**The University of Texas at Tyler**
**Department of Electrical Engineering**

**EENG 4307: Microprocessors and Embedded Systems (required)**

**Syllabus**

Catalog Description:

Microprocessor architecture, programming and interfacing. Introduction to assembly language programming; Microcomputers, microcontrollers, instruction set, chip interfacing, addressing modes, interrupts, input/output, communication. Hardware/software interfacing and embedded systems applications. Three hours of lecture per week with integrated laboratory sessions. **Prerequisites:** EENG 3302 and COSC 1336

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| Prerequisites: | EENG 3302 - Digital Systems Design, COSC 1336 – Programming Fundamentals |
| Credits: | ( 2 hours lecture, 3 hours laboratory per week ) |
| Text(s): | Yifeng Zhu, **Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C, 4th ed**. E-Man Press LLC, 2023. ISBN-13: 978-0982692677 |
| Additional Material: | Nucleo-64 development board with STM32L476RG (NUCLEO-L476RG) (http://www.st.com/en/evaluation-tools/nucleo-l476rg.html). USB cable and electronics kit parts. Keil MDK-ARM development tools on Windows 10 computer. Laboratory projects are integrated to provide students with hands-on experience. |
| Course Coordinator: | Mukul V. Shirvaikar, Professor |

Topics Covered: (paragraph of topics separated by semicolons)

Microcomputer Fundamentals: number systems, codes, digital circuits, memory devices, and introduction to computers; Microprocessors: elements, structure, operation, memory, bus architecture, and instruction set; Microcomputer Programming: assembly language, arithmetic operations, decisions, loops, tables, lists, subroutines, and interrupts; Microcomputer Interfacing: input/output modes, serial and parallel interfaces, synchronous and asynchronous communication. Hardware/software interfacing and embedded systems applications.

Evaluation Methods: (only items in dark print apply):

1. Examinations/ Quizzes
2. Homework
3. Report/ Paper
4. Computer Programming
5. Project/ Model
6. Presentation
7. Course Participation
8. Peer Evaluation

Course Learning Outcomes[1]: By the end of this course students will be able to:

1. Solve problems involving conversions between decimal, binary, octal and hexadecimal number systems, signed numbers, arithmetic operations, floating point numbers and representation standards [1]
2. Understand the operation of basic digital systems in the context of microcontroller design including parallel/serial transmission, tri-state logic, clocking, flip-flops and registers, data bus operation [1]
3. Demonstrate knowledge of memory systems including architecture, operation, types, read/write cycles, timing diagrams, applications and techniques to expand word size and capacity [1]
4. Explain the basic operational principles of microprocessors and microcontrollers including architecture, instruction formats, machine language, program and data sections, firmware, step-wise program execution detail and the fetch-decode-execute cycle [1]
5. Design complete and partial address decoding schemes for the microcontroller using memory modules, memory maps, read/write timing and logic components like decoders and tri-state buffers [1]
6. Identify and explain the microcontroller operation from functional block diagrams including: register section, ALU, timing and control, multiplexed buses, pinout, modes of operation and signals [3]
7. Analyze the various types of microcontroller assembly language instructions including addressing modes, processor condition codes, speed of operation and analysis of programs or code segments [3]
8. Outline the operation of an assembler and implement the entire process of writing, compiling, loading and running an assembly language program [3]

9. Illustrate the following concepts and their implementation on the microcontroller: stack operation, interrupt service routines, reset vectors, memory maps, time delay routines [1]
10. Formulate microcontroller input-output solutions utilizing general purpose I/O, interrupts and the timer subsystem [3]
11. List input/output interfacing solutions for issues like voltage mismatch, implementation technology mismatch, power requirements, isolation from electrical loads, and parallel/serial interfacing [1]
12. Implement microcontroller applications using peripherals like the serial interface and the analog-to-digital convertor (ADC) subsystem [3]
13. Incorporate information gained by independent learning from microcontroller technical reference manuals and other sources to implement projects and enhance reports [3]
14. Utilize modern software and hardware tools and techniques to design, debug and test microcontroller based projects using assembly language programming [4]
15. Perform laboratory experiments utilizing microcontroller systems demonstrating combined hardware-software interaction, co-design and debugging [3]
16. Write laboratory reports with experimental results demonstrating visual and written communication skills [3]

[1]*Numbers in brackets refer to method(s) used to evaluate the course objective.*

Relationship to Student Outcomes (only items in dark print apply) [2]: This course supports the following Electrical Engineering Student Outcomes, which state that our students will possess:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics [1-4, 6, 7, 9, 11]
2. 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 [5, 10]
3. an ability to communicate effectively with a range of audiences [16]
4. 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 [16]
5. 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
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions [8, 12, 14, 15]
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies. [13]

[2]*Numbers in brackets refer to course learning outcome(s) that address the Program Outcome.*

Contribution to Meeting Professional Component: (in semester hours)

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|---|---|---|
| Mathematics and Basic Sciences: | | hours |
| Engineering Sciences and Design: | 3 | hours |
| General Education Component: | | hours |

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| Prepared By:<br>Modified By: | Mukul V. Shirvaikar | Date: | January 5, 2021<br>January 4, 2022<br>January 1, 2023<br>January 1, 2024 |

**The University of Texas at Tyler**
**Department of Electrical Engineering**

# EENG 4307: Microprocessors and Embedded Systems
**2024 Spring Semester**

## COURSE OUTLINE


Course Coordinator: Dr. Mukul V. Shirvaikar, Electrical Engineering
Office: RBN 2014
Phone: 903-565-5620
E-mail: mshirvaikar@uttyler.edu
Website: http://www.uttyler.edu/ee


Class Location/Time: RBS 2019
11:00AM-11:55AM T R
Laboratory – RBN 2021 or Zoom (Two-way interactive) /
2:00PM-4:45PM T

Office Hours: Zoom (Two-way interactive) / 10:00AM-11:00AM T R
4:00PM-5:00PM W or by appointment

Grading Policy:

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|---|---|
| Quizzes | 25% |
| Mid-Term Examination | 25% |
| Laboratory Projects | 25% |
| Final Examination | 25% |

**Note:** Students are required to submit all lab reports to obtain a passing grade in the class. Instructor reserves the right to modify the above grading policy including final grade thresholds at any point of time.

Semester Schedule:

| WEEK | DATE | TOPICS COVERED | READING ASSIGNMENT |
|---|---|---|---|
| **1** | 15-Jan-2024 | **1.** See a Program Running | Chapter 1 |
| **2** | 22-Jan-2024 | **1.** See a Program Running | Chapter 1 |
| **3** | 29-Jan-2024 | **2.** Data Representation | Chapter 2 |
| **4** | 5-Feb-2024 | **2.** Data Representation | Chapter 2 |
| **5** | 12-Feb-2024 | **3.** ARM Instruction Set Architecture | Chapter 3 |
| **6** | 19-Feb-2024 | **4.** Arithmetic and Logic | Chapter 4 |
| **7** | 26-Feb-2024 | **5.** Load and Store | Chapter 5 |
| **8** | 4-Mar-2024 | **6.** Branch and Conditional Execution | Chapter 6 |
| **9** | 11-Mar-2024 | **SPRING BREAK** | |
| **10** | 18-Mar-2024 | **14.** GPIO<br>**Midterm Review**<br>**MIDTERM EXAM**<br>**Tuesday, Mar. 19** | Chapter 14 |
| **11** | 25-Mar-2024 | **7.** Structured Programming | Chapter 7 |
| **12** | 1-Apr-2024 | **8.** Subroutines | Chapter 8 |
| **13** | 8-Apr-2024 | **10.** Mixing C and Assembly | Chapter 10, 16 |
| **14** | 15-Apr-2024 | **11.** Interrupts | Chapter 11 |

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| **15** | 22-Apr-2024 | **14.** Memory-mapped I/O | Chapter 14, 22 |
| **16** | 29-Apr-2024 | **FINAL EXAM**<br>**Tuesday, April 30, 11:00AM-1:00PM** | |

NOTE: Please maintain a class folder with all your work including class notes, homework and lab assignments, quizzes, and mid-term exam.

## Computer Equipment Policy:

In order to take this class, integrated laboratory sessions and quizzes/exams, you will need the following items as specified below:

- Windows 10 Computer or Mac running Windows virtualization software
- High-speed Internet connection
- Webcam (internal or external)
- NI Multisim software

| Type | Minimum | Recommended |
|---|---|---|
| Web Camera | 640×480 resolution | 1280×720 resolution |
| PC Users | Windows Vista | Windows 10 (10 S is not supported) |
| Mac Users | OS X 10.5 or higher | OS X 10.13 High Sierra |
| Internet Download Speed | .768 Mbps | 1.5 Mbps |
| Internet Upload Speed | .384 Mbps | 1 Mbps |
| RAM | 1024 MB | 2 GB |
| Ports | 1935, 843, 80, 443, 61613, UDP/TCP | 1935, 843, 80, 443, 61613, UDP/TCP |

## Homework, Examination and Lab Project Policy:

Homework and project reports will be due in Canvas one week after assignment. Project reports should be written as per the guidelines provided. A 25% penalty will be assessed for missing the submission deadline and an additional 25% penalty will apply per week for late project reports and homework. Any deviation from this rule will be at the sole discretion of the instructor.

**All submissions are required to be in Microsoft Word format with machine readable text and not images or other representations of text. This rule will be applied to all sections of the report including the appendices and program code with comments. All flowcharts and diagrams must be prepared using Microsoft Office and not by hand. Any attempts to defeat the plagiarism checking software by submission of documents that include images instead of body text or any other mechanism will result in a grade of zero. The instructor or responsible grader reserves all rights to make this judgement and reject a project report if the above rules are not followed. Any violations may result in ACADEMIC DISHONESTY charges to be filed against the student.**

Student waives all rights to a make-up exam if they miss a scheduled testing date. Any make-up testing will be at the sole discretion of the instructor.

## Academic Integrity:

Students should be aware that absolute academic integrity is expected of every student in all undertakings at The University of Texas at Tyler. Failure to comply can result in strong university-imposed penalties. **All lab reports and assignments will be verified using plagiarism checking software and violations will result in a grade of zero for the lab report or assignment at a minimum, and possibly stronger penalties such as a failing grade in the course and a scholastic dishonesty report submitted to the university.**

## Proctoring

The assessments in this online course will be proctored using ProctorU or two-way interactive Zoom sessions. Beyond the cost of initial equipment needed (e.g. a camera for your computer),

there will not be any additional cost for proctoring. You will need to create a ProctorU account and install the ProctorU extension before attempting any assessment.

To create a ProctorU account, follow the ProctorU tool within Canvas. Please make sure you are using the current version of Chrome or Firefox and download the ProctorU extension available at http://bit.ly/proctoruchrome or https://www.proctoru.com/firefox.

In order to use ProctorU, you will need the following:

- High-speed Internet connection
- Webcam (internal or external)
- Windows, Mac, or Chrome Operating System
- Up-to-date Chrome or Firefox browser and ProctorU extension installed
- Valid photo ID
- Quiet environment to take your assessment

You can visit the Test Taker Resource Page for additional information at https://bit.ly/ProctorMe

**UT Tyler Honor Code**
Every member of the UT Tyler community joins together to embrace: Honor and integrity that will not allow me to lie, cheat, or steal, nor to accept the actions of those who do.

**Students Rights and Responsibilities**
To know and understand the policies that affect your rights and responsibilities as a student at UT Tyler, please follow this link: http://www.uttyler.edu/wellness/rightsresponsibilities.php

**Campus Carry**
We respect the right and privacy of students 21 and over who are duly licensed to carry concealed weapons in this class. License holders are expected to behave responsibly and keep a handgun secure and concealed. More information is available at http://www.uttyler.edu/about/campus-carry/index.php

**UT Tyler a Tobacco-Free University**
All forms of tobacco will not be permitted on the UT Tyler main campus, branch campuses, and any property owned by UT Tyler. This applies to all members of the University community, including students, faculty, staff, University affiliates, contractors, and visitors.

Forms of tobacco not permitted include cigarettes, cigars, pipes, water pipes (hookah), bidis, kreteks, electronic cigarettes, smokeless tobacco, snuff, chewing tobacco, and all other tobacco products.

There are several cessation programs available to students looking to quit smoking, including counseling, quitlines, and group support. For more information on cessation programs please visit www.uttyler.edu/tobacco-free.

**Grade Replacement/Forgiveness and Census Date Policies**
Students repeating a course for grade forgiveness (grade replacement) must file a Grade Replacement Contract with the Enrollment Services Center (ADM 230) on or before the Census Date of the semester in which the course will be repeated. Grade Replacement Contracts are available in the Enrollment Services Center or at http://www.uttyler.edu/registrar. Each semester's Census Date can be found on the Contract itself, on the Academic Calendar, or in the information pamphlets published each semester by the Office of the Registrar.

Failure to file a Grade Replacement Contract will result in both the original and repeated grade being used to calculate your overall grade point average. Undergraduates are eligible to exercise grade replacement for only three course repeats during their career at UT Tyler; graduates are eligible for two grade replacements. Full policy details are printed on each Grade Replacement Contract.

The Census Date is the deadline for many forms and enrollment actions of which students need to be aware. These include:

- Submitting Grade Replacement Contracts, Transient Forms, requests to withhold directory information, approvals for taking courses as Audit, Pass/Fail or Credit/No Credit.
- Receiving 100% refunds for partial withdrawals. (There is no refund for these after the Census Date)
- Schedule adjustments (section changes, adding a new class, dropping without a "W" grade)
- Being reinstated or re-enrolled in classes after being dropped for non-payment

- Completing the process for tuition exemptions or waivers through Financial Aid

**State-Mandated Course Drop Policy**

Texas law prohibits a student who began college for the first time in Fall 2007 or thereafter from dropping more than six courses during their entire undergraduate career. This includes courses dropped at another 2-year or 4-year Texas public college or university. For purposes of this rule, a dropped course is any course that is dropped after the census date (See Academic Calendar for the specific date).

Exceptions to the 6-drop rule may be found in the catalog. Petitions for exemptions must be submitted to the Enrollment Services Center and must be accompanied by documentation of the extenuating circumstance. Please contact the Enrollment Services Center if you have any questions.

**Disability/Accessibility Services**

In accordance with Section 504 of the Rehabilitation Act, Americans with Disabilities Act (ADA) and the ADA Amendments Act (ADAAA) the University of Texas at Tyler offers accommodations to students with learning, physical and/or psychological disabilities. If you have a disability, including a non-visible diagnosis such as a learning disorder, chronic illness, TBI, PTSD, ADHD, or you have a history of modifications or accommodations in a previous educational environment, you are encouraged to visit https://hood.accessiblelearning.com/UTTyler and fill out the New Student application.

The Student Accessibility and Resources (SAR) office will contact you when your application has been submitted and an appointment with Cynthia Lowery, Assistant Director of Student Services/ADA Coordinator. For more information, including filling out an application for services, please visit the SAR webpage at http://www.uttyler.edu/disabilityservices, the SAR office located in the University Center, # 3150 or call 903.566.7079.

**Student Absence due to Religious Observance**

Students who anticipate being absent from class due to a religious observance are requested to inform the instructor of such absences by the second class meeting of the semester.

Student Absence for University-Sponsored Events and Activities

If you intend to be absent for a university-sponsored event or activity, you (or the event sponsor) must notify the instructor at least two weeks prior to the date of the planned absence. At that time the instructor will set a date and time when make-up assignments will be completed.

**Social Security and FERPA Statement**

It is the policy of The University of Texas at Tyler to protect the confidential nature of social security numbers. The University has changed its computer programming so that all students have an identification number. The electronic transmission of grades (e.g., via e-mail) risks violation of the Family Educational Rights and Privacy Act; grades will not be transmitted electronically.

**Emergency Exits and Evacuation**

Everyone is required to exit the building when a fire alarm goes off. Follow your instructor's directions regarding the appropriate exit. If you require assistance during an evacuation, inform your instructor in the first week of class. Do not re-enter the building unless given permission by University Police, Fire department, or Fire Prevention Services.

**Student Standards of Academic Conduct**

Disciplinary proceedings may be initiated against any student who engages in scholastic dishonesty, including, but not limited to, cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts.

i. "Cheating" includes, but is not limited to:

- copying from another student's test paper;
- using, during a test, materials not authorized by the person giving the test;
- failure to comply with instructions given by the person administering the test;
- possession during a test of materials which are not authorized by the person giving the test, such as class notes or specifically designed "crib notes". The presence of textbooks constitutes a violation if they have been specifically prohibited by the person administering the test;
- using, buying, stealing, transporting, or soliciting in whole or part the contents of an unadministered test, test key, homework solution, or computer program;
- collaborating with or seeking aid from another student during a test or other assignment

without authority;

- discussing the contents of an examination with another student who will take the examination;
- divulging the contents of an examination, for the purpose of preserving questions for use by another, when the instructors has designated that the examination is not to be removed from the examination room or not to be returned or to be kept by the student;
- substituting for another person, or permitting another person to substitute for oneself to take a course, a test, or any course-related assignment;
- paying or offering money or other valuable thing to, or coercing another person to obtain an unadministered test, test key, homework solution, or computer program or information about an unadministered test, test key, home solution or computer program;
- falsifying research data, laboratory reports, and/or other academic work offered for credit;
- taking, keeping, misplacing, or damaging the property of The University of Texas at Tyler, or of another, if the student knows or reasonably should know that an unfair academic advantage would be gained by such conduct; and
- misrepresenting facts, including providing false grades or resumes, for the purpose of obtaining an academic or financial benefit or injuring another student academically or financially.

ii. "Plagiarism" includes, but is not limited to, the appropriation, buying, receiving as a gift, or obtaining by any means another's work and the submission of it as one's own academic work offered for credit.

iii. "Collusion" includes, but is not limited to, the unauthorized collaboration with another person in preparing academic assignments offered for credit or collaboration with another person to commit a violation of any section of the rules on scholastic dishonesty.

iv. All written work that is submitted will be subject to review by plagiarism software.

**UT Tyler Resources for Students**

- UT Tyler Writing Center (903.565.5995), writingcenter@uttyler.edu
- UT Tyler Tutoring Center (903.565.5964), tutoring@uttyler.edu
- The Mathematics Learning Center, RBN 4021, this is the open access computer lab for math students, with tutors on duty to assist students who are enrolled in early-career courses.
- UT Tyler Counseling Center (903.566.7254)

**Important Covid-19 Information for Classrooms and Laboratories**

Students are required to wear face masks covering their nose and mouth, and follow social distancing guidelines, at all times in public settings (including classrooms and laboratories), as specified by Procedures for Fall 2020 Return to Normal Operations. The UT Tyler community of Patriots views adoption of these practices consistent with its Honor Code and a sign of good citizenship and respectful care of fellow classmates, faculty, and staff.

Students who are feeling ill or experiencing symptoms such as sneezing, coughing, or a higher than normal temperature will be excused from class and should stay at home and may join the class remotely. Students who have difficulty adhering to the Covid-19 safety policies for health reasons are also encouraged to join the class remotely. Students needing additional accommodations may contact the Office of Student Accessibility and Resources at University Center 3150, or call (903) 566-7079 or email saroffice@uttyler.edu.

**Recording of Class Sessions**

Class sessions may be recorded by the instructor for use by students enrolled in this course. Recordings that contain personally identifiable information or other information subject to FERPA shall not be shared with individuals not enrolled in this course unless appropriate consent is obtained from all relevant students. Class recordings are reserved only for the use of students enrolled in the course and only for educational purposes. Course recordings should not be shared outside of the course in any form without express permission.