Ideas for Changes for ECE 2214

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I. Introduction

A. ECE 2214 - Introduction to Digital Design

Introduction to Digital Design serves as the first course in the core classes for electrical and computer engineering majors at the University of Oklahoma. This course creates a foundation for follow-on courses by introducing computer architecture concepts and helping students become familiar with designing and creating basic circuits. In addition, this course helps students develop circuit debugging skills that will be used throughout other labs in the degree program. By creating a positive and supportive environment and with some general structural changes, students can be better prepared for continuing with their degree choice.

B. Problem Statement

Students enter into engineering with varied backgrounds and knowledge levels and as a result different students can approach a subject differently. Introduction to Digital Design presents a foundation of knowledge that is then built on in future classes. To ensure that students have a solid starting point they must be well equipped to understand course material. Preparing and encouraging students can help retain students in the program. Changes can be made to the course material on a structural level and to lab practices to encourage students and support everyone no matter their background.

II. General Course Changes

A. Textbook

The current textbook used in ECE 2214 is a Zybooks textbook. Zybooks textbooks have issues with a high cost for a resource that does not last past a semester. This can especially pose a problem if a student needs to retake the course. There are also issues with Zybooks where the student just clicks through the required portions for the grade and does not actually learn the material. The proposed change is to switch to Digital Design and Computer Architecture (2nd Edition) by David Harris and Sarah Harris [1]. This textbook includes many good examples with end of chapter problems. In addition, the end of chapter problem sets include sample interview questions which tie the material back to real-world applications. As this book is a cheaper alternative to Zybooks students will have less of a cost restriction due to price and will not be required to purchase an online tool to complete homework. As an added benefit, this book ties material to computer architecture throughout and ties in with FPGA applications. This can help students better understand the context of the material they are learning. This book could very well be used with a computer engineering follow-on course that focused on reworking ECE 2214 materials with FPGAs.

B. Lab Equipment

The current lab equipment uses myRios to produce digital inputs and outputs for circuits. However, these devices have developed issues with age. In addition, by obfuscating how the circuit inputs are generated it can create a disconnect in understanding with the students. By switching to using several DIP switches, logical highs and lows can easily be produced and explained to students. This helps avoid hiding material behind a magical box and can help students that do not have a circuits background better understand. In addition, per lab table a myRio is shared between two students. This can limit debugging time and may make shyer students uncomfortable about speaking up to switch to their turn to debug. For labs that require a clock input, a clock input can be created with a 555 circuit. The values for the 555 circuit would be provided to the students to reduce complexity, but this would remove any obfuscation of the lab inputs as well as introduce them to components that they will encounter in future lab courses. By providing students with a breadboard power supply, circuit construction can also be started and practiced outside of assigned lab time slots.

C. Lab Simulation

Students currently are required to create a schematic before starting on a lab where a schematic is necessary. The use of a basic digital logic simulator can be used to create schematics and simulate them to test for accuracy before beginning to build the circuit. This helps with neatness as it can be difficult to draw easy to read schematics while learning the basics of circuit design. An easy to read schematic in turn helps with debugging as it is easier to see how to connect various parts together. A simulator also helps develop intuition about how the different portions connect and can be used to debug as various values can be confirmed given specific inputs. This can be used as a way to double check the expected output. CircuitVerse is an online digital logic simulator that uses a simple model and allows students to focus on simulation instead of how to simulate something [2]. Since follow-on courses use more complicated simulation tools, CircuitVerse serves as basic introduction that can then be built on in the future.

D. Encourage Good Debugging Practices

Debugging practices are used throughout all of the lab courses in the degree program and are also necessary for industry work. By encouraging good debugging practice not only do students have an easier and more enjoyable time in this lab, but also in future labs and circuit work. Good debugging practices can be started before circuit construction has started by cutting wires to length to avoid spaghetti and by building a circuit section by section and testing as portions are completed. In addition, students can be instructed on how to construct and build a logic probe with an LED to find messed up circuit logic.

E. Collected Notes and Reference Material Handbook

As labs or classes can be canceled from time to time, the material covered in lecture and the lab assignments may become out of sync. A collected handbook composed of materials like how to debug circuits, chip datasheets, how to read datasheets, lab materials, testing tips, and references for useful book sections can be provided on the course website to help students succeed. In addition, as different students come from various backgrounds with regards to STEM and support, a collected set of notes can be useful in developing design standards and confidence.

III. Retention Improvement Changes

A. Advertise Support and Resources

By advertising support and resources via posters and links on the course website, students can be encouraged to seek support both academically and socially. Creating a support network via on-campus tutoring services and seeing various representation can help create a welcoming environment. These posters can include tutoring hours for engineering tutoring, math center tutoring, and general support. General support can include a poster with "All Are Welcome Here," a poster provided for free via the National Center on Domestic Violence [4]. Additional support networks and professional opportunities can be found via student organizations. A poster can be created and displayed that showcases organizations specific to ECE as well as Diversity, Equity, and Inclusion organizations.

B. Additional Resources for Teaching Assitants

As the teaching assistants are the main guide as students are learning the material in the lab, providing consistent information about the labs and materials will help avoid issues. As TAs can be somewhat randomly assigned to a class, additional training can help provide consistent and accurate information to the students. [5] [6] [7]

C. More Lab Time to Allow for Differences in Backgrounds

Retention focused programs attempt to account in differences of the backgrounds and experience with STEM of incoming students by including an extra course in the sequence to bring students up to speed. However, as this change would be difficult to implement for this situation, it can be simulated in other ways [7]. Depending on lab availability and scheduling times, additional open lab office hours could be offered for questions and concerns. This would allow students to get more experience and clear up any concerns that could not be addressed in the two-hour lab period. Another possible solution could be to allow students to come to any lab timeslot during lab makeup weeks. While students could come to any timeslot (space allowing), preference would be given to students that are enrolled in that lab section. This allows students to spend more time on material that may be confusing them as well as gain more experience in the lab setting.

IV. Assessment of Changes

Assessment of changes can be evaluated based on results from student surveys. Mid-semester reviews can also be used to perform tweaks and adjustments to provide more specific resources as needed. These student surveys could include multiple choice and free responses questions geared to various course changes such as the textbook, homework, and lab. In addition, an optional section can be used to collect information of how else a student could be supported in this class and their future college plans, whether that is to continue studying ECE or other options. In addition, assessment of course changes can be made based on the differences in grades between previous semesters and Spring 2022. Specifically, the comparison of the number of successfully completed labs between semesters.

References

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