A. Overview: This is an intensive laboratory course, with a strong emphasis on independent data analysis and dissemination of results. The main goal is to help prepare you for graduate-level research and a possible career as an experimental physicist or engineer. As part of the course, you will gain experience with common methods of error analysis and curve fitting; learn the basics of the Perl programming language, the LabVIEW data acquisition and control software, and the LaTeX document preparation program; complete four experiments and write a formal report for three of them, with the results of one experiment presented as a 12 minute talk; become familiar with fundamental machine shop components and use; design and construct a hardware component to be used in one of the experiments using the Department of Physics and Astronomy Machine Shop; and design an experiment where the data acquisition and at least part of the data analysis is performed using LabVIEW.

B. Experiments: A list of experiments and their associated instructions will be available from the course web page. Each experiment may be performed by a team of two people, with the exception of the LabVIEW Project (see below). However, the data analysis and dissemination of the results (written report or oral presentation) are to be performed individually. It is strongly recommended that you record all of your data for each experiment in a dedicated bound notebook (not loose-leaf paper). All students must schedule a “research meeting” with the instructor prior to the start of each experiment.

C. Lab Safety: Good laboratory safety practices are an important part of this course. There are several machines and experimental apparatus that could cause you great harm if they are not used in a careful and responsible way. Thus safety will stressed heavily throughout the semester, and how well you follow the safety procedures can affect your score on any project during the semester.
D. Report Grading: All lab reports must be produced using LaTeX. They will be graded on a 100–point scale based on the content of each section, data reporting and analysis, error analysis and propagation, discussion and interpretation of results, software developed as part of the data analysis, and answers to questions posed in the lab instructions. Late reports will accrue a 10–point reduction for each day past the due date. Note that your last report will also be used for departmental assessment purposes.

E. Schedule: Approximate deadlines for the reports, oral presentation, and projects are:

- Report 1: February 16
- Shop Drawing: February 23
- Report 2: March 6
- Report 3: March 30
- Machine Shop Project: April 3
- Oral Presentation: April 20
- LabVIEW Project: May 5

F. Report Format: The report format will follow the same general guidelines as those used in the Physical Review, the premier domestic journal of physics research. (See http://publish.aps.org/ for a sample article from one of the subsections of this journal.) The following gives an outline of the different sections to be included in each report.

Title, Author List, Date: At the top of the first page of the report, give a concise, relevant title in bold type, then list your (the author) name and the name of your lab partner on the second line, and finally the date the report was turned in on the third line.

Abstract: A short (one paragraph) synopsis of the report which contains the main results and which does not refer to the main text. In short, the abstract states briefly what you did, how you did it, and what you got. It is the first text that appears following the Title, Author List, and Date, just prior to the Introduction section (see below).

I. Introduction: Contains relevant background information and a description of the main goals of the experiment.

II. Theory: Provides a derivation of the theory for the experiment, including (numbered) mathematical equations if applicable.

III. Experimental Techniques: A description of the experiment and procedure consisting of text and possibly figures (labeled by figure captions). The text must be sufficiently detailed, including a brief description of the apparatus used in the experiment.

IV. Results and Discussion: Briefly summarize the results, and discuss results that are not obvious by simply reading the tables or which were obtained by nonstandard means. Tabulate your data (including table captions and uncertainties in all measured quantities) and include figures where appropriate. Display the data efficiently, in a way that is easy to read. Note that you may not need to show all of the data that you obtained. Show how you performed error propagation, and describe the type of error (random and/or systematic) accounted for in your analysis. Compare your experimental result with the accepted value (when appropriate) and see if they agree within experimental uncertainty. Discuss and try to
explain any discrepancies between the two. Include suggestions on how to improve the experimental method so as to reduce the uncertainties. Provide meaningful interpretation of the results, including any relevant relationships among the experimental data. Answer any questions posed in the lab instructions.

V. Summary: A summary of the experiment, main results, and interpretations/conclusions.

References: A list of textbooks and/or articles that you used for your report which are referred to in the text. The source is listed by author, title, journal name (or publisher), volume number, first page number of article, and year of publication. For example:


Web page: Give URL

G. Machine Shop Project: You will design a hardware component intended to be used as part of the fourth experiment that you will perform, and will then build it using the Department of Physics and Astronomy Machine Shop. Your instructor will train you on the basic use of the machining tools available in the shop, and on techniques needed to produce an effective shop drawing for your component. All projects must be approved (based on the design drawing) by the instructor prior to the beginning of its construction in the shop. Components may be built by a team of two people. **At least two people must be working in the shop at all times — never work in the shop alone!** Shop work must also be performed when at least one departmental faculty or staff member is present in their office.

H. LabVIEW Project: You will design and implement an experiment using the National Instruments LabVIEW software tool. The data acquisition and control from LabVIEW will be interfaced with the experimental apparatus using the hardware used in the introductory physics laboratory curriculum. During the semester, you will be given instructions on how to get started with LabVIEW, and what tasks you need to become familiar with in order to make LabVIEW perform the necessary data acquisition and analysis. The experiment you design is intended to be suitable for PHYS 110L or 111L (based on the theories of classical mechanics, electromagnetism, etc.), but those of more contemporary interest are also possible. No formal report is required at the completion of the project; only an “instruction manual” for the experiment and a demonstration of its functionality. This project is to be performed on an individual basis.

I. Grading: Your semester grade will be based on the following percentages and approximate grading scale:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
<th>Grade Range</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>10%</td>
<td>86–87% A–</td>
<td>&gt; 87% A</td>
</tr>
<tr>
<td>Lab Reports (3)</td>
<td>45%</td>
<td>73–74% B–</td>
<td>75–83% B</td>
</tr>
<tr>
<td>Oral Presentation</td>
<td>15%</td>
<td>60–61% C–</td>
<td>62–70% C</td>
</tr>
<tr>
<td>Machine Shop Project</td>
<td>15%</td>
<td>50–51% D–</td>
<td>52–57% D</td>
</tr>
<tr>
<td>LabVIEW Project</td>
<td>15%</td>
<td>&lt; 50% F</td>
<td></td>
</tr>
</tbody>
</table>

Students with disabilities will be accommodated in every way possible, as per University policy. The University policy on academic honesty, as defined in the OWU Catalog, will be enforced in the strictest sense.