University of Tehran

School of Electrical and Computer Engineering

Course:	**Modern Physics**		
Course type:	Elective	EE	Credit: 3
Level:	Under Graduate		
Co-requisite(s):			
Prerequisite(s):	Electronic Circuit 1		
Prerequisite by topic:	Being familiar with basic physics, mathematics, and electronic elements		
Textbook(s):	[1] J. Morrison, "*Modern Physics for Scientists and Engineers,*" Academic Press; 2nd edition (2015). [2] K. Krane, "*Modern Physics,*" Wiley; 3nd edition (2012). [3] R. Eisberg, R. Resnick, "*Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles,*" John Wiley and Sons,;2nd, (1985).		
Coordinator:	Mahdi Pourfath		
Goals:	Introducing the students with the following topics: – History of quantum mechanics – Wave-particle duality and Heisenberg uncertainty principle – Schroedinger equation and its application – Many particle quantum systems and statistics – Quantum description of solids		
Outcome:	Upon successful completion of the course, students will be able to: – Understand the limits of classical physics and consequence of quantum mechanics and probabilistic behavior of such systems – Applying Schroedinger equation to open and closed systems and analyzing the behavior of quantum mechanical systems – Understanding and analyzing nanoelectronic devices		
Topics:	**The Wave-Particle Duality** The particle model of light, the wave model of radiation and matter **The Schrödinger Wave Equation** The wave equation, probabilities and average values, the finite potential well, simple harmonic oscillator, time evolution of the wave function **Operators and Waves**		

	Observables, operators, and eigenvalues, electron scattering, the Heisenberg uncertainty principle **The Hydrogen Atom** The Hydrogen structure, radiative transitions, fine structure of Hydrogen **Many-Electron Atoms** The independent-particle model, shell structure and the Periodic table, LS term energies, configurations of two electrons, the Hartree-Fock method **Masers and Lasers** Radiative transitions, Laser amplification, Laser cooling, Magneto-optical traps, basic equations **Statistical Physics** The nature of statistical laws, ideal gas, applications of Maxwell-Boltzmann statistics, entropy and the laws of thermodynamics, perfect quantum gas, Bose-Einstein condensation, free-electron theory of metals **Electronic Structure of Solids** Bravais lattice, additional crystal structures, reciprocal lattice, lattice planes, Bloch's theorem, diffraction of electrons by an ideal crystal, the Bandgap, classification of solids **Semiconductors** Density of charge carriers in semiconductors, doped crystals, motion of electrons in a crystal, band structure of semiconductors, heterostructures, quantum wells, quantum barriers, reflection and transmission of light, diode lasers
Grading:	Assignments: 5% Projects: 15% Midterm exams: 40% Final exam: 40%
Further readings:	
Prepared by:	Mahdi Pourfath
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