Section 1: Instructional Support

Section 1.1: Course Instructor

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Office Location</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christian Schultz-Nielsen</td>
<td>MacNaughton 431</td>
<td><a href="mailto:cschultz@uoguelph.ca">cschultz@uoguelph.ca</a></td>
</tr>
</tbody>
</table>

Section 1.2: Graduate Teaching Assistants

<table>
<thead>
<tr>
<th>Teaching Assistant</th>
<th>Office Location</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scott Annett</td>
<td>MacNaughton 402</td>
<td><a href="mailto:sannett@uoguelph.ca">sannett@uoguelph.ca</a></td>
</tr>
<tr>
<td>Erin Shelton</td>
<td>MacNaughton 534</td>
<td><a href="mailto:eshelt01@uoguelph.ca">eshelt01@uoguelph.ca</a></td>
</tr>
</tbody>
</table>

Section 2: Learning Resources

Section 2.1: Course Website

Course material, news, announcements, and grades will be regularly posted to the PHYS*2180 Courselink site. You are responsible for checking the site regularly. Please ensure that your grades are recorded correctly and notify the course instructor of any discrepancies.

Section 2.2: Primary Course Reference

None.

Section 2.3: Recommended Course References


The above books are not required for PHYS*2180, but students may find them useful at various points in the course. These books are also very useful references for PHYS*3510 and PHYS*4500.

As the experiments in the laboratory courses frequently complement other courses in the physics curriculum, textbooks from those courses will also be excellent resources.

**Section 2.4: Communication and Email Policy**

Lectures and laboratory sessions are your primary opportunity to ask questions about the course.

The course instructor is available to provide help in his office during designated office hours, which will be assigned during the introductory lecture. If you wish to obtain help at another time, please email to make an appointment or see them before or after lectures/labs to arrange a mutually convenient time. *Short questions* can often be handled in the lecture room just before or after lectures.

*As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.*

**Section 3: Assessment**

**Section 3.1: Final Grade Breakdown**

<table>
<thead>
<tr>
<th>Assessment Tool</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Notebook (equal weighting for all labs)</td>
<td>40%</td>
</tr>
<tr>
<td>Formal Lab – Scientific Paper (2 reports, equally weighted)</td>
<td>25%</td>
</tr>
<tr>
<td>Final Group Project – Essay</td>
<td>15%</td>
</tr>
<tr>
<td>Final Group Project – Oral Presentation</td>
<td>10%</td>
</tr>
<tr>
<td>Final Group Project – Peer Evaluation</td>
<td>5%</td>
</tr>
<tr>
<td>Lab Skills &amp; Performance</td>
<td>5%</td>
</tr>
</tbody>
</table>

*All assessments submitted late without legitimate cause (see Section 3.3) will be penalized 10% per late day, to a maximum of 50%. After five days, the late work will no longer be accepted and the student will receive a grade of 0 for that assessment.*

**Section 3.1.1: Lab Notebooks**

Students will submit their lab notebooks one week after completing each experiment, and these will be evaluated based on the criteria developed during their first lab session.

**Section 3.1.2: Formal Lab – Scientific Paper**

The student’s evaluation on this performance assessment will be based on students’ ability to give rationale for, to interpret, and to discuss the data that they generate during the labs.
Each student will hand in two written formal lab reports, written in the style of a scientific paper. Each formal lab will be submitted via Dropbox as a PDF file.

The first formal lab (Driven Damped Oscillators experiment) will be submitted on Monday, February 26th (please note that this is the day before the midterm exam for PHYS*2340 – Electricity & Magnetism II, so do not leave your report to the last minute!).

The second formal lab (Current Balance experiment) will be submitted two weeks after the experiment was completed, either in Week 8 or Week 9.

Section 3.1.3: Final Group Project – Essay

Throughout the semester, students will work in groups of two randomly assigned by the course instructor. Each group will submit one collaborative paper describing an advanced experimental technique in physics. This paper will provide an overview of the relevant physics and describe at least one research paper where that technique was used. A list of suitable experimental techniques will be provided by the course instructor in class, but students who wish to discuss a different technique can do so if they receive permission from the instructor. Papers will be submitted via Dropbox as PDF documents before the students present their final project in Week 12.

Section 3.1.4: Final Group Project – Oral Presentation

During the lab periods in Week #12, each group of students will present their chosen research technique to their classmates. The presentations shall be limited to 12 minutes, with 3 minutes for questions. Groups will sign up to one of the lab periods on a first-come, first-served basis.

Section 3.1.5: Final Group Project – Peer Evaluation

During the student presentations in Week #12, each student will use a provided rubric to grade the oral presentations of their peers. Constructive feedback must be provided, and this will be assembled by the course instructor and forwarded to the presenters.

Section 3.1.6: Lab Skills & Performance

Throughout the semester, the lab instructor and teaching assistants will be monitoring student attitudes and initiative in the laboratory. Students will be assessed on their willingness to try to understand experiments on their own (within reason – we do not want students wasting their time when they have no idea what to do next), their preparedness for labs throughout the semester, and their ability to adhere to established lab safety protocols (e.g. no food or drink of any type in the lab room).

Section 3.2: Time Conflicts Between Courses

Sometimes students will have a time conflict between a midterm exam in another course and either a lecture or a lab in this course. The University has a very clear policy to cover this situation: the regularly-scheduled lecture or lab holds priority. In other words, it is the
responsibility of the faculty member who has scheduled the midterm exam to make special arrangements with students who have conflicts.

Section 3.3: Course Grading Policies

Section 3.3.1: Missed Assessments

If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor or TA. See the undergraduate calendar for information on Regulations and Procedures for Academic Consideration.

Section 3.3.2: Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations.

Section 3.3.3: Mark Adjustments

If you have questions about any grade, please inquire promptly after the material has been returned to you. Students are ultimately responsible for ensuring that the grades on all submitted material were entered properly in Courselink – check the entered grades frequently throughout the semester and report any discrepancies to your teaching assistant or course instructors.

Section 4: Aims and Course Objectives

Section 4.1: Calendar Description

This course is designed to aid students in the development of core practical skills in physics. Students will be required to conduct a series of experiments exploring fundamental concepts in mechanics, electricity & magnetism, thermal physics, as well as the experimental basis of quantum physics. There will be a strong emphasis on data and error analysis with a variety of software applications.

Section 4.2: Course Aims

This course is not a “lab course” but rather seeks to introduce students to basic experimental techniques, measurement theory and experiment design. The primary goal is to develop an appreciation of the role and significance of experimentation in the field of science. Students will be exposed to a number of widely employed experimental techniques, and will become familiar with some of the instrumentation that is used in experimental physics research. Students will understand how to critically assess the quality of experimental data, and will begin to develop their skills in the modeling of experimental data and presenting scientific research.
Section 4.3: Learning Objectives

At the successful completion of this course, students will have:

- mastered the use of digital multimeters and oscilloscopes to measure DC and AC voltages and currents.
- mastered the assessment of reasonable experimental uncertainty in a variety of different measurements, and understood how to minimize that uncertainty.
- rigorously analyzed experimental data using accepted error analysis methodologies to verify theoretical predictions.
- developed scientific presentation skills (both verbal and technical writing).
- learned to efficiently search the scientific literature and critically assess the scientific merit of what they read.
- become acquainted with a number of common experimental techniques in physics, many of which will be built upon in PHYS*3510 and PHYS*4500.

Section 4.4: Instructor’s Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for students with differing learning aptitudes. Some lecture materials may be provided on Courselink after lectures for students who struggle to get everything copied in lecture, but this material is not intended to replace the lecture experience. Discussions resulting from student questions, for example, are of particular importance for students.

Section 4.5: Students’ Learning Responsibility

Students are expected to take advantage of the learning opportunities provided during lectures and laboratory periods. Students having difficulty with the course content are advised to consult with the course instructor when they are struggling to understand a particular course concept, not after they have been assessed – this is too late!

Students who do (or may) fall behind due to illness, work, or extra-curricular activities (including varsity sports, student leadership activities, etc.) are advised to keep the instructor informed such that extra resources or accommodation can be provided, if appropriate.

Students are expected to attend lectures and tutorials and are expected to complete their lab notebooks, formal lab reports and term projects in a timely fashion. Students are provided with deadlines for course materials at the beginning of the semester and are expected to work towards those deadlines accordingly.

Section 4.6: Relationship With Other Courses & Labs

Prerequisite Courses: Students must have completed PHYS*2330. Students are strongly encouraged to take PHYS*2240 prior to this course and be co-registered in PHYS*2310 and PHYS*2340.
Students that have not completed IPS*1500 and IPS*1510 are strongly encouraged to review the error analysis package used in those courses (provided on Courselink).

**Restrictions:** None.

**Follow-on Courses:** PHYS*2180 is the first in a sequence of three laboratory-based courses in the physics major. PHYS*3510 builds upon the scientific instrumentation learned in PHYS*2180, and is itself followed by PHYS*4500.

Some experiments in PHYS*2180 complement material taught in PHYS*2240, PHYS*2310, and PHYS*2340, but this is **not** the primary role of this course.

**Section 5: Teaching and Learning Activities**

**Section 5.1: Timetable**

**Lectures:**

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Classroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday</td>
<td>10:00 – 11:20</td>
<td>MacKinnon (MACK) 115</td>
</tr>
<tr>
<td>Thursday</td>
<td>10:00 – 11:20</td>
<td>MacKinnon (MACK) 115</td>
</tr>
</tbody>
</table>

**Labs:**

<table>
<thead>
<tr>
<th>Day</th>
<th>Section</th>
<th>Time</th>
<th>Classroom</th>
<th>TA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday</td>
<td>0101</td>
<td>14:30 – 17:20</td>
<td>MacNaughton 414</td>
<td>Annett/Shelton</td>
</tr>
<tr>
<td>Thursday</td>
<td>0102</td>
<td>14:30 – 17:20</td>
<td>MacNaughton 414</td>
<td>Annett/Shelton</td>
</tr>
<tr>
<td>Friday</td>
<td>0103</td>
<td>14:30 – 17:20</td>
<td>MacNaughton 414</td>
<td>Annett/Shelton</td>
</tr>
</tbody>
</table>

Students are responsible for all information presented in lectures and labs. Active participation by students in the tutorials and lectures is required!

**Every** student has the right to participate and contribute in lectures and labs. If a student feels that there is something preventing their full contribution, they must notify the course instructor or lab/tutorial instructor as soon as possible. We cannot fix problems that we are not aware of!

**The learning environment must be free from harassment. Offensive or inappropriate (homophobic, racist, sexist, etc.) comments are strictly prohibited.** Offending students will at the very least be required to leave the lab or class, and a mark of zero will be given for any assessments arising from that course activity. More serious cases will be forwarded to the University of Guelph Judicial Committee, where the maximum penalty is suspension or expulsion from the University of Guelph. For more details, students should consult the [University of Guelph’s current Policy on Non-Academic Misconduct](#).
Section 5.2: Tentative Lecture Content

The content covered during lectures for this course will introduce students to basic experimental techniques, measurement theory and experiment design. The underlying theory for many individual experiments (as outlined in the lab schedule below) will also be presented and discussed during lectures.

Provisional list of lecture topics:

- discussion of experimental physics
- uncertainties and errors, counting statistics
- review of resistors and capacitors, DC circuits
- discussion of inductors and diodes
- AC circuits, resonance
- scientific writing, searching the literature
- experimental basis of early quantum theory
- basic spectroscopy
- microscopy and image analysis
- introduction to semiconductors, Hall probes, and detectors (time permitting)
- oral scientific presentations

Section 5.3: Tentative Lab Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Laboratory Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Jan 08 – 12</td>
<td><em>Tutorial: Review of uncertainties and propagation of errors, introduction to complex numbers and functions</em></td>
</tr>
<tr>
<td>02</td>
<td>Jan 15 – 19</td>
<td><em>Lab 1: Poisson Statistics</em> (Done as class)</td>
</tr>
<tr>
<td>03</td>
<td>Jan 22 – 26</td>
<td><em>Lab 2: Kirchhoff’s Rules</em></td>
</tr>
<tr>
<td>04</td>
<td>Jan 29 – Feb 2</td>
<td><em>Lab 3: AC Circuits</em></td>
</tr>
<tr>
<td>05</td>
<td>Feb 5 – 9</td>
<td><em>Lab 4: Driven Damped Oscillators</em> (Formal Lab #1)</td>
</tr>
<tr>
<td>06</td>
<td>Feb 12 – 16</td>
<td>One of the following experiments:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lab 5: Current Balance</em> (Formal Lab #2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lab 6: Force and Torque on a Magnetic Dipole</em></td>
</tr>
<tr>
<td>n/a</td>
<td>Feb 19 – 23</td>
<td>WINTER BREAK – NO LECTURES OR LABS</td>
</tr>
<tr>
<td>07</td>
<td>Feb 26 – Mar 2</td>
<td>One of the following experiments:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lab 5: Current Balance</em> (Formal Lab #2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lab 6: Force and Torque on a Magnetic Dipole</em></td>
</tr>
<tr>
<td>08</td>
<td>Mar 5 – 9</td>
<td>One of the following experiments:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lab 7: Visible Light Spectroscopy</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lab 8: Brownian Motion</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lab 9: Compton Scattering</em></td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Lab 10: Introduction to Computed Tomography</em></td>
</tr>
</tbody>
</table>
Week | Dates | Laboratory Schedule
--- | --- | ---
09 | Mar 12 – 16 | One of the following experiments:  
Lab 7: Visible Light Spectroscopy  
Lab 8: Brownian Motion  
Lab 9: Compton Scattering  
Lab 10: Introduction to Computed Tomography
10 | Mar 19 – 23 | One of the following experiments:  
Lab 7: Visible Light Spectroscopy  
Lab 8: Brownian Motion  
Lab 9: Compton Scattering  
Lab 10: Introduction to Computed Tomography
11 | Mar 26 – 30 | One of the following experiments:  
Lab 7: Visible Light Spectroscopy  
Lab 8: Brownian Motion  
Lab 9: Compton Scattering  
Lab 10: Introduction to Computed Tomography
12 | Apr 2 – Apr 6 | Term Project Oral Presentations

**Note:** The information above is provided as a *rough guide* for the term. Future announcements about changes to the table or of any kind will be made in class and posted on Courselink; **these announcements take precedence over the original course outline!** All students are responsible for what is said in class, whether or not they attended every class.

Outlines for the laboratory experiments will be provided on Courselink at least one week in advance of students performing the experiment. Students are expected to be familiar with the experiment BEFORE arriving at the laboratory.

If you know that you cannot make your assigned lab in a particular week due to exceptional circumstances, arrange with your teaching assistant to do the experiment in one of the other sections (if possible).

**Section 5.4: Other Important Dates**

Friday March 9th is the fortieth class day, the last day to drop one semester courses.

**Section 6: Lab Safety**

**Section 6.1: Department of Physics Laboratory Safety Policy**

The Department of Physics is committed to ensuring a safe working and learning environment for all students, staff and faculty. As a student in the laboratory, you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, students are responsible for reporting all safety issues to the graduate teaching assistant or course instructor as soon as possible. Students are not required to work in
an environment that they deem to be unsafe. If you have any concerns whatsoever, please consult your teaching assistant or course instructors!

In this course, students may be exposed to the following potential hazards:

- $\gamma$-radiation sources
- intense light, including laser light
- voltages and currents that can be harmful if proper precautions are not taken

All experiments have been designed such that students have minimal (but not zero!) risk, if proper laboratory protocols are followed. At all times, students must be aware of the risks of their experiment and the positioning of their fellow students and behave accordingly.

Section 6.2: Food and Drink in the Laboratory

As with all laboratories on the University of Guelph campus, **ALL food and drink is strictly prohibited** in the laboratory. This applies to all faculty, staff, and students. In the PHYS*2180 laboratory, this rule is strictly enforced as a criterion for lab certification with the Radiation Safety Office at the University of Guelph. Students must not, under any circumstances, bring any food or drink to the laboratory benches. If students have water bottles or food in their backpacks, these must be left at the front of the room and must not be accessed within the room at any time.

Section 7: Academic Misconduct and Collaboration

Section 7.1: Collaboration

Collaboration and communication are essential for progress and advancement; much of modern society is built upon these skills. Students are encouraged to collaborate and discuss course concepts! However, all material submitted for grading must be each student's own work. Plagiarism is a form of academic misconduct, and will not be tolerated.

A good guideline when it comes to crossing the line from collaboration to academic misconduct (see next section) is that a student must never look at another student’s written work. For the vast majority of students, they will be incapable at arriving at their own form of a derivation or analysis after they have looked at another student’s work. For students seeking help from their peers, ask conceptual questions as opposed to “How do you derive Equation 4?” For student helping their peers, never give the answer explicitly, but explain your reasoning.

Section 7.2: Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their
location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection. **All papers submitted in this course will be assessed using the Turnitin plagiarism checker built into Courselink.**

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

**Section 8: Accessibility**

**Section 8.1: Accessibility**

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Student Accessibility Services as soon as possible.

For more information, contact SAS at 519-824-4120 ext. 52073 or email accessibility@uoguelph.ca or see the website: https://wellness.uoguelph.ca/accessibility.

**Section 8.2: Electronic Recording of Classes**

The electronic recording of classes is expressly forbidden without the prior consent of the instructor. This prohibition extends to all components of the course, including, but not limited to, lectures, tutorials, and lab instruction, whether conducted by the instructor or teaching assistant, or other designated person. When recordings are permitted they are solely for the use of the authorized student and may not be reproduced, or transmitted to others, without the express written consent of the instructor.

**Section 8.3: Posting Course Materials on Websites**

Posting any course materials, including lecture notes or experiment outlines, is strictly prohibited. These materials are copyright of the course instructor, Department of Physics, and University of Guelph.
Section 9: Course Evaluation

Section 9.1: Course Evaluation

The Department of Physics requires student assessment of all courses taught by the Department. These assessments provide essential feedback to faculty on their teaching by identifying both strengths and possible areas of improvement. In addition, annual student assessment of teaching provides part of the information used by the Department’s Tenure and Promotion Committee in evaluating the faculty member's contribution in the area of teaching.

The Department's teaching evaluation questionnaire invites student response both through numerically quantifiable data, and written student comments. In conformity with University of Guelph Faculty Policy, the Department’s Tenure and Promotions Committee only considers comments signed by students (choosing "I agree" in question 14). Your instructor will see all signed and unsigned comments after final grades are submitted. Written student comments may also be used in support of a nomination for internal and external teaching awards.

Note: No information will be passed on to the instructor until after the final grades have been submitted.