Charge transport and devices simulation

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Teaching staff

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Reception hours: Friday 11:00-13:00

Program of the course:

Introduction to the quantum and semiclassical charge transport: Ohm law - From semiclassical/continuum to quantum/atomistic formalisms - Contact resistance concept - Landauer formula - bottom-up: one level device.

Quantitative numerical analysis of the quantum carrier dynamics: Charging and self-consistency - Quantum capacitance - Coulomb blockade - Non Equilibrium Green Function - Contact Self Energies- el-ph scattering - perturbative corrections - variational formalism – examples: graphene, nanotubes, atoms' chains. Need of device atomic structure for quantitative numerical predictions - Kinetic Monte Carlo approach for process simulation at atomic resolution - Bridges between atomistic process simulations and NEGF simulations.

Boltzmann formalism and semiclassical methods: semiclassical carriers – Boltzmann-equation – Scattering kernels - Fermi Golden rule - relaxation times – Phonon scattering – Impurity scattering –

charge/charge scattering – Avalanche carriers' generation – Monte Carlo approach – Monte Carlo – Poisson Device simulation – Continuum models – Drift-Diffusion models and device simulations – Hydrodynamic models and device simulation – TCAD introduction.

Bibliography:

S.M. Sze. K. K. Ng "Physics of Semiconductor Devices John Wiley & Sons, Inc."

K.Tomizawa "Numerical Simulation of Submicron Semiconductor devices" Artech House Inc. Norwood

S. Datta "Quantum Transport: Atom to Transistor" Cambridge University Press

S. Datta "Electronic Transport in Mesoscopic Systems" Cambridge University Press

Additional scientific papers and course slides will be provided by the teacher