The University of Texas at Tyler
Department of Electrical Engineering

EENG 4307: Microprocessors and Embedded Systems (required)

Syllabus

Catalog Description:

Microprocessor architecture, programming and interfacing. Introduction to assembly language programming; Microcomputers, microcontrollers, instruction set, chip interfacing, addressing modes, interrupts, input/output, communication. Hardware/software interfacing and embedded systems applications. Three hours of lecture per week with integrated laboratory sessions. **Prerequisites:** EENG 3302 and COSC 1336

Prerequisites:	EENG 3302 - Digital Systems Design, COSC 1336 – Programming Fundamentals
Credits:	(2 hours lecture, 3 hours laboratory per week)
Text(s):	Yifeng Zhu, **Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, 4th ed**. E-Man Press LLC, 2023. ISBN-13: 978-0982692677
Additional Material:	Nucleo-64 development board with STM32L476RG (NUCLEO-L476RG) (http://www.st.com/en/evaluation-tools/nucleo-l476rg.html). USB cable and electronics kit parts. Keil MDK-ARM development tools on Windows 10 computer. Laboratory projects are integrated to provide students with hands-on experience.
Course Coordinator:	Fatemeh Kalantari, Assistant Professor of Instruction

Topics Covered: (paragraph of topics separated by semicolons)

Microcomputer Fundamentals: number systems, codes, digital circuits, memory devices, and introduction to computers; Microprocessors: elements, structure, operation, memory, bus architecture, and instruction set; Microcomputer Programming: assembly language, arithmetic operations, decisions, loops, tables, lists, subroutines, and interrupts; Microcomputer Interfacing: input/output modes, serial and parallel interfaces, synchronous and asynchronous communication. Hardware/software interfacing and embedded systems applications.

Evaluation Methods: (only items in dark print apply):

1. Examinations/ Quizzes
2. Homework
3. Report/ Paper
4. Computer Programming
5. Project/ Model
6. Presentation
7. Course Participation
8. Peer Evaluation

Course Learning Outcomes[1]: By the end of this course students will be able to:

1. Solve problems involving conversions between decimal, binary, octal and hexadecimal number systems, signed numbers, arithmetic operations, floating point numbers and representation standards [1]
2. Understand the operation of basic digital systems in the context of microcontroller design including parallel/serial transmission, tri-state logic, clocking, flip-flops and registers, data bus operation [1]
3. Demonstrate knowledge of memory systems including architecture, operation, types, read/write cycles, timing diagrams, applications and techniques to expand word size and capacity [1]
4. Explain the basic operational principles of microprocessors and microcontrollers including architecture, instruction formats, machine language, program and data sections, firmware, step-wise program execution detail and the fetch-decode-execute cycle [1]
5. Design complete and partial address decoding schemes for the microcontroller using memory modules, memory maps, read/write timing and logic components like decoders and tri-state buffers [1]
6. Identify and explain the microcontroller operation from functional block diagrams including: register section, ALU, timing and control, multiplexed buses, pinout, modes of operation and signals [3]
7. Analyze the various types of microcontroller assembly language instructions including addressing modes, processor condition codes, speed of operation and analysis of programs or code segments [3]

8. Outline the operation of an assembler and implement the entire process of writing, compiling, loading and running an assembly language program [3]
9. Illustrate the following concepts and their implementation on the microcontroller: stack operation, interrupt service routines, reset vectors, memory maps, time delay routines [1]
10. Formulate microcontroller input-output solutions utilizing general purpose I/O, interrupts and the timer subsystem [3]
11. List input/output interfacing solutions for issues like voltage mismatch, implementation technology mismatch, power requirements, isolation from electrical loads, and parallel/serial interfacing [1]
12. Implement microcontroller applications using peripherals like the serial interface and the analog-to-digital convertor (ADC) subsystem [3]
13. Incorporate information gained by independent learning from microcontroller technical reference manuals and other sources to implement projects and enhance reports [3]
14. Utilize modern software and hardware tools and techniques to design, debug and test microcontroller based projects using assembly language programming [4]
15. Perform laboratory experiments utilizing microcontroller systems demonstrating combined hardware-software interaction, co-design and debugging [3]
16. Write laboratory reports with experimental results demonstrating visual and written communication skills [3]

[1]*Numbers in brackets refer to method(s) used to evaluate the course objective.*

Relationship to Student Outcomes (only items in dark print apply) [2]: This course supports the following Electrical Engineering Student Outcomes, which state that our students will possess:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics [1-4, 6, 7, 9, 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 [5, 10]
3. an ability to communicate effectively with a range of audiences [16]
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 [16]
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
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions [8, 12, 14, 15]
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. [13]

[2]*Numbers in brackets refer to course learning outcome(s) that address the Program Outcome.*

Contribution to Meeting Professional Component: (in semester hours)

Mathematics and Basic Sciences:		hours
Engineering Sciences and Design:	3	hours
General Education Component:		hours

Prepared By:	Mukul V. Shirvaikar	Date:	January 5, 2021
Modified By:	Fatemeh Kalantari		January 4, 2022 January 1, 2023 January 14, 2025