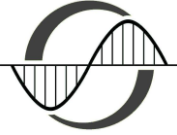




UNIVERSITÀ  
degli STUDI  
di CATANIA



DIPARTIMENTO DI FISICA E ASTRONOMIA  
“ETTORE MAJORANA”

DOTTORATO DI RICERCA IN FISICA  
CICLO XXXIX A.A. 2023/2024

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## Charge transport and devices simulation

2 CFU

### Teaching staff

**Antonino La Magna**

**Email:** antonino.lamagna@imm.cnr.it

**Office:** Zona Industriale VIII Strada 5 I 95121 Catania Italy

**Reception hours:** Friday 11:00-13:00

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### 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. 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.

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## **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