

ECE 4510/5530 MICROCONTROLLER APPLICATIONS SPRING 2020

Instructor: Dr. Janos Grantner
Lecture: MWF 3:30- 4:20pm, Room C-123
Labs: T 6:30 - 9:10pm, Room B-210 (Mr. Mohammed Al-Gailani)
R 12:30 - 3:10pm, Room B-210 (Mr. Mohammed Al-Gailani)
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Hours: MW 4:30- 5:20pm, or by appointment

Prerequisites (for UG students): ECE 2210 Electronics I
ECE 2510 Introduction to Microprocessors
Recommended: ECE 4525 Digital Design
ECE 3570 Computer Architecture

Required Materials:

- Jonathan Valvano, Embedded Systems: Real-Time Interfacing to ARM[®] Cortex[™]-Microcontrollers, Volume 2, 5th Ed., 2017, ISBN-13: 978-1463590154, ISBN-10: 1463590156, available in the University Bookstore, Bernhard Center.
- Instructor's Lecture Notes and other support materials, posted on the Class Web Page
- Advanced ARM-based 32-bit MCUs Reference Manual by Advanced RISC Machines, available through the Class Web Page
- Cortex-M4 Programming Manual by Advanced RISC Machines, available through the Class Web Page
- STM32CubeMX configuration tool, available through the Class Web Page
- STM Studio Reference Guide, available through the Class Web Page
- Cortex-M4 Technical Reference Manual by Advanced RISC Machines, available through the Class Web Page
- STM32F429I Reference Manual, available through the Class Web Page
- STM32F429Ixx Datasheet by STMicroelectronics, available through the Class Web Page
- STM32F429I-DISC1 Board User's Manual, available through the Class Web Page

In order to work on lab and homework assignments as well as projects, students are

required to have a **STM32F429I-DISCO1** Evaluation Board by **STMicroelectronics**, a **free permanent** copy of the **ARM Work Bench (32 KB code limit)** software development and debugger system by **IAR**, the **STM32CubeMX** configuration tool, the **STMStudio**, the **Atollic trueSTUDIO**, some other utility software as listed on the class web page and a **large solderless breadboard** and a set of electronic parts (**ECE 4510/5530 Parts Kit**). With respect to the DISCO1 EVB and the electronic parts, students can purchase them through the University Bookstore, or through on-line vendors. Students may already own the required solderless breadboard through a former lab class. If they don't, they can either purchase them through the University Bookstore, or through on-line vendors. With respect to the development software, students should directly download them from the IAR and STMicroelectronics Web sites, respectively.

Recommended Material:

Jean J. Labrosse, μ C/OS-III The Real-Time Kernel, Micrium Press, 2009, ISBN: 978-9823375-3-0

Course Description

The primary emphasis of the course will be microcontroller architecture, firmware and embedded software design. In addition, hardware interface design issues will also be extensively covered. Students are expected to show expertise in both areas.

Topics to be tentatively covered in this course include:

- Introduction to the ARM Cortex-M Microcontroller Family
- ARM Cortex-M4 Architecture and Memory Map
- ARM Cortex-M4 Programmer's Model
- C Programming with the IAR Work Bench
- Interfacing to the Parallel I/O Ports
- Interrupts and interrupt service routines
- Programming the Timer Module
- Input Capture and Output Compare
- Programming the PWM Module
- Analog Input and Output Interface
- Digital Camera Interface and DMA Controller (if time permits)
- Asynchronous Serial Communications Interface
- SPI Interface
- I2C Interface
- CAN Interface
- Advanced I/O Interfacing Techniques
- Design of Static Memory Systems
- Interfacing Static Memory to the ARM Cortex-M4 External Bus
- Critical Timing Analysis for Interfacing to the External Bus

Lab Work

The hardware platform in the lab is the STM32F4-DISCO1 Board by STMicroelectronics. Programs will be created, compiled, and downloaded to the DISCO1 Board using the IAR Work

Bench environment that also supports program debugging. Additional debugging capability is also provided by the ST-Link Utility. **Outside** of the scheduled and extended lab hours students should use their **own copy of the IAR software and the various STM software tools along with their STM32F429I-DISC1 Boards** to work on the course assignments.

For the laboratory, students will also need a thumb drive, a large solderless breadboard and the Parts Kit as published on the Class Web Page. You will work in the lab in teams. A team is usually made up of two students, however, **each student is required to have a STM32F429I - DISC1 Board, the IAR Work Bench software, the suite of STM software tools, a breadboard and a Parts Kit.** Work will be done simultaneously on lab and homework assignments and the design projects. Lab and project teams will have different make ups.

We will be using standard scientific/engineering procedure regarding laboratory reports. This means that **you are expected to come to the labs prepared. Prelab Assignments** will be posted on the Class Web Page. The objective and design sections (the latter contains pseudocode of software, circuit schematic diagrams, timing diagrams, math formulas, etc.) of your lab report should be completed **before lab** as a **draft**. The finalized design, data/results and conclusion sections of the Team's **Lab Report** should be completed either during the lab session, or shortly thereafter. In the conclusions section you will describe major concepts observed/discovered, discuss any anomalies and suggest what caused them.

Prelab Assignments are **individual work! Prelabs should be submitted in the appropriate Drop Boxes through Elearning.** They will be checked by the Lab TA **at the beginning of each lab. Missing, or insufficient Prelabs will be penalized by losing 3 pts (out of 12 pts) for the lab.**

Software tools are provided on the class web page to develop schematic diagrams. Typed lab reports using a word processor are required. The penalty will be severe for sloppy schematics and reports.

Lab reports, in .pdf form, are due no later than 5:00pm, on Friday (Tuesday Lab) and on Monday (Thursday Lab), respectively, following the lab. Late lab reports will be penalized by **-10% for each day** they are tardy, or will receive a score of **0pts. after three days** unless **prior** arrangements have been made. **Lab reports should be submitted in the appropriate Drop Boxes through Elearning.** If you don't show up for a lab, you forfeit the points associated with it and cannot later make up the lab. Exceptions will be made only for those individuals who contact their Lab TA before the lab, giving an adequate reason why they cannot attend that day.

Please note that you must achieve a passing grade in the lab (total 60% out of 100%) in order to pass the course. Plagiarism and/or the copying/duplication of another student's, or team's designs or reports will result in zero scores for the prelab, lab, homework, or design project for all individuals involved.

There will be a **Lab Final Exam** (worth of **three** regular labs).

Extended Lab Hours

There will be **swipe card access** to the B-210 Laboratory for students **registered** for the course. Outside regular work hours it is required that at least two students should be present in the lab. It is for your safety and it is also required by the CEAS insurance policy.

Homework

There will be regular homework assignments. **Late homework submissions will not be accepted and receive a 0 score. Homework solutions should be submitted in the appropriate Drop Boxes through Elearning.**

Design Projects

The **ECE 5530 Section** will be assigned an **extra midterm project (Project #1)** in addition to a final **Lab Project/Project #2** which should be done by **both** the undergraduate and the graduate sections, respectively. Projects will be carried out using the Parts Kit and equipment readily available in the lab. Projects will be done **in teams of two students**, or may be worked on individually. The demonstration of the projects working correctly will be worth up to 40% of the credit assigned.

Project #1 is due 5:00pm, on Wednesday, March 11, 2020 and the Lab Project/Project #2 is due 5:00pm, on Wednesday, April 15, 2020. Demonstration will be given in the B-210 Lab. Project reports should be submitted in the appropriate Drop Boxes through Elearning.

Late projects will be accepted up to **three business days** after due date (**not** after the last week of classes, though) but will be penalized by **-10% for each day** that is tardy! Failure to work on any project or submit the project report(s) will result in an **X grade** for the course.

Exams

There will be **one 50-minute Midterm Exam, a Lab Final Exam, and a two-hour Final Exam. Support materials** will be made available on the **desktops of the PC workstations** used for the exams. The **Midterm and the Final Exams** will be given **simultaneously in the B-210 Lab and in other designated laboratories**. The **Midterm Exam** is scheduled for **3:30-4:20pm, on Friday, February 14, 2020. Lab Final Exams** are scheduled for **Tuesday, April 7, 2020, Thursday, April 9, 2020**, respectively, **in the B-210 Lab**. The **Final Exam** is scheduled for **2:45-4:45pm, on Monday, April 20, 2020. The solutions to all exams should be submitted in the appropriate Drop Boxes through Elearning.**

The **Final Exam will be comprehensive**, however, more weight will be allocated to course material subsequent to the Midterm Exam. Students are required to attend **all exams as scheduled**, failure to do so will result in an **X grade** for the course (if an emergency arises, you must contact the course instructor **prior to** the examination). There will be no make up exams unless in extreme circumstances.

Grading Policy:

Grades will be determined on the basis of the following:

ECE 4510 Section

Homework	10%
Lab Work	30%
PROJECT	10%
MIDTERM	15%
FINAL	35%

ECE 5530 Section

Homework	10%
Lab Work	30%
PROJECT 1	5%
PROJECT 2	10%
MIDTERM	15%
FINAL	30%

The break up for the letter grades is as follows:

ECE 4510 Section

A:	85 - 100%
BA:	80 - 84%
B:	70 - 79%
CB:	65 - 69%
C:	55 - 64%
D:	45 - 54%
E:	<45%

ECE 5530 Section

A:	88 - 100%
BA:	83 - 87%
B:	73 - 82%
CB:	68 - 72%
C:	58 - 67%
D:	48 - 57%
E:	<48%

In borderline cases, the Final Exam may be given a higher weight, up to the course instructor's discretion.

Codes, Policies, Processes and Procedures:

The ECE 4510/5530 Web Home Page will be used as **official communications media** for the class.

The **WMU College of Engineering and Applied Sciences Honesty Code** will apply in this course.

Homework and Prelabs are individual work! Students may discuss with their classmates the basic approaches to arrive at the solutions in principle. However, they are not allowed to share schematic diagrams, calculations, program files, and the like. Similarly, there must not be leaks of detailed design information among lab and project teams, respectively.

Students are responsible for making themselves aware of and understanding the University policies and procedures that pertain to Academic Honesty. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. The academic policies addressing Student Rights and Responsibilities can be found in the Undergraduate Catalog at <http://catalog.wmich.edu/content.php?catoid=24&navoid=974> and the Graduate Catalog at <http://catalog.wmich.edu/content.php?catoid=25&navoid=1030>. If there is reason to believe you have been involved in academic dishonesty, you will be referred to the Office of Student Conduct. You will be given the opportunity to review the charge(s) and if you believe you are not responsible, you will have the opportunity for a hearing. You should consult with your instructor if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test.

Students and instructors are responsible for making themselves aware of and abiding by the “Western Michigan University Sexual and Gender-Based Harassment and Violence, Intimate Partner Violence, and Stalking Policy and Procedures” related to prohibited sexual misconduct under Title IX, the Clery Act and the Violence Against Women Act (VAWA) and Campus Safe. Under this policy, responsible employees (including instructors) are required to report claims of sexual misconduct to the Title IX Coordinator or designee (located in the Office of Institutional Equity). Responsible employees are not confidential resources. For a complete list of resources and more information about the policy see www.wmich.edu/sexualmisconduct.

In addition, students are encouraged to access the Code of Conduct, as well as resources and general academic policies on such issues as diversity, religious observance, and student disabilities:

Office of Student Conduct www.wmich.edu/conduct

Division of Student Affairs www.wmich.edu/students/diversity

University Relations Office <http://www.wmich.edu/policies/religious-observances-policy>

Disability Services for Students www.wmich.edu/disabilityservices