Session 2547

The Fundamental Digital Circuits Laboratory at The University of Central Florida

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Abstract

A course in Digital Circuits is an essential part of a well-rounded Electrical Engineering Technology (EET) curriculum. With hands-on experiments significantly improving the understanding and visualization of complex subject matters, a series of laboratory experiments have been developed in order to enhance the teaching and learning processes of Digital Circuits at the University of Central Florida. The laboratory manual has been designed in order to bridge the wide gap between textbook theory and real-life problems, while the laboratory assignments provide the student with both practical and problem-solving experiments to reinforce class lectures.

I. Introduction

The Digital Technology course (CET 3323) has been taught as a required course for electrical engineering technology students at the University of Central Florida since the program’s inception. The Digital Technology course introduces the concept and application of Boolean Algebra, Karnaugh Map, Combinational Circuits, and Sequential Circuits. The allocation of time amongst lectures and lab work is extremely important for a successful teaching plan. Without a sufficient amount of laboratory experiments, students are left with rather vague concepts regardless of the instructor’s effectiveness. Laboratory assignments clarify textbook materials and examples, as well as help to close the gap between theory and real-life problems. An efficient laboratory experiment must [1]:

clearly relate to and support textbook theory,
relate to real life instances,
challenge students’ ability to design, build, and test, and
encourage student to analyze the design and draw conclusion.

With these considerations in mind a laboratory workbook has been developed at the University of Central Florida for the digital technology course [2].

II. Overview of Laboratory Experiments

The experiments are designed to compliment and reinforce the lecture material throughout the semester [3]. The following lab assignments are in the same sequential order as the material presented in the course textbook:

Introduction to Laboratory Equipment

1. Laboratory Report Format
2. Logic Gates and Boolean Algebra
3. Combinational Circuit Design
4. Multi-Function Gate Design
5. Fundamentals of Flip-Flops
6. Digital Arithmetic
7. Multiplexers and Decoders
8. Counters and Registers
9. Asynchronous and Synchronous circuits
10. Memory Devices
11. Sequential Circuit Design

A brief description of each experiment's objective is given below. The equipment used in the laboratory includes a Digital Voltmeter (DVM), voltage generator, DC power supply, electronic breadboard, and miscellaneous wires, gates, and test boards.

Experiment 1. Introduction to Laboratory Equipment

To familiarize students with digital voltmeter, electronic breadboard, and miscellaneous gates, wires, and test boards.

Experiment 2. Laboratory Report Format

To teach students how to write a technical report and to demonstrate the organization of an effective laboratory report.

Experiment 3. Logic Gates and Boolean Algebra

To predict the theoretical operation of logic gates from the logic charts and then build and test for the actual outcome. To show that it is possible to combine different gates and get a desired output.

Experiment 4. Combinational Circuit Design

a) To analyze combinational logic circuits and to predict their operation
b) To construct and test more complex combinational logic circuits

Experiment 5. Multi-Function Gate Design

To design, build, and test Multi-Function Gates using multiple single function gates.

Experiment 6. Fundamentals of Flip-Flops

a) To build and investigate the operation of a simple single-bit memory unit
b) To design multi-bit memory units
c) To convert a certain type of flip-flop to other types

Experiment 7. Digital Arithmetic

To enhance students understanding of digital arithmetic circuits.

a) Design, build, and test a three-bit binary adder
b) Build a multiplier circuit

Experiment 8. Multiplexers and Decoders

To familiarize students with Multiplexers and Demultiplexers.

a) This experiment requires usage of Medium Scale Integration (MSI) devices
b) Eight to one multiplexer and 3:8 decoder are introduced
c) Investigation of the applications of the MSI devices in combinational circuits

Experiment 9. Counters and Registers

a) To introduce and investigate the operations of General Sequence Counters, and their applications
b) To produce specified count sequences using IC counter chips
c) To apply IC counter chips in design applications requiring the cascading of chips together
d) To design, build, and test a four-bit parallel load register and examination of its applications

Experiment 10. Asynchronous and Synchronous circuits

a) To analyze asynchronous counter circuits to predict their theoretical operation
b) To construct and test asynchronous counter circuit designs
c) To analyze synchronous counter circuits to predict their theoretical operation
d) To construct and test synchronous counter circuit designs

Experiment 11. Memory Devices

To familiarize students with the RAM and its application in realizing logic circuits

Experiment 12. Sequential Circuit Design

a) To investigate and design sequential circuits
b) To introduce clocked or synchronous sequential circuits
c) To examine non-clocked or asynchronous sequential circuits

III. Conclusion

Well-designed laboratory experiments can significantly increase a students knowledge and understanding of Digital Circuits. This knowledge, acquired through experimental laboratory observation and participation, is vital in the preparation of a students career in electrical engineering technology.

Bibliography
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