Department of Electrical and Computer Engineering

EEL 4746 – MICROCOMPUTERS I
Fall 2022

Instructor : Atoussa Tehrani
Office Hours : Monday-Wednesday 4:00 PM – 6:00 PM
Office : EC 3113
Phone : (305)348.4943
Class Time : Monday, Wednesday: 7:50 PM – 9:05 PM
Classroom : EC2410
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Catalog Description:
RAM, ROM, and CPU architecture. Instruction set. Timing sequence. Subroutines. Interrupts. Peripherals. Applications. System design. (3 Credits)

Prerequisites: EEL 4709C Computer Design
Corequisite: EEL 4746L

Textbook
Rob Toulson and Tim Wilmshurst***, Fast and Effective Embedded Systems Design: Applying the ARM mbed,*** Second edition, Elsevier, ISBN: 978-0-08-100880-5, 2017

Learning Outcomes:
1. Extend student knowledge towards the understanding of software, hardware, and compatibility issues of high performance ARM Cortex-M microprocessors.
2. Understand and apply the key aspects of ARM mbed LPC1768.
3. Learn about interfacing capabilities of the ARM Cortex-M microprocessors.
4. Exploit more of the programming aspects as they relate to the different hardware components.
5. Learn both hardware aspects along with existing software about memory design, GPIO, A/D and D/A converters, SPI, I2C, and Interrupts, all in relation to the ARM 32-bit microprocessors.
6. Learn the theory to conduct laboratory experiments that are based on a complete development board centered around the 32-bit ARM family microprocessor.
7. Identify ARM low power and sleep modes.
8. Learn about the hardware and software tradeoffs in digital design.
9. Develop embedded C/C++ programs and libraries for ARM Cortex-M3 processor, software flow, input/output and peripherals access.

Topics Covered:
1. Historical Background**:** Historical progression of ARM processor designs, processor classifications, features and levels of complexity.
2. mbed LPC1768 development board functions and features.
3. General Purpose I/O and principles of interfacing of Cortex-M microcontroller with input/output devices. GPIO alternate functions programming.
4. Analog to digital, digital to analog converters.
5. Embedded C/C++ programming
6. Serial communication protocols, SPI, I2C, and UART.

7. Interrupts: Interrupt handling, Interrupt inputs and pending behavior, NVIC for interrupt control, priority level, special registers for interrupts or interrupt masking.
8. General-purpose timers and timers programming.
9. Low Power Sleep modes.
10. Architecture of the ARM 32-bit Microprocessor**:** Registers, memory space and data organization, user and exception modes of operations.
11. Memory System: memory map, data alignment and unaligned data access support.
12. Writing library packages for an ARM processor.

Relationship of course to program outcomes

In the course EEE 4746 student will have to show

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics. (through course assignments)
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.(through course project)
3. an ability to communicate effectively with a range of audiences (through project report and presentation)
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. (through course project)
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. (through hardware-software integration and implementation assignments)

Evaluation Criteria

Category	Weight
Assignments	30%
Mid-term Exam	15%
Final Exam	30 %
Course project	25%
Total	100%

Course Material:

- Course material is posted on Canvas.

Assignments:

- Students must submit their assignment on Canvas by the due date. Student can upload a file or enter the text in Canvas. The file formats that can be uploaded are .pdf, .doc, or .txt.

Course project:

- Students have the option to team up with another student for final project or complete it by themself. Each team must design and develop a product using LPC1768 development board. Each team will present their project to class on the last day of class. Each team must submit a project proposal and a project report as described in the course project assignment.

Course Outline

Wk	Date	EEL4746 Weekly Topic Fall 2022	Due Assignment
1	8/22/22	Introduction to ARM processors, Chapter 1	
	8/24/22	Introducing the mbed LPC1768, Chapter 2	
2	8/29/22	mbed API	
	8/31/22	Digital Input and Output, Chapter 3	
3	9/5/22	Labor day holiday (No Class)	
	9/7/22	Analog output - DAC, Chapter 4	Assignment 1
4	9/12/22	Analog output - PWM, Chapter 4	
	9/14/22	Analog Input - ADC, Chapter 5	
5	9/19/22	Analog Sensors	
	9/21/22	Further Programming Techniques, Chapter 6	Assignment 2
6	9/26/22	Further Programming Techniques, Chapter 6 Liquid Crystal Display, Chapter 8	
	9/28/22	Serial Communications, SPI, Chapter 7	
7	10/3/22	Serial Communications, I2C, Chapter 7	
	10/5/22	Review for MidTerm Exam	Assignment 3
8	10/10/22	**MidTerm Exam, Units 1-7, 7:50 pm-9:05 pm**	
	10/12/22	Interrupts, Chapter 9	
9	10/17/22	Interrupts, Chapter 9	
	10/19/22	Timers, Chapter 9	Course Project Proposal
10	10/24/22	Timers, Chapter 9	
	10/26/22	mbed Hardware Insights, Chapter 11	
11	10/31/22	mbed Low-power modes, Chapter 11	Assignment 4
	11/2/22	ARM Architecture and Memory System	
12	11/7/22	Letting Go of the mbed Libraries, Chapter 14	
	11/9/22	Digital Input/Output without mbed Libraries, Chapter 14	
13	11/14/22	Using DAC without mbed Libraries, Chapter 14	Assignment 5
	11/16/22	Using ADC without mbed Libraries, Chapter 14	
14	11/21/22	Keil IDE for debugging LPC1768	
	11/23/22	Keil IDE for debugging LPC1768	
15	11/28/22	Project Presentations	Assignment 6
	11/30/22	Project Presentations and Review for Final Exam	Project Report
16	**12/05/22**	**Final Exam, Units 1-15, 7:15 PM – 9:15 PM**	

Policies:

- **Exams:** ***No makeup exams*** offered.
- **Academic Misconduct:** For work submitted, it is expected that each student will submit their own original work. Any evidence of duplication, cheating or plagiarism will result at least a failing grade for the course.
- **Deadlines:** Assignments must be uploaded on Canvas by the due date at 11:59 pm. You will not be able to upload past the due date. No other form of submission is accepted.
- Instructor reserves right to change course materials or dates as necessary.

Course Project Rubric

- Level of difficulty 5 points
- Demonstration and presentation of working project 15 points
- Project report with all required information 5 points

Total 25 points

Grading Scale:		Points per Credit hour:	University's Code of Academic Integrity http://academic.fiu.edu/academic_misconduct.html
A	92-100	4.00	"Florida International University is a community dedicated to generating and imparting knowledge through excellent teaching and research, the rigorous and respectful exchange of ideas, and community service. All students should respect the right of others to have an equitable opportunity to learn and honestly to demonstrate the quality of their learning. Therefore, all students are expected to adhere to a standard of academic conduct, which demonstrates respect for themselves, their fellow students, and the educational mission of the University. All students are deemed by the University to understand that if they are found responsible for academic misconduct, they will be subject to the Academic Misconduct procedures and sanctions, as outlined in the Student Handbook."
A-	90-92	3.67	
B+	88-90	3.33	
B	82-88	3.00	
B-	80-82	2.67	
C+	78-80	2.33	
C	70-78	2.00	
D	60-70	1.00	
F	<60	0.00	