



# CE1901 LABORATORY PROJECT

## SUMMARY

Modern digital logic design relies extensively on computer-aided design tools and field-programmable gate arrays (FPGAs) that contain tens-of-thousands of configurable logic components. These FPGAs often contain a hardcore processor and large memories as well. Thus, an FPGA provides a rich fabric of computing components that can be configured and embedded into some product. For example, mobile telephones contain FPGAs, as do media players, game stations, and most other smart products.

Achieving skill with computer-aided design tools is fundamental to success as an engineer. Quartus is one example of an FPGA design tool environment. Quartus is provided to engineers by the Intel corporation. Intel makes many different FPGAs that can all be configured from within Quartus. Schematic designs of digital logic circuits can be created within Quartus. These blueprints describe the electrical connection of logic switches. It is not important at this stage to understand the diagrams you will draw in this laboratory. The goal of the laboratory is to introduce you to the computer-aided design tools.

## PRE-LABORATORY WORK TO BE COMPLETED DURING STUDY TIME

1. **Complete** the Quartus software installation instructions given on your syllabus.
2. **Complete** the schematic design and simulation tutorial distributed by your instructor.
3. **Complete** the FPGA programming tutorial distributed by your instructor.

## DELIVERABLES DUE DURING THE LABORATORY PERIOD

1. **Draw** and **simulate** the circuit of Figure 1. It detects 4-bit numbers greater than 4.
2. **Draw** and **simulate** the circuit of Figure 2. It detects 4-bit numbers between 7 and 11.
3. **Draw** and **simulate** the circuit of Figure 3. It detects 4-bit numbers 6, 7, 8, 9, and 10.
4. **Assign DE10-Lite** input toggle switches and an LED as the design inputs and output.
5. **Configure** each hardware design on your DE10-Lite and test using the slide switches. **Test** the entire ABCD number line!



# CE1901 LABORATORY PROJECT

## DEMONSTRATION AND SUBMISSION

1. **Demonstrate** each DE10-Lite design to the instructor during the laboratory period.
2. **Use** Microsoft Word to **create** a short laboratory report that includes sections for each circuit. Each section should briefly describe the circuit function, include the circuit diagram copied from Quartus, include the Quartus simulation diagram, and include a picture of the circuit taken using a camera – cellphone cameras work well. Talk to your instructor if you do not have access to a camera.
3. **Submit** your laboratory report using the preferred submission method of your instructor.

## REFERENCE FIGURES

**Review** the Quartus Design Flow introduced in the Programming Tutorial. **Make** a new project for each design using this design flow.



Now move to the next page to find Figure 1 and begin your work.

**These homework and laboratory exercises are © Dr. Russ Meier, Milwaukee School of Engineering. All Rights Reserved. Unauthorized reproduction in print or electronic form is prohibited.**

# CE1901 LABORATORY PROJECT

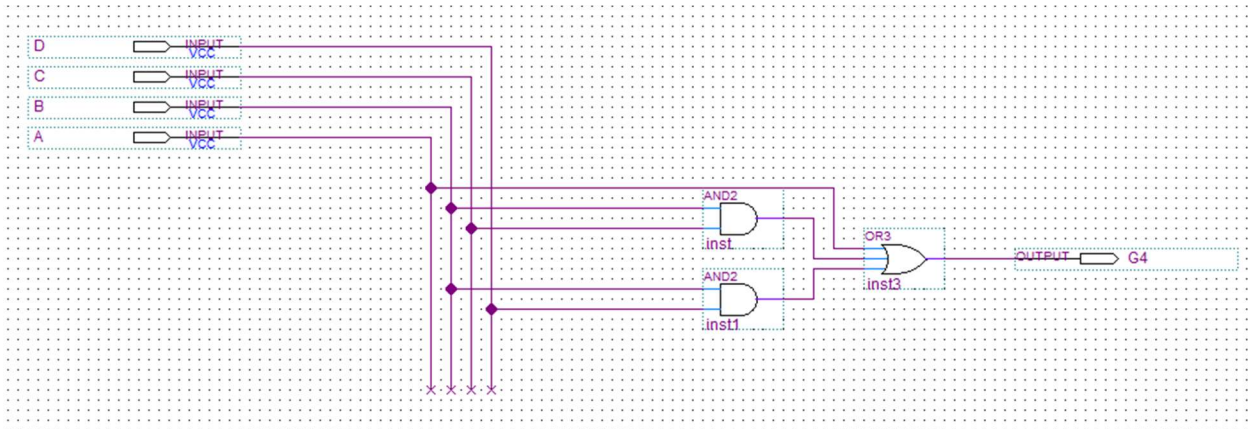


Figure 1: G4 detector

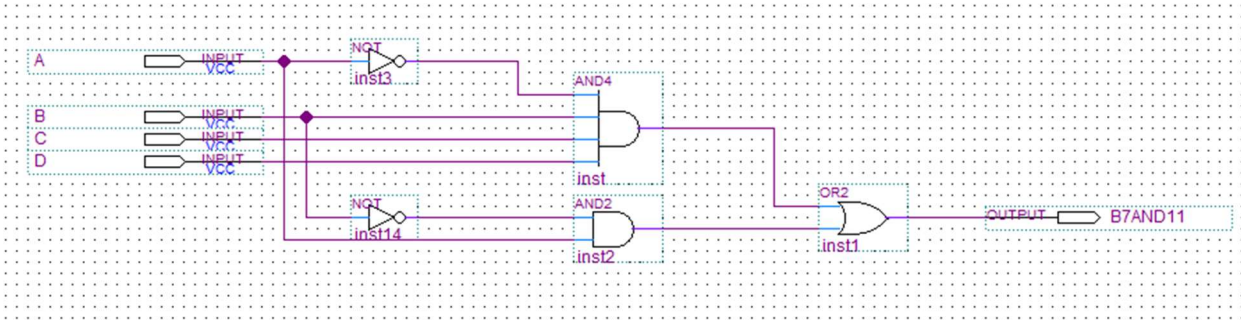


Figure 2: B711 detector

# CE1901 LABORATORY PROJECT

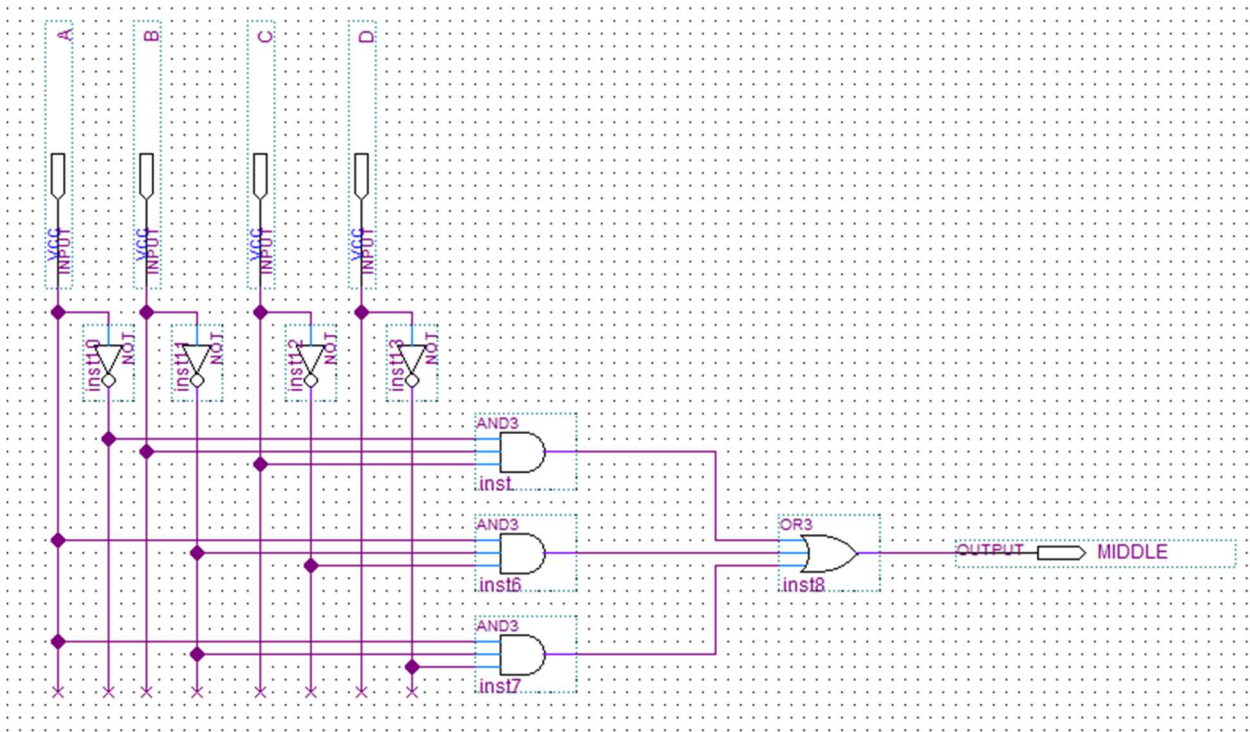


Figure 3: Middle detector