Courses in English
Course Description

Department	06 Applied Sciences and Mechatronics
Course title	**Quantum Physics 1 (MNM 011)**
Hours per week (SWS)	6
Number of ECTS credits	8
Course objective	ENTRY for the master degree program MNT / conveys physical fundamentals and mathematical concepts for the other modules of the program. Upon successful completion of the module, students have the following skills: They possess the essential physical and mathematical foundations of the other modules of the program. They have a deep understanding of the physical and chemical properties of micro-and nanoscale systems. They can capture and describe micro-and nanoscale systems quantitatively. They have the basics for modeling micro-and nanoscale systems and have knowledge of different modeling methods and their applications and limitations.
Prerequisites	Solid State Physics
Recommended reading	R.P. Feynman, R.B. Leighton, M. Sands: The Feynman Lectures on Physics, I - III. A.A. Sokolow, J.M. Loskutow, L.M. Ternow: Quantenmechanik, Akademie-Verlag, Berlin, 1964. D.I. Blochinzew: Grundlagen der Quantenmechanik, Verlag Harri Deutsch, FFM, 1972. L.D. Landau, E.M. Lifschitz: Lehrbuch der theoretischen Physik III, Akademie-Verlag, Berlin, 1974. G.M. Barrow: Introduction to Molecular Spectroscopy, McGraw Hill, New York, 1962. C. Kittel: Introduction to Solid State Physics, 4th ed., J. Wiley \& Sons, New York. J.N. Murrell, S.F.A. Kettle, J.M. Tedder: Valence Theory, 2nd edition, J. Wiley & Sons, Ltd., London/New York, 1970. F. Seitz: The Modern Theory of Solids, McGraw-Hill, Inc. New York, N.Y., 1940. J.C. Slater: Solid-State and Molecular Theory: A Scientific Biography, J. Wiley & Sons, New York, N.Y., 1975. J.M. Ziman: Einfuehrung in die Festkoerpertheorie, Verlag Harri Deutsch, Frankfurt am Main und Zuerich.
Teaching methods	lecture, exercises, lab class
Assessment methods	100% written exam
Language of instruction	English
Name of lecturer	Prof. Dr. Katja Beha
Email	katja.beha@hm.edu
Link	https://sci-intern.hm.edu/fk/modulbeschreibungen.php?lang_nr=&id=1527&lang=en

Course content

1. Quantum Mechanics
Quantum effects: radiation of the black body, Einstein photoelectric effect, the uncertainty principle of a harmonic wave group, wave nature of the electron, uncertainty of a matter wave, Compton effect.
Bohr model: data history, postulates, calculating the innermost orbit, computing the spectrum, quantization for higher atoms, stability of atoms, correspondence principle.
Axioms of quantum mechanics: vector and Hilbertraum, abelian groups, wave functions in configuration and momentum space
Wave Mechanics: Classical and quantum mechanical systems, Schrödinger equation (time dependent and time independent), operators, electron in the box, perturbation theory, interaction with radiation, selection rules.
Tunnel effect: limitations of transport, quantum particles in the potential well: WKB method, energy eigenvalues for a quantum particle in the finite potential well, alpha-particles in the potential well, statistical interpretation of the uncertainty relation, uncertainty principle and tunneling.
Eigenvalue problems: potential energy curves of molecules, Harmonic Oscillator
Antisymmetry principle and Pauli exclusion principle
Atomic orbital function and Orbital, radial and angular-dependent part of the wave function.

2. Solid State Physics
Lattice models: the real and reciprocal lattice, formalism of the reciprocal lattice
Metals: The free electron model, Mean energy of the electrons, the distribution function of the free electron gas, degeneracy, band structure, electrical conductivity, contact potentials.
Solids: The almost free electron model, unit cells in the reciprocal lattice: Brillouin zones, Bragg reflection and reciprocal lattice, band and zone boundaries, effective mass.
Semiconductors: Electrical behavior, the Fermi energy in semiconductors, electrical conductance, p-n-transitions, effective mass, excitons

Remarks