Preface

Introduction

Mastering Electronics is not an easy task. While many concepts are straightforward, their application to a real-world device are often non-trivial. Part of the difficulty is that in addition to new concepts one often has to learn new numerical and algebraic tools that enable us to predict the values of various components to use, to select their settings and operating points for optimum performance. Putting it all together can be quite daunting.

In this laboratory you will use a variety of tools to achieve just that:

- hands-on experiments, where you will assemble real circuits using real components, meters, wires, and devices — workstations with multi-meters, function generators, oscilloscopes, programmable power supplies, and bread-boarding stations are provided for this purpose;
- computer-based tutorials using software called `Electronics Workbench`, where virtual circuits are assembled, tested and analyzed using the common graphical "drag-and-drop" skills;
- graphing and numerical analysis of the results of your real or virtual experiments, with the help of the `physica` software or its graphical version `physicalab`.

A typical lab experiment may consist of simulating a circuit, choosing the optimal value for some component, then assembling the very same circuit on the breadboard in the lab, testing it, and finally, analyzing your measurements and comparing them to the predictions of the theory learned in the lectures.

Lab books, reports and marking

Some lab sessions are devoted to the computer-based exercises using `Electronics Workbench`. As you go through the exercises, be sure to answer all the questions in your lab book and record pertinent observations. Screen capture a copy of all the circuits that you simulate and import them into your lab report. Be sure to save a copy of all the working circuits to your file space *before* you begin the simulation.

Other experiments involve actual electronic components and circuits. Sometimes you will assemble exactly the same circuits that you had simulated in an earlier experiment. A similar step-by-step write up in the lab book is expected. All of your individual observations and measurements must be included. Here you can capture the screen output and settings from the digital oscilloscope and save it to your lab report.

Following every lab you are required to submit a lab report analyzing and summarizing the data and the experimental procedures. The lab report should be typed, single-sided, and submitted in a clear report cover/document folder. The grading is based on the following:

- overall neatness and coherence in the structure of the report;

- completion of all the required simulated and experimental steps;

- inclusion of printouts, data tables, circuit and waveform sketches;

- thoughtful and understandable responses to the guide questions;

- adherence to the designated lab format.

  You will find it most efficient to open a wordprocessor document at the start of the lab and then enter observations, data, screen captures of circuits, graphs and oscilloscope traces as you proceed with the experiment. This way, the overall structure of the lab report will have been created and can be easily enhanced with further details and insights.

A lab report should start with an overall statement of purpose of the experiments. Then *for each exercise* include a schematic diagram of the circuit and graphs of the waveforms observed, formula derivations, a description of the theoretical behaviour of the circuit and comparison with your actual observations, and answers to the pertinent questions. The presentation of your results should be organized and complete, your diagrams titled and referenced, so that someone who is not familiar with the experiments would have no difficulty understanding what was done.

At the end of the lab report, include a brief Conclusions section that summarizes the results and discusses problems encountered and insights gained. The purpose is to reach the synthesis stage, to give you a chance to establish intermediate milestones in your learning.

Completed lab reports will be collected at the beginning of the next lab; thus you have a full week to complete your lab reports. However, you will find it easier to do the write-up within one or two days of the end of the lab, while the details are still fresh in your mind. There will be no time extensions given for late submissions. Late labs receive a zero grade; all labs must be completed with a passing grade to satisfy the lab component for the course.

Be prepared!

Some of the experiments will require the full 3-hour lab period; therefore, it is essential that you are fully prepared *before* attending your lab session.

- Arrive on time. Your lab starts at 2:00 pm sharp!
- Be sure you have read through the experiment *in its entirety* at least once before arriving.

Your partner cannot be expected to wait for you. Failure on the above two points can result in you working alone (time permitting), or being asked to make up the experiment some other time (depending on the availability of equipment).

Plagiarism

When you are working closely with your partner, it is understood that parts of the lab reports will appear similar; however, plagiarism will result in a *zero* for that report. It is your responsibility to consult the section on Academic Misconduct of the University Calendar prior to the first lab session.

Conventions used in this manual

(!) Whenever you see a paragraph marked off with this symbol, it indicates an experimental step. You are expected to perform one or several operations and write down your results and observations in the lab book.

$\boxed{?}$ When you encounter this symbol, it indicates a question or a problem. You are expected to perform the necessary calculation (using pen and paper) and to provide a written answer and, possibly, a brief explanation in your lab book *before* you proceed to the next stage of the experiment.

Plotting and fitting with `physica`

An integral part of every lab is an analysis of the results, and it is best done with the help of a scientific visualization/plotting/fitting computer program. The Physics Department uses a plotting and fitting package called `physica`, written at the TRIUMF accelerator in Vancouver, BC. This is the recommended software for use in the analysis of experimental data and in the preparation of lab reports, theses, and scientific articles.

The main `physica` "engine" is an "old-fashioned" piece of software in the sense that it has a command language and requires typing of commands at the prompt, and not clicking a mouse and using visual widgets. On the other hand, it is easy to learn, its numerical engine is an extremely powerful one, and a macro language allows you to automate many tasks using only a text editor.

- A simple to use interface to Physica available only on the Physics Department computers is the `Physicalab` data acquisition and plotting software used in the first-year Physics labs. Open a terminal window and type `Physicalab` at the command prompt to invoke the program.

- In addition, `Physica Online` is a web-based interface into `physica` which may be accessed from any web browser. It is fairly self-explanatory and can be invoked by pointing a web browser to

  `http://www.physics.brocku.ca/physica/`

- For more advanced tasks, `Physicalab` and `Physica Online` provide an "expert mode" which allow access to full capabilities of `physica`. In order to harness the full power of `physica` you may need to spend some time learning its command language. i

References

In addition to your course textbook, numerous excellent introductory electronics books exist, and you are encouraged to refer to them often. Some selected titles are listed below, with Brock Library calling numbers shown where appropriate.

Other references such as manufacturers' data books and the equipment manuals should be consulted as needed; most of them are available online. The web page of the course has some select pointers in the section $\boxed{\text{References}}$ and is a good place to start.

1. D. Barnaal, *Analog and Digital Electronics for Scientific Applications.* Waveland Press, 1982. TK7816 B34.