Outline and policies for PHYS 461 - Nanophysics, part I

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This is information for getting started on the course.

Important note about the two parts forming PHYS 461.— PHYS 461 is a one-term course divided in two parts. Part 1 focuses on mesoscopic transport and is taught by Adrian Lupascu. Part 2 focuses on biophysics and is taught by Zoya Leonenko. Students are evaluated for each part separately and the final mark is an equal weight average of the two marks. Note that the marking scheme applied to the two parts may be different.

The information below refers to the first part of the course. Please contact Zoya Leonenko (email zleonenko@uwaterloo.ca) for questions concerning part 2 of the course.

Coordinates.—
TTh 2:00-3:20, PHY 308.

About the topic.— When the dimensions of solids are reduced to sizes in the range 1 nm to 1 μm, new physical phenomena emerge. This is the realm of mesoscopic physics, where concepts from both solid-state physics and atomic physics enter in the description of physical phenomena. This mesoscopic behavior has a direct consequence on the properties of electrons in general and of electronic transport in particular. Electronic transport in this regime is of direct relevance to new types of electronic devices.

Part 1 of PHYS461 will focus on the physics of electrons at the nanoscale, and the new electronic functionality we can achieve this way.

The following topics will be covered:

1. Solid-state update
   (a) Electronic structure of crystalline solids
   (b) Occupation of electron levels
   (c) Electron scattering
   (d) Electron transport

2. Conduction in mesoscopic conductors
   (a) Transport modes
   (b) Landauer-Buttiker formalism
   (c) Scattering states

3. Quantum Hall effect

4. Phase coherent transport
   (a) Aharonov-Bohm effect
   (b) Weak localization and universal conductance fluctuations
   (c) Resonant tunneling devices

5. Single-charge effects
   (a) Introduction to Coulomb blockade
   (b) Charging energy in a metallic system
   (c) The single electron tunneling transistor
   (d) Quantum dots

6. Modern devices
   (a) Graphene
   (b) Carbon nanotubes
   (c) Magnetoelectronics

7. Experimental techniques in nanophysics

Texts.—
There is no single good textbook which covers the different aspects of nanophysics and nanoelectronics considered in this lecture. A collection of materials is being prepared within UW courseware. This required text will be available for purchase at the copy shop in the EIT building. Additional materials, not included in the courseware package, will be made available.

The textbooks this material is based on are

These books will be available as well on course reserve at UW Davis Center library.

LEARN.—
The course will make use of LEARN for distribution of materials, assignments, solutions, notes etc. Please check it regularly.

Marking and examinations.—
Your mark will contain the following components:

1. 2 assignments, counting in total 20% of the final mark
2. A paper on a topic related to the material presented in the course, counting 30% of the final mark
3. A written test, counting 50% of the final mark. Location and time TBD
The two assignments will count each 10% of the final mark, for a total of 20% of the final mark. Tentative dates for the assignments are:

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<thead>
<tr>
<th>No.</th>
<th>Posted</th>
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<tbody>
<tr>
<td>1</td>
<td>Sep 20</td>
<td>Oct 4</td>
</tr>
<tr>
<td>2</td>
<td>Oct 4</td>
<td>Oct 18</td>
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Assignments handed in late will be penalized: the penalty is 10%/day of the obtained mark. Assignments which are more than a week late will not be accepted.

Project topics will expand and/or build on the subjects treated in the course. They will be posted on LEARN and you can take them on a first come, first served basis. Please contact me directly if you would like to propose your topic. The paper should have a length of 2-4 pages when formatted in REVTEX two-column format. Please discuss with the instructor about using other formats.

For the written test, you are allowed a non-programmable calculator and a single letter-size handwritten (!) sheet of notes.

Getting in touch.—

My coordinates are: Email alupascu@uwaterloo.ca, Phone extension 35468, Office RAC 2112.

My office is in UW’s Research Advancement Centre 1 (RAC1), which is on North Campus. Please look at iqc.uwaterloo.ca for details on how to get there. There is a van service from the main campus that you can use.

Given that the RAC1 location may be inconvenient, I will keep office hours in the Physics building, room no PHY 211A. If you want to see me in my at other times, please email me beforehand to make an appointment or call me so that you do not make the trip to RAC in vain.

This is a list of times relevant on how to reach me.

- Weekly office hour: PHY 211A, Tuesday 3:30-4:30
- If you want to meet me at other times, call me/email me first so you do not make the long trip in vain.
- I will try to answer your emails within a day (I usually read my email in the morning).

Expectation of academic integrity.—

In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility.

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy # 70, Student Petitions and Grievances, Section 4. When in doubt please be certain to contact the department’s administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the Undergraduate Associate Dean. For information on categories of offenses and types of penalties, students should refer to Policy # 71, Student Discipline, For typical penalties check Guidelines for the Assessment of Penalties, www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

 Appeals: A decision or penalty imposed under Policy # 70 (Student Petitions and Grievances) (other than petitions) or Policy # 71 (Student Discipline) may appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy # 72 (Student Appeals).