

ELEC 2220 - COMPUTER SYSTEMS (SUMMER – ARM VERSION)
Summer 2015

Bulletin Data: ELEC 2220. COMPUTER SYSTEMS (3) LEC, 3. Pr., ELEC 2200. Computer hardware and software organization, processor programming models, data representation, assembly language programming, design of memory systems, input and output device interfacing and programming, multiprocessing.

Textbook: *Embedded Systems with ARM Cortex-M3 Microcontrollers in Assembly Language and C*, Dr. Yifeng Zhu, E-Man Press, LLC, 2014, ISBN 978-0-9826926-2-2.
(available at amazon.com and other sources)
Textbook web page: <http://web.eece.maine.edu/~zhu/book/lab.php>

References: (optional) *ARM Assembly Language Fundamentals and Techniques, 2nd Ed.*, William Hohl and Christopher Hinds, CRC Press, 2015, ISBN 978-1-4822-2995-1.
Introduction to ARM Cortex-M Microcontrollers (Volume 1), Jonathan W. Valvano, ISBN-13: 978-1477508992, ISBN-10: 1477508996 (amazon.com paperback/Kindle)

Class Web Site: <http://www.eng.auburn.edu/~nelsovp/courses/elec2220>
(Homework assignments, slides, supplementary documents, etc.)

Instructor: Victor P. Nelson, Professor of Electrical & Computer Engineering
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Course Objectives:

1. To understand the basic components, structure and operation of a digital computer system.
2. To be able to develop computer programs in assembly language.
3. To be able to design hardware and software for microcontroller-based systems containing various input/output devices and memory components.

Prerequisites by topic:

1. High-level language programming ((C or Java in COMP 1200, COMP 1210, or equivalent)
2. Digital logic circuits (ELEC 2200 or equivalent)

Topics

1. Introduction to computer hardware and software components
2. Data representation, number systems, codes, code conversion
3. Processor instruction set architecture
4. Assembly language programming with *MDK-ARM*
5. Memory organization and addressing
6. Processor instruction set
 - Data movement operations
 - Arithmetic operations
 - Logical operations
 - Program control operations
7. Program debug with *MDK-ARM*
8. Assembly language program design & structured programming
9. Parallel input/output ports & devices
10. CPU interrupts & interrupt-driven input/output
11. Interrupt service routines
12. Computer memory technologies (on-chip)
13. Expanded memory & input/output subsystems
14. Timing functions
15. Serial communication
16. Analog-to-digital and digital-to-analog conversion

Reading assignments in text:

- Chap. 1
- Chap. 2, ELEC 2200 text
- Chap. 3
- Chap. 3, Online doc's
- Chap. 1, Chap. 3
- Chap. 4.10, Chap. 5
- Chap. 4.1 – 4.4
- Chap. 4.5 – 4.8
- Chap. 6
- Online doc's
- Chap. 7, Chap. 8
- Chap. 14
- Chap. 12
- Chap. 12
- Online doc's
- Online doc's
- Chap. 15
- Chap. 22
- Chap. 20, 21

FINAL EXAM: Thursday, July 30, 4:00 – 6:30 p.m.

COURSE GRADING

Homework (programming assignments, etc.):	15%
Term project (due at final class period)	15%
Mid-term exams (2 @ 20% each)	40%
Final exam:	30%

COURSE HOMEWORK AND PROJECTS

The key to learning any engineering concept is to study it, work with it, and understand how to apply it to solve problems. The role of the course instructor is to assist you in this endeavor by discussing and explaining concepts in class and providing meaningful homework to help you study and learn them.

Each student will write, debug, and demonstrate a number of short assembly language programs for an ARM Cortex-M microcontroller using the Keil *MDK-ARM* integrated development environment and the *STM32F4-Discovery* board. Several small computer subsystems will also be designed (on paper) as homework exercises. These will make up the "homework" grade listed above. During the last three weeks of the semester, each student will do a microcontroller design project, due at the last class period. This will make up the "term project" grade listed above.

On all homework, please include the following header.

Your Name
ELEC 2220 Assignment #N
Date submitted (eg. May 19, 2014)

For programming assignments, submit a printout of your "source program" with the above information entered at the top of the program as a block of "comments", and a printout of the results, as indicated in the assignment. *Hand-written programs are not acceptable.* Late homework will be accepted only under extenuating circumstances.

Students are encouraged to use their own PCs for programming assignments. *MDK-ARM* can be downloaded from the Keil web site and used free of charge for limited-size programs. The ECE Department PC labs (Broun Hall 308 and 310) are available for ELEC 2220, except when scheduled for lab meetings in other ELEC courses. These are unlocked from 8 A.M. to 5 P.M. on weekdays. After-hours access is by coded entry only. See me if you require after-hours access. Keil *MDK-ARM* is installed on these PCs (*but not in other College of Engineering labs*).

CLASS ATTENDANCE:

Class attendance is required; class convenes promptly at 1:15 p.m. Please notify the instructor of any absences or other issues via email. If you have an AU-approved excuse for absence, please submit documentation (or a scanned copy), identifying the class involved, the particulars, and your name.

Regular, on-time class attendance is important because:

- Your understanding of the material will be greater. You will receive a professionally prepared presentation on, and discussion of, the subject, which frequently includes supplementary material not in the text, plus opportunities to interact with your fellow students to promote learning.
- The course will be easier, and your grade will be higher.
- You are made aware of any administrative changes relating to the course, receive returned homework, quizzes, copies of handouts, etc.
- Late arrivals, or early departures, are distractions to the class, and are inconsiderate.
- It is expected that a 3-credit course receive at least 9 hours of effort per week (**13.5 hours on the summer schedule**). The most efficient and constructive use of three hours of this time is to spend it in class.

Therefore, your attendance record will be a factor in determining your course grade as follows.

- 3 unexcused absences will result in the final course grade being reduced by one letter grade.
- 4 or 5 unexcused absences will result in the final course grade being reduced by two letter grades.
- 6 or more unexcused absences will result in a final course grade of "FA" (failure due to excessive absences)

OFFICE HOURS: You are encouraged to come by my office during posted hours to discuss problems or anything related to the course (or anything else that might be on your mind). This course builds on itself as it progresses, so it is important that you address and resolve problems as they arise, rather than waiting until the day before an exam. Conceptual problems and other issues can often be resolved more efficiently in a one-on-one setting, outside of class.

ACCOMMODATIONS: Students who need accommodations are asked to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by E-mail. Bring a copy of your Accommodation Memo and an Instructor Verification Form to the meeting. If you do not have an Accommodation Memo but need accommodations, make an appointment with The Program for Students with Disabilities, 1244 Haley Center, 844-2096 (V/TT).

ACADEMIC HONESTY POLICY: All portions of the Auburn University student academic honesty code (Title XII) found in the *Tiger Cub* will apply to this class. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee.

Each student is required to develop his/her own homework solutions.

Collaboration and comparison of solutions are acceptable, as a way of learning from each other. However, **each student must submit only his/her own individual work.** Identical submissions will be considered “copies”, and therefore an academic honesty policy violation, to be handled according to the procedures in the *Tiger Cub*.

Primary student outcomes related to this course:

- Outcome 1. Ability to apply knowledge of math, science and engineering to solve problems.
- Outcome 2. Ability to apply in-depth knowledge of one or more disciplines within ECE
- Outcome 3. Ability to design an electrical component or system, containing hardware and software components, to meet desired needs
- Outcome 6. Proficiency in the use of computers and other modern tools and skills