EECS 541 Computer Systems Design Laboratory

Syllabus and Introduction

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What is (Computer) Engineering Design

- The systematic and creative application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems – *The International Technology Education Association (ITEA)*
- The creative ability required for the development of better devices, systems, processes, and new products – *IEEE/ACM Computing Curricula*
- The process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs – *Accreditation Board for Engineering and Technology (ABET)*

Computer Engineering Design[1]

- Involves computer software and hardware systems and computer-controlled equipment.
- Applies the theories and principles of science and mathematics to design hardware, software, networks, and processes and to solve technical problems.
- Fundamentally, design is about making well-considered choices or trade-offs, subject to given realistic constraints
  - choices in matters of techniques, technologies, methodologies, interfaces, and selection of components
  - constraints include economic factors, safety, reliability, aesthetics, ethics and social impact
- Final solution should be simple and elegant.

[1] IEEE/ACM Computing Curricula

Aims of the Capstone Project

- Demonstrate the ability to integrate concepts from several different subjects into a comprehensive solution.
- Demonstrate the application of disciplines associated with computer engineering.
- Demonstrate creativity and innovation.
- Develop time management and planning skills.
- Produce a well-written document detailing the design and the design experience.
- Other learning opportunities include making presentations, producing a web-page, team-building, etc.

Steps in the Design Process[2]

1. Define, understand, and analyze the problem.
2. Gather extensive information about what is known about the problem, and pros and cons of available solutions.
3. Understand constraints imposed by client, cost, environmental, or other external factors.
4. Explore and analyze different possible alternatives, and decide on your solution.
5. You may also have to present and sell your design.
6. Develop/build the product.

[2] adapted from ABET

Case Study: New Processor Design

- Target (customer) domain: embedded, general-purpose, high-performance? Other domain constraints?
- Architecture: CICS, RISC, VLIW, custom?
- Data width: 8-bit, 16-bit, 32-bit, 64-bit?
- Pipeline length?
- Branch prediction: yes/no, static or dynamic?
- Caches: yes/no, sizes?
- Instruction issue width?
- In-order or out-of-order?
- Number of functional units, floating-point support, register renaming, etc.