Project Selection and Proposal Guidelines

◇ Overview

- ⇒ The course projects must demonstrate practical engineering and design by prototyping a moderately complex analog/digital electronic and/or software system.
- ⇒ A typical project should involve the design of a digital system interfaced to an analog or software system. The digital portion design should be entered into a CAD tool (e.g., Quartus) using VHDL/Verilog and be simulated to make sure it meets the specified requirements. Analog components can be simulated using PSPICE.
- ⇒ The digital electronics portions of each project can be based on the available Altera boards or on a micro-controller. Some analog components are available and others can be ordered for the project. A wide variety of programming packages are available on the computers in the lab for software interfacing projects.
- ⇒ Groups can select their project topics, however, they must obtain the instructor's approval regarding the topic prior to submitting the proposals.
- ⇒ The students are required to choose projects that demonstrate some level of software and/or hardware design and their interface. This could include the design and implementation of code to extend the instruction set of an embedded processor, write software to control an external device interfaced to the board or design circuits for analog-to-digital (A/D) conversion, digital-to-analog (D/A) conversion, pulse-width-modulation (PWM), optical encoder interface, linear current amplifier, writing drivers to interface a PC to an external peripheral etc.
- ⇒ The groups are free to choose how to implement the digital logic for their project. The lab has the Quartus which allows for systems to be written in VHDL/Verilog, synthesized and downloaded into the Altera boards.
- ⇒ Students are free to choose an alternative micro-controller based board to implement their digital logic, subject to the approval of the instructor.

◇ Topic Selection - Some previous and potential project topics:

- ⇒ Extending the NIOS core or interfacing to another system
- ⇒ Motion estimation using FPGA
- ⇒ Audio band signal processing system
- ⇒ Friendly Fireman robot
- ⇒ A sound controlled motor using a FPGA
- ⇒ Various types of video games

- ⇒ Hearing aid system with automatic gain control
- ⇒ Self-adjusting solar panel tilting device
- ⇒ Temperature sensitive cooling device
- ⇒ ECG heart rate counter
- ⇒ Video camera control using FPGA
- ⇒ Implementation of Discrete Cosine Transform (DCT) using FPGA
- ⇒ Error correction coding using FPGA
- ⇒ A robot controlled by UP board
- ⇒ A train control system using UP board
- ⇒ Image enhancement system (consisting of high pass filtering and histogram equalization) using FPGA
- ⇒ A high speed ATM switch implementation using FPGA
- ⇒ A digital AM receiver
- ⇒ Wireless FM audio-transmission
- ⇒ Finger print scanner for Linux
- ⇒ Web accelerator HTML compression/decompression engine
- ⇒ Free-space optical communication link
- ⇒ Advanced RPN calculator
- ⇒ Voice recognition engine
- ⇒ Extending NIOS core with some DSP functionality
- ⇒ Partial JVM hardware implementation
- ⇒ ... and many more.

◇ Some additional resources for picking topics:

- ⇒ The web site of the textbook (`http://users.ece.gatech.edu/~hamblen/book/book.htm`) contains interesting projects implemented using UP1.
- ⇒ The following web page from University of Alberta has interesting projects implemented on UP1 board: `http://www.ee.ualberta.ca/ elliott/ee552/`
- ⇒ Laboratory exercises at the end of each chapter of the textbook contain interesting project ideas.
- ⇒ Chapter 13 of the textbook provides the details of a robot controlled by UP board. One or more groups can work on robot-related projects.
- ⇒ The application note (An) directory on the CD of the textbook has many application implemented using Altera devices. Some examples are:
  1. ATM packet scheduler
  2. Implementing Cyclic Redundancy Code Checkers (CRCC)
  3. Implementing RAM
- ⇒ Application notes on Altera web site `http://www.altera.com/literature/lit-an.html` have a list of interesting application of FPGAs.

- ⇒ Check any recent conference proceedings on Programmable Logic Devices, Field Programmable Gate Arrays, Application Specific Integrated Circuits (ASICs). They contain papers describing what engineers in academia and industry are developing.

◇ Important Regulations:

- ⇒ All members of a project group have to contribute equally to all stages of the project (e.g., selection of topic, implementation of project and writing the reports). A student's project mark depends on his/her contribution to the project. If a student has difficulties with their project partners, they should inform the instructor in writing before end of October.
- ⇒ Students are encouraged to use electrical and mechanical parts from previous projects if applicable.
- ⇒ To be reimbursed by the department for the parts (e.g., motor, sensor, ADC) purchased for a project, get the approval of the instructor before ordering the parts.
- ⇒ Keep in mind that there might be delay in parts delivery, but the course timetables and deadlines are strict and will **not** be changed.
- ⇒ Keep a copy of your final report. We will **NOT** return your project report.
- ⇒ Many companies are interested in ECE graduates skilled in Verilog/VHDL and ASIC design and interfacing. Try to choose a good project and write a good report. You might want to show it to prospective employers.

◇ Format of Proposal: The project proposal should be short (5-8 pages), readable and relevant. It should consist of the following sections (as a minimum):

1. Objectives - Explain what you are trying to accomplish by the end of the course. Try to be as specific as possible in establishing your goals and/or criteria for success.
2. Literature Search - Explain the work done by others in the specific topic and cite all the relevant references. Each project must have at least **five (5) references** to previously published examples of this technology. References can be made to technical as well as trade literature. This section should clearly explain the motivation for doing this particular project and give an analysis of the advantages and disadvantages of their technology.
3. Proposal Details - A breakdown of your design into conceptual blocks that logically fit together so that you achieve your stated goal. Give a brief description of each block and formally describe the interface to all other blocks. Give a diagram indicating the interconnection of the blocks.
4. Sustainability Analysis - Give a brief analysis of the social, economic and environmental factors affecting your design. Consider the impact of your design if it were implemented on a large scale.
5. Tasks, Scheduling, and Implementation - This is the "when" and "how" for the project. The vast majority of this depends on estimation, so try to be reasonable. If there are a lot of "I don't know" points in your project then either you have to schedule time for research or the project is too big. One useful thing to do when planning a project is to take each of your conceptual blocks and resolve it into solid actions. So if one of your conceptual blocks is "Getting the monitor to display

a clock" you would want to include the tangible evidence such as "get the clock working", "get the monitor to display a single, fixed digit", etc. Describe the role of each group member in the project. Who is responsible for what?

6. Bill of Materials - a tentative list of all components you will require for your project both software and hardware components. Include all part numbers, manufacturers, vendors, cost and expected lead times. Include alternate (backup) part numbers in the event your initial selection is unavailable. Include a brief discussion of how each part will be used in your design including initial schematics. Have the data sheets of all components listed available for future reference.
7. Budget - a preliminary budget for the project including all required parts, shipping cost, etc. Discuss the performance-price trade-off of your design. Discuss any performance limitations in your project which may arise due to your budget. Be realistic in your estimates. The final budget of your project will be compared versus this estimate.
8. Assumptions/Risks - Explain the assumptions made about the availability of components, scheduling etc. and describe the risks such as delay in arrival of components and its impact on the project.
9. Deliverables - Itemize each deliverable and categorize them according to Bronze, Silver and Gold levels (where Bronze is the most conservative level of functionality). This is a summary of your report and will give a point form list of features which your design will provide by the end of the course. Your final demonstration will be checked versus this list of deliverables.
10. References - Cite relevant sources for this preliminary exploration of your topic.

The groups will present their proposals to the class in short (10–15 minute) presentations during the class/lab sessions. Please prepare an appropriate number of slides in Powerpoint or Adobe pdf format and email to the instructor **at least one hour before class** on the day of your presentation. The presentation should touch upon all of the points outlined above for the project proposal report.