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

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)

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

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

The University of Texas at Tyler
Department of Electrical Engineering

EENG 4307: Microprocessors and Embedded Systems
2026 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: https://www.uttyler.edu/directory/electrical-engineering/shirvaikar.php

Class Location/Time:
RBN 2012
11:00AM-11:55AM T R
Laboratory – RBN 2021 2:00PM-4:45PM T

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

Grading Policy:
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 (*a grade of zero for the entire laboratory projects category will be enforced if all labs are not completed*). 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	13-Jan-2025	12-Jan-2026		**1.** See a Program Running
2	20-Jan-2025	19-Jan-2026		**1.** See a Program Running
3	27-Jan-2025	26-Jan-2026		**2.** Data Representation
4	3-Feb-2025	2-Feb-2026		**2.** Data Representation
5	10-Feb-2025	9-Feb-2026		**3.** ARM Instruction Set Architecture
6	17-Feb-2025	16-Feb-2026		**4.** Arithmetic and Logic
7	24-Feb-2025	23-Feb-2026		**5.** Load and Store
8	3-Mar-2025	2-Mar-2026		**6.** Branch and Conditional Execution
9	10-Mar-2025	9-Mar-2026		**SPRING BREAK**
10	17-Mar-2025	16-Mar-2026		**14.** GPIO **Midterm Review MIDTERM EXAM Tuesday, Mar. 17**
11	24-Mar-2025	23-Mar-2026		**7.** Structured Programming
12	31-Mar-2025	30-Mar-2026		**8.** Subroutines
13	7-Apr-2025	6-Apr-2026		**10.** Mixing C and Assembly

14	14-Apr-2025	13-Apr-2026	**11.** Interrupts
15	21-Apr-2025	20-Apr-2026	**14.** Memory-mapped I/O
16	28-Apr-2025	27-Apr-2026	**FINAL EXAM** **Tuesday, April 28,** **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

University Policies and Information

Withdrawing from Class

Students may withdraw (drop) from this course using the Withdrawal Portal. Withdrawing (dropping) this course can impact your Financial Aid, Scholarships, Veteran Benefits, Exemptions, Waivers, International Student Status, housing, and degree progress. Please speak with your instructors, consider your options, speak with your advisor, and visit the One-Stop Service Center (STE 230) or email enroll@uttyler.edu to get a complete review of your student account and the possible impacts to withdrawing. We want you to make an informed decision. UT Tyler faculty and staff are here for you and often can provide additional support options or assistance. Make sure to carefully read the implications for withdrawing from a course and the instructions on using the Withdrawal portal..

Texas law prohibits students from dropping more than six courses during their entire undergraduate career*. The six courses dropped includes those from other 2-year or 4-year Texas public colleges and universities. Consider the impact withdrawing from this class has on your academic progress and other areas, such as financial implications. We encourage you to consult your advisor(s) and Enrollment Services for additional guidance. **CAUTION #1**: Withdrawing before census day does not mean you get a full refund. Please see the Tuition and Fee Refund Schedule. **CAUTION #2**: All international students must check with the Office of International Programs before withdrawing. All international students are required to enroll full-time for fall and spring terms. **CAUTION #3:** All UT Tyler Athletes must check with the Athletic Academic Coordinator before withdrawing from a course. CAUTION #4: All veterans or military-affiliated students should consult with the Military and Veterans Success Center.

* Students who began college for the first time before 2007 are exempt from this law.

Artificial Intelligence Statement

UT Tyler is committed to exploring and using artificial intelligence (AI) tools as appropriate for the discipline and task undertaken. We encourage discussing AI tools' ethical, societal, philosophical, and disciplinary implications. All uses of AI should be acknowledged as this aligns with our commitment to honor and integrity, as noted in UT Tyler's Honor Code. Faculty and students must not use protected information, data, or copyrighted materials when using any AI tool. Additionally, users should be aware that AI tools rely on predictive models to generate content that may appear correct but is sometimes shown to be incomplete, inaccurate, taken without attribution from other sources, and/or biased.
Consequently, an AI tool should not be considered a substitute for traditional approaches to

research. You are ultimately responsible for the quality and content of the information you submit. Misusing AI tools that violate the guidelines specified for this course is considered a breach of academic integrity. The student will be subject to disciplinary actions as outlined in UT Tyler's Academic Integrity Policy.

For this course, **AI is not permitted in this course at all.** I expect all work students submit for this course to be their own. I have carefully designed all assignments and class activities to support your learning. Doing your own work, without human or artificial intelligence assistance, is best for your efforts in mastering course learning objectives. For this course, I expressly forbid using ChatGPT or any other artificial intelligence (AI) tools for any stages of the work process, including brainstorming. Deviations from these guidelines will be considered a violation of UT Tyler's Honor Code and academic honesty values.

The work submitted by students in this course will be generated by themselves. This includes all process work, drafts, brainstorming artifacts, editing, and final products. This extends to group assignments where students must create collaboratively create the project. Any instance of the following constitutes a violation of UT Tyler's Honor Code: a student has another person/entity do any portion of a graded assignment, which includes purchasing work from a company, hiring a person or company to complete an assignment or exam, using a previously submitted assignment and/or using AI tools (such as ChatGPT).

Final Exam Policy
Final examinations are administered as scheduled. If unusual circumstances require that special arrangements be made for an individual student or class, the Dean of the appropriate college, after consultation with the faculty member involved, may authorize an exception to the schedule. Faculty members must maintain student final examination papers for a minimum of three months following the examination date.

Incomplete Grade Policy
If a student, because of extenuating circumstances, is unable to complete all of the requirements for a course by the end of the semester, then the instructor may recommend an Incomplete (I) for the course. The "I" may be assigned in place of a grade *only when **all** of the following conditions are met*: (a) the student has been making satisfactory progress in the course; (b) the student is unable to complete all coursework or final exam due to unusual circumstances that are beyond personal control and are acceptable to the instructor, and (c) the student presents these reasons before the time that the final grade roster is due. The semester credit hours for an Incomplete will not be used to calculate the grade point average.

The student and the instructor must submit an Incomplete Form detailing the work required and the time by which the work must be completed to their respective department chair or college dean for approval. The time limit established must not exceed one year. Should the student fail to meet all of the work for the course within the time limit, then the instructor may assign zeros to the unfinished work, compute the course average for the student, and assign the appropriate grade. If a grade has yet to be assigned within one year, then the Incomplete will be changed to an F, or NC. If the course was initially taken under the CR/NC grading basis, this may adversely affect the student's academic standing.

Grade Appeal Policy
Disputes regarding grades must be initiated within sixty (60) days from the date of receiving the final course grade by filing a Grade Appeal Form with the instructor who assigned the grade. A grade appeal should be used when the student thinks the final course grade awarded does not reflect the grades earned on assessments or follow the grading scale as documented in the syllabus. The student should provide the rationale for the grade appeal and attach supporting document about the grades earned. The form should be sent via email to the faculty member who assigned the grade. The faculty member reviews the rationale and supporting documentation and completes the instruction section of the form. The instructor should return the form to the student, even if a grade change is made at this level. If the student is not satisfied with the decision, the

student may appeal in writing to the Chairperson of the department from which the grade was issued. In situations where there is an allegation of capricious grading, discrimination, or unlawful actions, appeals may go beyond the Chairperson to the Dean or the Dean's designee of the college from which the grade was issued, with that decision being final. The Grade Appeal form is found in the Registrar's Form Library.

NOTE: The Grade Appeal Form is different from the Application for Appeal form submitted to the Student Appeals Committee, which does not rule on grade disputes as described in this policy.

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 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 the Assistant Director Student Accessibility and Resources/ADA Coordinator. For more information, including filling out an application for services, please visit the SAR webpage at https://www.uttyler.edu/disability-services, the SAR office located in the Robert Muntz Library, LIB 460, email saroffice@uttyler.edu, or call 903.566.7079."

Military Affiliated Students
UT Tyler honors the service and sacrifices of our military-affiliated students. If you are a student who is a veteran, on active duty, in the reserves or National Guard, or a military spouse or dependent, please stay in contact with your faculty member if any aspect of your present or prior service or family situation makes it difficult for you to fulfill the requirements of a course or creates disruption in your academic progress. It is important to make your faculty member aware of any complications as far in advance as possible. Your faculty member is willing to work with you and, if needed, put you in contact with university staff who are trained to assist you. The Military and Veterans Success Center (MVSC) has campus resources for military-affiliated students. The MVSC can be reached at MVSC@uttyler.edu or via phone at 903.565.5972.

Students on an F-1 Visa
To remain in compliance with Federal Regulations requirements you must do the following:
- Traditional face-to-face classes: Attend classes on the regular meeting days/times.
- Hybrid Classes: Attend all face-to-face classes convened by the instructor according to the schedule set for your specific course.
- Online course: Only one online course can count toward your full-time enrollment. Students are expected to be fully engaged and meet all requirements for the online course.

Academic Honesty and Academic Misconduct
The UT Tyler community comes together to pledge that "Honor and integrity will not allow me to lie, cheat, or steal, nor to accept the actions of those who do." Therefore, we enforce the Student Conduct and Discipline policy in the Student Manual Of Operating Procedures (Section 8).

FERPA
UT Tyler follows the Family Educational Rights and Privacy Act (FERPA) as noted in University Policy
5.2.3. The course instructor will follow all requirements to protect your confidential information.

Absence for Official University Events or Activities
This course follows the practices related to Excused Absences for University Events or Activities as noted in the Catalog.

Absence for Religious Holidays

This course follows the practices related to Excused Absences for Religious Holy Days as noted in the Catalog.

Absence for Pregnant Students

This course follows the requirements of Texas Laws SB 412, SB 459, SB 597/HB 1361 to meet the needs of pregnant and parenting students. Part of the supports afforded pregnant students includes excused absences. Faculty who are informed by a student of needing this support should make a referral to the Parenting Student Liaison. NOTE: Students must work with the Parenting Student Liaison in order to receive these supports. Students should reach out to the Parenting Student Liaison at parents@uttyler.edu and also complete the Pregnant and Parenting Self-Reporting Form.

Campus Carry

We respect the right and privacy of students 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.

Student Resources:

Resources to assist you in the course

- UT Tyler Student Accessibility and Resource (SAR) Office (provides needed accommodations to students with document needs related to access and learning)
- UT Tyler Writing Center
- The Mathematics Learning Center
- UT Tyler PASS Tutoring Center
- UT Tyler Supplemental Instruction
- Upswing (24/7 online tutoring) - covers nearly all undergraduate course areas
- Robert Muntz Library and Library Liaison

- Canvas 101 (learn to use Canvas, proctoring, Unicheck, and other software)
- Digital Support Toolkit (for supported courses only. Students are automatically enrolled in the toolkit for supported courses)
- LIB 422 -- Computer Lab where students can take a proctored exam
- The Career Success Center
- UT Tyler Testing Center
- Office of Research & Scholarship Design and Data Analysis Lab

Resources available to UT Tyler Students

- UT Tyler Counseling Center (available to all students)
- MySSP App (24/7 access to Student Support Program counseling through phone or chat and online wellness resources available in a variety of languages)
- Student Assistance and Advocacy Center
- Military and Veterans Success Center (supports for our military-affiliated students)
- UT Tyler Patriot Food Pantry
- UT Tyler Financial Aid and Scholarships
- UT Tyler Student Business Services (pay or set up payment plans, etc.)
- UT Tyler Registrar's Office
- Office of International Programs
- Title IX Reporting
- Patriots Engage (available to all students. Get engaged at UT Tyler.)