

## Course Description:

Covers microscopic theory of electron transport in nanoelectronic devices and transistors. Topics include: Ballistic Transport, Quantum Conductance, NEGF-Landauer Formalisms, Molecular Conductors, Graphene and Carbon Nanotubes, Quantum Resonant Tunneling Devices, Nanotransistors and Spintronics.

**Prerequisites:** EE211 or EE216 and instructor's permission (some background in basic matrix algebra and MATLAB programming is needed).

## Textbook:

S. Datta, "Quantum Transport: Atom to Transistor", Cambridge Press. (Required)

Matlab Software

## Lecture Schedule:

Lect.	Topic	Reading Assign.	Numerical Homeworks
1	Introduction & Molecular, Ballistic & Diffusive Transport	Ch. 1.1, 1.2	
2	Landauer Model & Quantum Conductance	Ch. 1.3, 1.4	HW.1 (Ch. 1.1-1.4)
3	Schrodinger Equation & Method of Difference Elements	Ch. 2.1, 2.2, 2.3	HW.2 (Ch. 2.1-2.3)
4	Self-Consistent Field & Differential Matrix Relations	Ch. 3.1, 3.2	
5	Basis Functions as a Computational Tool & Tight Binding Method	Ch. 4.1, 4.2	
6	Equilibrium Density Matrix & Perturbation Theory	Ch. 4.3, 4.4	HW.3
7	Bandstructure Calculations of Bulk Semiconductors	Ch. 5.1, 5.2, 5.3 & 5.4	HW.4
8	Bandstructure Calculations of Low Dimensional Conductors (Quantum Wires, Graphene & Carbon Nanotubes)	Ch. 6.1, 6.2, 6.3	HW.5
9	Open Systems & Energy Level Broadening	Ch. 8.1, 8.3	
<b>MIDTERM</b>			
10	Local Density of States & Green's Functions	Ch. 8.2, 8.4	NO HW
11	Self Energy & Lifetime	Ch. 9.1, 9.2	HW. 6
12	Non-Equilibrium Density Matrix & Inflow/Outflow	Ch. 9.3	
13	Transmission & NEGF Formalism (Quantum Transport)	Ch. 9.4	HW. 7
14	Buttiker Probes & Landauer-Buttiker Relations	Ch. 9.4, 9.5.1	HW. 8
15	Dephasing & Resonant Tunneling Diodes	Ch. 9.5.2	HW. 9
16	2-D Mesoscopic Transport, Subbands & Quantized Conduction Revisited	Lessons Nanoelect. Ch. 20, 21.1	
17	Electron Transport in Low Dimensional Devices (Graphene & Carbon Nanotubes)	Lessons Nanoelect. Ch. 21.2	HW. 10
18	Zeeman Field & Quantum Hall Effect (2-D Numerical Analysis)	Lessons Nanoelect. Ch. 21.3 & Handout	
19	Spinors & Spin Dependent Transport	Lessons Nanoelect. Ch. 22.1, 22.2, 22.3	
20	Rashba Effect, Spintronic Devices & Spin Hall Effect (Numerical Analysis)	Lessons Nanoelect. Ch. 22.5 & Handout	
<b>FINAL</b>	<b>FINAL PROJECT</b>		