SCHULICH School of Engineering

UNIVERSITY OF CALGARY

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ENEL 353 -- *Digital Circuits*

Welcome to the ENEL 353 Laboratory

1 Introduction

The ENEL 353 lab exercises are a very important part of the course, and are designed to support and extend the course lecture material. The primary learning outcomes are to gain experience in the following key areas.

1. Practical Experience: to gain practical hands-on experience at wiring and testing a variety of very useful digital circuits, ranging in complexity from individual logic gates to flip-flops and synchronous sequential circuits.

2. Design Experience: to pursue a more in-depth study of some important digital circuits and their applications, including digital arithmetic circuits, combinational circuits, and synchronous sequential circuits. Design work is a key part of this, and is one of an engineer's most important skills. These circuits may include some that are not directly covered in lectures.

Each of the four lab exercises given in this course come with an introductory review of the subject material and what you must do to prepare for each session. *In order to successfully complete any lab session, prior study is required.* Where appropriate, relevant sections of the course textbook are listed for your review.

In this guide, we briefly describe the physical locations of the labs, how you should prepare for each session, what is required in terms of a lab report, and where and when to hand in the reports.

2 The Laboratories

The labs are performed in adjoining labs located in A-block on the third floor of the Engineering Building in rooms ENA 301 and 305 at the following times:

- B01/B02: Monday 2:00-5:00 PM.
- B03/B04: Wednesday 8:00-11:00 AM.

The two labs are identically equipped, with a total of 16 stations available in each. Feel free to set up in either lab, not necessarily the one to which you have been assigned. You must work in groups of two, although you may work individually, space permitting. Group sizes larger than two will not be permitted except by special arrangement.

3 Pre-Lab Preparation

Prior to each lab session, each student is responsible for making an effort to come prepared for the experiment. This is essential in order to use the limited lab time effectively. Because of the tight scheduling of the lab space, students may not get a chance to finish an experiment, or get a chance to recheck an erroneous measurement possibly not discovered until well after the lab session has completed. In particular, for labs that require design work, it is essential to have this design work done ahead of time. Avoid going into lab sessions "cold!"

Detailed instructions on preparing for each of the lab sessions is given in each lab handout.

4 The Laboratory Report

Each group is required to submit a group-prepared lab report for each lab experiment. Only one report is required per group, and make certain *the names of all group members are clearly indicated on the report.*

Reports may be neatly hand-written or generated using any word-processing system or drawing software. Material may also be simply cut out of the lab exercise and pasted into the report. The use of a standard hard-cover lab notebook is not required. If the report is not in a hard-cover notebook, *please ensure that it is securely stapled or fastened.*

4.1 Due Dates and Late Penalties

Reports are due one week following the lab session.

- **B01/B02:** the due date is 1:00 PM on the next Monday.
- **B03/B04:** the due date is 1:00 PM on the next Wednesday.

A late penalty of 30% is applied to reports that are up to 24 hours late. Reports that are 24-or-more hours late will not be accepted.

Reports should be submitted to the ENEL 353 lab boxes in the second-floor west-side corridor of the ICT Building (a whole wall of nothing but boxes). Marked reports will be returned at or before the beginning of the next lab session.

4.2 Guidelines for Writing Laboratory Reports

During the course of performing an experiment, take care to ensure that all of the required measurements and observations are recorded. This is essential for the later job of analyzing the results and writing up the lab report.

The report structure and content will vary from lab to lab, but the report should appropriately include the following sections and components.

4.2.1 Cover Page

Every lab report should have a cover page with a title, the names of the group members, the lab section number, and the date of the lab session.

4.2.2 Introduction

This is a one- or two-paragraph section to provide useful background information. The purpose of the introduction is generally to answer "why" you are doing the experiment. This information is generally provided in the lab handout, but try to restate in your words.

4.2.3 Design/Analysis Work, Measurements, and Discussion

This is clearly the most important part of the lab report. This is where you present the following key matters.

- Details and discussion of your design or analysis work prepared in advance of the lab session.

- The circuits that you are building and what tests you are performing. Provide your observations and measurements, along with your discussion and interpretation. It is important to try to provide sufficient detail here to convey your understanding of the circuits being investigated.

  Be sure to include anything relevant, such as printed schematic diagrams, timing diagrams, and text-based program source listings or parts thereof.

- Make sure that you answer all of the questions being asked.

Try to organize this material in a clear and logical manner. For example, a sensible approach to writing this part of the report might be to organize it into subsections corresponding to each of the lab exercises (each lab has multiple exercises). Each of these subsections could integrate all of the above-bulleted items, from preliminary design or analysis work, to completed tests, measurements, and discussion.

Be sure to include anything relevant, such as printed schematic diagrams, timing diagrams, and text-based program source listings or parts thereof.

4.2.4 Conclusion

This is typically one paragraph summarizing the purpose of the lab, key results, and conclusions. It is often the place to also make recommendations, if any, that are supported by your discussion in the body of the report.

4.2.5 Appendices

Any material that you feel should be part of the report, but is too bulky to be placed in the body of the report, is usually placed in an appendix. This could include long program listings (VHDL code for PLDs, for example), device specification sheets, etc. This could then be referred to in the body of the report when appropriate without unnecessarily detracting from the readability of the report. *(Remember, an appendix must be referred to in the report.)*

4.2.6 Language and Style – Really Important!

It is important to remember that facts and figures alone do not make a good lab report; *quality of presentation* is extremely important, and is perhaps one of the most difficult parts of the job. Put some careful thought into what is the best way to organize everything, and try your best to demonstrate a clear understanding of the material. The report is graded on the technical content, proper and well-reasoned explanations, clear and concise language, and correct grammar.

4.2.7 A Well-Written Lab Report

A well-written lab report is one that can be read by others who may then easily reproduce your results and conclusions (this may be *YOU* at some later time!). The report should be a stand-alone document without the reader having to rely on instructions given in a lab handout, as no such document may exist in the engineering world outside of university. *Engineers are often asked to continue the work of previous engineers on various projects, so the importance of proper documentation cannot be emphasized strongly enough.*

5 Laboratory Schedule

Watch the course home page for updates to the lab schedule:

http://people.ucalgary.ca/~nbartley/Enel353/synopsis.html

Norm Bartley and Steve Norman, September 8, 2019.