

ENGR 355 - Embedded System Design
Walla Walla University - School of Engineering
Winter 2022

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Textbook: Embedded Systems Fundamentals with ARM Cortex-M based Microcontrollers
(required) by Alexander G. Dean. Arm Education Media, 2017

Also, NXP product literature (data sheets) and handouts will be used.

Prerequisites: CPTR-280 Assembly Language Programming, ENGR 228 Circuit Analysis, and ENGR-354 Digital Logic

Location: Class will typically meet in CSP-164 at 2pm on Monday and Friday and in CSP-316 (the digital lab) Wednesday 2-5pm.

General: This class is an introduction to the design of digital systems that have within them a microprocessor or microcontroller where the function or purpose of the digital system is not general purpose computing. Modern appliances, equipment that has user controlled features, Internet of Things (IOT) devices, etc. almost always have an embedded processor. Thus the concepts and theory of this class are widely applicable.

Bulletin: Design of embedded microprocessor systems; system organization, CPU structures, address decoding and memory design, interrupts, real-time operating systems, input/output; hardware/software co-design. Laboratory work required

Objectives: - Understand basic operation of microprocessors and microcontrollers.
- Be able to design hardware for a digital system that incorporates a microprocessor or microcontroller.
- Understand digital circuit interfacing, voltages and currents.
- Be able to design, implement, and test software for an embedded system that does not depend on operating system resources.
- Design, construct, test, and debug an embedded system, both hardware and software.

Handouts: Handouts may be given and unless stated otherwise, **you are expected to treat handouts as part of the textbook, i.e. read and understand them.**

Class notes: Material may be presented in lecture that is not in the handouts. Take notes. This material is fair game for tests.

Project: This class incorporates a mix of project-based hands-on work with textbook

material to help you learn about embedded system design. We will use the Digital lab (CSP316) for designing and debugging hardware and software as well as schematic capture and circuit board layout. Here is more information about how we go about this:

Each student will work independently on various class and lab assignments whose purpose is to form building blocks that will culminate in a class project. More particulars on the specific class project will be provided as we work our way through the quarter.

Programming will be done in the C language. Although the ARM instruction set will be reviewed in class, it is assumed that you have already written programs in assembly language for some processor as well as C or C++ programs. You will be developing hardware and software in parallel.

We will use an NXP (Freescale) Kinetis series KL25Z micro controller. You will design a circuit and software using this processor based on a project definition. You will prototype the circuit using a FRDM-KL25Z development board, create initial software, and test your design. You will draw a schematic and layout a circuit board. You will solder parts onto a custom circuit board, check out board functionality, and complete application software to meet project requirements.

Lectures attempt to introduce material, give illustrations, provide a forum for questions and answers, and aid learning in general. You are expected to read assigned textbook material prior to coming to class. For detailed technical material like that encountered in a class of this nature, **it is not possible to cover every detail in class** or lab. As a working engineer, you routinely will need to read technical literature provided by the manufacturers and figure out how a device works (known as life-long learning). Therefore, **it is assumed that you will read and work through the assigned material until you understand it**. When stumped, bring questions to class, email or call the instructor, etc.

Homework: Homework is due at the start of class on the day it is due. Homework turned in after class starts will lose 10%. Late work should be avoided, but if submitted will be reduced an additional 10% per day up to one week, then no credit.

Hand written solutions are to be neatly printed on engineering paper using standard engineering format (see problem solution format handout). A ruler and/or a template should be used when drawing diagrams or schematics by hand.

Your work: I expect everything you turn in for grading to be your work and represent your understanding of the material. Homework, labs, or tests that include work that is not your own is cheating and will receive a score of zero. The only exception is a group or team assignment. At the instructor's discretion, cheating will be rewarded with an F as the **final grade** for the class.

- (your work continued) Recognizing that a cooperative study session may enhance understanding, here is my expectation. In general, sharing ideas and strategies verbally will be acceptable in the context of a study group but sharing written work is not. Validating your answers with the group after all members of the group have successfully completed a problem may be acceptable. A rule of thumb is that you need to be responsible for your own work meaning that you understand what you did, you could reproduce it on your own if asked, and you did not copy the solution from someone else or a solution manual.
- Lab: Wednesday 2pm to 5pm is considered lab time (although there could be days when it is shorter) and will meet in the digital lab.
- Lab Book: You will need a lab notebook. It does not need to have carbon pages but should be "bound". I accept spiral notebooks as bound. (It may be helpful if the book is large enough to tape/past in full size 8.5x11" printouts.)
- Grade composition: Homework, quizzes, in-class participation/presentations - 25%
Labs and project- 35%
Midterms - 40%
The instructor reserves the right to shift this distribution to best serve the needs of the class. Scoring generally follows 90,80,70,60% for A,B,C,D but scores may be curved when needed.
- Missed exams will receive a score of zero and cannot be made up. (Contact me prior to test time if illness prevents attendance). Attendance at the scheduled final exam time is required as part of the lab/project grade.
- Help: Out of class help from the instructor is available for those who attend class and thoroughly read the text and handouts (translation: please attend class regularly). If you have questions please come by my office, send email, or call me at the office or home (note the phone numbers at the top of the syllabus). I'm eager to help you but can only do so if you contact me.
- Web Site: I have a web page for this class, found at people.wallawalla.edu/~larry.aamodt/, that I will use for posting information. Homework assignments will be posted there (newest first) as well as reference material or links to additional reference material. Occasionally an assignment or lab needs clarification after it is handed out. Check the web page to see if additional information or changes have been posted (new notes appear at the top). Some homework will be turned in on paper in class and some may be turned in on D2L. The homework definition will state where to turn it in.
- Special needs: Students who have disabilities and desire special accommodation must determine the required accommodation in consultation with Disability Support Services (527-2366) and must also inform the instructor of this class.

Walla Walla University (WWU) is a Seventh Day Adventist institution of higher education

WWU Integrity policy:

On the WWU home page
[academics/academic-administration/academic-policies/academic-integrity-policy/](#)

WWU Emergency information

WWU is committed to having a safe campus. Emergency information is at:
www.wallawalla.edu/campus-life/student-life/campus-security

WWU Disability accommodations

In addition to phone number 527-2366, see:
www.wallawalla.edu/?id=4318

WWU Title IX sex discrimination and sexual misconduct policy

WWU prohibits all forms of sex discrimination and sexual misconduct including, but not limited to, sex-based intimidation and harassment, sexual harassment, domestic violence, dating violence, stalking and sexual violence. If you have been subjected to, or are aware of, an instance of sex discrimination or sexual misconduct, you are highly encouraged to report it to the Title IX coordinator, through the Title IX webpage, or by calling (509) 527-2141. The University has resources to help.

Title IX coordinator email address: cassandre.beccai@wallawalla.edu

Title IX web page:

www.wallawalla.edu/resources/human-resources-payroll/titleix/

Relationship of this class to the WWU core themes

Excellence in Thought

This class helps students develop ability to perform design that requires excellence in thought.

Generosity in Service

Course content does not directly address generosity in service although as an engineering professional there are opportunities to contribute professional service to the community.

Beauty in Expression

There is beauty in carefully crafted documentation that is clear, concise, and complete. Such is required in this class.

Faith in God

A life with inner peace comes through faith in God.

Religious accommodation

Consistent with Washington state policy, WWU reasonably accommodates a student for an absence of up to two days per academic year for reasons of faith or conscience, observance of religious holidays, or participation in an organized activity conducted by a religious denomination, church, or organization. The full policy and request form can be found on the WWU website.