Module title	**MScNano S04 Chemical and biological aspects of nanosciences**
Module type	Required elective module (focus chemistry and biology)
Educational outcomes, competencies, qualification objectives	Students … have acquired a thorough knowledge about the chemistry of nanosystems … know the principles of colloid, polymer and supramolecular chemistry … know bottom-up strategies for the preparation of chemical nanostructures … have acquired knowledge far beyond the contents of textbooks … know advantages and limitations of molecular and physiological methods … have reached profound insight into structure function relationships **Integrated key competences:** … Students are able to draw cross-links between different disciplines in the context of nanosciences
Types of courses, contact hours	VL 3+3+2+2 SWS
Contents	**Nanochemistry I (Colloid and polymer chemistry)** Intermolecular forces and colloid forces, hydrophobic effect, DLVO theory, association colloids, micelles, liquid crystals, micro- and macroemulsions, polymer structure and nomenclature, radical and ionic polymerizations, living polymerizations, catalyzed polymerizations, polycondensation and polyaddition, radius of gyration, scaling laws, polymer solutions and blends, Flory-Huggings model, demixing mechanisms, block copolymers, physicochemical properties of macromolecules **Nanochemistry II (Supramolecular chemistry, special topics)** a) Non-covalent interactions (bond interactions, H-bridges), molecular recognition, artificial enzymes, nanocarriers, molecular wires Contents b) Sol-gel process, oxide-based gels, aerogels and xerogels, porous materials, metal-organic-frameworks (MOFs), oxide-based nanoparticles, core-shell-hybrids, solid materials by gas phase reactions (CVS, CVD) c) Host-guest chemistry, self-assembly and -organization, rotaxanes and catenanes, molecular knots, container molecules, coordination polymers, self-assembling monolayers (SAM), nanopatterning (microcontact printing, dip-pen nanolithography) **Nanobiology I** Assembly of bacterial flagella and pili structures Polymerising proteins of the prokaryotic and eukaryotic cytoskeleton Engineering of turning and stepping motors Force production on a nano scale by cytoskeletal motor proteins Protein Machines and the rise of Synthetic Biology Visualisation and measurement of nano scale forces in biological materials Protein folding into membranes – α-helical vs. β-barrel membrane proteins Transmembrane transport – Structure-function relationships of outer membrane proteins Transmembrane signal transduction in phototaxis **Nanobiology II** Mass spectrometry Labelling methods Data analysis Applying mass spectrometry to biomedical sciences Protein kinases and epithelial cell polarity Structure and function of nerve-cells and ion channels Signal transduction cascades on excitable membranes Synaptic transmission and information processing in the brain
Course titles	(a) Nanochemistry I (b) Nanochemistry II (c) Nanobiology I (d) Nanobiology II
Teaching methods	Lectures
Applicability	M. Sc. Nanoscience
Duration	two semesters
Frequency	annually, start in winter or summer semester possible
Language	English
Recommended Skills	Fundamental knowledge in chemistry and biology on Bachelor level with respect to the interdisciplinary scientific paradigm of nanoscience
Prerequisites for participation	Admission to M.Sc. program Nanoscience
Students workload	Contact time: 150 h, Independent studies: 210 h, Sum = 360 h
Course projects / nongraded learning assignments	none
Prerequisites for admission to examination	none
Examination	Written or oral exams (to be announced) for courses (a), (b), (c) and (d)
Credits	12 C (including 1 C for integrated key competences)

Responsible coordinator	Backes
Lecturer(s)	Fuhrmann-Lieker, Siemeling, Faust, Pietschnig, Kapp, Kleinschmidt, Maniak, Müller, Neupert
Media	Blackboard, projector, digital platforms
Literature	**Nanochemistry I:** Israelachvili, Intermolecular and Surface Forces, 3rd Ed., Academic Press, Amsterdam 2011 Dörfler, Grenzflächen und kolloid-disperse Systeme, Springer, Berlin 2002 Hiemenz, Rajagopalan, Principles of Colloid and Surface Chemistry, 3rd Ed., M. Dekker 1997 Butt, Graf, Kappl, Physics and Chemistry of Interfaces, Wiley-VCH, Weinheim 2006 Tieke, Makromolekulare Chemie, Wiley-VCH, Weinheim, 2005 Gnanou, Fontanille, Organic and Physical Chemistry of Polymers, Wiley, Hoboken 2008 Ravve, Principles of Polymer Chemistry, 3rd Ed., Springer 2012 Young, Lovell, Introduction to Polymers, 3rd Ed., CRC Press, Boca Raton 2011 Cowie, Arrighi, Polymers: Chemistry and Physics of Modern Materials, 3rd Ed. , CRC press, Boca Raton, 2007 **Nanochemistry IIa:** Steed, Atwood, Supramolecular Chemistry, 2nd Ed., Wiley-VCH, Chichester 2009 Beer, Gale, Smith, Supramolecular Chemistry, Oxford University Press, Oxford 1999 Lehn, Supramolecular Chemistry, VCH, Weinheim 1995 **Nanochemistry IIb:** Schubert, Hüsing, Synthesis of Inorganic Materials, Wiley-VCH, Weinheim 2000 Brinker, Scherer, Sol-Gel-Science - The Physics and Chemistry of Sol-Gel Processing, Academic Press, San Diego 1989 **Nanochemistry IIc:** Beer, Gale, Smith, Supramolecular Chemistry, Oxford University Press, Oxford 1999 Lehn, Supramolecular Chemistry, VCH, Weinheim 1995 Ozin, Arsenault, Nanochemistry, RSC, Cambridge 2005 Steed, Atwood, Supramolecular Chemistry, 2nd Ed., Wiley-VCH, Chichester 2009 Steed, Turner, Wallace: Core Concepts in Supramolecular and Nanochemistry, Wiley-VCH, Weinheim 2007 Vögtle, Supramolekulare Chemie, Teubner, Stuttgart 1989 Special literature, to be announced by the lecturers
Additional remarks	Lectures of the module which are part of other modules as well may only be credited once

Module title	**MScNano S05 Biological and physical aspects of nanosciences**
Module type	Required elective module (focus biology and physics)
Educational outcomes, competencies, qualification objectives	Students … have acquired knowledge far beyond the contents of textbooks … know advantages and limitations of molecular and physiological methods … have reached profound insight into structure function relationships … have acquired a thorough knowledge about the fundamental physics of low-dimensional systems and nanomaterials … understand the principles of propagation of electrons and light in nanostructured materials … know about quantum mechanical principles and limits of various physical nanosystems ... know about fabrication and characterization techniques of nanosystems … get an overview about actual and potential applications of nanostructured materials **Integrated key competences:** … Students are able to draw cross-links between different disciplines in the context of nanosciences
Types of courses, contact hours	VL 2+2+3+3 SWS
Contents	**Nanobiology I** Assembly of bacterial flagella and pili structures Polymerising proteins of the prokaryotic and eukaryotic cytoskeleton Engineering of turning and stepping motors Force production on a nano scale by cytoskeletal motor proteins Protein Machines and the rise of Synthetic Biology Visualisation and measurement of nano scale forces in biological materials Protein folding into membranes – α-helical vs. β-barrel membrane proteins Transmembrane transport – Structure-function relationships of outer membrane proteins Transmembrane signal transduction in phototaxis **Nanobiology II** Mass spectrometry Labelling methods Data analysis Applying mass spectrometry to biomedical sciences Protein kinases and epithelial cell polarity Structure and function of nerve-cells and ion channels Signal transduction cascades on excitable membranes Synaptic transmission and information processing in the brain **Nanophysics I (Basics)** - Introduction to the physics of nanostructured systems - Fundamental electronic, optical, thermal and mechanical properties of nano structures - Quantum mechanical considerations of nanostructured systems - Overview about physical fabrication techniques - Overview of characterization techniques for nanostructure technologies -Further keywords: density of states, electronic and photonic band structures, low-dimensional systems, light-matter interaction, quantum well, wire, dot, giant magnetic resistance, tunnel magnetic resistance, single electron transport, single photon emission, nanocavities, photonic crystals **Nanophysics II (Applications)** - Overview about properties and fabrication of nanostructured electronic devices - Introduction to quantum effect devices - Introduction to quantum information technologies and different physical realizations - Introduction of nanostructured optoelectronic devices - Fundamental properties of carbon nanotubes and their potential applications - Overview about nanostructured memory devices based on various physical techniques including electronic, optical, magnetic, mechanical and crystallographic
Course titles	(a) Nanobiology I (b) Nanobiology II (c) Nanophysics I (d) Nanophysics II
Teaching methods	Lectures
Applicability	M. Sc. Nanoscience
Duration	two semesters
Frequency	annually, start in winter or summer semester possible
Language	English
Recommended Skills	Fundamental knowledge in biology and physics on Bachelor level with respect to the interdisciplinary scientific paradigm of nanoscience
Prerequisites for participation	Admission to M.Sc. program Nanoscience
Students workload	Contact time: 150 h, Independent studies: 210 h, Sum = 360 h
Course projects / nongraded learning assignments	none
Prerequisites for admission to examination	none
Examination	Written or oral exams (to be announced) for courses (a), (b), (c) and (d)

Credits	12 C (including 1 C for integrated key competences)
Responsible coordinator	Maniak
Lecturer(s)	Kapp, Kleinschmidt, Maniak, Müller, Neupert, Reithmaier, Popov
Media	Blackboard, projector, digital platforms
Literature	Special literature, to be announced by the lecturers **Nanophysics I:** - J.D. Jackson, "Klassische Elektrodynamik", Walter de Gryter, 1981. - Stephan Gasiorowicz, "Quantenphysik", Oldenburg-Verlag, 2. Aufl., 1981. - Charles Kittel, "Einführung in die Festkörperphysik", Olderburg-Verlag, 6. Aufl., 1983. - N. W. Ashcroft, N. D. Mermin, "Solid State Physics", Saunders College Publishing, 1976. - Stratis Karamanolis, "Faszination Nanotechnologie", Elektra-Verlag, 2005. - Horst-Günter Rubahn, "Nanophysik und Nanotechnologie", Teubner-Verlag, 2002. - Michael Köhler, "Nanotechnologie", Wiley-VCH Verlag, 2001. - Gregory Timp, "Nanotechnology", Springer-Verlag, 1999. - Siegmar Roth, "One-Dimensional Metals", VCH-Verlag, 1995. - Dieter Bimberg, Marius Grundmann, Nikolai N. Ledentsov, "Quantum Dot Heterostructures", John Wiley & Sons, 1999. - Thomas Heinzel, "Mesoscopic Electronics in Solid State Nanostructures", Wiley-VCH Verlag, 2003. - Paul Harrison, "Quantum Wells, Wires and Dots", John-Wiley & Sons, 2000. - J.D. Joannopoulos, R.D. Meade, J.N. Winn, "Photonic Crystals: Molding the flow of light", Princeton University Press, 1995. - G. Ali Mansoori, "Principles of Nanotechnology", World Scientific Publishing, 2005. - K. Busch, S. Lölkes, R.B. Wehrspohn, H. Föll, "Photonic Crystals", Wiley-VCH Verlag, 2004. - K. Inoue, K. Ohtaka, "Photonic crystals: physics, fabrication and applications", Springer Verlag, 2004. - K. Sakoda, "Optical Properties of Photonic Crystals", Springer Verlag, 2004. - D. A. Bonnell, „Scanning Tunneling Microscopy and Spectroscopy“, VCH, 1993. - F. Henneberger, O. Benson, „Semiconductor Quantum Bits“, Pan Standford Publishing, 2007. **Nanophysics II:** - Rainer Waser, "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices", Wiley-VCH, 2003. - J.P. Reithmaier P. Petkov, W. Kulisch, C. Popov, "Nanostructured Materials for Advanced Technological Applications“, Springer, Nato ASI Series B, Physics and Biophysics, 2009. - J.P. Reithmaier P. Paunovic, W. Kulisch, C. Popov, P. Petkov, "Nanotechnological Basis for Advanced Sensors", Springer, Nato ASI Series B, Physics and Biophysics, 2011.
Additional remarks	Lectures of the module which are part of other modules as well may only be credited once

Module title	**MScNano S06 Physical and chemical aspects of nanosciences**
Module type	Required elective module (focus physics and chemistry)
Educational outcomes, competencies, qualification objectives	Students … have acquired a thorough knowledge about the fundamental physics of low-dimensional systems and nanomaterials … understand the principles of propagation of electrons and light in nanostructured materials … know about quantum mechanical principles and limits of various physical nanosystems ... know about fabrication and characterization techniques of nanosystems … get an overview about actual and potential applications of nanostructured materials … have acquired a thorough knowledge about the chemistry of nanosystems … know the principles of colloid, polymer and supramolecular chemistry … know bottom-up strategies for the preparation of chemical nanostructures **Integrated key competences:** … Students are able to draw cross-links between different disciplines in the context of nanosciences
Types of courses, contact hours	VL 3+3+3+3 SWS
Contents	**Nanophysics I (Basics)** - Introduction to the physics of nanostructured systems - Fundamental electronic, optical, thermal and mechanical properties of nano structures - Quantum mechanical considerations of nanostructured systems - Overview about physical fabrication techniques - Overview of characterization techniques for nanostructure technologies -Further keywords: density of states, electronic and photonic band structures, low-dimensional systems, light-matter interaction, quantum well, wire, dot, giant magnetic resistance, tunnel magnetic resistance, single electron transport, single photon emission, nanocavities, photonic crystals **Nanophysics II (Applications)** - Overview about properties and fabrication of nanostructured electronic devices - Introduction to quantum effect devices - Introduction to quantum information technologies and different physical realizations - Introduction of nanostructured optoelectronic devices - Fundamental properties of carbon nanotubes and their potential applications - Overview about nanostructured memory devices based on various physical techniques including electronic, optical, magnetic, mechanical and crystallographic **Nanochemistry I (Colloid and polymer chemistry)** Intermolecular forces and colloid forces, hydrophobic effect, DLVO theory, association colloids, micelles, liquid crystals, micro- and macroemulsions, polymer structure and nomenclature, radical and ionic polymerizations, living polymerizations, catalyzed polymerizations, polycondensation and polyaddition, radius of gyration, scaling laws, polymer solutions and blends, Flory-Huggings model, demixing mechanisms, block copolymers, physicochemical properties of macromolecules **Nanochemistry II (Supramolecular chemistry, special topics)** a) Non-covalent interactions (bond interactions, H-bridges), molecular recognition, artificial enzymes, nanocarriers, molecular wires Contents b) Sol-gel process, oxide-based gels, aerogels and xerogels, porous materials, metal-organic-frameworks (MOFs), oxide-based nanoparticles, core-shell-hybrids, solid materials by gas phase reactions (CVS, CVD) c) Host-guest chemistry, self-assembly and -organization, rotaxanes and catenanes, molecular knots, container molecules, coordination polymers, self-assembling monolayers (SAM), nanopatterning (microcontact printing, dip-pen nanolithography)
Course titles	(a) Nanophysics I (b) Nanophysics II (c) Nanochemistry I (d) Nanochemistry II
Teaching methods	Lectures
Applicability	M. Sc. Nanoscience
Duration	two semesters
Frequency	annually, start in winter or summer semester possible
Language	English
Recommended Skills	Fundamental knowledge in physics and chemistry on Bachelor level with respect to the interdisciplinary scientific paradigm of nanoscience
Prerequisites for participation	Admission to M.Sc. program Nanoscience
Students workload	Contact time: 180 h, Independent studies: 180 h, Sum = 360 h
Course projects / nongraded learning assignments	none
Prerequisites for admission to examination	none

Examination	Written or oral exams (to be announced) for courses (a), (b), (c) and (d)
Credits	12 C (including 1 C for integrated key competences)
Responsible coordinator	Reithmaier
Lecturer(s)	Reithmaier, Popov, Fuhrmann-Lieker, Siemeling, Faust, Pietschnig
Media	Blackboard, projector, digital platforms
Literature	**Nanophysics I:** - J.D. Jackson, "Klassische Elektrodynamik", Walter de Gryter, 1981. - Stephan Gasiorowicz, "Quantenphysik", Oldenburg-Verlag, 2. Aufl., 1981. - Charles Kittel, "Einführung in die Festkörperphysik", Olderburg-Verlag, 6. Aufl., 1983. - N. W. Ashcroft, N. D. Mermin, "Solid State Physics", Saunders College Publishing, 1976. - Stratis Karamanolis, "Faszination Nanotechnologie", Elektra-Verlag, 2005. - Horst-Günter Rubahn, "Nanophysik und Nanotechnologie", Teubner-Verlag, 2002. - Michael Köhler, "Nanotechnologie", Wiley-VCH Verlag, 2001. - Gregory Timp, "Nanotechnology", Springer-Verlag, 1999. - Siegmar Roth, "One-Dimensional Metals", VCH-Verlag, 1995. - Dieter Bimberg, Marius Grundmann, Nikolai N. Ledentsov, "Quantum Dot Heterostructures", John Wiley & Sons, 1999. - Thomas Heinzel, "Mesoscopic Electronics in Solid State Nanostructures", Wiley-VCH Verlag, 2003. - Paul Harrison, "Quantum Wells, Wires and Dots", John-Wiley & Sons, 2000. - J.D. Joannopoulos, R.D. Meade, J.N. Winn, "Photonic Crystals: Molding the flow of light", Princeton University Press, 1995. - G. Ali Mansoori, "Principles of Nanotechnology", World Scientific Publishing, 2005. - K. Busch, S. Lölkes, R.B. Wehrspohn, H. Föll, "Photonic Crystals", Wiley-VCH Verlag, 2004. - K. Inoue, K. Ohtaka, "Photonic crystals: physics, fabrication and applications", Springer Verlag, 2004. - K. Sakoda, "Optical Properties of Photonic Crystals", Springer Verlag, 2004. - D. A. Bonnell, „Scanning Tunneling Microscopy and Spectroscopy“, VCH, 1993. - F. Henneberger, O. Benson, „Semiconductor Quantum Bits“, Pan Standford Publishing, 2007. **Nanophysics II:** - Rainer Waser, "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices", Wiley-VCH, 2003. - J.P. Reithmaier P. Petkov, W. Kulisch, C. Popov, "Nanostructured Materials for Advanced Technological Applications“, Springer, Nato ASI Series B, Physics and Biophysics, 2009. - J.P. Reithmaier P. Paunovic, W. Kulisch, C. Popov, P. Petkov, "Nanotechnological Basis for Advanced Sensors", Springer, Nato ASI Series B, Physics and Biophysics, 2011. **Nanochemistry I:** Israelachvili, Intermolecular and Surface Forces, 3rd Ed., Academic Press, Amsterdam 2011 Dörfler, Grenzflächen und kolloid-disperse Systeme, Springer, Berlin 2002 Hiemenz, Rajagopalan, Principles of Colloid and Surface Chemistry, 3rd Ed., M. Dekker 1997 Butt, Graf, Kappl, Physics and Chemistry of Interfaces, Wiley-VCH, Weinheim 2006 Tieke, Makromolekulare Chemie, Wiley-VCH, Weinheim, 2005 Gnanou, Fontanille, Organic and Physical Chemistry of Polymers, Wiley, Hoboken 2008 Ravve, Principles of Polymer Chemistry, 3rd Ed., Springer 2012 Young, Lovell, Introduction to Polymers, 3rd Ed., CRC Press, Boca Raton 2011 Cowie, Arrighi, Polymers: Chemistry and Physics of Modern Materials, 3rd Ed. , CRC press, Boca Raton, 2007 **Nanochemistry IIa:** Steed, Atwood, Supramolecular Chemistry, 2nd Ed., Wiley-VCH, Chichester 2009 Beer, Gale, Smith, Supramolecular Chemistry, Oxford University Press, Oxford 1999 Lehn, Supramolecular Chemistry, VCH, Weinheim 1995 **Nanochemistry IIb:** Schubert, Hüsing, Synthesis of Inorganic Materials, Wiley-VCH, Weinheim 2000 Brinker, Scherer, Sol-Gel-Science - The Physics and Chemistry of Sol-Gel Processing, Academic Press, San Diego 1989 **Nanochemistry IIc:** Beer, Gale, Smith, Supramolecular Chemistry, Oxford University Press, Oxford 1999 Lehn, Supramolecular Chemistry, VCH, Weinheim 1995 Ozin, Arsenault, Nanochemistry, RSC, Cambridge 2005 Steed, Atwood, Supramolecular Chemistry, 2nd Ed., Wiley-VCH, Chichester 2009 Steed, Turner, Wallace: Core Concepts in Supramolecular and Nanochemistry, Wiley-VCH, Weinheim 2007 Vögtle, Supramolekulare Chemie, Teubner, Stuttgart 1989 Special literature, to be announced by the lecturers
Additional remarks	Lectures of the module which are part of other modules as well may only be credited once