EE 310 - Digital Systems /Embedded Control
3 (2, 3) [Semester Credit Hour (Lecture, lab)] - 82551
COURSE SYLLABUS: Fall 2019

INSTRUCTOR INFORMATION

Instructor: Gerald Patrick Carter
Distinguished Lecturer, Electrical Engineering
Department of Engineering and Technology

Office Location: AG/ET 215
Office Hours: Tuesday (1:00pm – 3:30pm)
Thursday (1:00pm – 3:30pm)

Office Phone: 903-886-5706
Office Fax: 903-886-5960 (Inform instructor when fax is sent)

University Email Address: patrick.carter@tamuc.edu

Preferred Form of Communication: email
Communication Response Time: 24 hours (weekdays) to email

COURSE INFORMATION

Materials - Textbooks, Readings, Supplementary Readings

Course Format:

The class consists of lectures and Laboratory exercises.
Class: two hours per week.
Lab: three hours per week.

Class Meeting Schedule: Meets 8/26/2019 through 12/13/2019

Class Meeting Dates: Tuesday (9:30 AM– 11:30 AM)
Thursday (9:30 AM– 11:30 AM)

Classroom: AG/ET 214

Textbook(s) Required (Lecture and Lab books are both required)

Course theory part:

AVR Microcontroller and Embedded Systems: Using Assembly and C, (2015) Mazidi, Naimi & Naimi ISBN: 978-1133628473.

Course practical part (Lab Exercises):

Lab Manual is provided by the instructor

Software Required

- Microsoft Office - MS Word, Excel, Powerpoint
- IDE Arduino
- Atmel Studio 7

Optional Texts and/or Materials

Breadboard, wire cutters, pliers, Microcontroller, breadboard wire, 9V battery. Additional supplemental materials may be identified by instructor during course execution.

Course Description

This course introduces the hardware and software architecture of the AVR Microcontrollers and its applications. It also includes embedded system types, programming the microcontroller in assembly and C, serial and parallel data transfer, interfacing I/O devices. Real world applications using Arduino and other devices will be developed through lab exercises and course project design.

Prerequisites: CSCI 151 or COSC 1336 with a minimum grade of C
EE 210 with a minimum grade of C.

Student Learning Outcomes

After successfully completing the course, students will be able to:

- **Recognize** the major components of a microprocessor and microcontroller-based systems
- **Describe** the difference between a microprocessor and a microcontroller
- **Analyze** assembly and C language programs for the AVR microcontroller, and debug errors in syntax and logic.
- **Illustrate** program logic flow using flowcharts and develop assembly and C language programs from flowcharts.
- **Interface** a variety of I/O devices to the microcontroller by incorporating ADCs and DACs.
- **Use** appropriate Hardware and Software tools in the design, implementation, debugging,

and testing of microcontroller-based systems
- **Develop** and **design** interactive real-time applications with the AVR microcontroller
- **Perform** experiments/course project independently as well as in a group**.**
- **Write** a technical lab report.

COURSE REQUIREMENTS

Minimal Technical Skills Needed

Working knowledge and basic skills using Microsoft Word, Excel, and PowerPoint.

Instructional Methods

The instructional methods in this course include; lectures, class discussion, course project, written assignments, problem solving, writing a lab report, lab exercises, open ended problems, case study, and simulation assignments using software.

Instruction will be based on the course textbook and the lab manual.

Student Responsibilities or Tips for Success in the Course

Attendance:

Attendance is a requirement for this course. The instructor will take attendance at each class. Class Attendance Requirement (one lateness = 1/2 absence)

# of Absences	0 – 3	4	5	6	7	>7
Points Deduction	0	-5	-10	-20	-30	F

Unless directed and/or approved by the instructor, only MS Office-compatible formats (.doc, .docx, .rtf, .xls, .xlsx, .ppt and .pptx) will be accepted for assignments and submissions. NO OTHER DOCUMENT OR FILE FORMATS WILL BE ACCEPTED.

Failure to comply with required document formats will result in late or rejected assignments (zero credit).

Other specific formats may be dictated based on assignment and will be coordinated with/by the instructor prior to submission to assignment drop boxes.

Microsoft Word, Excel, PowerPoint, or Project files will be placed in the assigned drop boxes in eCollege in the accepted formats only (identified above). **Note**: Many students do not fully utilize the power within this document processing software. This can assist the user when they know how to use more of the functions in these standard tools. The use of the spelling and grammar checkers, page and section breaks, and APA templates is highly

encouraged PRIOR to submission of assignments.

APA Formatting is required for all reports assigned during this class. Non-adherence to APA formatting will result in points deduction on the assignment.

GRADING

The final course grade is based on 100 possible points (as described below in Assessments) and will be calculated based on the following grading scale:

Grading Scale:
A = 90-100 points
B = 80-89 points
C = 70-79 points
D = 60-69 points
F = < 60 points

Assessments

The following assessments will be performed throughout this course to assess individual progress toward learning outcomes. The final course grade will be calculated based on the following assessments:

Assessment task	Due Time	Weight
Homework	~ Every two weeks	12 %
Quizzes	3, 5, 10, 12	13 %
Midterm Exam	8	15 %
Design Project	15	10 %
Final Exam	16	25 %
Laboratory exercises	Weekly	25 %

Homework Assignments: Homework Assignments are due at the beginning of class, delivered in the appropriate drop box. No late submissions will be accepted. Some homework assignments will include the submission of simulation files created in MultiSim. Any file that is flagged as infected with malware or viruses will be receive a grade of zero. The instructor will use Norton Internet Security, and the student is advised to use something at least as good as NIS.

Exams and Quizzes
The two major examinations and quizzes will be old-fashioned paper, and pencil exercises. There will be 4 quizzes.

Lab Safety Training: Students registered for this course must complete all required lab safety training prior to entering the lab and undertaking any activities. Once completed, Lab Safety Training is valid for the remainder of the same academic year (i.e., through the following August) and must be completed anew in subsequent years. There are no

exceptions to this University policy. Failure to complete the required training will preclude participation in any lab activities, including those for which a grade is assigned.

Design Project: Students are required to complete a course design project and submit a comprehensive report at the end of the course. The project should demonstrate the student's ability to link the theoretical knowledge and practical skills acquired in the course to real-world applications. Student will work in a group up to three students. Students will submit their project proposal at week 8 to instructor for approval.

Lab Exercises:

In this lab, students learn about the hardware and software architecture of the 8-bit AVR microcontrollers, specifically ATmega328. Students will acquire practical skills through performing several experiments using Arduino Microcontroller, I/O devices, Sensors, Motors, wireless communication devices, etc. This lab will also provide students with hands on experience in implementing real world application using AVR ATmega328 microcontroller, assembly and C language. Students also design and build a robotic vehicle using software as well as hardware.

There will be 12 Lab Assignments distributed over the semester, a midterm and final lab exams. Students will work in group of up to three students.

Grading Policy for the Lab:

Assessment task	Due Time	Weight
Attendance	Weekly	3 %
Lab Work & Report	Weekly	8 %
Midterm Lab Exam	7	5 %
Lab Final Exam	16	9 %

Pre-labs must be completed prior to coming to lab. Students will be turned away from the Lab if the Pre-lab is not complete.

Lab circuits must be built during Lab on an empty breadboard. They may not be built prior to the Lab period. Each student will be provided your own Breadboard and wires and tools, and will be responsible for maintaining and returning the supplies at the end of the course. At the end of each lab, you will be asked to demonstrate your functioning circuit to the Instructor.

Formal Lab Reports should follow the same approach used in the lab, which is a Hypothesis/Test sequence. In Prelab, you will be asked to design a circuit to perform a specific function. During the lab time you built the circuit and collected test data to show how the circuit performed. The report, then, should be constructed as follows:

1) **Cover page**: Your lab report cover page should include the following information:
   a) Course name and title
   b) Experiment number and title
   c) Names of group members and their IDs
   d) Instructor's name.

e) Date
2) **Objectives**: State clearly the objectives of the experiment
3) **Equipment required**: List all the equipment and components used in the experiments
4) **Introduction:** Provide the necessary background to the problem that you are trying to solve in the lab and the approach to solve it.
5) **Procedure:** Each part of the lab experiment should explain the following**:**
   a) Basic measurements and calculation
   b) Explanation of the derived solution
   c) Schematics developed that demonstrate the solution
6) **Results and Analysis**: Each part of lab experiment should have the following:
   a) Include tests used to prove the solution worked.
   b) Include drawing of the solution you built in lab.
   c) State the observations made while performing the lab and an explanation of your results
7) **Conclusions:** In this section of the lab:
   a) Describe what you did and learned from the lab.
   b) Explain at what degree the objectives of the lab were achieved.
   c) Describe possible real time applications from the work done in the lab

A Formal Lab Report should enable someone else to duplicate your work and obtain the same results without reference to any other documents. This does not mean that you should append data sheets to your report but that the schematics and parts layout should be clear and accurate.

Submit the files containing the circuit simulation, a schematic, and data which explain the lab results you obtained. Graphics must be created using a graphics program.
Graphics in your lab reports may not be hand-drawn.

Lab Reports are due as hardcopy and by submission to the drop-box before lab time one week after the lab was performed. 10% per day will be deducted from the final lab grade for each 24 hours or portion thereof that a lab is late. Hardcopy of Lab Reports are to be submitted to the instructor.

Student Outcomes (ABET):
The program must have documented student outcomes that support the program educational objectives. Attainment of these outcomes prepares graduates to enter the professional practice of engineering. Student outcomes are outcomes (1) through (7), plus any additional outcomes that may be articulated by the program.

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- 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
- An ability to communicate effectively with a range of audiences
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

- 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
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

This course will assess the achievement of the following student outcomes:

- •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 (2)
- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions (6)
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies (7)
- 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

TECHNOLOGY REQUIREMENTS

LMS

All course sections offered by Texas A&M University-Commerce have a corresponding course shell in the myLeo Online Learning Management System (LMS). Below are technical requirements

LMS Requirements:

https://community.brightspace.com/s/article/Brightspace-Platform-Requirements

LMS Browser Support:

https://documentation.brightspace.com/EN/brightspace/requirements/all/browser_support.htm

YouSeeU Virtual Classroom Requirements:

https://support.youseeu.com/hc/en-us/articles/115007031107-Basic-System-Requirements

ACCESS AND NAVIGATION

You will need your campus-wide ID (CWID) and password to log into the course. If you do not know your CWID or have forgotten your password, contact the Center for IT Excellence (CITE) at 903.468.6000 or helpdesk@tamuc.edu.

Note: Personal computer and internet connection problems do not excuse the requirement to complete all course work in a timely and satisfactory manner. Each student needs to have a backup method to deal with these inevitable problems. These methods might include the availability of a backup PC at home or work, the temporary use of a computer at a friend's home, the local library, office service companies, Starbucks, a TAMUC campus open computer lab, etc.

COMMUNICATION AND SUPPORT

If you have any questions or are having difficulties with the course material, please contact your Instructor.

Technical Support

If you are having technical difficulty with any part of Brightspace, please contact Brightspace Technical Support at 1-877-325-7778. Other support options can be found here:

https://community.brightspace.com/support/s/contactsupport

Syllabus Change Policy

The syllabus is a guide. Circumstances and events, such as student progress, may make it necessary for the instructor to modify the syllabus during the semester. Any changes made to the syllabus will be announced in advance.

University Specific Procedures

Student Conduct

All students enrolled at the University shall follow the tenets of common decency and acceptable behavior conducive to a positive learning environment. The Code of Student Conduct is described in detail in the Student Guidebook.
http://www.tamuc.edu/Admissions/oneStopShop/undergraduateAdmissions/studentGuidebook.aspx

Students should also consult the Rules of Netiquette for more information regarding how to interact with students in an online forum: https://www.britannica.com/topic/netiquette

TAMUC Attendance

For more information about the attendance policy please visit the Attendance webpage and Procedure 13.99.99.R0.01.

http://www.tamuc.edu/admissions/registrar/generalInformation/attendance.aspx

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/academic/13.99.99.R0.01.pdf

Academic Integrity

Students at Texas A&M University-Commerce are expected to maintain high standards of integrity and honesty in all of their scholastic work. For more details and the definition of academic dishonesty see the following procedures:

Undergraduate Academic Dishonesty 13.99.99.R0.03

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/undergraduates/13.99.99.R0.03UndergraduateAcademicDishonesty.pdf

Graduate Student Academic Dishonesty 13.99.99.R0.10

http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/13students/graduate/13.99.99.R0.10GraduateStudentAcademicDishonesty.pdf

Students with Disabilities-- ADA Statement

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you have a disability requiring an accommodation, please contact:

Office of Student Disability Resources and Services

Texas A&M University-Commerce
Gee Library- Room 162
Phone (903) 886-5150 or (903) 886-5835
Fax (903) 468-8148
Email: studentdisabilityservices@tamuc.edu
Website: Office of Student Disability Resources and Services

http://www.tamuc.edu/campusLife/campusServices/studentDisabilityResourcesAndServices/

Nondiscrimination Notice

Texas A&M University-Commerce will comply in the classroom, and in online courses, with all federal and state laws prohibiting discrimination and related retaliation on the basis of race, color, religion, sex, national origin, disability, age, genetic information or veteran status. Further, an environment free from discrimination on the basis of sexual orientation, gender identity, or gender expression will be maintained.

Campus Concealed Carry Statement

Texas Senate Bill - 11 (Government Code 411.2031, et al.) authorizes the carrying of a concealed handgun in Texas A&M University-Commerce buildings only by persons who have been issued and are in possession of a Texas License to Carry a Handgun. Qualified law enforcement officers or those who are otherwise authorized to carry a concealed handgun in the State of Texas are also permitted to do so. Pursuant to Penal Code (PC) 46.035 and A&M-Commerce Rule 34.06.02.R1, license holders may not carry a concealed handgun in restricted locations.

For a list of locations, please refer to the Carrying Concealed Handguns On Campus document and/or consult your event organizer.

Web url:
http://www.tamuc.edu/aboutUs/policiesProceduresStandardsStatements/rulesProcedures/34SafetyOfEmployeesAndStudents/34.06.02.R1.pdf

Pursuant to PC 46.035, the open carrying of handguns is prohibited on all A&M-Commerce campuses. Report violations to the University Police Department at 903-886-5868 or 9-1-1.

COURSE OUTLINE / CALENDAR

The instructor reserves the right to adjust the schedule in order to serve the needs of the class and any changes will be communicated in a timely manner.

Course theory schedule:

Topics Covered (Tentative Schedule)

Week	Topics	Chapter	Assignment/Exams
1	Introduction to Computing; Microprocessors and Microcontrollers fundamentals;	Ch 0	
2	Introduction to AVR Microcontrollers; AVR	Ch 1	HW1
3	Microcontroller Architecture and Assembly Language Programming	Ch 2	Quiz 1
4	AVR Instruction Set	Ch 3	HW2
5	Assembly language programming	Ch 5	Quiz 2
6	AVR IO Port programming	Ch 4	HW3
7	Advanced Assembly language programming; AVR Addressing Modes	Ch 6	Midterm Exam I
8 & 9	AVR Programming in C	Ch 7	HW4/ Project Proposal submission
10 & 11	AVR Timers and Interrupt programming; Serial port programming	Ch 9, 10, 11	Quiz 3
12	IO Interfacing; LCD and keypad	Ch 12	Midterm Exam II
13	Interfacing A/D and D/A Converters, Sensors	Ch 12	HW5
14	Interfacing with motors & relays, PWM programming	Ch 14 & 16	Quiz 4 Project Prototype
15	SPI and I2C Communication protocols, AVR Applications	Ch 17 & 18	Project Demo & Presentation
16			**FINAL Exam**

Laboratory schedule:

Topics Covered (Tentative Schedule)

Wk	Lab #	Experiment
1	1	Introduction to the Arduino Microcontroller platform. Introduction to Atmel Studio 7.
2	2	Essential C Language Programming + Basic experiment with Arduino Uno and LEDs/Switches + Traffic Lights simulation
3	3	Interfacing Digital and Analog IO Devices to the Arduino board (LDR, Potentiometer, DC motor, Servo motor)
4	4	DC Motor Speed control using PWM + Interfacing with Analog Inputs
5	5	DC Motor Direction and Speed control using H-bridge + Interfacing with Ultrasonic Sensor
6	6	Temperature Sensing, Serial Monitor, and LCD display
7	7	Color Sensing with TSC2300 and Arduino Uno
8		**MIDTERM EXAM**
9	8	Wireless Comms using Bluetooth and XBee modules – Robot Vehicle Part 1
10		Final Project Workday
11		Final Project Workday
12		Final Project Workday
13		Final Project Workday
14		Final Project Workday
15		Final Project Workday
16		**LAB FINAL**