Final Course Project

ECE 241

Revision of October 31, 2023

The purpose of this course project is to integrate and apply the knowledge and skills acquired throughout the semester, allowing you to demonstrate a comprehensive understanding of the subject matter. It serves as a practical synthesis of the course material and provides an opportunity to apply what you've learned in a cohesive, real-world project.

As engineers, you will often work on a contract basis where you promise to complete a certain job, and then after winning the bid you will proceed to do it. As a group, you will be two or three contractors working on a project. As a contractor, during the proposal phase you will bid on completing certain components of the project, and you will be held responsible for the components you, as an individual, promised to do. They should have clear boundaries between group members, so we can assess you individually. For consistency, we have included a project cost to each component related to how difficult its implementation is expected to be. Your individual bid must have a cost of at least 1.0 to be acceptable. Don't promise more than that as then you will be liable for more. We have included a list of things you can promise and their cost, but if there is something else you wish to do that is not on the list, you can ask on Piazza, and we will respond with the project cost of that item. You will not be held responsible for the components bid on by your group members, you can help each other, but your grade is not affected by the quality of their individual sectors. You should also have a way to demonstrate just your section if needed.

Afterwards, you need to bring your projects together into a single cohesive project, and you will be graded on your ability to integrate all the components that were completed, or in the case some components of others are missing demonstrate you added the necessary hooks to get it to work. This includes both your components and those of your team members.

Of course, you can always surprise the client by doing more than is offered, and indeed if you manage to get more than you promised done, it will reflect very well in your grade. However, you are not to do the work that was bid by your colleagues, e.g., if your partner promised to do VGA, you can not do VGA yourself and claim it within your individual portion.

1 Motivation

Now that you've learned different digital system concepts in both labs and lectures, it's time to put them into practice with a project. This project is a glimpse into the real world of engineers. In the professional realm, engineers don't merely memorize textbook knowledge; they take individual parts, ideas, and theoretical concepts and piece them together to create functional, innovative systems. Similarly, this project tasks you with synthesizing your knowledge, utilizing various components and concepts to design a functional digital system.

It is also something potential employers will be interested in during job interviews. They want to see how you can apply what you've learned, your ambition for the project, and your deep understanding of the technical aspects. This project is your chance to showcase these skills, setting you up for success in the professional world. Also, it's not only about understanding the technical concepts but about demonstrating your teamwork and communication skills as well.

In this project, you are going to combine fragments of what you have learned into a cohesive system, so start with small steps, simulate, and debug each part before moving forward, and don't expect the code to work perfectly from the first time. Also, don't hesitate to ask questions when you're stuck.

Most importantly, enjoy the learning process - it can be fun!

2 Workflow and Deliverables

For this project, you'll be in groups of 2 or 3, the same groups as in the labs, and your teaching assistants will help you along the way. Please inform the teaching team of any group changes/swaps before the project proposal due date. Those are allowed if all parties involved agree, and if the new partners are all in the same lab timeslot. You get to choose the project idea that you want to work on, and it should cover some of the concepts that you've learned on the course. For example, you might opt to create a game or develop a complex ALU model. The project's complexity is addressed in the following section of this document, but in simple terms, it should be equivalent in effort to two regular labs.

In the process, you'll need to submit a project proposal by Friday, November 3rd at 11:59pm, and then you will demonstrate the final work to your TA in the week of December 4. The details of the deliverables and timeline are as follows:

Table 1: Timeline

Date	
Nov 3 at 11:59pm	Proposal submission You need to submit the proposal on Quercus. Only one submission per group is required
Week of Nov 6	Reading week, There are no labs. Use this time to finish lab 7 early and work on the project.
Week of Nov 13	Lab 7, is due. You can also receive assistance from the course TAs regarding the project during your lab session
Weeks of Nov 20 and Nov 27	Project help weeks You can receive assistance from the course TAs during your weekly lab timeslot in the same rooms in Bahen. Attendance is optional.
Week of Dec 4	Project Demo You will demo the project to your TA during your lab session

Deliverables:

1. You only need to submit your proposal on Quercus. The proposal must be a **maximum of one page** single-sided single-spaced of at least 11pt font stating:

   (a) The idea of your project summarized in 1-3 sentences.

   (b) A simple high-level block diagram of the hardware showing the datapath, the inputs and the outputs

   (c) The milestones of the project stating your individual intended progress on a week-by-week basis, dedicating at least 1.5 weeks to debugging and integration of the project at the end. Place internal deadlines on the individual components.

   (d) The division of tasks between team members. Each member must state the components they are taking responsibility for doing with a project cost of at least 1 point. Please refer to the project rubric

   In the days after the proposal is submitted, a TA will comment a reply with suggestions for the project.

2. The demo of the final work will take place during your assigned lab session by your TA. You need to show a working version of your system on the board, selling to us why it is interesting/complex and showcasing any and all features that you implemented, and which features you wanted to add but were unable. Partial marks will be given if you can only provide a simulation or if the project has significant bugs. Note, most of your grade comes from the individual proportion you committed to doing at the proposal stage.

   As you present your project you must mention these:

   (a) A complete description of the project

   (b) Your initial project idea and complexity points

   (c) The final project complexity points

   (d) Insights on why some parts/milestones of the project have bugs or did not work

   (e) Insights on what can be improved in your final work

   (f) Work Distribution between the team members. Be prepared to explain how the section you built works.

   You can not change individual components from what was set in the proposal without approval from a member of the teaching team. If the overall project is not well integrated, please prepare a test to best demonstrate your individual component. You are not responsible for the quality of your partner's individual portion, but you are responsible for integrating the components that are built together, it should be a single coherent project.

3 Rubric

Category	Value	Assessment Criteria	Due Date
Proposal	8 marks Group	Includes all 5 proposal components	Nov 3
	2 marks Group	Writing quality and presentation of proposal.	11:59pm
Presentation	8 marks Group	Includes all 6 Presentation Components	Demo
	2 marks Individual	Quality and Clarity of Presentation	Day
Individual Component of Project	60 marks Individual	Complexity and completeness of individual Component. Must include at least what was specified in the proposal with a complexity cost of 1. Going beyond what was proposed results in a better grade. However, you are not to do the portion assigned to your partner. Your component should run on hardware, if it is only demonstrable in simulation it will not get full marks.	Demo Day
Integration of Project	20 marks Group or Individual*	Ability to cohesively integrate all the individual components of both partners into a single design. For full marks you should be able to demonstrate the work of both partners in a single presentation. You will not be awarded grades based on the quality of the individual components, only on how well they are integrated together.	
*In cases of significant differences in the work done to integrate per person, this grade will be assessed individually. However, the teaching team must be made aware of team problems before the demo day for an individual assessment to happen.			
** The deadlines are final. You must present in your lab session with no extensions. Please prepare a video of your demo and presentation ahead of time in case you are unable to attend due to health issues or have technical issues on demo day Late proposals will be assessed a 5 mark per day penalty.			

4 Finding A Project

4.1 Project Cost

To help you decide if the complexity of your project is adequate, you will use the following guidelines. They include many components that you could include in your system, each with its particular complexity "points". The individual component of each group member should be at least 1 point to start, and then you can then add further complexity as the project comes along. It is better to have a simpler working project than a more complex broken project, we recommend you get something simple working before adding complexity. However, the more complex the final project is, assuming it works, the higher the mark. Not everything is included in the table, if you have something you wish to add, and you want to know the complexity cost, please ask on Piazza.

1. Finite State Machines, please specify in the proposal precisely what you aim your FSM to do:
   (a) No FSMs (0 points)
   (b) Small FSM; less than 10 states (0.25 points)
   (c) Many FSMs or one big FSM (more than 10 states) (0.5 points)
   (d) Complex ALU model with associated big state machine (1 point)
2. Datapath:
   (a) Simple datapath like adders (0 points)
   (b) More complex datapaths (0.25 to 0.5 points: depends on complexity). A good example is some sort of game with different moves or steps and a reasonable algorithm complexity.
3. Memory:
   (a) Simple inferred memories or registered states (0 points)
   (b) Using Block Memories and larger on-chip memories (0.25 points)
   (c) Using DDR and off-chip memory (0.5 points)
   (d) If the same memory port is accessible and shared by multiple distinct users with a complex access scheme(add 0.25 points to the above).
4. Inputs:
   (a) Switches and keys (0.25 points)
   (b) PS2 keyboard/ PS2 mouse (0.5 points)

(c) Audio (0.5 points)

5. Outputs:

   (a) Audio (0.5 points)

   (b) VGA display:

      i. Static image (0.125 points)

      ii. Moving images with tearing allowed (0.25 points)

      iii. Moving images with double buffering (0.5 points)

   (c) LEDs and 7-Seg display (0.125 points)
   Displaying a counter, timer etc. on the 7-Seg display aside from the VGA is always a good idea

6. Handling clock crossing (0.25 points)
   needed if different Input/Output devices use different asynchronous clocks