Computer Science Department
cs.salemstate.edu

**CSC 345 Embedded Systems** **4 cr.**

**Instructor:** TBA **Office:** location **Phone:** (978) 542-extension
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| Section | Time | Room | Final Exam |
|---|---|---|---|
| nn | days and times | location | date and time |

**Catalog description:**

This course covers fundamentals of embedded systems: basic architecture, programming, and design. A hands-on approach to microprocessor and peripheral system programming, I/O interfacing, and interrupt management will be utilized to understand and apply the concepts. A sequence of projects requiring programming and integration of FPGA-based systems will be conducted. Three lecture hours and three hours of scheduled laboratory per week.

**Prerequisite**: **CSC 295**

**Goals**:

The aim of this course is to introduce the students to the system hardware and software techniques for designing and implementing embedded systems. Specifically, the goals are for students to:

CG01: learn basic principles of embedded system design;
CG02: gain an extensive knowledge on micro-controller architecture and peripherals ;
CG03: be able to demonstrate an understanding of how to build and control embedded systems using both micro-controllers and FPGAs.

**Objectives:**

Upon completion of this course, students will have demonstrated the ability to:

CO01: use correct terminology to name the physical and software components of an embedded system;
CO02: explain the use of interrupts and other programming techniques related to micro-controllers;
CO03: recognize appropriate use of micro-controller and FPGA architectures, interfacing, and systems programming;
CO04: write simple programs using the sequence, selection, and loop patterns expressed in a hardware description language;
CO05: work in a team of 2 or 3 members on a project that may involve complex design goals.

**Program Outcome vs. Course Objectives matrix**

| Program Objective (condensed form) | CO01 | CO02 | CO03 | CO04 | CO05 |
|---|---|---|---|---|---|
| **PO-A:** apply knowledge of computing and math | ✓ | ✓ | ✓ | ✓ | |
| **PO-B:** analyze a problem and define its computing requirements | | ✓ | ✓ | ✓ | |
| **PO-C:** design, implement and evaluate applications | | ✓ | ✓ | ✓ | ✓ |
| **PO-D:** function effectively in teams to accomplish a common goal | | | | | ✓ |
| **PO-E:** professional, ethical, and social responsibilities | | | | | ✓ |
| **PO-F:** communicate effectively with a range of audiences | | | | | |
| **PO-G:** local and global impact of computing on people and society | | | | | |
| **PO-H:** need for continuing professional development | | | | | |
| **PO-I:** use current techniques, skills, and tools | | | | | ✓ |
| **PO-J:** apply theory and principles to model and design systems | | | ✓ | | ✓ |
| **PO-K:** apply design and development principles in constructing software | | | | | |

**Topics:**

- Introduction to Embedded Systems **OS10(3.5)**
  - Definition and Classifications
  - General Architecture
  - Overview of processors and hardware units in an embedded system
  - Software embedded into the system
  - Embedded systems in a chip (SoC)

- Algorithmic State Machines and Finite State Machines **SF3(6)**

- Hardware Programming **AR3(13)**
  - Instruction Set Architecture
  - Data Path and Controller
  - Programming Model
  - Addressing Modes

- Instruction Types
- Programming Flow and Organization
- Assembler
- Subroutines
- Parameter Passing
- Interrupts
- High-Level Language Interfacing

- Peripheral I/O Interfacing **AR5(10) SF3(4)**
  - I/O Management and Timing
  - Analog to Digital Conversion
  - Pulse-Width Modulation
  - Interrupt Management
  - Standard Communication Interfaces

- Code Optimization and Performance **OS10(3.5)**
  - Optimizing for Speed
  - Optimizing for Memory Usage

**Assignments:**

Students are evaluated using 5-10 homework assignments, 5-10 laboratory assignments, one group project, one mid-term examination, and a final-examination.

Each assignment has a specific due date, with a short grace period during which the assignment may be submitted for reduced credit. When the grace period has expired, the assignment will no longer be accepted, and a student who has failed to submit the assignment will have a penalty deducted from the term point-total.

**Grading:**

The course grade will be determined using the following approximate weights: Homework: 20%; Group Project: 10%; Lab Assignments: 20%; Midterm Exam: 25%; Final Exam: 25%.

**Course Objective / Assessment Mechanism matrix**

| | Homework | Laboratory Assignments | Project | Examinations |
|---|---|---|---|---|
| CO01 | ✓ | ✓ | ✓ | ✓ |
| CO02 | ✓ | ✓ | ✓ | ✓ |
| CO03 | ✓ | ✓ | ✓ | ✓ |
| CO04 | ✓ | ✓ | ✓ | ✓ |
| CO05 | | | ✓ | |

**Bibliography**:


- James K. Peckol, " Embedded Systems: A Contemporary Design Tool" Wiley Publishers 2007.
- Sundarajan Sriram, Shuvra S. Bhattacharyya, "Embedded Multiprocessors: Scheduling and Synchronization", Second edition, CRC Press 2009.
- Muhammad Ali Mazidi, " AVR Microcontroller and Embedded Systems : Using Assembly and C", Pearson Publishers, 2011.
- Pong P. Chu, "Embedded SoPC design with NIOS II processor and Verilog Examples", First edition, Wiley Publishers 2011.
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- Ivan Cibrario Bertolotti, Gabrieli Manduchi, "Real-time Embedded systems: Open Source Operating Systems Perspective", CRC Press 2012.
- Jonathan W. Valvano, " Embedded Microcomputer Systems: Real-Time Interfacing", 3rd Edition, Cengage Publishers, 2012.
- Carl Hamacher, Zvonko Vranseic, Safwat Zaky, Naraig Manjikian, "Computer Organization and Embedded Systems", 6th edition, Mc-Graw Hill Publications, 2012.
- Daniel W. Lewis, " Fundamentals of Embedded Software with the ARM Cortex M3", Pearson Publishers 2013.
- Stephen Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", 3rd Edition, Mc-Graw Hill Publications, 2014.
- Enoch O. Hwang, " Digital Logic and Microprocessor Design with Interfacing", 2nd edition, Cengage Publishers, 2018.