Course: EE 310/310L: Microprocessors & System Design  
Lecture & Lab: Salazar 2001  
Lecture/Lab: Tues. 9:00 am-11:40 am/ Thur. 8:00 am-10:40 am

Instructor: Dr. Farid Farahmand  
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Phone: (707) 664-3491  
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Web: http://www.sonoma.edu/users/f/farahman/

Office Hours: See office Hours - I am not available on Fridays.

Textbooks: Required: Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C (Third Edition) - Order from Amazon

References: Other eBooks from SSU Library

Required Material: Hardware for your project: Purchase STM Nucleo-F401RE from DigiKey; can also purchase directly from Mouser

Prerequisites: ES 210: Digital Circuit & Logic Design  
EE 230: Electronics I  
EE 220/221: Electric Circuits

Grading Plan (Lecture): Exams / Class Evaluation………………………………………………………….%35 *  
Quiz ………………………………………………………………………………….%40  
Homework / Articles / Piazza Discussion………………………………………….%10  
Final Project / Final Poster ……………………………………………………..%15 **

*Class evaluation is required to take the final exam  
** Poster is required to receive any grade

Grading Plan (Lab): Labs…………………………………………%80  
Exams…………………………………………%20 (in class individual labs)

NOTE: Students who fail the Lab exams (e.g., receive less than 70 percent in Lab exams) will fail EE 310L.

Grading:  
95 - 100 A  
90 – 93 A-  
87 – 89 B+  
84 – 86 B  
80 – 83 B-  
74 – 76 C  
70 – 73 C-  
77 – 79 C+  
67 – 69 D+  
64 – 66 D  
60 – 63 D-  
< 60 F

Reminder: EE 310/L is a 4 credit hour course requiring an average of 12 hours of study per week!
COURSE DESCRIPTION

Course Catalog Description:
Lecture: 3 hours. Hardware architecture of a general-purpose microprocessor and a microcontroller, memory hierarchy and supporting peripherals in micro controllers, comparison of various micro-controller architectures and capabilities, embedded system design using a micro-controller, data transfer protocols supported by a micro-controller, process of code writing, compiling, and executing programs using an IDE and a simulator. Prerequisites: ES 210 and EE 230, co-requisite EE 310L, or consent of instructor

Course Objectives:
The primary goal of this course is to give you the fundamental skills needed to understand, use, and design microcontroller-based systems. This includes the following: (1) What is a microcontroller? (2) What can it do (and not do)? (3) How does one design (and program) a microcontroller-based system? Specifically, the students in this course become familiar with basic programming of ARM Cortex-M cores in assembly and C at the register level, and the fundamentals of embedded system design. The course presents basic concepts such as data representations (integer, fixed-point, floating-point), assembly instructions, stack, and implementing basic controls and functions of C language at the assembly level. The course also covers advanced topics such as interrupts, mixing C and assembly, direct memory access (DMA), system timer (SysTick), multi-tasking, SIMD instructions for digital signal processing (DSP), and instruction encoding/decoding. The course also familiarize the students with interfacing peripherals, such as general purpose I/O (GPIO), LCD driver, keypad interaction, stepper motor control, PWM output, timer input capture, DAC, ADC, real-time clock (RTC), and serial communication (USART, I2C, SPI, and USB)

COURSE OBJECTIVES

At the conclusion of this course, including the lab), the successful student will be able to:
A. Gain a solid understanding of how microprocessors and microcontrollers operate.
B. Demonstrate a working knowledge of the necessary steps and methods used to interface a microcomputer system to devices such as stepper motors, sensors, etc.
C. Develop and demonstrate a structured assembly and C language program to accomplish a given task using a microcomputer.
D. Demonstrate the use of interrupts and other programming techniques related to micro-controllers. Complete the design, development, programming, and testing of a microcomputer based project.
E. Demonstrate a working knowledge of microcomputer busses and the flow of data within a microcomputer system.
F. Be able to write professional product report.
G. Be able to operate in team and work together towards a common goal.
   Become a more self-motivated and self-learner individual.
ASSIGNMENTS

DISCUSSION GROUP: Each individual student is required to have at least four entries into the class Piazza Discussion Group. Blog entries include answer to questions and responses to other students.

DESIGN PROJECT: You are required to submit one final design project. All projects require prior approval from your instructor. Maximum of **two people per group** is allowed. It is encouraged to have a partner, however, each person must clearly identify what his/her contribution was. For each project you must submit an abstract at the time of presentation. The abstract must include group members (who is doing what), project idea, and objective of the project. The final design project must be functional and properly operate as intended. Here are some Design Project guidelines:

- All projects must include a slide presentation using a **Tri-Fold**.
- Teams are highly encouraged to create a YouTube video of their presentations.
- All projects must be submitted on a CD. The CD should include the following: Circuit schematics, high-level block diagram, and list of parts.
- In your project you must use at least **THREE** of the following features of the microcontroller: ADC/DAC/Communication ports / Interrupt / Watchdog / Feedback/EEROM / Display (one or two LEDs are not considered as display!)
- All projects must have at least TWO of the following functionalities:
  - Data logging (SD card, EPROM, etc.)
  - Sensor interface (GPS, accelerometer, Microphone, PWM, etc.) – simple ADC does not count!
  - Software Interface (Android, LabVIEW, etc.)
  - LCD or 7-Segment (graphical, color display, etc.) – Simple display of numbers does not count!
  - Communication (wireless, USB, Bluetooth, Serial, etc.)
  - Power saving mode (sloop mode, etc.)

Please note that projects such as simple dice, flashing LED, single tone generator, are **NOT** considered as good projects. For some interesting projects refer to [YouTube](https://www.youtube.com).

It is **strongly** suggested that you take full advantage of your Spring Break to complete your project! Incomplete projects do **NOT** receive grades! Graduate students enrolled in the course are required to do more comprehensive final project.

QUIZZES: There will be a quiz almost once a week. The quizzes will be based on practice/homework problems (but not exactly the same). No make-ups are allowed. If you are late to class or stepped outside and missed a quiz, there will be no make-up. You can drop your lowest quiz grade. Note that all quizzes are limited to no longer than 10-15 minutes.

LABS & PRE-LABS: Each student must submit a single lab report. Please note that for each unexcused absence in the lab your *final* grade will be dropped by three points. All pre-labs must be typed, dated, and include student’s name and ID. All labs must follow the [Lab Template](#).
**EXAMS:** Exams will consist of problems designed to test your understanding of the concepts covered in class and lab. Anyone missing an exam will receive a zero grade for that exam. Make-up exams will only be given with a doctor's slip stating that you were too ill on the day of the exam to attend, or documented extraordinary circumstances. Please note that exams may include in-class programing assignment. **NOTE:** In order to be able to take the final exam you are required to bring a snapshot of your Moodle indicating that you have completed the class evaluations. You will not be allowed to take the final exam if you do not bring a proof that you have completed the class evaluation.

**LECTURE SERIES:** If you attend a minimum of SIX lecture series, I will drop your lowest quiz grade. Please return the signed form when you take your final exam.

**ARTICLES:** Each individual student is required to have at least FOUR article summery submissions. All submissions are through Moodle only. Late submissions will be penalized according to general submission rules.

**GRADING SUMMARY**

Each student’s final grade will be calculated according to the Grading Plan mentioned above. Please note the following:

1. All assignment must be submitted to **Moodle only.** DO NOT email your assignments please.
2. 10 points deduction per day for each late assignment (including weekends)
3. Any assignment that is later than 7 days will NOT be accepted.
4. There will be no curving (89.2 is still a B+).
5. There will be no make-ups.
6. Quizzes will be given at the beginning of each class.
7. Pay attention to the grading plan!
8. Incomplete Lab programs will not be accepted (any lab without fully working practical part will receive maximum of 50 points).
9. For each unexcused absence in the lab your final grade will be dropped by **three** points.

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**Please make sure you speak to me before you decide on dropping the class!**

**I will be available, if you are willing to learn!**
<table>
<thead>
<tr>
<th>Week</th>
<th>Chapters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2. Data Representation + Introduction</td>
</tr>
<tr>
<td>2</td>
<td>3. ARM Instruction Set Architecture</td>
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<tr>
<td>2,3</td>
<td>4. Arithmetic and Logic</td>
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<td>3</td>
<td>5. Load and Store</td>
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<td>4</td>
<td>6. Branch and Conditional Execution</td>
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<td>4</td>
<td>7. Structured Programming</td>
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<td>5</td>
<td>8. Subroutines</td>
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<td>5</td>
<td>9. 64-bit Data Processing</td>
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<td>6</td>
<td>10. Mixing C and Assembly</td>
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<td>6</td>
<td>11. Interrupt</td>
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<td>7</td>
<td>12. Fixed-point and Floating-point Arithmetic</td>
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<tr>
<td>7</td>
<td>13. Instruction Encoding and Decoding</td>
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<tr>
<td>8</td>
<td>14. General-purpose I/O</td>
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<td>8</td>
<td>15. General-purpose Timers</td>
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<tr>
<td>9</td>
<td>16. Stepper Motor Control</td>
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<tr>
<td>9</td>
<td>17. Liquid-crystal Display (LCD)</td>
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<td>9</td>
<td>18. Real-time Clock (RTC)</td>
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<tr>
<td>10</td>
<td>19. Direct Memory Access (DMA)</td>
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<td>10</td>
<td>20. Analog-to-Digital Converter (ADC)</td>
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<tr>
<td>10</td>
<td>21. Digital-to-Analog Converter (DAC)</td>
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<tr>
<td>11</td>
<td>22. Serial Communication Protocols</td>
</tr>
<tr>
<td>12</td>
<td>23. Multitasking</td>
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<tr>
<td>13</td>
<td>24. Digital Signal Processing</td>
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CLASSROOM PROTOCOL

CLASSROOM CONDUCTS: In order to create an appropriate environment for teaching and learning, students must show respect for their instructor and fellow students. Listed below are a few guidelines for classroom behavior. Students are expected to follow these rules to ensure that the learning environment is not compromised.

1. **Class Participation**: You are expected to be in class the entire class time. Please do not enter late or leave early. Rare exceptions may be made, particularly in emergency situations. Your participation in the class and lab and the discussions are very important and would help me understand how much you follow the material. As you go through the material before and after the class jot down your questions and ask me as I go through the slides.

2. **Absences**: Inform the instructor in advance, if you know you are going to miss a class. Also, take responsibility for getting missed assignments from other students. Your instructor is not responsible for re-teaching the material you missed due to an absence or being late.

3. **Conversation**: Do not carry on side conversations in class.

4. **Sleep**: Do not sleep in class.

5. **Internet browsing**: Please turn off all monitors/laptops and listen to lectures. Check your emails before coming to class!

6. **Attitude**: You are expected to maintain a civil attitude in class. You may not use inappropriate or offensive commentary or body language toward the instructor or fellow students.

7. **Cell phones**: You may not use your cell phone during class. Please turn off your cell phone upon entering the classroom.

See University policies (below) for more information.
UNIVERSITY POLICIES

There are important University policies that you should be aware of, such as the add/drop policy; cheating and plagiarism policy, grade appeal procedures; accommodations for students with disabilities and the diversity vision statement. See Important Policies and Procedures for Students http://www.sonoma.edu/uaffairs/policies/studentinfo.shtml.

Final Exam Schedule:
Please see https://www.sonoma.edu/academics/schedule-classes/final-exam-schedules

Dropping and Adding
Students are responsible for understanding the policies and procedures about add/drops, academic renewal, etc. How to Add a Class http://www.sonoma.edu/registration/addclasses.html has step-by-step instructions. Registration Information http://www.sonoma.edu/registration/regannounce.html lists important deadlines and penalties for adding and dropping classes.

Campus Policy on Disability Access for Students
If you are a student with a disability, and think you may need academic accommodations, please contact Disability Services for Students (DSS), located in Salazar Hall, Room 1049, Voice: (707) 664-2677, TTY/TDD: (707) 664-2958, as early as possible in order to avoid a delay in receiving accommodation services. Use of DSS services, including testing accommodations, requires prior authorization by DSS. See SSU’s policy on Disability Access for Students http://www.sonoma.edu/uaffairs/policies/disabilitypolicy.htm.

Emergency Evacuation
If you are a student with a disability and you think you may require assistance evacuating a building in the event of a disaster, you should inform your instructor about the type of assistance you may require. You and your instructor should discuss your specific needs and the type of precautions that should be made in advance of such an event (i.e. assigning a buddy to guide you down the stairway). We encourage you to take advantage of these preventative measures as soon as possible and contact the Disability Services for Students office if other classroom accommodations are needed.

Academic Integrity
Students should be familiar with the University’s Cheating and Plagiarism policy http://www.sonoma.edu/UAffairs/policies/cheating_plagiarism.htm. Your own commitment to learning, as evidenced by your enrollment at Sonoma State University and the University’s policy, require you to be honest in all your academic course work. Instances of academic dishonesty will not be tolerated. Cheating on exams or plagiarism (presenting the work of another as your own, or the use of another person’s ideas without giving proper credit) will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified.
RESOURCES

Library Research Guides and Subject Librarians

The University Library can help you find information and conduct research. You can make an appointment with a subject librarian, get help online, or drop by the library during open Research Help hours: http://library.sonoma.edu/about/hours/detailed. (Insert the URL address for the Research Guides http://libguides.sonoma.edu/ provided by your subject librarian, contact information for the Subject Librarians http://library.sonoma.edu/research/subjectlibrarians/, and any applicable Information for distance learners http://library.sonoma.edu/services/distancelearners/.)

Moodle Course

Moodle is SSU’s Learning Management System (LMS). Moodle is the place where you will find the course syllabus, read posted announcements in the news forum, participate in online class discussions with classmates, submit your assignments online and view the materials for this course. To access the Moodle course use your SSU Seawolf ID and password to log into SSU’s Online Services Portal https://login.sonoma.edu. Click on the Moodle link. When you get to the Moodle site home, click on the “My Courses” menu located on the top navigation. Click on the link for this course (classes are listed by course name and number). Note: The Login link is also conveniently located at the top of the Sonoma State University homepage http://www.sonoma.edu and many other university pages.

Visit Learning with Moodle http://www.sonoma.edu/it/students/moodle.html to review frequently asked questions about using Moodle and also to view a list of technical recommendations.

Moodle Help and Student Computing Resources

Moodle and General IT Help Desk: Contact the IT Help Desk http://www.sonoma.edu/it/helpdesk/ if you need assistance with Moodle or other information about computing and information technology at SSU. Three ways to contact the IT Help Desk are:

• Call: 707-664-4357
• Email: helpdesk@sonoma.edu
• Visit Location: Schulz 1000

Plugins: Download Plugins http://www.sonoma.edu/about/plugins.html lists plugins that may be needed to access some content on or linked from SSU websites and Moodle. (If applicable, list any other plugins that may be needed to access/use publisher materials).

General Student Computing

Review the information posted at Student Computing http://www.sonoma.edu/it/students. There you will find computer use guidelines and a list of available computer labs.
ADDITIONAL RESOURCES

SSU Writing Center
The SSU Writing Center, located at Schulz 1103, helps SSU students become better writers and produce better written documents. The knowledgeable and friendly tutors can help you with a wide array of concerns, from generating good ideas and organizing papers more clearly to learning citation formats and using semi-colons correctly. Visit the Writing Center website http://www.sonoma.edu/programs/writingcenter/default.html for more information on how to schedule time with a tutor.

Counseling and Psychological Services (CAPS)
CAPS is a unit of the division of Student Affairs of Sonoma State University. CAPS offers confidential counseling to students experiencing personal problems that interfere with their academic progress, career or well being. The CAPS website http://www.sonoma.edu/counselingctr provides information only. If you would like to talk with someone or make an appointment, please call (707) 664-2153 between 8 a.m. - 4:30 p.m., Monday-Friday.
# COURSE LEARNING OBJECTIVES (for ABET)

**EE 310/310L: Microprocessors & System Design**  
**Lecture & Lab: Salazar 2001**

Contribution of Course to Meeting the Professional Component:  
Engineering topics: 100%  
Math & Basic Science: 10%  
General Education: 15%

<table>
<thead>
<tr>
<th>ABET Student Outcomes</th>
<th>Course Learning Objectives</th>
<th>Level of Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) an ability to apply knowledge of mathematics, science, and engineering</td>
<td>B, F</td>
<td>3</td>
</tr>
<tr>
<td>(b) an ability to design and conduct experiments, as well as to analyze and interpret data</td>
<td>B, D, E, F</td>
<td>4 (310L)</td>
</tr>
<tr>
<td>(c) an ability to design a system, component, or process to meet desired needs</td>
<td>B, E, F, G</td>
<td>3</td>
</tr>
<tr>
<td>(d) an ability to function on multi-disciplinary teams</td>
<td>G</td>
<td>2</td>
</tr>
<tr>
<td>(e) an ability to identify, formulate, and solve engineering problems</td>
<td>B, F</td>
<td>4 (310)</td>
</tr>
<tr>
<td>(f) an understanding of professional and ethical responsibility</td>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>(g) an ability to communicate effectively</td>
<td>B, F</td>
<td>3</td>
</tr>
<tr>
<td>(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context</td>
<td>C, G</td>
<td>3</td>
</tr>
<tr>
<td>(i) a recognition of the need for, and an ability to engage in life-long learning</td>
<td>G</td>
<td>3</td>
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<tr>
<td>(j) a knowledge of contemporary issues</td>
<td>A</td>
<td>4 (310)</td>
</tr>
<tr>
<td>(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
<td>A-E</td>
<td>4 (310L)</td>
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