for solving initial value problems. Being able to construct and manipulate power series and Fourier series. Being able to use power series for solving ordinary differential equations.
E001460 Discrete Mathematics I	guided self-study seminar: coached exercises practicum lecture	written examination open book examination	Distinguishing and applying fundamental algebraic and discrete structures. Being fluent in graph algorithms and applying them to real problem situations. Deploying deductively correct reasonings in an independent way. Evaluating logical reasonings with respect to correctness / identifying errors. Deploying mathematical reasoning and proof argumentation. Using basic concepts from set theory, group theory, combinatorics and graph theory.
E098513 Modelling, Making and Measuring	project	report	Concepts: working collaboration in a group, scientific techniques, use of scientific language. Use of software tools to make simulations and diagrams
E015041 Informatics	lecture seminar: practical PC room classes	written examination open book examination	To master the structured programming paradigm and to realize a Python program, using this structured programming paradigm . To master the basic concepts of objectorientation and to realize an objectoriented program in Python.
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E000662 Geometry and Linear Algebra	guided self-study lecture: plenary exercises seminar lecture	written examination open book examination	Having acquired insight in the notions rank, image, kernel, invertability, and determinant of a linear transform. Having acquired skills in the manipulation of vectors. Being able to write down vector representations of curves and surfaces, and to perform chains of active and passive transforms on them. Being able to construct an orthogonal basis by means of the Gram-Schmidt-procedure, to project a vector orthogonally onto a subspace and to perform a least squares algorithm. Being able to give the matrix representation and the corresponding formulae of an affine or co-ordinate transform in threedimensional space, or of a linear transform between abstract vector spaces. Having acquired insight in the notions vector space, linear dependence and independence, basis and dimension. Being able to write down the respective reduced forms of a matrix and use them for solving systems of linear equations. Having acquired insight in the mathematical, physical and geometric meaning of eigenvalues and eigenvectors.
E090320 Electrical Circuits and Networks	seminar: coached exercises	written examination	Draw amplitude and phase Bode diagrams for transfer functions and determine the poles and zeros. Analyze linear circuits with resistors, (coupled) inductors and capacitors in dc, in the periodic regime and during transients.
E020220 Physics II	demonstration lecture	written examination participation	To be able to solve physics problems by applying these laws and concepts. To understand the physical laws and concepts of the covered chapters.
E045120 Transport Phenomena	lecture seminar: practical PC room classes seminar	open book examination	To master the laws of statics and dynamics and to be able to apply them. To solve problems of stationary heat transport. To know the basic laws of stationary heat transport and to be able to apply them. To understand the law of energy in open and closed systems and to be able to apply it.
E001321 Mathematical Analysis III	lecture seminar: coached exercises lecture: plenary exercises	written examination	To master the basic theory of curves. To apply the residue theorem in a variety of situations. To calculate complex line integrals both directly and by means of theoretical results. To have insight in the meaning of holomorphic functions and to be able to apply their properties. To calculate line and surface integrals both directly and by means of theoretical results. To have insight in the meaning of the notions line and surface integral and in the theorems of Green, Gauss and Stokes. To have acquired insight in the meaning of the notions scalar and vector potential, rotation and divergence free vector fields, conservative and solenoidal vector fields. To have acquired skills in calculations with the nabla operator.

E005020 Analysis of Systems and Signals	lecture seminar: coached exercises	written examination with multiple choice questions	To identify systems and signals; to describe them in continuous time and discrete time. To be able to execute the Laplace transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To be able to execute the Z-transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To have understood the sampling theorem and its applications. To have gained insight in the various Fourier transforms. To have gained insight in the impulse response , the frequency response and the transfer function as an alternative description of a linear system, as well as in their mutual relationships. To have gained insight in Fourier series as a basis for the decription of signals and as a basis for transforming signals. To describe linear systems by means of the state model. (exclusively for the 6 credit points course.)
E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises		Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems.
E040050 Theoretical Mechanics I	lecture seminar: coached exercises	written examination with open questions open book examination	To have insight in the Newtonian formulation of classical mechanics of point masses. To be able to set up the Lagrange and the Hamilton equations in concrete applications. To have insight in the Lagrangian and the Hamiltonian formalism for point masses. To be able to analyse and solve simple problems in mechanics and to be able to interpret their solution.
E023060 Quantum Mechanics II	lecture seminar: coached exercises	written examination oral examination	Have detailed knowledge of Perturbation theory (stationary and time-dependent) and scattering theory and being able to apply it to relevant problems. Have the skills for analyzing and applying two-level systems. Understand solution methods for Schrodinger equation in a spherical potential and being able to communicate about them. Possess detailed knowledge of concepts related to angular momentum and spin and have the ability to explain them.
E022110 Electromagnetism I	project seminar: coached exercises	written examination with open questions report written examination	To be able to program a numerical technique as applied to a "simple" wave problem. To understand, calculate and determine voltage and current behaviour on transmission lines.
E032010 Electronic Systems and Instrumentation	lecture practicum	written examination skills test	Being able to build and experimentally evaluate analog and digital electronic circuits at breadboard level with sufficient accuracy, perseverance and critical reflection. Have the skill to communicate about own design of electronic systems in writing and in graphics. Have the skills to perform numerical simulations of electronic circuits by means of standard models and methods, in particular PSpice. Analyse basic analog and digital electronic circuits and think in a conceptual, analytical, system-oriented way about them. Understand the operation of the basic electronic components
E024620 Solid-state Physics and Semiconductors II	lecture seminar practicum	written examination	Being able to draw and interpret energy band diagrams.
E030610 Photonics	group work seminar: coached exercises practicum lecture	written examination skills test assignment oral examination open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	project seminar: coached exercises	written examination report open book examination	Explain and apply concepts related to antennas and 3D radiations. Analyse and calculate the most important antenna characteristics. Understand and apply the principles and methods of electrodynamics of moving sources and materials and apply these concepts (such as Doppler effect) in the framework of special relativity. Describe and apply acustic phenomena. Computer-aided design simple wire antennas.
E099030 Cross-Course Project	guided self-study project	oral examination report	Write the goal, background, results and conclusions of a project in a written report. Make links between different knowledge domains.
E020310 Physics III	seminar: coached exercises	written examination oral examination	Understand the relation between macroscopic and microscopic description of matter. Application of the various statistical distribution functions on systems with a lot of degrees of freedom. Derivation of partition functions for simple and complicated systems.
E023010 Quantum Mechanics I	lecture: plenary exercises	written examination	Explaining quantisation of observables and the postulates of quantum mechanics. Describing and applying the operator concept in quantum mechanics. Explaining and elucidating wave-particle duality.
E040060 Theoretical Mechanics II	lecture seminar: coached exercises	written examination open book examination	To be able to give a mathematical formulation of problems from mechanics of rigid bodies, and to solve them analytically in simple cases. To be able to solve simple problems of small oscillations. To be able to apply the Lagrangian and Hamiltonian formulation to the mechanics of rigid bodies.
E024610 Solid-state Physics and Semiconductors I	lecture seminar: coached exercises practicum	written examination with open questions report oral examination open book examination	Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Being able to derive, schematize, and explain the relation between the internal structure of a solid and its macroscopic (elastic, thermal, electric and optical) properties. Recognize doping as a method to control the electronic properties of semiconductors. Understand the basic theoretical concepts of solid state and semiconductor physics (direct and reciprocal lattice, phonons, electronic band structure, Fermi level, effective mass, holes) and being able to apply these concepts to materials with a highly symmetric crystal structure. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E001142 Basic Mathematics	lecture seminar: coached exercises lecture: plenary exercises	written examination	Being able to formulate correctly and with mathematical precision.
E003043 Probability and Statistics	guided self-study seminar: coached exercises lecture	written examination with multiple choice questions open book examination	To reason and to work with multi-dimensional random variables To perform a linear regression and to interpret its results To understand and to apply methods for hypothesis testing To understand and to apply methods for (parameter) estimation To interpret and to judge the results of statistical sampling, and to represent them in an appropriate form To identify an appropriate probabilistic model for the analysis of an event or experiment To calculate probabilities of events and expectations of random variables
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E098512 Sustainability, Entrepreneurship and Ethics	project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E001132 Mathematical Analysis I	guided self-study lecture: plenary exercises seminar lecture	written examination open book examination	Being able to assess the convergence of numerical series and series of functions. To have acquired insight in the mathematical, geometric and physical interpretation of notions of primitive function, integral, improper integral and integrability. To know the structure of the general solution of a linear differential equation, as well as the lack of a general solution of a non-linear differential equation, to be able to solve specific differential equations and to check the existence and uniqueness conditions for the corresponding initial value problems. Being able to use Fourier series for solving partial differential equation by separation of variables. Being able to perform integral transforms, having acquired insight in their respective properties and being able to use them for solving initial value problems. Being able to construct and manipulate power series and Fourier series. Being able to use power series for solving ordinary differential equations.
E001460 Discrete Mathematics I	guided self-study seminar: coached exercises practicum lecture	written examination open book examination	Distinguishing and applying fundamental algebraic and discrete structures. Being fluent in graph algorithms and applying them to real problem situations. Deploying deductively correct reasonings in an independent way. Evaluating logical reasonings with respect to correctness / identifying errors. Deploying mathematical reasoning and proof argumentation. Using basic concepts from set theory, group theory, combinatorics and graph theory.
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E000662 Geometry and Linear Algebra	guided self-study lecture: plenary exercises seminar lecture	written examination open book examination	Having acquired insight in the notions rank, image, kernel, invertability, and determinant of a linear transform. Having acquired skills in the manipulation of vectors. Being able to write down vector representations of curves and surfaces, and to perform chains of active and passive transforms on them. Being able to construct an orthogonal basis by means of the Gram-Schmidt-procedure, to project a vector orthogonally onto a subspace and to perform a least squares algorithm. Being able to give the matrix representation and the corresponding formulae of an affine or co-ordinate transform in threedimensional space, or of a linear transform between abstract vector spaces. Having acquired insight in the notions vector space, linear dependence and independence, basis and dimension. Being able to write down the respective reduced forms of a matrix and use them for solving systems of linear equations. Having acquired insight in the mathematical, physical and geometric meaning of eigenvalues and eigenvectors.
E090320 Electrical Circuits and Networks	seminar: coached exercises	written examination	Analyze linear circuits with resistors, (coupled) inductors and capacitors in dc, in the periodic regime and during transients.
E045120 Transport Phenomena	lecture seminar: practical PC room classes seminar	open book examination	To understand the properties of fluids. To solve problems of stationary heat transport. To know the basic laws of stationary heat transport and to be able to apply them. To understand the law of energy in open and closed systems and to be able to apply it. To master the laws of statics and dynamics and to be able to apply them.
E001321 Mathematical Analysis III	lecture seminar: coached exercises lecture: plenary exercises	written examination	To master the basic theory of curves. To apply the residue theorem in a variety of situations. To calculate complex line integrals both directly and by means of theoretical results. To have insight in the meaning of holomorphic functions and to be able to apply their properties. To calculate line and surface integrals both directly and by means of theoretical results. To have insight in the meaning of the notions line and surface integral and in the theorems of Green, Gauss and Stokes. To have acquired insight in the meaning of the notions scalar and vector potential, rotation and divergence free vector fields, conservative and solenoidal vector fields. To have acquired skills in calculations with the nabla operator.

E005020	Analysis of Systems and Signals	lecture seminar: coached exercises	written examination with multiple choice questions	To identify systems and signals; to describe them in continuous time and discrete time. To be able to execute the Laplace transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To be able to execute the Z-transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To have understood the sampling theorem and its applications. To have gained insight in the various Fourier transforms. To have gained insight in the impulse response , the frequency response and the transfer function as an alternative description of a linear system, as well as in their mutual relationships. To have gained insight in Fourier series as a basis for the decription of signals and as a basis for transforming signals. To describe linear systems by means of the state model. (exclusively for the 6 credit points course.)
E007120	Modelling and Control of Dynamic Systems	lecture seminar: coached exercises		To evaluate in a correct way the results of computer simulations and numerical techniques when designing feedback control systems.
E040050	Theoretical Mechanics I	lecture seminar: coached exercises	written examination with open questions open book examination	To have insight in the Newtonian formulation of classical mechanics of point masses. To have a general insight in the construction and the meaning of a mathematical model for a physical theory. To be able to set up the Lagrange and the Hamilton equations in concrete applications. To have insight in the Lagrangian and the Hamiltonian formalism for point masses. To be able to analyse and solve simple problems in mechanics and to be able to interpret their solution.
E023060	Quantum Mechanics II	lecture seminar: coached exercises	written examination oral examination	Have detailed knowledge of Perturbation theory (stationary and time-dependent) and scattering theory and being able to apply it to relevant problems. Have the skills for analyzing and applying two-level systems. Understand solution methods for Schrodinger equation in a spherical potential and being able to communicate about them. Possess detailed knowledge of concepts related to angular momentum and spin and have the ability to explain them.
E032010	Electronic Systems and Instrumentation	practicum	skills test	Being able to build and experimentally evaluate analog and digital electronic circuits at breadboard level with sufficient accuracy, perseverance and critical reflection. Have the skill to communicate about own design of electronic systems in writing and in graphics. Have the skills to perform numerical simulations of electronic circuits by means of standard models and methods, in particular PSpice.
E030610	Photonics	group work seminar: coached exercises practicum lecture	written examination skills test assignment oral examination open book examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210	Electromagnetism II	project	report	Computer-aided design simple wire antennas.
E099030	Cross-Course Project	project	oral examination report	Write the goal, background, results and conclusions of a project in a written report. Work in a team, plan and execute tasks in a project. Present the results of a project in a scientific and captivating way.
E001810	Mathematical Tools in Engineering: Linear Algebra	seminar	written examination with open questions	Precision, perseverance and being critical.
E020310	Physics III	seminar: coached exercises	written examination oral examination	Derivation of partition functions for simple and complicated systems. Application of the various statistical distribution functions on systems with a lot of degrees of freedom.
E023010	Quantum Mechanics I	lecture: plenary exercises	written examination	Explaining quantisation of observables and the postulates of quantum mechanics. Describing and applying the operator concept in quantum mechanics. Explaining and elucidating wave-particle duality.
E099131	Engineering Project	project	participation report	Being able to accurately perform physical experiments in group, to analyze the obtained data and to interpret the results in a critical way with the application of appropriate error analysis. Being able to write an accurate, succinct and clear report of the experimental physical project based on a scientific paper (state of the art, objectives, experimental methods, results and conclusions). Learning specific ICT skills for word processing in Latex and data processing (graphs and tables).
E040060	Theoretical Mechanics II	lecture seminar: coached exercises	written examination open book examination	To be able to give a mathematical formulation of problems from mechanics of rigid bodies, and to solve them analytically in simple cases. To be able to solve simple problems of small oscillations. To be able to apply the Lagrangian and Hamiltonian formulation to the mechanics of rigid bodies.
E001820	Mathematical Tools in Engineering: Complex Analysis	seminar	written examination with open questions	Precision, perseverance and being critical.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E070080 Chemical Thermodynamics	guided self-study seminar: coached exercises lecture	written examination open book examination	Application of the laws of thermodynamics on chemical systems. Calculation of the solubility of ionic compounds in aqueous solutions. Calculation of the pH of aqueous solutions. Understand and apply chemical equilibrium.
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture		To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E098512 Sustainability, Entrepreneurship and Ethics	project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E020061 Physics I	demonstration lecture		To understand the physical laws and concepts of the covered chapters. To be able to solve problems by applying these laws and concepts.
E070070 Chemistry: the Structure of Matter	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform stoichiometric calculations. Identify and describe the different types of intermolecular interactions. Being able to determine the molecular geometry of covalent compounds. Identify and describe the different types of chemical bonding. Being able to order atoms and ions based on their periodic properties Being able to write the electron configuration of atoms and ions.
E098513 Modelling, Making and Measuring	project	participation report	Concepts: working collaboration in a group, scientific techniques, use of scientific language. Use of software tools to make simulations and diagrams
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E020220 Physics II	demonstration lecture	written examination participation	To be able to solve physics problems by applying these laws and concepts. To understand the physical laws and concepts of the covered chapters.
E005020 Analysis of Systems and Signals	lecture seminar: coached exercises	written examination with multiple choice questions	To identify systems and signals; to describe them in continuous time and discrete time. To be able to execute the Laplace transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To be able to execute the Z-transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To have understood the sampling theorem and its applications. To have gained insight in the various Fourier transforms. To have gained insight in the impulse response , the frequency response and the transfer function as an alternative description of a linear system, as well as in their mutual relationships. To have gained insight in Fourier series as a basis for the decription of signals and as a basis for transforming signals. To describe linear systems by means of the state model. (exclusively for the 6 credit points course.)
E076040 Sustainable Business Operations	lecture	written examination with open questions written examination with multiple choice questions	Understanding sustainability aspects in an economic context
E023060 Quantum Mechanics II	lecture seminar: coached exercises	written examination oral examination	Have detailed knowledge of Perturbation theory (stationary and time-dependent) and scattering theory and being able to apply it to relevant problems. Have the skills for analyzing and applying two-level systems. Understand solution methods for Schrodinger equation in a spherical potential and being able to communicate about them. Possess detailed knowledge of concepts related to angular momentum and spin and have the ability to explain them.
E030610 Photonics	group work	assignment	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E099030 Cross-Course Project	guided self-study project	oral examination report	Find information in the literature.
E023010 Quantum Mechanics I	lecture		Having developed a scientific curiosity for quantum mechanics and its applications.
E099131 Engineering Project	project	participation report	Being able to accurately perform physical experiments in group, to analyze the obtained data and to interpret the results in a critical way with the application of appropriate error analysis. Being able to look for information in scientific papers to solve specific research questions.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture		To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E005020 Analysis of Systems and Signals	lecture seminar: coached exercises	written examination with multiple choice questions	To identify systems and signals; to describe them in continuous time and discrete time. To be able to execute the Laplace transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To be able to execute the Z-transform, to calculate its inverse, and to apply when studying systems and signals. (exclusively for the 6 credit points course.) To have understood the sampling theorem and its applications. To have gained insight in the various Fourier transforms. To have gained insight in the impulse response , the frequency response and the transfer function as an alternative description of a linear system, as well as in their mutual relationships. To have gained insight in Fourier series as a basis for the decription of signals and as a basis for transforming signals. To describe linear systems by means of the state model. (exclusively for the 6 credit points course.)

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E001142 Basic Mathematics	lecture seminar: coached exercises lecture: plenary exercises	written examination	To have a thorough knowledge of the topics matrices, complex numbers, elementary functions and vectors. Being able to formulate correctly and with mathematical precision. Being able to make a correct reasoning and to write it down in a structured way.
E070080 Chemical Thermodynamics	guided self-study seminar: coached exercises lecture	written examination open book examination	Application of the laws of thermodynamics on chemical systems. Calculation of the solubility of ionic compounds in aqueous solutions. Calculation of the pH of aqueous solutions. Understand and apply chemical equilibrium.
E003043 Probability and Statistics	guided self-study seminar: coached exercises lecture	written examination with multiple choice questions open book examination	To reason and to work with multi-dimensional random variables To perform a linear regression and to interpret its results To understand and to apply methods for hypothesis testing To understand and to apply methods for (parameter) estimation To interpret and to judge the results of statistical sampling, and to represent them in an appropriate form To calculate probabilities of events and expectations of random variables
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E098512 Sustainability, Entrepreneurship and Ethics	lecture project	participation assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E020061 Physics I	demonstration lecture		To understand the physical laws and concepts of the covered chapters. To be able to solve problems by applying these laws and concepts.
E001132 Mathematical Analysis I	guided self-study lecture: plenary exercises seminar lecture	written examination open book examination	Being able to assess the convergence of numerical series and series of functions. To have acquired insight in the mathematical, geometric and physical interpretation of notions of primitive function, integral, improper integral and integrability. To know the structure of the general solution of a linear differential equation, as well as the lack of a general solution of a non-linear differential equation, to be able to solve specific differential equations and to check the existence and uniqueness conditions for the corresponding initial value problems. Being able to use Fourier series for solving partial differential equation by separation of variables. Being able to perform integral transforms, having acquired insight in their respective properties and being able to use them for solving initial value problems. Being able to construct and manipulate power series and Fourier series. Being able to use power series for solving ordinary differential equations.
E070070 Chemistry: the Structure of Matter	guided self-study seminar: coached exercises lecture		Being able to perform stoichiometric calculations. Identify and describe the different types of intermolecular interactions. Being able to determine the molecular geometry of covalent compounds. Identify and describe the different types of chemical bonding. Being able to order atoms and ions based on their periodic properties Being able to write the electron configuration of atoms and ions.
E098513 Modelling, Making and Measuring	project	report	Concepts: working collaboration in a group, scientific techniques, use of scientific language. Oral presentation Writing reports
E001222 Mathematical Analysis II	guided self-study seminar: coached exercises lecture: plenary exercises lecture	written examination open book examination	Being able to perform the chain rules for differentiable functions. Being able to carry out co-ordinate transforms in multiple integrals in two and three dimensions. Being able to compute integrals in two and three dimensions by subsequent integration. Having acquired insight in local, absolute and conditional extremum problems, and being able to solve such problems. Having acquired insight in the mathematical, geometric and physical interpretation of the notions limit, continuity, derivative, partial derivative, differentiability, gradient, multiple integral, Jacobian and co-ordinate transform.
E000662 Geometry and Linear Algebra	guided self-study lecture: plenary exercises seminar lecture	written examination open book examination	Having acquired insight in the notions rank, image, kernel, invertability, and determinant of a linear transform. Having acquired skills in the manipulation of vectors. Being able to write down vector representations of curves and surfaces, and to perform chains of active and passive transforms on them. Being able to construct an orthogonal basis by means of the Gram-Schmidt-procedure, to project a vector orthogonally onto a subspace and to perform a least squares algorithm. Being able to give the matrix representation and the corresponding formulae of an affine or co-ordinate transform in threedimensional space, or of a linear transform between abstract vector spaces. Having acquired insight in the notions vector space, linear dependence and independence, basis and dimension. Being able to write down the respective reduced forms of a matrix and use them for solving systems of linear equations. Having acquired insight in the mathematical, physical and geometric meaning of eigenvalues and eigenvectors.
E020220 Physics II	demonstration lecture	written examination participation	To be able to solve physics problems by applying these laws and concepts. To understand the physical laws and concepts of the covered chapters.
E045120 Transport Phenomena	lecture seminar: practical PC room classes seminar	open book examination	To understand the properties of fluids. To understand the similarities between transport of impulse, heat and mass. To solve problems of stationary heat transport. To know the basic laws of stationary heat transport and to be able to apply them. To understand the law of energy in open and closed systems and to be able to apply it. To master the laws of statics and dynamics and to be able to apply them.
E001321 Mathematical Analysis III	lecture seminar: coached exercises lecture: plenary exercises	written examination	To master the basic theory of curves. To apply the residue theorem in a variety of situations. To calculate complex line integrals both directly and by means of theoretical results. To have insight in the meaning of holomorphic functions and to be able to apply their properties. To calculate line and surface integrals both directly and by means of theoretical results. To have insight in the meaning of the notions line and surface integral and in the theorems of Green, Gauss and Stokes. To have acquired insight in the meaning of the notions scalar and vector potential, rotation and divergence free vector fields, conservative and solenoidal vector fields. To have acquired skills in calculations with the nabla operator.

E007120 Modelling and Control of Dynamic Systems	lecture seminar: coached exercises		Combining the knowledge of several engineering disciplines (electronics, electro-mechanical, physics, chemical engineering) in order to obtain mathematical models of physical dynamic systems. To design of controllers based on the application of root-locus techniques and frequency-response techniques such as Bode, Nyquist.
E040050 Theoretical Mechanics I	lecture seminar: coached exercises	written examination with open questions open book examination	To have insight in the Newtonian formulation of classical mechanics of point masses. To have a general insight in the construction and the meaning of a mathematical model for a physical theory. To have insight in the Lagrangian and the Hamiltonian formalism for point masses.
E030610 Photonics	group work seminar: coached exercises practicum lecture	assignment	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	lecture seminar: coached exercises project	written examination report open book examination	Explain and apply concepts related to antennas and 3D radiations. Analyse and calculate the most important antenna characteristics. Understand and apply the principles and methods of electrodynamics of moving sources and materials and apply these concepts (such as Doppler effect) in the framework of special relativity. Describe and apply acustic phenomena. Computer-aided design simple wire antennas.
E099030 Cross-Course Project	project	oral examination report	Write the goal, background, results and conclusions of a project in a written report. Present the results of a project in a scientific and captivating way.
E099131 Engineering Project	lecture project	report	Being able to write an accurate, succinct and clear report of the experimental physical project based on a scientific paper (state of the art, objectives, experimental methods, results and conclusions). Learning specific ICT skills for word processing in Latex and data processing (graphs and tables).
E040060 Theoretical Mechanics II	lecture seminar: coached exercises	written examination open book examination	To have a thorough command of the basic concepts and techniques concerning the statics and dynamics of rigid bodies, and to be able to apply them to simple engineering problems. To be able to apply the Lagrangian and Hamiltonian formulation to the mechanics of rigid bodies. To be able to give a mathematical formulation of problems from mechanics of rigid bodies, and to solve them analytically in simple cases.
E024610 Solid-state Physics and Semiconductors I	lecture seminar: coached exercises practicum online discussion group	written examination with open questions report oral examination open book examination	Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Being able to derive, schematize, and explain the relation between the internal structure of a solid and its macroscopic (elastic, thermal, electric and optical) properties. Recognize doping as a method to control the electronic properties of semiconductors. Understand the basic theoretical concepts of solid state and semiconductor physics (direct and reciprocal lattice, phonons, electronic band structure, Fermi level, effective mass, holes) and being able to apply these concepts to materials with a highly symmetric crystal structure. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E098512 Sustainability, Entrepreneurship and Ethics	project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E098513 Modelling, Making and Measuring	project	participation report	Concepts: working collaboration in a group, scientific techniques, use of scientific language.
E023060 Quantum Mechanics II	lecture seminar: coached exercises	written examination oral examination	Have detailed knowledge of Perturbation theory (stationary and time-dependent) and scattering theory and being able to apply it to relevant problems. Have the skills for analyzing and applying two-level systems. Understand solution methods for Schrodinger equation in a spherical potential and being able to communicate about them. Possess detailed knowledge of concepts related to angular momentum and spin and have the ability to explain them.
E022110 Electromagnetism I	project	report	To be able to program a numerical technique as applied to a "simple" wave problem.
E030610 Photonics	group work	assignment	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	project	report	Computer-aided design simple wire antennas.
E099030 Cross-Course Project	guided self-study project	oral examination report	Make links between different knowledge domains. Work in a team, plan and execute tasks in a project.
E024610 Solid-state Physics and Semiconductors I	practicum		Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E098512 Sustainability, Entrepreneurship and Ethics	project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E098513 Modelling, Making and Measuring	project	participation report	Concepts: working collaboration in a group, scientific techniques, use of scientific language.
E022110 Electromagnetism I	project	report	To be able to program a numerical technique as applied to a "simple" wave problem.
E032010 Electronic Systems and Instrumentation	practicum	skills test	Have the skill to communicate about own design of electronic systems in writing and in graphics.
E030610 Photonics	group work	assignment	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E099030 Cross-Course Project	project	report	Work in a team, plan and execute tasks in a project.
E099131 Engineering Project	project	participation report	Being able to accurately perform physical experiments in group, to analyze the obtained data and to interpret the results in a critical way with the application of appropriate error analysis. Being able to write an accurate, succinct and clear report of the experimental physical project based on a scientific paper (state of the art, objectives, experimental methods, results and conclusions). Learning specific ICT skills for word processing in Latex and data processing (graphs and tables).
E024610 Solid-state Physics and Semiconductors I	practicum		Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E066012 Materials Technology	guided self-study seminar: practical PC room classes seminar: coached exercises lecture	written examination	To name materials properties and to be able to distinguish between the different groups of materials To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties To have some basic understanding on the available possibilities to steer the structure of a material and consequently to design a material with the desired properties. To be able to correlate the structure and properties of materials To understand the basic concepts of materials science and engineering and to be able to explain materials behaviour when used in specific situations.
E098512 Sustainability, Entrepreneurship and Ethics	lecture project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E098513 Modelling, Making and Measuring	lecture project	report	Concepts: working collaboration in a group, scientific techniques, use of scientific language. Oral presentation Writing reports
E007120 Modelling and Control of Dynamic Systems	practicum	report	To implement modeling and control on small scale setups by using personal laptop
E023060 Quantum Mechanics II	lecture seminar: coached exercises	written examination oral examination	Have detailed knowledge of Perturbation theory (stationary and time-dependent) and scattering theory and being able to apply it to relevant problems. Have the skills for analyzing and applying two-level systems. Understand solution methods for Schrodinger equation in a spherical potential and being able to communicate about them. Possess detailed knowledge of concepts related to angular momentum and spin and have the ability to explain them.
E022110 Electromagnetism I	project	report	To be able to program a numerical technique as applied to a "simple" wave problem.
E032010 Electronic Systems and Instrumentation	practicum	skills test	Have the skill to communicate about own design of electronic systems in writing and in graphics.
E030610 Photonics	group work	assignment	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E022210 Electromagnetism II	project	report	Computer-aided design simple wire antennas.
E099030 Cross-Course Project	guided self-study project	oral examination report	Write the goal, background, results and conclusions of a project in a written report. Present the results of a project in a scientific and captivating way.
E099131 Engineering Project	project	report	Being able to write an accurate, succinct and clear report of the experimental physical project based on a scientific paper (state of the art, objectives, experimental methods, results and conclusions). Learning specific ICT skills for word processing in Latex and data processing (graphs and tables).
E024610 Solid-state Physics and Semiconductors I	practicum seminar: coached exercises	report	Have the practical skill to determine the crystal structure of a solid (with a highly symmetric lattice) from its X-ray diffraction pattern. Have the practical skill to derive information on the band structure of a semiconductor from its optical absorption spectrum.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E066012 Materials Technology	seminar: practical PC room classes	written examination	To be able to select, by using a material selection software program, the most appropriate material for a specific engineering problem taking into account various material properties
E098512 Sustainability, Entrepreneurship and Ethics	lecture project	participation assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E076040 Sustainable Business Operations	lecture	written examination with open questions written examination with multiple choice questions	Critical, creative thinking and scientific reasoning Be able to think carefully about social, scientific and ethical problems and possible solutions to these problems
E030610 Photonics	group work	assignment	To complete a task in team.

Course	Teaching methods	Evaluation methods	Course learning outcome
*Noot: leer- en evaluatievormen voorafgegaan door ** werden niet teruggevonden in de studiefiche*			
E098512 Sustainability, Entrepreneurship and Ethics	lecture project	assignment	Having a general knowledge about aspects of sustainability, entrepreneurship and ethics, and being able to apply those in the framework of engineering activities.
E076040 Sustainable Business Operations	lecture	written examination with open questions assignment written examination with multiple choice questions	Understand the technique of financial balance sheet reading and be able to apply it practically in simple accounting exercises Mastering the basic concepts of macroeconomics and microeconomy: law of supply and demand, markets (perfect competition, monopoly, oligopoly, game theory) Understanding the coherence between the different stakeholders of the company Being able to make a simple investment analysis and apply the concept of time value of money in all aspects of investment analysis Being able to make a complete costing for a product or a service Being able to distinguish between fixed, variable, direct and indirect costs Be able to analyze and assess the data of a company's balance sheet Understanding sustainability aspects in an economic context
E030610 Photonics	lecture	oral examination	To search information in scientific and industrial photonics literature. Exposure to recent trends in photonics. To complete a task in team. Understanding of imaging systems, of wave phenomena (interference and diffraction), of operation and diversity in laser systems, of technology and operation of semiconductor components. To write a synthesizing article about a photonics subject. Analytical calculation skills with respect to simple lighting problems with incoherent sources, imaging systems with paraxial matrix method, Gaussian beam propagation, plane waves in 3-layer structures, basic characteristics of lasers. To gain knowledge with respect to the concepts: radiometric and photometric quantities and units, ray approximation, paraxial matrixformalism for imaging systems, aberrations, dispersion and absorption, plane wave, reflection and refraction, interference, Gaussian beams, diffraction, Maxwell's equations, TEM plane wave, polarisation, Fabry-Perot etalon, waveguide modes, optical fiber, photons, photonflux statistics, resonance processes, Kramers-Kronig, photon-atom interaction, thermal light, luminescent light, fluorescence, phosphorescence, lasers, gain, population inversion, Einstein relations, oscilation condition, pump systems, rate equations, cavity stability, laser modes, Q-switching and mode locking, LEDs and laser diodes, photodiode, CCD, solar cell, gas discharge lamp, incandescent lamp, color coordinate system, basic operation of displays
E099030 Cross-Course Project	guided self-study	report	Work in a team, plan and execute tasks in a project.