NANO 705

Midterm Exam - Study Guide

Chap. 1: Prologue

-Basic types and functions of transistors

-Fermi-Dirac distribution, Fermi function

-Electrical resistance, conductance, conductivity, current density, Drude model

-Nanotransistor in steady state, simple picture (no broadening) - find current

-Potential profile, point channel, equivalent circuit, channel potential

-Poisson and Laplace terms, electron charging energy

-Self-consistent solution

-Same as above for nanocapacitor

-Level broadening, density of states

-Assumptions: low-T, large broadening, $r_1 = r_2$ → maximum (quantum of) conductance/level

-General expressions for I, N that include broadening and channel potential changes.

Chap. 2: Schrödinger equation

-Bohr model, bohr radius, rydberg

-momentum operator, kinetic energy, energy operator, Schödinger equation

-Constant energy states, time-independent SE

-Wave function, plane waves, sine/cosine waves, probability amplitude/density, electron density

-Particle in a box, method of finite differences, normalization

-Solving simple eigenvalue problems, diagonalization

-Multi-dimensional problems, separation of variables, spherical coordinates

-Solving H-like atom ground-state wave function

Chap. 3: Self-consistent field

-He atom, 1st & 2nd ionization, electron-electron interaction energy

-Radial electron density

-Perturbation theory, variational principle

-Evaluating U_{ee}

-Ionization vs. affinity energies

-One- vs. multi-electron picture, assume constant electron charging energy

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Chap. 4: Basis Functions

-Sometimes useful to express solution as a linear combination of relevant basis functions.

-Basis functions may not be orthonormal: Need to find matix $[S]$. Can also build orthonormal basis.

-Equilibrium electron concentration $n(\mathbf{r})$ is probability density weighted by thermal factors.

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-Equilibrium density matrix $[\rho]$, real-space and eigenstate representations
-Trace used to find expectation value of an operator: $<\hat{\mathrm{A}}>= \mathrm{Trace}([\rho]\cdot[\hat{A}])$
-Find $n(\mathbf{r})$ using basis functions that are not energy eigenfunctions.
-Continuity equation