

Department of Electrical and Computer Engineering

**EEL 4746 – MICROCOMPUTERS I**  
**Fall 2015**

**Instructor** : Atoussa Tehrani  
**Office Hours** : Monday 5 PM – 7 PM  
**Office** : EC 3910  
**Phone** : (305)348.2683  
**Class Time** : Monday and Wednesday: 7:50 PM – 9:05 PM  
**Classroom** : EC1115  
**Email** : [tehranifu@gmail.com](mailto:tehranifu@gmail.com)

**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:**

Yifeng Zhu, *Embedded Systems with ARM® Cortex-M3 Microcontrollers in Assembly Language and C*, First edition, ISBN: 978-0-9826926-2-2, 2014

**Reference books:**

Joseph Yiu, *The definitive guide to ARM® Cortex®- M3 and Cortex®-M4 Processors*, Third edition, ISBN-13: 978-0-12-408082-9, 2014

Joseph Yiu, *The definitive guide to ARM® Cortex®-M0*, ISBN: 978-0-12-385477-3, 2011

Jonathan W. Valvano, *Real-Time Interfacing to ARM® Cortex™-M Microcontrollers*, Volume 2 Third edition, ISBN-13: 978-1463590154, 2013

**Learning Outcomes:**

1. Extend student knowledge towards the understanding of software, hardware, and compatibility issues of high performance ARM microprocessors.
2. The student can learn a sophisticated new instruction set in concert with the architecture of 32-bit ARM microprocessors.
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, DMA design, A/D and D/A converters, Interrupts, and I/Os, all in relation to the ARM 32-bit microprocessors.
6. Expose the students to laboratory experiments that are based on a complete development board centered around the 32-bit ARM family microprocessor.
7. Allow the student to learn about the hardware and software tradeoffs in digital design.

**Topics Covered:**

1. **Historical Background:** Historical progression of ARM processor designs, processor classifications, features and levels of complexity.
2. **Architecture: Programmer's Model of the ARM 32-bit Microprocessor:** Registers, memory space and data organization, user and exception modes of operations.
3. Program execution mechanism and runtime memory image of ARM Cortex-M3.
4. **Instruction Set:** Assembly Language, memory access, logic, arithmetic, shift operations, bit-field processing, program flow control, saturation operation, stack usage, sleep mode related instructions and assembler directives.
5. **Memory System:** memory map, memory endianness, data alignment and unaligned data access support.
6. **Generic Purpose I/O and principles of interfacing of Cortex-M microcontroller with input/output devices.** GPIO alternate functions programming.
7. Subroutines, call process and passing parameters.
8. **Exceptions and Interrupts:** Exception handling, Interrupt inputs and pending behavior, NVIC for interrupt control, priority level, special registers for exceptions or interrupt masking.
9. Serial communication protocols, USART, I2C, and SPI.
10. Analog to digital, digital to analog converters and direct memory access.
11. **Low Power and System Control Features,** Sleep modes, Wake-up conditions, WFI, WFE instructions.
12. General-purpose timers and timers programming.
13. **Debugging tools:** Debug and Trace features, debug architecture, components and operation.
14. **Writing C program for ARM,** software flow, data types, inputs, outputs and peripherals access, CMSIS.

**Relationship of course to program outcomes**

In the course EEE 4746 student will have to show

- (a) an ability to apply knowledge of mathematics, science and engineering
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) an ability to function in multi-disciplinary teams (through lab experiments)
- (e) an ability to identify, formulate and solve engineering problems (homework and lab experiments)
- (g) an ability to communicate effectively (through project reports)
- (j) a knowledge of contemporary issues (in microprocessor technology)
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (through hardware-software integration and implementation)

Grading Scale:		University's Code of Academic Integrity <a href="http://academic.fiu.edu/academic_misconduct.html">http://academic.fiu.edu/academic_misconduct.html</a>
A	92-100	"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	
B+	88-90	
B	82-88	
B-	80-82	
C+	78-80	
C	72-78	
C-	70-72	
D+	68-70	
D	62-68	
D-	60-62	
F	<60	

**Department Regulations Concerning Incomplete Grades**

An incomplete grade is a temporary symbol given at the discretion of the instructor for work not completed because of serious interruption not caused by the student’s own negligence. To qualify for an Incomplete, a student:

1. Must contact the instructor and request incomplete grade before or during missed portion of class.
2. Must be passing the course prior to that part of the course that is not completed.
3. Must make up the incomplete work through the instructor of the course.
4. All missed work must be finished before last two weeks of the following term.

**Evaluation Criteria**

Category	Weight
Homework Assignments	10%
Programming Assignments	20%
Mid-term Exam	25%
Final Exam	25%
Programming project	20%
Total	100%

**Course Outline**

<b>Wk</b>	<b>Date</b>	<b>EEL4746 Weekly Topic Fall 2015</b>	<b>Due Assignment</b>
1	8/24/15	Keil uVision and STM32 L1 Discovery board Introduction to ARM processors	
	8/26/15	ARM Architecture	
2	8/31/15	ARM Memory system	HW1
	9/2/15	See a Program Running, Chapter 1	
3	9/7/15	Labor day holiday (University closed)	
	9/9/15	ARM Instruction Set Architecture, Chapter 3	HW2
4	9/14/15	ARM Instruction Set Architecture, Chapter 3	HW3, P. Assign. 1
	9/16/15	Writing Assembly for ARM, Arithmetic and Logic, Chapt. 4	
5	9/21/15	Writing Assembly for ARM, Load and Store, Chapter 5	HW4, P. Assign 2
	9/23/15	GPIO Chapter 14	
6	9/28/15	Branch and Conditional Execution, Chapter 6	HW5, P. Assign.3
	9/30/15	Structured Programming, Chapter 7	
7	10/5/15	Review for Mid-term exam	HW5, P. Assign.4
	10/7/15	<b>Mid-term Exam</b>	
8	10/12/15	ARM Subroutines Stack Preserve Environment	
	10/14/15	Passing Parameters to Subroutine, Chapter 8	Final Project Proposal
9	10/19/15	Interrupts, Chapter 12	HW6, P. Assign. 5
	10/21/15	Interrupts, Chapter 12	
10	10/26/15	Serial Communication Protocols, UART, Chapter 22	HW7, P. Assign 6
	10/28/15	Serial Communication Protocols, I2C, Chapter 22	
11	11/2/15	Analog-to-Digital Converter, Chapter 20	HW8, P. Assign 7
	11/4/15	Digital-to-Analog Converter, Chapter 21	
12	11/9/15	DMA, Chapter 19	HW9, P. Assign 7
	11/11/15	Veterans' day (University closed)	
13	11/16/15	Basics of Low Power Programming	P. Assign. 8
	11/18/15	Mixing C and Assembly, Chapter 10	
14	11/23/15	Fixed Point Numbers, Chapter 11	HW10, P. Assign 9
	11/25/15	General-Purpose Timers, Chapter 15	
15	11/30/14	Project Presentation	Project Report
	12/2/14	Review for Final Exam	
16	12/7/15	<b>Final Exam, 7:15 PM – 9:15 PM, Room EC1115</b>	

**Keil uvision IDE:**

- Download MDK-ARM version 5 from the following website:  
<https://www.keil.com/download/product/>
- Download and install the STML32L1 Keil package

**ST Link Driver**

- Use the following link to install ST Link Driver  
<http://www.st.com/web/en/catalog/tools/PF258168>

**STM132L Board:**

- STM132L1 Discovery board for programming assignments can be purchased from Mouser:  
<http://www.mouser.com/ProductDetail/STMicroelectronics/STM32L152C-DISCO/?qs=%2fha2pyFadugzkcJpeFRtYttAbH%252bjmaCINRQUAuPUOW5TWNFRJr5Jvg%3d%3d>

**Policies:**

- **Exams and Quizzes:** *No makeup exams or quizzes* 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 are due at the beginning of the class period on the date specified. Assignments submitted late (within 1 week) will receive **half credit**.
- Instructor reserves right to change course materials or dates as necessary.

**Assignment Submission:**

- Assignments must be submitted by email at: [tehranifiu@gmail.com](mailto:tehranifiu@gmail.com)
- You can scan, take pictures or send the pdf file for homework assignments.
- For programming assignments take a screen shot of successfully built project and send it. The main program saved as assembly or C file must be also sent.
- The course number, student's name and assignment number must be mentioned in the email subject field. Example:

