

**Embedded Processors and Architectures**  
**ECE 594 - Online Offering – Fall**  
**Course Description**  
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**Course Description:**

This course introduces the fundamentals of computer system architecture and organization, and the use of embedded processors in design and implementation of digital systems. Topics include RT level design, numeric processors, ISA, CPU structure and function, addressing modes, instruction formats, memory system organization, memory mapping and hierarchies, concepts of cache, standard local buses, IO devices, pipelining, memory management, embedded processors, embedded environments, and embedded system implementation. The architecture principles underlying RISC and CISC processors are presented in detail. An example embedded design environment will be presented in details. The course also includes a number of design projects, including simulating a target machine, architecture using a high-level language (HLL), and a multi-processor core system.

**Course Outline:**

1. Review
  - RT Level logic design
  - Verilog HDL
  - RTL design with Verilog
2. Embedded design
  - Procedures
  - Definitions
  - Tools
  - Altera ModelSim and Quartus II
3. Computer arithmetic
  - Carry look-ahead
  - Sequential multiplier
  - Array multiplier
  - Pipeline multiplier
  - Booth multiplier
  - Dividers
  - Floating point arithmetic
    - Adders
    - Multipliers
4. Instruction set architecture

- Software
- Hardware
- Interfacing
- 5. Processor architectures
  - Single cycle processors
  - Multi-cycle processors
  - Pipelining
- 6. Memory
  - Memory types
  - Interfacing
  - Handshaking
  - Memory mapped IO
- 7. Processor devices
  - Parallel interface
  - Serial interface
  - Interrupts
  - DMA
- 8. Embedded processor design
  - Nios II processor
    - Architecture
    - Implementation
  - Avalon switch fabric
    - Architecture
    - Features
    - Hardware implementation
  - Hardware configuration tool: SOPC Builder
  - Software programming: IDE
  - Calculator design example
  - Multiprocessor design example

**Prerequisites:** Undergraduate course in logic circuits and microprocessor system design, as well as familiarity in assembly language and a structured high-level language such as C/C++. Strong logic background and prior knowledge of a hardware description language are required. The course includes preparation materials covering the necessary backgrounds.

**Course Material:**

- Zainalabedin Navabi, Embedded Core Design with FPGAs: McGraw Hill-Professional, 2006, New York, NY, ISBN: 0071474811 (required).
- D. A. Patterson and J. L. Hennessy, “Computer Organization & Design: The Hardware/Software Interface”, Third Edition, Morgan Kaufmann Publishers, 2005 (required).
- Software: Verilog Simulator: ModelSim; Design Environment and Synthesis: Quartus II, version 9. This can be downloaded for free from Altera.