

EEL4740 - Embedded Computing Systems

Three Credits, Two and a half hours, Engineering Topic.

Instructor: Dr. Atoussa Tehrani.

Textbook:

1. Digital Design: An Embedded System Approach Using VHDL (Optional). Authors: Peter J Ashenden Publisher: Elsevier 2008 ISBN: 978-0-12-369528-4

2. Embedded System Design (Optional). Authors: Frank Vahid, Tony Givargis. Publisher: John Wiley and Sons 2002 ISBN: 978-0-471-38678-0

Specific Course Information:

This is an undergraduate-level course which covers the principles of embedded computing systems.

The course presents the main elements in the design of embedded systems and how FPGA technology is used for such a design. Since the course is intended to serve students with a background in Computer or Electrical Engineering, prior knowledge of computer design is expected. These include Computer Architecture, Processor, Combinational and Sequential Logic Design. Topics covered include embedded systems design metrics, FPGA, VHDL, designing custom single-purpose processors and implementing the corresponding VHDL model in FPGA.

This course will consist of 4 modules and a final project. Module availability is open; however, students are expected to complete each module by the due date. Students must take the quiz for each module to practice the material covered in each module and also prepare themselves for the midterm and the final exam. Students must submit their assignments and their project by the due date and take their midterm exam and their final exam on the dates specified on the course portal. Project can be completed individually or by teams of two students; project will be due toward the end of the semester. Submitted assignments will be evaluated within one week of submission. Communication will take place via class live Zoom meetings on Tuesdays and Thursdays, email and professor announcements. Zoom meetings will be recorded and posted in Canvas. At the end of the course, you would have learned how to design a custom single purpose processor and program it into an FPGA board in VHDL. You will also become familiar with how microcontrollers are used in embedded system design.

Specific Goals for the Course

a. Specific outcomes of instruction

Upon successful completion of this course, the student will:

1. identify different embedded systems related concepts and technologies.
2. List integrated circuit (IC) technologies used for embedded systems.
3. Explain the design of embedded processing system using the field programmable gate array (FPGA).
4. Use VHDL hardware description language to implement FPGA designs.
5. Examine VHDL models implemented in FPGA.
6. Design custom single-purpose processors.
7. Implement custom single-purpose processors in FPGA.

8. Analyze the characteristics of a General-Purpose Processor.
9. Assess the features of different Standard Single Purpose Processors or peripherals. Design an embedded system to implement the required functionality.
- b. Explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course.

In this course the student will have to show

- (a) an ability to apply knowledge of mathematics, science, and engineering (X)
- (b) an ability to design and conduct experiments (simulations), as well as to analyze, interpret data (X)
- (c) an ability to design a system, component, or process to meet desired needs (X)
- (d) an ability to function in multi-disciplinary teams (N/A)
- (e) an ability to identify, formulate, and solve engineering problems (homework) (X)
- (f) an understanding of professional and ethical responsibility (N/A)
- (g) an ability to communicate effectively (through project reports) (X)
- (h) the broad education necessary to understand the impact of engineering solutions in a global and societal context (X)
- (i) a recognition of the need, and an ability to engage in life-long learning (X)
- (j) a knowledge of contemporary issues (X)
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (X)
- (l) a knowledge of probability and statistics (N/A)

Brief list of the topics to be covered

1. Getting Started
2. Introduction to Embedded Systems
3. Programming FPGA in VHDL
4. Custom Single-Purpose processor Design and Implementation in VHDL
5. General-Purpose Processors and Microcontrollers

GRADING:

Course Requirement	Weight
Quizzes	6%
Assignments	30%
Midterm Exams	14%
Final Project	20%
Final Exam	30%
Overall Grade	100%

Conversion of Numerical Grade to Letter Grade

95<=A<=100	83<=B<86	70<=C<76
90<=A-<94	80<=B-<82	60<=D<69
87<=B+<89	77<=C+<79	F: Below 59