Digital Systems Design

The University of Toledo
Electrical Engineering Technology
EET 3350:002,003,004 (CRN 50192, 50193, 50194)

Instructor:	Sandrine Mubenga, PhD, PE	**Class Location**:	PL2400
Email:	ngalula.mubenga@utoledo.edu	**Class Day/Time**:	M, W 4:00PM-5:20PM
Office Hours:	MW 9.30AM-12PM	**Lab Location**:	NE2350
Office Location:	NE 1624	**Lab Day/Time**:	Section 002: M/2:20PM-3:54PM
Instructor Phone:	419-530-3896		Section 003: W/2:20PM-3:54PM
Offered:	Fall 2019	**Credit Hours**:	4
Course Website:	Blackboard Learn		

CATALOG/COURSE DESCRIPTION

This course covers different aspects of real-time embedded systems implementation with low-level access to hardware resources of microcontrollers. Topics include but not limited to low-level and high-level microcontroller programming covering Assembly and C, I/O access, interrupt-driven programming, timers, serial interfacing, analog-to-digital conversion (ADC), digital-to-analog conversion (DAC), introduction to printed circuit board (PCB) design and fabrication. It uses system design approach, such as flow charts, finite state machines (FSM) while implementing embedded systems. This course is based on project based learning and entrepreneurial minded learning.

COURSE OVERVIEW

Welcome to Digital Systems Design! Embedded systems are ubiquitous nowadays. The overall course objective is to help the students to understand how embedded systems interact with the external world environment. The course aims to provide hands-on experiences of how an embedded system could be used to solve some daily life problems through automation. The focus will be given to understand basic building blocks of an embedded system instead of complex system design. Students will be introduced to printed circuit board (PCB) design and fabrication for prototyping the embedded system.

This course is based on project based learning (PBL) and entrepreneurial minded (EM) learning. The goal of EM learning is to understand the bigger picture, recognize opportunities, acquire important professional and business ready skills, and learn from mistakes. EM learning adds value to engineering education and higher output for employers. The values of EM learning for students are personal satisfaction, job security, and marketable skill sets (technical and professional skills). Both project based learning and entrepreneurial minded learning will be strongly emphasized during the final team project.

Indeed, the final project will demonstrate the students' ability to identify a problem in society, work as a team to find a solution that uses an embedded system, and evaluate the cost of their solution vs. current technology. The students will then design and build an embedded system prototype using the concepts learned throughout the course, make an oral presentation, a video, and a report in order to explain the solution and its impacts. The final project has an emphasis on the process of coming together as a team with students from diverse background and introduces students to the need for continuing professional development outside of the classroom.

ABET STUDENT LEARNING OUTCOMES

Outcome a) an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly defined engineering technology activities;

Outcome b) an ability to select and apply knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;
Outcome c) an ability to conduct standard test and measurements; to conduct, analyze and interpret experiments; and apply experimental results to improve processes;
Outcome d) an ability to design systems, components, or processes for broadly – defined engineering technology problems appropriate to program educational objectives;
Outcome e) an ability to function effectively as a member or a leader on a technical team;
Outcome f) an ability to identify, analyze, and solve broadly – defined engineering technology problems;
Outcome g) an ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature;
Outcome h) an understanding of the need for and an ability to engage in self – directed continuing professional development;
Outcome i) an understand of and a commitment to address professional and ethical responsibilities including a respect for diversity;
Outcome j) a knowledge of the impact of engineering technology solutions in a societal and global context; and
Outcome k) a commitment to quality, timeliness and continuous improvement.an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities;

OBOR/TAG STUDENT LEARNING OUTCOMES

Students will be able to:

1. Explain microprocessor architecture.
2. Utilize assembly language programming to develop code for a microprocessor.
3. Explain and utilize bus timing diagrams.
4. Demonstrate an understanding of and applications for bus structures.
5. Utilize memory technologies and interfacing in microprocessors.
6. Implement input/output (I/O) systems, I/O interface requirements, and interrupt based I/O.
7. Utilize direct memory access (DMA) in microprocessor applications.
8. Utilize microprocessors/microcontrollers in a variety of applications.

COURSE OBJECTIVES

No additional content covered beyond the TAG outcomes.

PHILOSOPHY OF TEACHING (TEACHING METHODOLOGY)

This is an active learning course that will require students to be fully engaged. Face-to-face instructions in lectures will provide maximum help to students. Homework, quizzes, and comprehensive tests will be given. Laboratory sessions are used to reinforce digital logic design

concepts. The purpose of this course is to help students understand the fundamental embedded system design theories and use those theories to solve the relevant problems. Students are welcome to ask questions and discuss problems. The course will be instructed based on the philosophy of cycling education:

- through the theory to understand the formula
- through the usage of formulae to understand examples
- through the examples to solve similar exercise problems
- through face-to-face instruction to improve learning efficiency
- through lab guides reinforcement of principles provided in lecture
- through exams to emphasize importance and clarify confusion
- through taking this course to have the capability to self-study for future work or research

Recommendations for success:

- Come to lectures on time and take notes
- Read the relevant contents in the textbook
- Solve examples in the textbook and do homework
- Review the relevant contents and homework before each test or exam
- Read the relevant contents and prepare the lab experiment prior to going to the lab
- Take ownership of your learning. You are responsible for troubleshooting your prototype until it works.

Never hesitate to ask for help from the instructor.

PREREQUISITES

(EET-2210 and EET 3150) or (EET 2210 and CSET 2230)

REQUIRED TEXTS AND ANCILLARY MATERIALS

Free eBook online at http://users.ece.utexas.edu/~valvano/Volume1/E-Book/
$12.99 Launchpad Stellaris http://www.iar.com or Tiva http://www.ti.com/tool/ek-tm4c123gxl

TECHNOLOGY EXPECTATIONS

Web assist - Blackboard http://blackboard.utdl.edu/
Web assist – http://DrMubenga.com/
Applications- PowerPoint, Words
Programming language- Assembly Language (CSET), C language (EET)

UNIVERSITY POLICIES

Academic Accommodations

The University of Toledo is committed to providing equal opportunity and access to the educational experience through the provision of reasonable accommodations. For students who have an accommodations memo from Student Disability Services, it is essential that you correspond with me as soon as possible to discuss your disability-related accommodation needs for this course. For students not registered with Student Disability Services who would like information regarding eligibility for academic accommodations due to barriers associated with a potential disability, please contact the Student Disability Services Office.

COURSE EXPECTATIONS

1. *All assignments including homework are graded based on correctness.*
2. *All assignments are to be completed on time and turned in at the beginning of the class/lab.*
3. *You are responsible for all materials covered in class as well as the material assigned in the book.*
4. *There is no make-up quiz, exams or homework for this course.*
5. *Cheating and Academic dishonesty is not allowed and will be punished by rules of University of Toledo Student Handbook. Read this* *http://www.utoledo.edu/policies/academic/undergraduate/pdfs/3364-7104%20%20Academic%20dishonesty.pdf*

Electronica Policy: No electronic items: cellular telephones, Blackberrys, personal digital assistants, digital music players or similar items that may disrupt the learning environment may be used at any time for any purpose during the classroom or laboratory time. If a cell phone must be kept on due to a potential emergency situation, it must be on a silent setting. If an emergency call must be taken during a class, the student must leave the classroom prior to answering the call and not return until the call is completed. See also Article IV.B Conduct Rules and Regulations of the Student Code of Conduct at the University of Toledo.

Readings: Reading for the course is shown on the accompanying handout. Readings are to be completed prior to the lecture and lab portions of the class.

If there is a conflict or misunderstanding, see the instructor privately for a resolution.

OVERVIEW OF COURSE GRADE ASSIGNMENT

Midterm Grading

Midterm grades will be presented per university requirements and based on the current updated cumulative scores obtained by the students usually the first 5 or 6 weeks.

Final Grading

A >= 90, B >= 80, C > = 70, D > = 60

Overall: *Homework 6%, Quizzes 12%, Lab 35 %, Project 20%, Test1 12%, Final Exam 15 %(Comprehensive)*

Details are shown in the following table.

Assignment	Weight for each	Nbr. of assignments	Overall
Homework	1%	7	7%
Quiz	2%	7	14%
Lab reports	5%	7	35%
Final Project	17%	1	17%
Test	12%	1	12%
Final Exam	15%	1	15%
Total:			100%

Grading for missed assignment due to an emergency: For missed assignments due to an emergency or a foreseeable event, students must fill out the missed assignments form and email the form along with written documentations from a 3rd party. **The missed assignment form must be emailed to the instructor on Monday November 23, 2019.** Final exam grade will be used in lieu of the missed assignment to calculate final grading.

Late lab reports will be accepted with a reduction of 20% per day.
Extra credit work will be given during the semester. It will be announced publicly to all the students in the same manner. There will not be extra credit for an individual or group of students. Both the midterm and final grading use the same formula, scale, and weights.

COURSE GUIDELINES

Please use your UT student email address (XX@Rockets.Utoledo.edu) for all your communications. The subject line must be***: EET3350 LastName Keyword***. E.g.: subject: EET3350 Mubenga Homework4. Homework assignments are accepted only before or on the assigned day. Homework is graded on correctness. The final answer alone is not enough to get credit. Solution steps must be shown to get credit.

When not done in person, preferred communication between the instructor and students will take place via BlackBoard and email to a student's Rocket email address. While the instructor will not communicate via email on a regular basis throughout the semester, it is advisable that students check their BlackBoard and email regularly so as to keep abreast of any special instructions, clarifications on assignments or cancellations that may occur during the term

SAFETY AND HEALTH SERVICES FOR UT STUDENTS

http://www.utoledo.edu/offices/provost/utc/docs/CampusHealthSafetyContacts.pdf

COURSE, ASSIGNMENTS, AND HANDS-ON ACTIVITIES SCHEDULES

No Class Dates: September 2, October 10-11, November 11, November 27-29.
Test Date: Wednesday, October 2nd, 2019 4.00PM-5.20PM
Final Exam Date: Wednesday December 11, 2019 5PM-7PM PL2400

Course Schedule (Subject to Change depending on the course progress)

Week No.	Course Content	Assessment
1	Embedded Systems, Embedded System Architecture	Homework
2	Digital Logic	Quiz
3	ARM Machine Language, Assembly and C language programming	Homework, Lab
4	I/O Port Interfacing	Quiz, Lab
5	Switches and LED Interfacing	Homework, Lab
6	Review	Test
7	Software Design and Development	
8	PCB Design and fabrication	Homework, Quiz, Lab
9	Array and Functional Debugging	Homework, Quiz, Lab
10	Finite State Machine , Phase-Lock-Loop	Homework, Lab
11	Serial communication UART	Homework, Quiz, Lab
12	I/O Synch. & Interrupts	Homework, Lab
13	Analog/Digital Conversion (ADC and DAC)	Quiz
14	Entrepreneurial Minded Learning + Project based learning	Quiz
15	Final projects presentations	Final Project
16	All	Final Test

Assignment Schedule (Subject to Change depending on the course progress)

Date	Week	Read Ebook	Test	Homework	Posted on	Due on	Quiz	Due Wed.
26-Aug	1	chap 2, 3		ch2/3	26-Aug	28-Aug		
2-Sep	2	chap 4					ch2/3	4-Sep
9-Sep	3	chap 5		ch4/5	9-Sep	16-Sep		
16-Sep	4	chap 6					ch4/5	18-Sep
23-Sep	5	chap 6/8		ch6/8	23-Sep	7-Oct		
30-Sep	6	Review	Test					
7-Oct	7	chap 8/ 7					ch6/8	9-Oct
14-Oct	8	Handout		PCB	14-Oct	21-Oct		
21-Oct	9	9.1-9.5		ch7/9	21-Oct	28-Oct	PCB quiz	23-Oct
28-Oct	10	10.1-10.5					ch7/9	30-Oct
4-Nov	11	11.1-11.5		ch10/11	4-Nov	13-Nov		
11-Nov	12	chap 12/13		ch12/13	13-Nov	18-Nov	ch10/11	13-Nov
18-Nov	13	14 + Review					ch12/13	20-Nov
25-Nov	14	Team Mtg.						
2-Dec	15	Presentations						
9-Dec	16		Final					

Hands-on Activities Schedule (Subject to Change depending on the course progress)

Date	Experiment/Lab	Final Project Milestone due Monday of the week
26-Aug	Lab Intro: Syllabus + safety + team	
2-Sep	NO LAB	
9-Sep	Exp 1: NXT 2.0 Lab/-Build and program a robot	Team (4 max), topic, project plan due
16-Sep	Exp 2: Lab 0 - Intro to Keil and TM4C123	
23-Sep	Exp 3: Lab 1- Simulated i/o	
30-Sep		
7-Oct	Exp 4: Lab 2 - Hardware i/o interface	
14-Oct	Exp 5: Lab 3- LED interface /Panic button	Background, pseudocode, flowchart due
21-Oct	Exp 6: PCB Design and fabrication	
28-Oct	Exp 7: Lab 4- Switch + LED	Keil Simulation, circuit diagram, PCB schematic+ layout due
4-Nov	Group exercise: Traffic lights- FSM	
11-Nov		
18-Nov		Selection of presentation time
25-Nov	Mandatory Team Meeting	Mandatory Team Meeting
2-Dec	Final Project Presentation + Report due	Final Project Presentation + Report due
9-Dec		

OBOR/ TAG Student Learning Outcomes (SLO) Total Time

1. Explain microprocessor architecture.
2. Utilize assembly language programming to develop code for a microprocessor.
3. Explain and utilize bus timing diagrams.
4. Demonstrate an understanding of and applications for bus structures.
5. Utilize memory technologies and interfacing in microprocessors.
6. Implement input/output (I/O) systems, I/O interface requirements, and interrupt based I/O.
7. Utilize direct memory access (DMA) in microprocessor applications.
8. Utilize microprocessors/microcontrollers in a variety of applications.

SLO Number	Chapters and Topics	Time on each SLO
1	Chap 2 Fundamental Concepts Chap 3 Electronics Chap 6 Microcontroller ports Chap 8 Switches and LEDs Chap 11 UART – The Serial Interface Chap 12 Interrupts Chap 13 DAC and Sound Chap 14 ADC and Data Acquisition	12.9% (7)
2.	Chap 2 Fundamental Concepts Chap 4 Digital Logic Chap 5 Introduction to C Chap 6 Microcontroller ports Chap 7 Design and Development Chap 8 Switches and LEDs Chap 9 Array and Functional Debugging	22 %(12)
3.	Chap 11 UART – The Serial Interface Chap 12 Interrupts	7% (3.75)
4.	Chap 2 Fundamental Concepts Chap 6 Microcontroller ports Chap 8 Switches and LEDs Chap 11 UART – The Serial Interface Chap 12 Interrupts	8.3% (4.5)
5.	Chap 9 Array, Time and Functional Debugging Chap 12 Interrupts	10.2% (5.5)
6.	Chap 2 Fundamental Concepts Chap 3 Electronics Chap 4 Digital Logic Chap 5 Introduction to C Chap 6 Microcontroller ports Chap 7 Design and Development Chap 8 Switches and LEDs Chap 9 Array and Functional Debugging Chap 10 Finite state machine Chap 11 UART – The Serial Interface Chap 12 Interrupts Chap 13 DAC and sound Chap 14 ADC and Data Acquisition Handout PCB design and fabrication	33% (18)

7.	Chap 12 Interrupts	1% (0.5)
8.	Chap 2 Fundamental Concepts Chap 3 Electronics Chap 4 Digital Logic Chap 5 Introduction to C Chap 6 Microcontroller ports Chap 7 Design and Development Chap 8 Switches and LEDs Chap 9 Array and Functional Debugging Chap 10 Finite state machine Chap 11 UART – The Serial Interface Chap 12 Interrupts Chap 13 DAC and sound Chap 14 ADC and Data Acquisition	5.6 % (3.25)

I have received and read the syllabus.

Student Name…….

Signature……Date……..