과목명	Quantum Mechanics for IT/NT/BT	개발기간/ 운영시기	2015.04~2015.08 / 2015.09~2015.12
개발 교·강사명	김대만(Dae Mann Kim)	운영 교·강사명	김대만(Dae Mann Kim)
수업목표	IT/NT/BT 학습을 위한 양자물리와 양자화학의 기초지식을 응용 위주로 제공함.		
평가방법	home work	이수기준	중간고사와 학기말 고사에서 합격점수 획득
교재 (저자,출판사,출판년도포함)	Introductory Quantum Mechanics for Applied Nanotechnology Dae Mann Kim, John Wiley, April 2015		

주차	차시 (모듈)	차시별 학습내용	수업방법	학습자료 (과제 개요)	주차별 평가방법
1	1	Generalities of Quantum Mechanics And Review of Classical Theories	판서녹화	Quantum Mechanics & IT/NT/BT. harmonic oscillator, Boltzmann distribution function, equipartition theorem, mobility and conductivity, non-equilibrium distribution function	
	2	Review of Classical Theories	판서녹화	Maxwell's equations, E & H fields, plane waves & wave packets, band width & pulse duration	Exercises
	3	Milestones Leading to Quantum Mechanics	판서녹화	blackbody radiation & quantum of energy, photoelectric effect & photon, Compton scattering & particle nature of light	
	4	Milestones Leading to Quantum Mechanics	판서녹화	duality of matter, de Broglie wavelength, Bohr's theory of H-atom, atomic radius, quantized energy level, quantum transitions	Exercises
2	1	Schrödinger Wave Equation	판서녹화	time-dependent SE, operator algebra & basic postulates, wavefunction, probability density, expectation value,	
	2	Schrödinger Wave Equation	판서녹화	time-independent SE, eigenequation, eigenfunction, eigenvalue, commutation relation, conjugate variables & uncertaity relation, properties of eigenfunction	Exercises
	3	Bound States in Quantum Well & Wire	판서녹화	electrons in solids, bounbd states in infinite square well potential, quantized energy level, particle in 3D box, 1D, 2D & 3D densities of states	
	4	Bound States in Quantum Well & Wire	판서녹화	quantum well, quantum wire, subbands, particle in quantum well, particle in quantum wire	Exercises

3	1	Scattering & Tunneling of 1D Particle	판서녹화	scattering at step potential, probability current density, reflection & transmission coefficients, scattering from quantum well, resonant transmission, tunneling & tunneling probability	
	2	Scattering & Tunneling of 1D Particle	판서녹화	tunneling through a single & multiple potential barrier, resonant tunneling, direct & F-N tunneling, scanning tunneling microscopy, field emission display, single electron transistor	Exercises
	3	Energy Bands in Solids	판서녹화	Kronig-Penny potential, Bloch wavefunction, secular equation & dispersion elation, allowed band & forbidden gap	
	4	Energy Bands in Solids	판서녹화	E-k curves in 1st Brillouin zone, electron velocity in energy band, effective mass of electron, energy band & resonant tunneling	Exercises
4	1	Quantum Treatment of Harmonic Oscillator	판서녹화	eigenfunction & eigenenergy, energy spectrum, zero point energy, properties of eigenfunction, correspondence principle	
	2	Quantum Treatment of Harmonic Oscillator	판서녹화	uncertainty relation in eigenstate, HO in linearly superposed states, operator treatment of HO, creation & annihilation operators, number operator, phonon	Exercises
	3	Schrödinger Treatment of Hydrogen Atom	판서녹화	angular momentum operators & commutation relations, spherical harmonics & spatial quantization, angular momentum & magnetic quantum numbers, atomic orbitals	
	4	Schrödinger Treatment of Hydrogen Atom	판서녹화	electron-proton interaction, center of mass & relative motions, reduced mass, principal quantum number and energy eigenvalue, Bohr radius, atomic spectroscopy, degeneracy, reduced [probability density	Exercises
5	1	Perturbation Theory	판서녹화	time-independent perturbation theory; non-degenerate & degenerate, Stark effect in H-atom, atomic polarizability	
	2	Perturbation Theory	판서녹화	Time-dependent perturbation theory, harmonic perturbation, Fermi's golden rule	Exercises
	3	System of Identical Particles	판서녹화	electron spin and Pauli spin matrices, spin operators & spin eigenfunctions, two-electron system & Helium atom, ionization energies; 1st & 2nd, singlet & triplet states, overlap & exchange integrals	
	4	System of Identical Particles	판서녹화	multi-electron atoms and periodic table, electron configuration, ionization energy & screening of charge, affinity factor, spin-orbit coupling & fine structure of speectral lines, Zeeman effect, electron paramgnetic resonance,	Midterm Exam

6	1	Molecules and Chemical Bonds	판서녹화	ionized hydrogen molecule, overlap, Coulomb & exchange integrals, bonding & anti-bonding, binding energy	
	2	Molecules and Chemical Bonds	판서녹화	hydrogen molecule, Heitler-London theory, covalent bond, ionic bond, Van der Waals attraction, polyatomic molecules, hybridization	Exercises
	3	Molecular Spectra	판서녹화	Born-Oppenheimer approximation, rotational & vibrational spectra, selection rule, P & R branches,	
	4	Molecular Spectra	판서녹화	nuclear spin & magnetic moment, hyperfine interaction & structure, Zeeman splitting, nuclear magnetic resonance, molecular imaging	Exercises
7	1	Atom-Field Interaction	판서녹화	classical treatment; stimulated & spontaneous emission, Einstein A coefficient, atom-dipole, Rabi flopping formula	
	2	Atom-Field Interaction	판서녹화	quantum treatment; quantization of EM field, creation, annihilation & number operators, photons	Exercises
	3	Interaction of EM Waves with Optical Media	판서녹화	attenuation & amplification, dispersion, attenuation & gain coefficients, permittivity, atomic susceptibility	
	4	Interaction of EM Waves with Optical Media	판서녹화	density matrix, relaxation times; longitudinal & transverse, laser oscillator, population inversion, rate equation, threshold pumping, laser intensity & frequency	Exercises
8	1	Semiconductor Statistics	판서녹화	quantum statistics, conductor, insulator & semiconductor, Fermion, Boson, Fermi-Dirac distribution function, Bose-Einstein distribution function	
	2	Semiconductor Statistics	판서녹화	electron density in conduction band, hole density in valence band, equilibrium, law of mass action, Fermi level. intrinsic & extrinsic semiconductors, donors, acceptors, Fermi potential	Exercises
	3	Carrier Transport	판서녹화	mobility, drift velocity, diffusion coefficient, Einstein relation, current density, equilibrium & Fermi level	
	4	Carrier Transport	판서녹화	non-equilibrium and quasi-Fermi level, generation & recombination; band to band & trap-assisted, recombination &generation rates, minority carrier lifetime	Exercises

9	1	P-N Junction Diode: I-V Behavior	판서녹화	p-n junction in equilibrium & non-equilibrium, junction band bending, depletion depth, built-in potential, charge injection & extraction,	
	2	P-N Junction Diode: I-V Behavior	판서녹화	forward & reverse biases, forward & reverse currents, generation & recombination currents, junction breakdown; avalanche & Zener	Exercises
	3	P-N Junction Diode: Applications	판서녹화	optical absorption in semiconductors, absorption coefficient, photodiode, photocurrent,	
	4	P-N Junction Diode: Applications	판서녹화	junction solar cell, photovoltaic effect, open circuit voltage, short circuit current, LED, laser diode, superlattice structure & sub-bands	Exercises
10	1	Field Effect Transistors	판서녹화	MOSFET, NMOS, PMOS, channel inversion, threshold voltage, surface charge, ON, OFF & subthreshold currents	
	2	Field Effect Transistors	판서녹화	silicon nanowire FET, subband spectra, long & short channel FETs, ballistic FET, tunneling FET, subthreshold swing, thermionic & field emission	Exercises
	3	The Application and Novel Kinds of FETs	판서녹화	Nonvolatile flash EEPROM programming, erasing & reading, solar cell; planar, multi-junction & nanowire	
	4	The Application and Novel Kinds of FETs	판서녹화	biosensor, ISFET, target molecule & probe molecule, spin FET, transport of spin up & down states, spin qubits and quantum computing, entanglement, parallel NOT operation	Final Exam