ECE 441 – Microcomputers and Embedded Computing Systems

Credits: 4, **Contact Hours:** Two 75 minute lecture session per week, one 160 minute laboratory session per week.

Coordinator: J. Saniie, Professor of ECE

Textbook: Clements, *Microprocessor Systems Design*, PWS Publishing Company
Motorola, *MC68000 Microprocessor Programmer's Reference Manual*
J. Saniie, S.H. Perich, *SANPER-1 Lab Manual and Course Notes*
Motorola, *MC68000 Educational Computer Board User's Manual*

Reference: T. L. Harman and D.T. Hein, The Motorola MC68000 Microprocessor Family: Assembly Language, Interface Design, and System Design, Prentice Hall
T. Igoe, *Making Things Talk (3rd edition)*, Maker Media 2017
R. Gajjar, *Raspberry Pi Sensors*, Packt Publishing, 2015

2019 Catalog Data: ECE 441: Microcomputers and Embedded Computing Systems. Credit 4. Microprocessors and microcontrollers. Standard and special interfaces. Hardware design and software development tools. Memories. Interrupt systems. Microcomputer system design and troubleshooting. Design with embedded computing systems. Emphasis on examples and applications. Lecture: 3 Lab: 3 Credits: 4 Satisfies: ECE Professional Elective (P)

Prerequisites or co-requisites by topic: [(CS 350) OR (ECE 242)] AND [(CS 470) OR (ECE 218)]
Digital logic, basic electronics, assembly language programming, ability to work with assembler and simulator software

Enrollment: Required course for CPE majors; elective course for EE majors.

Specific outcomes of instruction:

After completing this course, the student should be able to do the following:

1. Describe the MC68000 microprocessor's architecture, pin functions, instructions and addressing.
2. Implement exception processing software routines and function controls.
3. Design memory hardware and bus timing of address, data and control signals.
4. Design input/output interfaces to the microprocessor.
5. Design a system utilizing programmable input/output devices and synchronous bus control signals.
6. Design a system utilizing an asynchronous programmable input/output device and trap handler.
7. Perform hardware design for DTACK logic, reset and interrupts.
8. Design, implement, and test a monitor software project incorporating engineering standards and realistic constraints, and demonstration of the software project.
9. Design, implement, and test a system by co-designing hardware and software utilizing embedded computing and system designs with contemporary topics, design tools and standards.
10. Complete an engineering design incorporating engineering standards and realistic constraints.
11. Prepare an informative and organized design project report.
12. Report on Technology Impact Project.

Relationship of ECE 441 specific outcomes of instruction to student outcomes:

	Student Outcomes	Course Goals
1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	1-11
2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	1-11
3	An ability to communicate effectively with a range of audiences	1-12
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	12
5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	1-10
6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	1-11
7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	8,12

Topics:

- Importance of the microcomputer and recent developments in microprocessor design (1 week)
- MC68000 architecture, pin functions, instructions and addressing (1 weeks)
- Interrupt handling, exception processing, instructions and addressing (2 weeks)
- Timing of address, data and control signals (0.5 week)
- Memory design (1.5 week)
- Input/output design (1 week)
- Synchronous bus control signals (1 week)
- Design with programmable input/output device (1 week)
- Design with asynchronous programmable input/output device (1 week)
- Embedded computing systems (1 week)
- Hardware design for reset, bus timeout logic, interrupts and course review (2 weeks)
- Tests (1 week)

Laboratory topics:

- Introduction to SANPER-1 microprocessor architecture and TUTOR Resident Monitor program
- TUTOR command utilization and program development
- Interrupts and exception processing
- Code conversion, bit manipulation and software development
- Design memory hardware and bus cycle timing
- Design input/output hardware and interrupt logic
- Design with the programmable parallel input/output device
- Design with the programmable asynchronous serial input/output device
- Design with embedded computing systems (Arduino and Raspberry Pi)
- Design and implement a monitor software project for SANPER-1

Prepared by: J. Saniie **Date:** February 28, 2020