



Description of the degree program

Quantum Technologies in Electrical and Computer Engineering (Master)

PO 1

Date: 15.04.2026

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Master Quantum Technologies in Electrical and Computer Engineering

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Compulsory Module Fundamentals

| | | | |
|---|--|--------------------------|--|
| Title | Advanced Applications of Field Theory | | |
| Number | 2420000080 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für CMOS Design |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Thomas Kämpfe |
| Workload (h) | 150 | | |
| Class attendance (h) | 56 | Self studying (h) | 94 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | written exam (120 min) or oral exam (30 min) | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> • Potential formalism: scalar potential and vector potential • Energy considerations, Poynting theorem • Potentials for the dynamic case, Hertzian dipole and radiation, approximations in field descriptions • Field theory in quantum mechanics: electromagnetic interactions in Schrödinger theory • Field theory in microelectronics: Propagators and Green's function, effective and field theory for antenna design | | | |
| Objective qualification | | | |
| <p>Upon completion of the module, students will be able to explain the structure of Maxwell's equations in differential form, derive the fully dynamic field solution of Hertz's dipole from this, and justify idealized approximate solutions depending on the application. This will enable them to analyze basic electrical engineering arrangements using field theory methods and abstract the essential details. They can select and apply suitable solution methods, for example, for energy problems, Poynting's theorem, and fields that vary in time and space. They can integrate electromagnetic interactions into the Schrödinger equation of quantum mechanics and solve elementary problems in this context. They are familiar with applications of field theory in the field of antenna design.</p> | | | |
| Literature | | | |
| <p>D.J. Griffiths: Electrodynamics</p> <p>J.D. Jackson: Classical Electrodynamics</p> <p>A. Enders: Electromagnetic Fields (TU Braunschweig)</p> | | | |
| Remark | | | |
| <p>Students can either choose this module or the module "Ambits of Electromagnetic Field Theory". It is not possible to attend both.</p> | | | |



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|--|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |
| Advanced Applications of Field Theory | 2,0 | Lecture | english |
| Literature | | | |
| D.J. Griffiths: Electrodynamics | | | |
| J.D. Jackson: Classical Electrodynamics | | | |
| A.Enders: Electromagnetic Fields (TU Braunschweig) | | | |
| Advanced Applications of Field Theory | 2,0 | Exercise | english |
| Literature | | | |
| D.J. Griffiths: Electrodynamics | | | |
| J.D. Jackson: Classical Electrodynamics | | | |
| A.Enders: Electromagnetic Fields (TU Braunschweig) | | | |

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|--|--|--------------------------|--|
| Title | Advanced Quantum Technology for Engineers | | |
| Number | 2413000000 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Halbleitertechnik |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Andreas Waag |
| Workload (h) | 150 | | |
| Class attendance (h) | 56 | Self studying (h) | 94 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (120 min) or oral exam (30 min) | | |
| Course achievement | Presentation (§ 9 APO) | | |
| Contents | | | |
| <ul style="list-style-type: none"> • Quantum mechanical wavefunctions and the Schrödinger equation • Bra- and ket vectors, observables and hermitian operators • Free particles, “particle in a box”, harmonic oscillator, hydrogen atom • Second quantization, creation and annihilation operators • Single- and many-particle systems: bosons and fermions, exchange interaction • Fundamentals of macroscopic quantum phenomena (ferromagnetism, superconductivity) • Distributions function in quantum statistical descriptions • Entanglement | | | |
| Objective qualification | | | |
| <p>The students can apply the concept of the Schrödinger equation and the corresponding formalism of wave mechanics to derive the energy levels and the quantum mechanical states of free particles, the “particle in a box”, the quantum mechanical harmonic oscillator and the hydrogen atom. They can apply the “bra – ket” formalism to describe and analyze the quantum mechanical states of single- and many-particle systems. They can set-up new and interpret given Hamiltonians in the formalism of the “second quantization” and understand the concept of creation and annihilation operators. They understand the concept of entanglement and can use it to describe basic concepts of quantum cryptography and quantum computing. They can apply the basic concepts of quantum statistics to describe bosonic and fermionic many-particle systems including exchange interaction and interpret given quantum statistical distribution functions. The students can present their work to a non-professional audience.</p> | | | |
| Literature | | | |
| <p>Cohen-Tannoudji, Diu, Laloe 2020, Quantum Mechanics Vol. 1-3, Wiley VCH Leon van Dommelen: Quantum Mechanics for Engineers (2018), pdf available online</p> | | | |

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|--|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| All courses have to be attended | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |
| Advanced Quantum Technology for Engineers | 2,0 | Lecture | english german |
| Literature | | | |
| Cohen-Tannoudji, Diu, Laloe 2020, Quantum Mechanics Vol. 1-3, Wiley VCH Leon van Dommelen: Quantum Mechanics for Engineers (2018), pdf available online | | | |
| Advanced Quantum Technology for Engineers | 2,0 | Exercise | english |
| Literature | | | |
| Cohen-Tannoudji, Diu, Laloe 2020, Quantum Mechanics Vol. 1-3, Wiley VCH Leon van Dommelen: Quantum Mechanics for Engineers (2018), pdf available online | | | |
| Advanced Quantum Technology for Engineers | 2,0 | Seminar | english |
| Literature | | | |
| Cohen-Tannoudji, Diu, Laloe 2020, Quantum Mechanics Vol. 1-3, Wiley VCH Leon van Dommelen: Quantum Mechanics for Engineers (2018), pdf available online | | | |

| | | | |
|---|--|--------------------------|--|
| Title | Introduction to Quantum Information Technology and Quantum Computing | | |
| Number | 2413000010 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Halbleitertechnik |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Tobias Voß |
| Workload (h) | 150 | | |
| Class attendance (h) | 56 | Self studying (h) | 94 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (120 min) or oral exam (45 min) | | |
| Course achievement | Presentation (§ 9 APO) | | |
| Contents | | | |
| <ul style="list-style-type: none"> • QBits: concept and different realizations • Bloch-Sphere and Q-Sphere • Basic quantum logic gates: CNOT, Hadamard, ... • Combinations of quantum logic gates and their applications • Quantum Information and Quantum Communications • Quantum Cryptography and Quantum Key Distribution • Quantum Walks and Search Algorithms • Quantum Simulation • Quantum Error Correction | | | |
| Objective qualification | | | |
| <p>The students can describe different realizations of qbits and can visualize them using the Bloch sphere or the Q-Sphere, respectively. They can apply basic quantum logic gates to form basic applications of qbits (Bell states and others). They can describe basic and advanced models of quantum information processing, transmission, and computing systems. They know the important quantum effects including teleportation, super-dense coding, and no-cloning theorem and can relate them to the quantum algorithms.</p> <p>From quantum communications, the students know the fundamental results on capacities of quantum-assisted classical, classical-quantum, and pure quantum channels. The students know the current state of the art of multi-user quantum channels and the available rate characterizations.</p> <p>From quantum computing, the students learn about circuits and operations on qubits and the elements of quantum algorithms, such as Shor's algorithm, Grover's algorithm, and quantum random walks. They also understand the corresponding aspects of runtime (lower and upper bounds) and the relation to classical algorithms. The students can present their work to a non-professional audience.</p> | | | |
| Literature | | | |
| <ol style="list-style-type: none"> 1. Nielsen, Michael A.; Chuang, Isaac L. (2010). Quantum Computation and Quantum Information (2nd ed.). Cambridge: Cambridge University Press. 2. Cariolaro, Gianfranco. 2015. Quantum Communications. Springer, Cham. 3. Holevo, Alexander S. 2019. Quantum Systems, Channels, Information. De Gruyter. 4. Cohen-Tannoudji, Diu, Laloe 2020, Quantum Mechanics Vol. 1-3, Wiley VCH | | | |



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|--|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| All courses have to be attended | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |
| Introduction to Quantum Information Technology and Quantum Computing | 4,0 | Lecture | english |
| Literature | | | |
| 1. Nielsen, Michael A.; Chuang, Isaac L. (2010). Quantum Computation and Quantum Information (2nd ed.). Cambridge: Cambridge University Press. 2. Cariolaro, Gianfranco. 2015. Quantum Communications. Springer, Cham. 3. Holevo, Alexander S. 2019. Quantum Systems, Channels, Information. De Gruyter. 4. Cohen-Tannoudji, Diu, Laloe 2020, Quantum Mechanics Vol. 1-3, Wiley VCH | | | |
| Introduction to Quantum Information Technology and Quantum Computing | 4,0 | Exercise | english |
| Literature | | | |
| 1. Nielsen, Michael A.; Chuang, Isaac L. (2010). Quantum Computation and Quantum Information (2nd ed.). Cambridge: Cambridge University Press. 2. Cariolaro, Gianfranco. 2015. Quantum Communications. Springer, Cham. 3. Holevo, Alexander S. 2019. Quantum Systems, Channels, Information. De Gruyter. 4. Cohen-Tannoudji, Diu, Laloe 2020, Quantum Mechanics Vol. 1-3, Wiley VCH | | | |
| Introduction to Quantum Information Technology and Quantum Computing | 4,0 | Seminar | english |
| Literature | | | |
| 1. Nielsen, Michael A.; Chuang, Isaac L. (2010). Quantum Computation and Quantum Information (2nd ed.). Cambridge: Cambridge University Press. 2. Cariolaro, Gianfranco. 2015. Quantum Communications. Springer, Cham. 3. Holevo, Alexander S. 2019. Quantum Systems, Channels, Information. De Gruyter. 4. Cohen-Tannoudji, Diu, Laloe 2020, Quantum Mechanics Vol. 1-3, Wiley VCH | | | |

Optional Required Subjects: Quantum Structure Devices

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|---|--|--------------------------|--|
| Title | Nonlinear Photonics | | |
| Number | 2415470 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Hochfrequenztechnik |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Thomas Schneider |
| Workload (h) | 150 | | |
| Class attendance (h) | 56 | Self studying (h) | 94 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam, 90 minutes, or oral exam, 30 minutes | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> - Basics of linear optics - 2nd order nonlinear optical effects - 3rd order nonlinear optical effects - Nonlinear scattering - Optical telecommunications - Nonlinear effects in optical fibers - Suppression of nonlinear effects - Applications of nonlinear effects | | | |
| Objective qualification | | | |
| After a successful participation, the students know the main basics of nonlinear photonics and will be able to use them for the evaluation of optical systems and optical data transmission systems. | | | |
| Literature | | | |
| T. Schneider "#Nonlinear Optics in Telecommunications#", Springer Verlag | | | |

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|--|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Nonlinear Photonics | 2,0 | Lecture | english |
| Nonlinear Photonics | 2,0 | Exercise | english |

| | | | |
|--|--|--------------------------|--|
| Title | Fundamentals of Nano Optics | | |
| Number | 1520430 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Halbleitertechnik |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Stefanie Kroker |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (120 min) or oral exam (30 min) | | |
| Course achievement | | | |
| Contents | | | |
| <ol style="list-style-type: none"> 1. Basic concepts (photonic crystals, plasmonics) 2. Production and characterisation (metrology) of nano structures 3. Photonic nano materials / meta materials / meta surfaces 4. Optic nano emitters and nano antennae 5. Active photonic elements | | | |
| Objective qualification | | | |
| <p>The participants can describe basic phenomena of light propagation (reflection, scattering, absorption, transmission) at interfaces and in homogeneous media qualitatively and quantitatively.</p> <p>Participants can name important basic elements of nanooptics, such as waveguides, optical gratings, photonic crystals or metamaterials, discuss their properties qualitatively and name fields of application.</p> <p>Participants are able to identify the basic elements in complex optical systems and describe their respective functions.</p> <p>The participants can name important processes of micro- and nanostructuring and explain how they work.</p> <p>The participants can solve the wave equation in simple dielectric, metallic and hybrid nanooptical systems analytically and semi-analytically and interpret the solutions.</p> <p>Participants can classify optical resonance phenomena in nanooptical systems and name their essential properties.</p> | | | |
| Literature | | | |
| <p>Novotny, Hecht: Principles of nano-optics, Cambridge University Press 2016</p> <p>Prasad: Nanophotonics, John Wiley & Sons 2004</p> <p>Jahns, Helfert: Introduction to Micro- and Nanooptics, Wiley VCH 2012</p> | | | |

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|--|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |
| Fundamentals of Nano Optics | 2,0 | Lecture | english |
| Fundamentals of Nano Optics | 1,0 | Exercise | english |

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|---|--------------------------|--------------------------|--|
| Title | Semiconductor Technology | | |
| Number | 2413420 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Halbleitertechnik |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Andreas Waag |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Oral exam 30 min | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> - physical and chemical basics - manufacturing of single crystals and wafers - epitaxial crystal growth processes and crystal defects - doping processes - semiconductor measurement technology - planar technology - basics of photolithography, deposition processes for dielectrics and etching processes | | | |
| Objective qualification | | | |
| <p>After completing the semiconductor technology module, students have:</p> <ul style="list-style-type: none"> • an understanding of the basic manufacturing technologies of semiconductors as well as components and integrated circuits made from them. • the ability to recognize the principles of the most modern manufacturing processes in semiconductor technology and their modes of operation • the ability to analyze and extrapolate trends in semiconductor technology developments | | | |
| Literature | | | |
| <ul style="list-style-type: none"> • Lecture transparencies • Script in Englisch (H.-H. Wehmann and A. Schlachetzki) • Waldemar von Münch: Einführung in die Halbleitertechnologie; Teubner(Stuttgart, 1998) ISBN: 3-519-06167-8 • Ingolf Ruge, Hermann Mader: Halbleiter-Technologie Springer (Berlin, 1991) ISBN: 3-540-53873-9 • Werner Prost: Technologie der III/V-Halbleiter, Springer (Berlin, 1997) ISBN. 3-540-62804-5 • Ulrich Hilleringmann: Silizium-Halbleitertechnologie, Teubner (Stuttgart, 2004) ISBN: 3-519-30149-0 | | | |
| Remark | | | |
| Language German or English | | | |



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|--|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |
| Semiconductor Technology | 2,0 | Lecture | english |
| Literature | | | |
| Waldemar von Münch: Einführung in die Halbleitertechnologie; Teubner(1998) Ingolf Ruge, Hermann Mader: Halbleiter-Technologie Springer (1991) Werner Prost: Technologie der III/V-Halbleiter, Springer (1997) Ulrich Hilleringmann: Silizium-Halbleitertechnologie, Teubner (2004) Ausführliches Skript in Englisch Vorlesungsfolien | | | |
| Semiconductor Technology | 1,0 | Exercise | english |
| Literature | | | |
| Übungsmaterial wird verteilt. | | | |

| | | | |
|---|-------------------------|--------------------------|--|
| Title | Molecular Electronics | | |
| Number | 2413600 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Halbleitertechnik |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Tobias Voß |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Oral exam (30 min) | | |
| Course achievement | Presentation | | |
| Contents | | | |
| <p>Introduction to molecular electronics basic considerations (molecular orbitals, conjugated systems) characterisation tools transport mechanisms conductive polymers optoelectronic applications of molecular systems</p> | | | |
| Objective qualification | | | |
| <p>Students are familiar with the fundamentals of organic chemistry. They can explain the structure of molecular orbitals and describe the different hybridization states of carbon atoms in the context of LCAO. They analyze the electron transfer between different molecules in the framework of the Marcus theory and can describe the essential aspects of electronic tunneling processes. They understand the content of current research publications and present them in short presentations. They can describe the structure of conductive polymers, their doping and electronic transport. They analyze the optoelectronic properties of polymers and organic dyes and can classify and explain the relevant electronic excitations and processes.</p> | | | |
| Literature | | | |
| <p>Introduction to Nanoscience, S.M. Lindsay, Oxford Polymer Electronics, M. Geoghegan, G. Hadziioannou, Oxford</p> | | | |

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|---|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |
| Molecular Electronics | 2,0 | Lecture | english |
| Literature | | | |
| "Molecular Nanoelectronics", M. A. Reed, T. Lee (Eds.), American Scientific Publishers (2003) "Introducing Molecular Electronics", Cuniberti et al. (Eds.), Springer (2005) | | | |
| | 1,0 | Exercise | english |
| Literature | | | |
| lecture slides, exercise materials | | | |

| | | | |
|--|---|--------------------------|--|
| Title | Nanoelectronics | | |
| Number | 2411200 | Module version | |
| Shorttext | | Language | |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Oleksandr Dobrovolskiy |
| Workload (h) | 150 | | |
| Class attendance (h) | 56 | Self studying (h) | 94 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Oral exam (30 min), written exam (120 min) only for a high number of participants | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> • Quantum mechanics Wave function, potentials, interaction • Magnetism • Superconductivity • Manufacturing processes • Josephson junctions • SET components • Data memory • THz transistors • Quantum computing | | | |
| Objective qualification | | | |
| After completing the module 'Nanoelectronics', students will have an overview of the fundamentals of quantum mechanics and its application to metallic, magnetic and superconducting components with nanometre dimensions. | | | |
| Literature | | | |
| <p>A multi-media CD ROM with script and exercises is available for the lecture</p> <ul style="list-style-type: none"> - R. Waser, #Nanoelectronics and Information Technology#, Wiley-VCH, 2003, ISBN 978-3527403639 - M. Köhler, #Nanotechnologie#, Wiley-VCH, 2007, ISBN 978-3527318711 - Jasprit Singh, #Modern Physics for Engineers#, Wiley, 1999, ISBN 978-0471330448 - N. Ashcroft, N. Mermin, #Solid State Physics#, Cengage Learning Services, 1976, ISBN 978-0030839931 - S. Flügge, #Rechenmethoden der Quantentheorie#, Springer Verlag 1993, ISBN 978-3540567769 - W. Nolting, #Quantenmechanik#, Band 5 aus #Grundkurs: Theoretische Physik#, Springer-Verlag, 2007, ISBN 978-3540688686 | | | |

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|---|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |
| Nanoelectronics | 2,0 | Lecture | german |
| Literature | | | |
| <ul style="list-style-type: none"> • R. Waser, Nanoelectronics and Information Technology, Wiley-VCH • M. Köhler, Nanotechnologie, Wiley-VCH • Jasprit Singh, Modern Physics for Engineers, Wiley • N. Ashcroft, N. Mermin, Solid State Physics • S. Flügge, Rechenmethoden der Quantentheorie • W. Nolting, Quantenmechanik, Band 5 aus Grundkurs: Theoretische Physik | | | |
| Nanoelectronics | 1,0 | Exercise | german |
| Literature | | | |
| <ul style="list-style-type: none"> • R. Waser, Nanoelectronics and Information Technology, Wiley-VCH • M. Köhler, Nanotechnologie, Wiley-VCH • Jasprit Singh, Modern Physics for Engineers, Wiley • N. Ashcroft, N. Mermin, Solid State Physics • S. Flügge, Rechenmethoden der Quantentheorie • W. Nolting, Quantenmechanik, Band 5 aus Grundkurs: Theoretische Physik | | | |

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|--|---|--------------------------|--|
| Title | Measurement Electronics with Experiments | | |
| Number | 2411330 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik |
| Hours per Week / ECTS | 6 / 8,0 | Module owner | Prof. Dr. Meinhard Schilling |
| Workload (h) | 240 | | |
| Class attendance (h) | 84 | Self studying (h) | 156 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Oral exam (30 min), written exam (120 min) only for a high number of participants | | |
| Course achievement | Successful participation in lab work | | |
| Contents | | | |
| <p>Measuring amplifiers with transistors and OPVs</p> <ul style="list-style-type: none"> - Electronic switches - Source circuits - Measuring transducers - Analogue filter circuits - Treatment of interference signals and noise - Correlation analysis - Measurement converters (A/D and D/A) - Measuring device buses - Time measurement - Oscilloscopes and trigger circuits <p>and</p> <p>carrying out experiments in the following areas</p> <ul style="list-style-type: none"> - Electronically controllable switches - Reference sources for voltages and currents - Measuring amplifiers - Analogue-to-digital/digital-to-analogue converters - Time and frequency measurement - Oscilloscope - Correlator | | | |
| Objective qualification | | | |
| <p>After completing the module 'Measurement Electronics with Practice', students will have an overview of the circuit technology and measurement methods of measurement electronics. The practical knowledge they have acquired enables them to set up circuits for measurement applications. In-depth practical experience with measurement methods that are dealt with in the measurement electronics lecture is taught in the laboratory. In accordance with the didactic concept of the course and the design of the individual components,</p> | | | |

interdisciplinary skills are taught and practised. In the context of papers, colloquia and final presentations, these include scientific writing and documentation

Literature

A multi-media CD ROM with script and exercises is available for the lecture
 - Allan R. Hambley #Electronics#, Prentice Hall, ISBN 978-0136919827
 - U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002, ISBN 978-3540641926
 - Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag, ISBN 978-3772365263
 - P. Horowitz #The Art of Electronics#, Cambridge Univ. Press, ISBN 978-0521689175
 - Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996, ISBN 978-3211828731



Related courses

Rules for the choice of courses

Compulsory attendance

| Name of the course | SWS | Eventtype | Language |
|--------------------|-----|-----------|----------|
|--------------------|-----|-----------|----------|

| | | | |
|-------------------------|-----|---------|--------|
| Measurement Electronics | 2,0 | Lecture | german |
|-------------------------|-----|---------|--------|

Literature

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

| | | | |
|-------------------------|-----|----------|--------|
| Measurement Electronics | 1,0 | Exercise | german |
|-------------------------|-----|----------|--------|

Literature

- Allan R. Hambley #Electronics#, Prentice Hall
- U. Tietze, Ch. Schenk #Halbleiter-Schaltungstechnik#, Springer-Verlag, 2002
- Dieter Nüßmann #Das komplette Werkbuch Elektronik#, Franzis-Verlag
- P. Horowitz #The Art of Electronics#, Cambridge Univ. Press
- Rupert Patzelt, Herbert Schweinzer, #Elektrische Messtechnik#, Springer Verlag 1996

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|------------------------------------|-----|------------|--------|
| Electronics measurement internship | 3,0 | Internship | german |
|------------------------------------|-----|------------|--------|

Literature

Internship script

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|---|---|--------------------------|--|
| Title | Electromagnetic Compatibility with Seminar | | |
| Number | 2419130 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Elektromagnetische Verträglichkeit |
| Hours per Week / ECTS | 5 / 6,0 | Module owner | Prof. Dr. Thomas Kleine-Ostmann |
| Workload (h) | 180 | | |
| Class attendance (h) | 70 | Self studying (h) | 110 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (60 min) or oral exam, presentation of seminar topic | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> - Terms and definitions of EMC - Sources of interference and disturbance variables, immunity of susceptible devices - Coupling mechanisms: galvanic, capacitive, inductive coupling, wave and radiation interference - Establishing of EMC by measures at the sources of interference, at the coupling paths and at the susceptible devices; shielding, overvoltage and overcurrent protection - Legal basis, product liability, standardization - EMC test engineering - Electromagnetic compatibility of biological systems - Current EMC issues presented in seminar talks | | | |
| Objective qualification | | | |
| <p>The students are able to analyze mutual interference and interaction scenarios for electrotechnical and electronic systems and components by emitted interference levels and susceptibilities. The students are able to choose appropriate protection and compatibility measures. The students are able to predict EMC-aspects for the design of facilities and systems at an early stage, as well as to decide on cost-efficient solutions. The students are able to describe the responsibilities for the EMC product safety by the state of standards. The students are able to assess the EMC product safety by failure mechanisms. The students are able to investigate current EMC issues autonomously, structure and present them to an audience.</p> | | | |
| Literature | | | |
| <ul style="list-style-type: none"> - continuously updated script handout - Joachim Franz, EMV - Störungssicherer Aufbau elektronischer Schaltungen, Teubner, 2002, ISBN 3-519-00397-X - Clayton R. Paul, Introduction to Electromagnetic Compatibility, Wiley, 2006, ISBN 0-471-75500-1 - Kenneth L. Kaiser, Electromagnetic Compatibility Handbook, CRC Press, 2005, ISBN 0-8493-2087-9 | | | |



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|--|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| You can either choose Electromagnetic Compatibility with Seminar or Electromagnetic Compatibility (without seminar). The seminar can also be attended in the summer semester after having attended the EMC lecture. | | | |
| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Electromagnetic Compatibility | 2,0 | Lecture | german |
| Teacher training college EMC | 2,0 | Seminar | english |
| Electromagnetic Compatibility | 1,0 | Exercise | german |

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|--|-------------------------------------|--------------------------|--|
| Title | Analog Integrated Circuits with Lab | | |
| Number | 2420140 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für CMOS Design |
| Hours per Week / ECTS | 6 / 8,0 | Module owner | Prof. Dr. Vadim Issakov |
| Workload (h) | 240 | | |
| Class attendance (h) | 84 | Self studying (h) | 156 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Oral exam (30 min) | | |
| Course achievement | | | |
| Contents | | | |
| <p>All modern mobile communications applications (e.g., GSM, WLAN, GPS, Bluetooth, DECT, etc.) use analog receiver and transmitter circuits that are composed of a few elementary circuit blocks. For cost reasons, these are increasingly being integrated into low-cost CMOS technology, resulting in significant differences from the classic design of high-frequency circuits based on discrete components. The lecture provides an introduction to the design of analog, integrated CMOS mobile communications receiver circuits.</p> <p>The lecture is divided into the following chapters:</p> <ul style="list-style-type: none"> • High-frequency amplifier circuits • Simulation of electronic noise • Low-noise input amplifiers in CMOS • Mixer circuits • HPhase-locked loops (PLLs) • Voltage-controlled oscillators | | | |
| Objective qualification | | | |
| <p>After completing the module, students will have acquired knowledge of analog receiver and transmitter circuits in CMOS technology and have an advanced understanding of the design and function of modern analog integrated circuits for mobile radio applications (e.g. high-frequency amplifier circuits and simulation of electronic noise).After completing the module, students will have acquired knowledge of analog receiver and transmitter circuits in CMOS technology and have an advanced understanding of the design and function of modern analog integrated circuits for mobile radio applications (e.g. high-frequency amplifier circuits and simulation of electronic noise).</p> <p>They will acquire fundamental knowledge in the use of the Spectre-RF design tool, which is widely used in industry for the design of analog integrated circuits.</p> <p>In accordance with the didactic concept of the course and the structure of the individual components, interdisciplinary skills are taught and practiced. These include scientific writing and documentation, conversation</p> | | | |

and presentation techniques, and teamwork in the laboratory or on projects, which are covered in assignments, colloquia, and final presentations.

Literature

Thomas H. Lee " The Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press

Remark

For the Master's degree programs in Electrical Engineering, Industrial Engineering Electrical Engineering, and Information Systems Engineering



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|---|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| Requirements for this module: circuit technology (<i>Schaltungstechnik</i> , ST) | | | |
| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Analog Integrated Circuits (2013) | 1,0 | Exercise | english |
| Analog Integrated Circuits (2013) | 1,0 | Internship | english |
| Analog Integrated Circuits (2013) | 2,0 | Lecture | english |

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|--|--|--------------------------|--|
| Title | Applied Quantum Computing: Basics and Devices | | |
| Number | 2413620 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Halbleitertechnik |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Stefanie Kroker |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (120 min) or oral exam (30 min), alternativ: homework with final presentation | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> - Basics of Quantum Mechanics - From Bit to Qubit - Quantum Circuits I - Quantum Circuits II - Entanglement and Teleportation - Algorithms of Quantum Computing - Quantum Hardware I - Quantum Hardware II | | | |
| Objective qualification | | | |
| <ul style="list-style-type: none"> - The students can name the prerequisites for the realization of qubits as well as typical platforms and explain their significance. - Students will be able to name the strengths and weaknesses of different hardware platforms in common application scenarios and weigh them against each other. - The students can name the essential process steps for the realization of different quantum computer platforms and to explain challenges that may arise in the manufacturing process. - Students will be able to use an exemplary platform to explain how selected quantum gates can be realized. | | | |
| Literature | | | |
| <p>[1] C. Bernhardt: Quantum Computing for everyone (The MIT Press) 2019 [2] M. A. Nielsen & I. L. Chuang: Quantum Computation and Quantum Information (Cambridge University Press) 2010 [3] J. D. Hiday: Quantum Computing: An Applied Approach (Springer) 2019 [4] M. Homeister: Quantum Computing verstehen (Springer Vieweg) 2018 [5] W. Scherer: Mathematics of Quantum Computing (Springer) 2019</p> | | | |

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|---|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Applied Quantum Computing: Basics and Devices | 2,0 | Lecture | german |
| Literature | | | |
| [1] C. Bernhardt: Quantum Computing for everyone (The MIT Press) 2019 [2] M. A. Nielsen & I. L. Chuang: Quantum Computation and Quantum Information (Cambridge University Press) 2010 [3] J. D. Hidary: QuantumComputing: An Applied Approach (Springer) 2019 [4] M. Homeister: Quantum Computing verstehen (Springer Vieweg) 2018 [5] W. Scherer: Mathematics of Quantum Computing (Springer) 2019 | | | |
| Applied Quantum Computing: Basics and Devices | 1,0 | Exercise | german |

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|---|---|--------------------------|--|
| Title | Experimental Aspects of Quantum Computing | | |
| Number | 1511000000 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Physik der Kondensierten Materie |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Dirk Menzel Prof. Dr. Stefan Süllo |
| Workload (h) | 180 | | |
| Class attendance (h) | 60 | Self studying (h) | 120 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Oral exam (45 min) | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> - superconductivity - spintronics - low temperature - realization of qubits - charge and spin transport | | | |
| Objective qualification | | | |
| <p>The students learn and know the fundamentals in quantum physics for the realization of qubits. They transfer the physical concepts of superconductivity and spintronics into the context of 'quantum computing'. They learn possible structuration methods to represent qubits in real systems and can implement experimental techniques, e. g., charge and spin transport at low temperature.</p> | | | |
| Literature | | | |
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| Remark | | | |
| Students either have to choose "Superconductivity" or "Physical Fundamentals of Spintronics" (lecture + exercise). | | | |



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| Related courses | | | |
| Rules for the choice of courses | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |
| Experimental Aspects of Quantum Computing | | Lecture | german |
| Physical Fundamentals of Spintronics | 2,0 | Lecture | english german |
| Physical Fundamentals of Spintronics | 1,0 | Exercise | english german |
| Superconductivity | 2,0 | Lecture | english german |
| Superconductivity | 1,0 | Exercise | english german |

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|---|---|--------------------------|--|
| Title | Gallium Nitride Technology | | |
| Number | 2413000030 | Module version | |
| Shorttext | | Language | english german |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Halbleitertechnik |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Andreas Waag |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (90 min) or oral exam (30 min) | | |
| Course achievement | | | |
| Contents | | | |
| <p>The course builds on 'Lighting Technology I'. While Lighting Technology I focusses on general questions of lighting and lighting technology, this course discusses LED technology and gallium nitride technology in particular:</p> <ul style="list-style-type: none"> • Physical principles of LEDs. Band gap engineering in LEDs. • Semiconductor materials for optoelectronics • Relationship between material properties and LED properties • Manufacturing processes • Efficiency considerations • Front-end and back-end processing • Application examples in general lighting, automotive technology, sensor technology • Infrared LEDs, visible light, UV LEDs | | | |
| Objective qualification | | | |
| <p>After completing the module, students will have an overview of the current state of LED technology and the development opportunities that solid state lighting will offer in the future. In addition, they will have a basic understanding of the physical processes within LEDs.</p> | | | |
| Literature | | | |
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| Related courses | | | |
| Rules for the choice of courses | | | |
| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Gallium Nitride Technology | 2,0 | Lecture | german |
| Gallium Nitride Technology | 1,0 | Exercise | german |

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|--|---|--------------------------|--|
| Title | Semiconductor Optics | | |
| Number | 1511000010 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | irregular | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Physik der Kondensierten Materie |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Farsane Tabataba-Vakili |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Recommended requirements | Fundamentals of solid state physics, quantum mechanics, optics/electrodynamics from Bachelor's degree in physics or equivalent. | | |
| Expected performance/ Type of examination | oral exam (20 min) or written exam (90 min) | | |
| Course achievement | | | |
| Contents | | | |
| Phonons, semiconductor band structure, bulk semiconductors, heterostructures and quantum wells, macroscopic optical properties, interband absorption, excitons, luminescence, cavity exciton-polaritons, 2D materials, excitons in 2D semiconductors, heterostructures of 2D semiconductors | | | |
| Objective qualification | | | |
| The students are able to explain the physical fundamentals of crystalline solids relevant to semiconductor optics. They acquire a detailed understanding of the interaction between light and matter, with a focus on the optical properties of semiconductors. The students gain an overview of exciton physics, particularly in 2D semiconductors, including discussions of current research topics. | | | |
| Literature | | | |
| <ul style="list-style-type: none"> • Fox: Optical Properties of Solids, • Davies: The Physics of low-dimensional semiconductors, • Yu and Cardona: Fundamentals of Semiconductors, • Kalt and Klingshirn: Semiconductor Optics 1, • Grundmann: The Physics of Semiconductors, • Marx und Gross: Festkörperphysik, • Hungklinger: Festkörperphysik | | | |

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| Related courses | | | | |
| Rules for the choice of courses | | | | |
| Compulsory attendance | | | | |
| Name of the course | | | | |
| | | SWS | Eventtype | Language |
| Semiconductor Optics | | 2,0 | Lecture | english |
| Literature | | | | |
| <ul style="list-style-type: none"> • Fox: Optical Properties of Solids, • Davies: The Physics of low-dimensional semiconductors, • Yu and Cardona: Fundamentals of Semiconductors, • Kalt and Klingshirn: Semiconductor Optics 1, • Grundmann: The Physics of Semiconductors, • Marx und Gross: Festkörperphysik, • Hungklinger: Festkörperphysik | | | | |
| Semiconductor Optics | | 1,0 | Exercise | english |
| Literature | | | | |
| <ul style="list-style-type: none"> • Fox: Optical Properties of Solids, • Davies: The Physics of low-dimensional semiconductors, • Yu and Cardona: Fundamentals of Semiconductors, • Kalt and Klingshirn: Semiconductor Optics 1, • Grundmann: The Physics of Semiconductors, • Marx und Gross: Festkörperphysik, • Hungklinger: Festkörperphysik | | | | |

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|--|--|--------------------------|--|
| Title | Nanostructures on Surfaces | | |
| Number | 1520000010 | Module version | |
| Shorttext | | Language | german |
| Frequency of offer | irregular | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Angewandte Physik |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Uta Schlickum |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Oral exam (30 min) or written exam (120 min) | | |
| Course achievement | | | |
| Contents | | | |
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| Objective qualification | | | |
| | | | |
| Literature | | | |
| 1. Physics at Surfaces, A. Zangwill, Cambridge University Press, 1988 2. Oberflächenphysik des Festkörpers, M. Henzler und W. Göpel, Teubner Studienbücher, 1994 3. Oberflächenphysik, Grundlagen und Methoden, T. Fauster, L. Hammer, K. Heinz, und M.A. Schneider, Oldenbourg Verlag München, 2013 4. Scanning Probe Microscopy and Spectroscopy, R. Wiesendanger, Cambridge University Press, 1994 5. Applied Scanning Probe Methods, B. Bhushan, H. Fuchs, und S. Hosaka, Springer Berlin Heidelberg, 2004 | | | |

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|--|------------|------------------|-----------------|
| Related courses | | | |
| Rules for the choice of courses | | | |
| | | | |
| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |

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|--|-----|------------------|--------|
| Nanostructures on Surfaces | 3,0 | Lecture/Exercise | german |
| Literature | | | |
| <ol style="list-style-type: none">1. Physics at Surfaces, A. Zangwill, Cambridge University Press, 19882. Oberflächenphysik des Festkörpers, M. Henzler und W. Göpel, Teubner Studienbücher, 19943. Oberflächenphysik, Grundlagen und Methoden, T. Fauster, L. Hammer, K. Heinz, und M.A. Schneider, Oldenbourg Verlag München, 20134. Aktuelle Publikationen | | | |

Optional Required Subjects: Quantum Information Processing and Quantum Computing

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|--|---|--------------------------|--|
| Title | Information Theory | | |
| Number | 2424720 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Nachrichtentechnik |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Eduard Jorswieck |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (90 min) or oral exam (30 min) | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> • Basics from probability theory <ul style="list-style-type: none"> • Event, probability, random variable, random vector, stochastic process, convergence of random series, convergence theorems • Basics from information theory <ul style="list-style-type: none"> • Measures for discrete random variables: entropy, conditional entropy, relative entropy, mutual information, conditional mutual information, inequalities • Measures for continuous random variables: differential entropy, conditional differential entropy, relative entropy, mutual information, inequalities • Measure for random series • Typical sequences and asymptotic equipartition property • Source and source coding <ul style="list-style-type: none"> • Definition and properties • Source coding for discrete memoryless sources (fixed and variable-length) • Selected source codes: Morse, Huffman, Shannon-Fano-Elias • Data transmission and channel capacity <ul style="list-style-type: none"> • Discrete memoryless channel: channel coding theorem • Discrete memoryless channel with state: channel capacities • Gaussian channel: model and channel coding theorem • Bandlimited Gaussian channel, vector valued channels | | | |
| Objective qualification | | | |
| <p>The lecture provides an introduction to the fundamentals of Shannon information theory. The goal is that students can derive the main information theoretic results on maximal achievable lossless (source coding) and lossy (rate distortion theory) compression of data and on maximum data rates for reliable data transmission (channel coding). The methods and tools required, e.g., information measures (entropy, mutual information, capacity etc.) and their properties (typical sequences) will be covered as well as practical applicable simple codes (block, turbo and polar codes).</p> | | | |

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| Literature |
| #R.W. Yeung: Information Theory and Network Coding, Part I, Springer, 2008. R.W. Yeung: A First Course in Information Theory, Springer, 2002. T.M. Cover und J.A. Thomas: Elements of Information Theory, Wiley-Interscience, 2006. R.G. Gallager: Information Theory and Reliable Communication, Wiley, 1968. R.G. Gallager: Principles of Digital Communication, Cambridge University Press, 2008. S. Moser: S. Moser: Information Theory, https://moser-isi.ethz.ch/scripts.html#it |

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| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Information Theory | 2,0 | Lecture | german |
| Literature | | | |
| - R.W. Yeung: Information Theory and Network Coding, Part I, Springer, 2008. - R.W. Yeung: A First Course in Information Theory, Springer, 2002. - T.M. Cover und J.A. Thomas: Elements of Information Theory, Wiley-Interscience, 2006. - R.G. Gallager: Information Theory and Reliable Communication, Wiley, 1968. - R.G. Gallager: Principles of Digital Communication, Cambridge University Press, 2008. - S. Moser: S. Moser: Information Theory, https://moser-isi.ethz.ch/scripts.html#it | | | |
| Information Theory | 1,0 | Exercise | german |
| Literature | | | |
| - R.W. Yeung: Information Theory and Network Coding, Part I, Springer, 2008. - R.W. Yeung: A First Course in Information Theory, Springer, 2002. - T.M. Cover und J.A. Thomas: Elements of Information Theory, Wiley-Interscience, 2006. - R.G. Gallager: Information Theory and Reliable Communication, Wiley, 1968. - R.G. Gallager: Principles of Digital Communication, Cambridge University Press, 2008. - S. Moser: S. Moser: Information Theory, https://moser-isi.ethz.ch/scripts.html#it | | | |

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|---|---|--------------------------|--|
| Title | Network Information Theory | | |
| Number | 2424650 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Nachrichtentechnik |
| Hours per Week / ECTS | 4 / 6,0 | Module owner | Prof. Dr. Eduard Jorswieck |
| Workload (h) | 180 | | |
| Class attendance (h) | 56 | Self studying (h) | 124 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (90 min) or oral exam (30 min) | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> • Review point-to-point channel capacity and coding theorem • Strong typical sequences and their properties • Multiple-Access Channel: Capacity region compared to TDMA/FDMA/SDMA/NOMA • #Broadcast Channel: degraded BC capacity region, non-degraded BC achievable rate region and converse • Interference Channel: very strong, strong, weak interference capacity region, medium interference achievable rate region and converse • #Relay Channel: achievable schemes amplify-and-forward, decode-and-forward, compress-and-forward, estimate-and-forward #Generalization and application of elements to complex networks | | | |
| Objective qualification | | | |
| <p>After completing the lecture, the students will know the building blocks of complex communications networks, i.e., the multiple-access channel, the broadcast channel, the relay channel and the interference channel, their achievable rates and capacity regions including coding and decoding schemes. In addition, the students obtain knowledge to design future wireless and multi-hop as well as ad-hoc networks. They master information-theoretic and mathematical tools to prove coding theorems. They know the state of the art as well as open problems in network information theory.</p> | | | |
| Literature | | | |
| <p>#A. El Gamal and Y.-H. Kim: Network Information Theory, Cambridge University Press, 2011. D. Tse and P. Viswanath: Fundamentals of Wireless Communications, Cambridge University Press, 2007. T. M. Cover and J. A. Thomas: Elements of Information Theory, 2nd ed., New York: Wiley-Interscience, Juli 2006. S. Boyd and L. Vandenberghe: Convex Optimization, Cambridge University Press, 2004. R. W. Yeung: Information Theory and Network Coding, Part I, Springer, 2008.</p> | | | |

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| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Network Information Theory | 2,0 | Lecture | english |
| Literature | | | |
| <p>A. El Gamal and Y.-H. Kim: Network Information Theory, Cambridge University Press, 2011 D. Tse and P. Viswanath: Fundamentals of Wireless Communications, Cambridge University Press, 2007 T. M. Cover and J. A. Thomas: Elements of Information Theory, 2nd ed., New York: Wiley-Interscience, Juli 2006 S. Boyd and L. Vandenberghe: Convex Optimization, Cambridge University Press, 2004 R. W. Yeung: Information Theory and Network Coding, Part I, Springer, 2008</p> | | | |
| Network Information Theory | 2,0 | Exercise | english |
| Literature | | | |
| <p>- A. El Gamal and Y.-H. Kim: Network Information Theory, Cambridge University Press, 2011. - D. Tse and P. Viswanath: Fundamentals of Wireless Communications, Cambridge University Press, 2007. - T. M. Cover and J. A. Thomas: Elements of Information Theory, 2nd ed., New York: Wiley-Interscience, Juli 2006. - S. Boyd and L. Vandenberghe: Convex Optimization, Cambridge University Press, 2004. - R. W. Yeung: Information Theory and Network Coding, Part I, Springer, 2008.</p> | | | |

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|---|--|--------------------------|--|
| Title | Coding Theory | | |
| Number | 2424420 | Module version | |
| Shorttext | | Language | english german |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Nachrichtentechnik |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Thomas Kürner |
| Workload (h) | 150 | | |
| Class attendance (h) | 56 | Self studying (h) | 94 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Oral exam (20 min) or written exam (120 min) | | |
| Course achievement | Colloquium or lab journal | | |
| Contents | | | |
| <ul style="list-style-type: none"> - Introduction - Fundamentals of information theory - Basics of channel coding - Single-error-correcting block codes - Block codes for correcting burst errors - Convolutional codes - Special coding techniques | | | |
| Objective qualification | | | |
| Upon completion of the module, students will have an understanding of the information-theoretical limits of data transmission and will have acquired knowledge of source and channel coding methods in theory and application. Students will be able to assess the performance of source and channel coding methods and construct simple codes. | | | |
| Literature | | | |
| Lecture notes H.Rohling: Einführung in die Informations- und Codierungstheorie, Teubner R.Togneri, C.J.S. deSilva: Fundamentals of Information Theory and Coding Design, Chapman&Hall/CRC H.Schneider-Obermann: Kanalcodierung, Vieweg | | | |

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| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Coding Theory | 2,0 | Lecture | english german |
| Literature | | | |
| Vorlesungsskript H. Rohling: Einführung in die Informations- und Codierungstheorie, Teubner R. Togneri, C. J. S. de Silva: Fundamentals of Information Theory and Coding Design, Chapman&Hall/CRC H. Schneider-Obermann: Kanalcodierung, Vieweg | | | |
| Coding Theory | 1,0 | Exercise | english german |
| Literature | | | |
| siehe Vorlesung | | | |
| Computer exercise on Coding Theory | 1,0 | Laboratory | english german |

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|--|---|--------------------------|--|
| Title | Quantum Communication Networks | | |
| Number | 2424000030 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the summer term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für Nachrichtentechnik |
| Hours per Week / ECTS | 3 / 6,0 | Module owner | Dr. Christian Deppe |
| Workload (h) | 180 | | |
| Class attendance (h) | 42 | Self studying (h) | 138 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | Written exam (60 min) or oral exam (30 min) | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> • Introduction to the basic concepts of quantum mechanics and quantum systems • Introduction to quantum information theory • Protocols for quantum computation and programming • Introduction to quantum communication networks • Capacity calculations for entanglement-assisted communication • Introduction to communication with the help of quantum repeaters | | | |
| Objective qualification | | | |
| <p>The students</p> <ul style="list-style-type: none"> • know the basics of quantum communication networks • understand quantum information theory models • can calculate rate limits of quantum information-theoretical networks • understand simple protocols for quantum communication networks • can simulate simple protocols for quantum communication networks • can independently develop their own protocols for new models | | | |
| Literature | | | |
| <p>Bassoli, R., Boche, H., Deppe, C., Ferrara, R., Fitzek, F. H., Janssen, G., & Saedinaeni, S. (2021). Quantum communication networks (Vol. 23, pp. 1-213). Berlin/Heidelberg, Germany: Springer.</p> <p>Bassoli, R., Boche, H., Deppe, C., Ferrara, R., Fitzek, F. H., Janssen, G., & Saedinaeni, S. (2023). <i>Quantenkommunikationsnetze</i>, Berlin/Heidelberg, Germany: Springer (2023).</p> | | | |

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| Related courses | | | |
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| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Quantum Communication Networks | 2,0 | Lecture | english |
| Quantum Communication Networks | 1,0 | Exercise | english |

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|---|---|--------------------------|---|
| Title | Online Algorithms | | |
| Number | 4227260 | Module version | V2 |
| Shorttext | | Language | english german |
| Frequency of offer | every 2 years in the summer term | Teaching unit | Carl-Friedrich-Gauß-Fakultät |
| Module duration | 1 | Institution | Institut für Betriebssysteme und Rechnerverbund |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Sandor Fekete |
| Workload (h) | 150 | | |
| Class attendance (h) | 56 | Self studying (h) | 94 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | graded work: written exam (120 minutes) or oral exam (30 minutes) or Take-Home-Exam. The form of the examination depends on the number of participants and will be announced at the beginning of the lecture. | | |
| Course achievement | non-graded work: 50% of the exercises must be passed | | |
| Contents | | | |
| <ul style="list-style-type: none"> - Competitive Analysis - Self-Organizing Data Structures - Distributed Paging - Online Scheduling - Robot Motion Planning (Exploration, Search) - Online Packing | | | |
| Objective qualification | | | |
| Participants know the necessity and role of algorithms with incomplete information. They can master the most important techniques for analysis and complexity of online algorithms, in particular how to establish upper and lower bounds for competitive factors. | | | |
| Literature | | | |
| <ul style="list-style-type: none"> - Allan Borodin und Ran El-Yaniv. Online Computation and Competitive Analysis. Reissue edition. Cambridge University Press, 2005. - Amos Fiat und Gerhard Woeginger. Online Algorithms. Springer Verlag, 1998. | | | |

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| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |

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|--|-----|-----------------------|---------|
| | 2,0 | Lecture | english |
| | 1,0 | Exercise | english |
| | 1,0 | Exercise, small group | english |

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|--|--|--------------------------|---|
| Title | Approximation Algorithms | | |
| Number | 4227270 | Module version | |
| Shorttext | | Language | english german |
| Frequency of offer | every 2 years in the summer term | Teaching unit | Carl-Friedrich-Gauß-Fakultät |
| Module duration | 1 | Institution | Institut für Betriebssysteme und Rechnerverbund |
| Hours per Week / ECTS | 4 / 5,0 | Module owner | Prof. Dr. Sandor Fekete |
| Workload (h) | 150 | | |
| Class attendance (h) | 56 | Self studying (h) | 94 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | graded work: written exam (120 minutes) or oral exam (30 minutes) minutes) or Take-Home-Exam. The form of the examination depends on the number of participants and will be announced at the beginning of the lecture. | | |
| Course achievement | non-graded work: 50% of the exercises must be passed | | |
| Contents | | | |
| <ul style="list-style-type: none"> - A basic introduction to NP-completeness and approximation - Approximation for vertex and set cover - Packing problems - Tour problems and variations - Current research problems <p>In the context of various problems, a wide spectrum of techniques and concepts will be provided.</p> | | | |
| Objective qualification | | | |
| Participants know the necessity and role of approximation algorithms. They can master the most important techniques for analysis and complexity of approximation algorithms for designing, including the validity of upper and lower bounds. | | | |
| Literature | | | |
| <ul style="list-style-type: none"> - Vijay V. Vazirani: Approximation Algorithms. 1st edition. Springer Verlag, 2001. - Dorit Hochbaum: Approximation Algorithms for NP-hard Problems. Course Technology Inc, 1996. | | | |

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| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |

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|--|-----|-----------------------|----------------|
| Approximation Algorithms | 3,0 | Lecture/Exercise | english german |
| Literature | | | |
| - Vijay V. Vazirani: Approximation Algorithms. 1st edition. Springer Verlag, 2001. | | | |
| - Dorit Hochbau: Approximation Algorithms for NP-hard Problems. Course Technology Inc, 1996. | | | |
| | 1,0 | Exercise, small group | english german |

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|--|---|--------------------------|------------------------------|
| Title | Mathematical Foundations of Information Theory and Coding Theory | | |
| Number | 1294600 | Module version | V3 |
| Shorttext | | Language | |
| Frequency of offer | every 2 years in the winter term | Teaching unit | Carl-Friedrich-Gauß-Fakultät |
| Module duration | 1 Semester | Institution | |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | 1 oral exam (20-30 minutes) according to examiner's specifications. The exact examination specifications will be announced at the beginning of the course. | | |
| Course achievement | Non-graded coursework (Studienleistung): Homework or presentation according to examiner's specifications. The exact examination specifications will be announced at the beginning of the course. | | |
| Contents | | | |
| <ul style="list-style-type: none"> - Kraft Inequality and McMillan's Theorem - Huffman Codes - Stochastic Processes - Entropy and Entropy Rates - The Shannon-McMillan-Breiman Theorem - Universal Codes and the Lempel-Ziv Code - Rate Allocation | | | |
| Objective qualification | | | |
| <p>Technical/methodological skills</p> <p>Students understand the interconnections and complex relationships between their own mathematical knowledge and the content of the course. They understand the theory of the course as a whole and have mastered the associated methods. Students can apply and analyse the methods taught in the course and have mastered the essential fundamentals of the field. They can place individual methods in a larger context.</p> <p>Social skills</p> <p>Social skills are strengthened in particular through professional exchange among students, for example when working together to develop solution strategies, discussing mathematical concepts or cooperatively dealing with complex problems.</p> <p>Personal skills</p> <p>Students independently acquire new knowledge and perspectives and discuss mathematical content with others; they develop solutions in a focused, precise and goal-oriented manner. Students can train and improve their teamwork skills in homework assignments, compare the requirements of the module with their own prior knowledge and independently close any gaps in their knowledge, as well as reflect on their learning progress and adjust their learning behaviour if necessary.</p> | | | |

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| Literature |
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| - Cover & Thomas „Elements of Information Theory“ (Wiley) |
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| Related courses |
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| Rules for the choice of courses |
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| The module 'Mathematical Foundations of Information Theory and Coding Theory' consists of a lecture and a tutorial. |
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| Compulsory attendance |
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| Name of the course | SWS | Eventtype | Language |
|--|-----|------------------|----------------|
| Mathematical Foundations of Information Theory and Coding Theory | 3,0 | Lecture/Exercise | english german |

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|---|--|--------------------------|------------------------------|
| Title | Introduction to Quantum Information Theory | | |
| Number | 1294540 | Module version | V3 |
| Shorttext | | Language | german |
| Frequency of offer | every 2 years in the summer term | Teaching unit | Carl-Friedrich-Gauß-Fakultät |
| Module duration | 1 | Institution | |
| Hours per Week / ECTS | 4 / 6,0 | Module owner | Studiendekan der Mathematik |
| Workload (h) | 180 | | |
| Class attendance (h) | 56 | Self studying (h) | 124 |
| Compulsory requirements | | | |
| Recommended requirements | A basic knowledge of classical information theory is recommended | | |
| Expected performance/ Type of examination | graded examination (Prüfungsleistung): 1 written exam (90 minutes) or 1 oral exam (20-30 minutes) according to examiner's specifications. After approval by the examination board mathematics (Prüfungsausschuss Mathematik), the examiner can also choose the take-home exam as the form of examination. The exact examination specifications will be announced at the beginning of the course. | | |
| Course achievement | Non-graded coursework (Studienleistung): Homework according to examiner's specifications. The exact examination specifications will be announced at the beginning of the course. | | |
| Contents | | | |
| <ul style="list-style-type: none"> - Vectors and Operators, - States, Observables, Statistics, - Composite Systems and Entanglement, - Classical Entropy and Information, - The Classical-Quantum Channel, - Quantum Evolutions and Channels, - Quantum Entropy and Information Quantities | | | |
| Objective qualification | | | |
| <p>The students</p> <ul style="list-style-type: none"> - understand the of the complex links between their previous mathematical knowledge and the contents of the lecture - understand the theoretical body of the lecture as a whole and master the corresponding methods - are able to analyze and apply the methods of the lecture <ul style="list-style-type: none"> - acquainted with the basic objects, constructions, and mathematical theorems and their proofs of quantum information theory - obtain an understanding of the similarities of, and the fundamental differences between, classical information theory and quantum information theory - learn about applications of quantum information theory in quantum computing and communication. | | | |
| Literature | | | |
| <ul style="list-style-type: none"> • A. Holevo: Quantum Systems, Channels, Information, De Gruyter | | | |



| Related courses | | | |
|--|------------|-----------------------|-----------------|
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Introduction to Quantum Information Theory | 3,0 | Lecture/Exercise | english german |
| Introduction to Quantum Information Theory | 1,0 | Exercise, small group | german |

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|--|---|--------------------------|--|
| Title | Phase-Locked Loops and Frequency Synthesis | | |
| Number | 2420000020 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | only in the winter term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | Institut für CMOS Design |
| Hours per Week / ECTS | 3 / 5,0 | Module owner | Prof. Dr. Vadim Issakov |
| Workload (h) | 150 | | |
| Class attendance (h) | 42 | Self studying (h) | 108 |
| Compulsory requirements | | | |
| Recommended requirements | Basic knowledge in analogue circuits | | |
| Expected performance/ Type of examination | oral exam (30 min) or written exam (60 min) | | |
| Course achievement | | | |
| Contents | | | |
| <ul style="list-style-type: none"> - System overview - Jitter and phase noise - Basic PLL architectures - Analog integer PLL - Digital integer PLL - Fractional PLL - Clock data recovery - Delay locked loop - Numerically controlled oscillator - Software PLL | | | |
| Objective qualification | | | |
| <p>Upon completion of the module, students will have a comprehensive understanding of the fundamentals and advanced concepts of phase-locked loops (PLLs) and frequency synthesis. They will be familiar with the systematic architecture of various PLL types, including analog and digital integer PLLs as well as fractional PLLs. Students will understand the causes and effects of jitter and phase noise, and will be able to evaluate and minimize them. They will be acquainted with specialized circuits such as Costas loops, delay locked loops (DLL), numerically controlled oscillators (NCOs), and software-based PLL implementations. The knowledge they acquire enables students to independently research related topics and apply theory to practice. This allows them to analyze and solve practical problems independently.</p> | | | |
| Literature | | | |
| <p>Best, Roland E., Phase-Locked Loops: Design, Simulation, and Applications. 6. Auflage, McGraw-Hill Education, 2007</p> <p>Behzad Razavi "Design of CMOS Phase-Locked Loops: From Circuit Level to Architecture Level", Cambridge University Press, 2020</p> | | | |



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| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |
| Phase-Locked Loops and Frequency Synthesis | 2,0 | Lecture | english |
| Literature | | | |
| Best, Roland E., Phase-Locked Loops: Design, Simulation, and Applications. 6. Auflage, McGraw-Hill Education, 2007. | | | |
| Behzad Razavi "Design of CMOS Phase-Locked Loops: From Circuit Level to Architecture Level", Cambridge University Press, 2020 | | | |
| Phase-Locked Loops and Frequency Synthesis | 1,0 | Exercise | english |
| Literature | | | |
| Best, Roland E., Phase-Locked Loops: Design, Simulation, and Applications. 6. Auflage, McGraw-Hill Education, 2007. | | | |
| Behzad Razavi "Design of CMOS Phase-Locked Loops: From Circuit Level to Architecture Level", Cambridge University Press, 2020 | | | |

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| Interdisciplinary Qualification |
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|---|---|--------------------------|--|
| Title | Industrial Internship | | |
| Number | 2499040 | Module version | |
| Shorttext | | Language | english german |
| Frequency of offer | every term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | |
| Hours per Week / ECTS | 8 / 12,0 | Module owner | |
| Workload (h) | 360 | | |
| Class attendance (h) | | Self studying (h) | |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | | | |
| Course achievement | Final presentation in accordance with the separate regulations "Internship guidelines of the Faculty of Electrical Engineering, Information Technology, Physics" in the version valid at the beginning of the course. | | |
| Contents | | | |
| individual; requirements according to internship guidelines | | | |
| Objective qualification | | | |
| <p>The industrial internship provides in-depth preparation for professional life by working directly in an industrial company for at least 10 weeks. Students gain insight into organisational and operational processes and structures as well as into the work methods of engineering activities in industrial companies. Within the wide variety and breadth of structural areas (e.g. research, development, production, sales,...) and fields of activity (e.g. hardware or software development, production planning, quality assurance, sales, (project) management,...) in an industrial company, an exemplary selection with in-depth familiarisation with one or a few of these areas or fields is expected.</p> <p>The aim of the module is the further development of action patterns and techniques appropriate to the situation and task as well as the further development and adaptation of the methodological skills taught during the course in the engineering solution of technical problems. In addition, students deepen their interdisciplinary knowledge and skills (e.g. discussion and negotiation skills, presentation techniques, documentation, etc.), for example by participating in meetings or by being involved in conceptual, planning or management tasks. They also carry out their own engineering activities (e.g. in conceptual planning, development or quality assurance) independently and represent their own interests. In doing so, they apply the technical knowledge and skills acquired during their studies to practical tasks in an industrial environment.</p> <p>The activities carried out as part of the industrial internship must be presented in an ungraded presentation. The presentation, including preparation and follow-up work, is worth 3 credits within the 12 credits of this module.</p> | | | |
| Literature | | | |
| | | | |
| Remark | | | |
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The activities carried out as part of the industrial internship must be presented in an ungraded presentation. The presentation, including preparation and follow-up work, is worth 3 credits within the 12 credits of this module. The workload is exclusively at the location of the industrial partner, usually outside the university.

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| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |

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|--|--|--------------------------|--|
| Title | Professionalisation | | |
| Number | 2499560 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | every term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 2 | Institution | |
| Hours per Week / ECTS | 0 / 14,0 | Module owner | |
| Workload (h) | 420 | | |
| Class attendance (h) | | Self studying (h) | |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | according to the requirements of the course taken from the pool selection | | |
| Course achievement | according to the requirements of the course taken from the pool selection; seminar presentation: presentation according to § 9 APO | | |
| Contents | | | |
| individual | | | |
| Objective qualification | | | |
| <p>Key qualifications will be achieved in the following fields:</p> <ul style="list-style-type: none"> - Action-oriented courses, scientific cultures <p>For this purpose, courses from the overall program (pool) of interdisciplinary courses at the Technische Universität Braunschweig are to be selected. The type of examination or coursework and the number of credit points will be announced individually for each module. https://www.tu-braunschweig.de/studium-lehre/im-studium/lehrveranstaltungen The Dean of Studies ensures that a list of available courses is published each semester, in which recommendations for particularly practice-oriented courses are given.</p> <ul style="list-style-type: none"> - Seminar lecture <p>Seminar presentation at one of the institutes of the EITP faculty involved in the degree program. An independent examination of a topic with the inclusion and evaluation of relevant literature as well as the presentation and communication of the results in an oral presentation and in a subsequent discussion.</p> | | | |
| Literature | | | |
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| Related courses | | | |
| Rules for the choice of courses | | | |
| A total of 13-17 credits has to be achieved. The seminar presentation of 3 credits is compulsory. | | | |
| Compulsory attendance | | | |
| | | | |
| Name of the course | SWS | Eventtype | Language |

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|--|--|--------------------------|--|
| Title | Master's Team Project | | |
| Number | 2499520 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | every term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | |
| Hours per Week / ECTS | 0 / 8,0 | Module owner | |
| Workload (h) | 240 | | |
| Class attendance (h) | 160 | Self studying (h) | 80 |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | | | |
| Course achievement | The Master's team project corresponds to the examination requirements of the draft (§ 9 APO). A written project plan must be submitted for the Master's team project at the beginning, which is to be updated during the course of the project. The comparison between initial planning and actual progress must be presented and justified in the final report. The results of the Master's team project must be summarized in a report in which the individual contributions of the project participants are identified. Furthermore, the results must be presented in a presentation (§ 9 APO). | | |
| Contents | individual | | |
| Objective qualification | The Master's team project is generally completed in groups of at least three students who carry out the design, analysis, construction or simulation of an electrical or information technology system using an overarching topic as an example. | | |
| Literature | | | |

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| Related courses | | | |
| Rules for the choice of courses | | | |
| The Master's team project can replace the industrial internship. | | | |
| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |

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| Completion Module |
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|---|---|--------------------------|--|
| Title | Master's Thesis | | |
| Number | 2499510 | Module version | |
| Shorttext | | Language | english |
| Frequency of offer | every term | Teaching unit | Fakultät für Elektrotechnik, Informationstechnik, Physik |
| Module duration | 1 | Institution | |
| Hours per Week / ECTS | 0 / 30,0 | Module owner | |
| Workload (h) | 900 | | |
| Class attendance (h) | | Self studying (h) | |
| Compulsory requirements | | | |
| Expected performance/ Type of examination | <ul style="list-style-type: none"> Preparation of the Master's thesis (28 credits) Presentation (according to § 4 para. 14 BPO) (2 credits) <p>The assessment of the presentation is included in the overall grade of the final module with double weighting.</p> | | |
| Course achievement | | | |
| Contents | | | |
| individual | | | |
| Objective qualification | | | |
| <p>With the successful completion of the final thesis (§ 14 APO) and the presentation, the student demonstrates that he/she is able to work independently on a problem from the chosen subject area using scientific methods within a specified period of time. The qualification objectives of the degree program (Annex 1, § 2 APO) are reflected in the implementation and results of the final thesis with regard to the following components:</p> <ul style="list-style-type: none"> Independent familiarisation with and scientific methodical processing of a topic fundamentally relevant to further development and research in the field of electrical engineering Literature research and presentation of the state of the art Development of new solution approaches for a scientific problem Presentation of the approach and results in the form of a paper Presentation of the main results in a comprehensible form Consolidation and refinement of key qualifications: management of an own project, presentation techniques and rhetorical skills | | | |
| Literature | | | |
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| Remark | | | |
| The Master's thesis is credited with 28 credits and the presentation with 2 credits; the assessment of the presentation is included in the overall grade of the final module with double weighting. | | | |

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| Related courses | | | |
| Rules for the choice of courses | | | |
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| Compulsory attendance | | | |
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| Name of the course | SWS | Eventtype | Language |

