Dordt University Engineering Department
EGR 304, Embedded Microcontroller Systems

Spring Semester, 2020

2019-20 Catalog Data	**Embedded Microcontroller Systems (4 credit hours)** ……Spring Even A course on the design of microcontroller-based systems and the associated software and hardware. Software issues such as modular design, interrupt driven I/O, and design for reliability are covered. Hardware issues such as serial and parallel interfacing, bus structures, grounding and shielding, and D/A and A/D conversions are also studied. Lab exercises provide design experience using a particular microcontroller or soft processor foundation in an FPGA. Prerequisites: Engineering 204, 220; Computer Science 115; or permission of instructor.
Textbook	Edward Ashford Lee & Sanjit Arunkumar Seshia, *Introduction to Embedded Systems: A Cyber-Physical Systems Approach*, 2nd edition, MIT Press 2017. Free download http://LeeSeshia.org
References	*Getting Started with Arduino Products*, https://www.arduino.cc/en/Guide/HomePage/ Derek Molloy, *Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux*, Wiley, 2016. Sedra and Smith, *Microelectronic Circuits*, Oxford Circuit Cellar magazine and Circuit Cellar Online. http://www.circuitcellar.com Nuts and Volts magazine. http://www.nutsvolts.com
Instructor	Douglas F. De Boer, Professor of Engineering, https://dfdeboer.github.io/ Office Phone: 712-722-6245; Office location: SB1638; Office hours—see link above. E-mail Douglas.DeBoer@Dordt.edu, Home Phone: 712-722-1414, call before 10 PM.
Course Objectives and Outcomes	*Creational Structure*: Students will design a system that uses an embedded processor. The design will incorporate input/output and a sensor to measure a physical quantity such as temperature, pressure, a radio signal, etc. This is a primary goal of this course. *Contemporary Response*: Students will consider the application of norms for the design of appropriate ergonomics for an I/O interface. *Creational Development*: Students will study the historical development of some standards, such as for serial interfacing, reflect on how these past developments now influence modern trends in computer engineering, and develop a professional demeanor toward new technology that recognizes technology's human origin.
Prerequisites by topic	Linear circuit analysis, elementary electronics, digital logic circuits, programming.
Laboratory	One or two design projects will be completed, each with a formal written report. Design projects may be proposed by the students but must be approved in advance by the instructor. Depending on the scope of the project work undertaken, there will also be a number of short lab exercises that are ungraded or may be graded as homework.
Computer use	An integrated development environment based on C, Java, Python or other computer language will be used for most projects. Students are encouraged (but not required) to use other software such as Mathcad or Matlab or PSpice, etc. where appropriate. All assignments and most handouts will be available via Dordt's course management system. Portions of this course's course management information are available to the world via a public Web portal at https://dfdeboer.github.io/S20/304S20.HTM
Academic Integrity	This course is subject to Dordt University's policies on academic integrity. https://www.dordt.edu/student-life/student-handbook/general-information#Academic%20Integrity Additional policies apply. They appear later in this syllabus and on the course's Canvas page.
Accommodations	Students who require assistance or accommodations based on the impact of a documented disability must contact the Coordinator of Services for Students with Disabilities to access accommodations. Contact Marliss Van Der Zwaag at the Academic Enrichment Center, Telephone 722-6490, e-mail Marliss.VanDerZwaag@dordt.edu
Means of Evaluation	Homework (10%), Two Tests (22% each) Laboratory Project(s) (22% total), Final Exam (24%) Most grades are curved. Professor De Boer grades using grade points on a scale from 4.00 to 0.00. Nominally, 4.00–3.75 =A, 3.7–3.45 = A–, 3.44–3.15 = B+, 3.14–2.85 = B, 2.84–2.50 = B–, 2.49–2.14 = C+, etc. For details, see https://dfdeboer.github.io/GDS.HTM
Role of this Course	This course is taught at the junior/senior level. It is required for students in the electrical and computer concentrations of the engineering major.

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Course Outline

Class meets for three 50-minute periods per week Monday, Wednesday, and Friday starting at Noon in room SB 2803.
The lab meets once a week for 180 minutes on Wednesdays starting at 2:00 PM in room SB 2803.

Class Dates (MWF, one row per wk.)			Class Topics	Laboratory (Proposed Schedule)
		1/10	Introduction to the course	
1/13	1/15	1/17	Microcontrollers & Microprocessors; Version Control	Introduction to Git
1/20	1/22	1/24	Ports, Digital I/O drivers interfacing strategies. Parallel I/O	Set up Arduino
1/27	1/29	1/31	Sensors, models of	Blind cycle I/O
2/03	2/05	2/07	Sensors, common examples	Set up Raspberry Pi
2/10	2/12	2/14	Actuators: Solenoids, motor types	Project I (week 1 of 4)
2/17	**2/19**	2/21	**Test #1, Wednesday 2/19**	Project I (week 2 of 4)
2/24	2/26	2/28	Interrupt driven I/O	Project I (week 3 of 4)
3/02	3/04		Interrupt driven I/O	Project I (week 4 of 4)
			(no class 3/06, 3/09, 3/11, 3/12, 3/16 Spring Break)	(no lab on 3/11)
	3/18	3/20	Motor control, PWM analog I/O	Project II (week 1 of 5)
3/23	**3/25**	3/27	Thyristors and AC load control **Project I Report due**	Project II (week 2 of 5)
3/30	4/01	4/03	Serial Interfacing—RS-232 and similar schemes	Project II (week 3 of 5)
4/06	**4/08**		**Test #2, Wednesday 4/08** (no class 4/10, 4/13, Easter Break)	Project II (week 4 of 5)
	4/15	4/17	Transmission lines	Project II (week 5 of 5)
4/20	**4/22**	4/24	Serial Interfacing—Ethernet **Project II Report due**	Transmission Lines
4/27	4/29	5/01	Serial Interfacing—USB; Memory Interfacing	(possible short lab)
Exam	**5/06**		**Final Exam, Wednesday 5/06, 10:30 AM – 12:30 PM**	

Prof. De Boer presents the above schedule as a probable example of the way the course might progress.
He reserves the right to make substantive changes in response to student interests and other opportunities.

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Note on the course outline

The course may vary considerably from the content shown on the previous page to accommodate student interests and abilities and other opportunities. The schedule shown is merely a reasonable projection based on past offerings of this course.

This is a messy course

It is the nature of embedded systems that some of the software and hardware we use may be incompletely or poorly documented and may have more bugs than found in typical commercial software sold to the general public. Developing a professional demeanor while dealing with bugs, poor documentation, and such, is a possible learning outcome of this course. It is very likely that students will encounter frustrating technical details that the professor has never seen before. This is because this class usually treads some new ground each time it is offered. We will work through these struggles together.

Some of the information from this point on is copied from the Student Handbook as per policy in Dordt University's "Syllabus Checklist." Additional information specific to this course (not in the Student Handbook) is in a serif typeface and has a black line down the left margin.

Academic Integrity

Dordt University is committed to developing a community of Christian scholars where all members accept the responsibility of practicing personal and academic integrity in obedience to biblical teaching. For students, this means not lying, cheating, or stealing others' work to gain academic advantage; it also means opposing academic dishonesty.

Academic Dishonesty. Students found to be academically dishonest will receive academic sanctions from their professor (from a failing grade on the particular academic task to a failing grade in the course), who will report the incident and the sanction given to the Student Life Committee for possible institutional sanctions (from a warning to dismissal from the university).

Appeals in such matters will be handled by the student disciplinary process as outlined in the Student Handbook.

Definitions

Academic dishonesty at Dordt University includes, but is not limited to, the following behaviors:

Stealing/Plagiarizing: copying another's work or ideas and creating the impression that they are one's own by failing to give proper credit or citation. This includes reading or hearing another's work or ideas and using them as one's own; quoting, paraphrasing, or condensing another's work without giving proper credit; purchasing or receiving another's work and using, handling, or submitting it as one's own work.

Cheating: unauthorized use of any study aids, equipment, or another's work during an academic task. This includes using unauthorized aids or other equipment during an examination; copying or looking at another individual's examination; taking or passing information to another individual during or after an examination; taking an examination for another individual; allowing another individual to take one's examination; stealing examinations.

All graded academic tasks are expected to be performed on an individual basis unless otherwise stated by the instructor.

An academic task may not be submitted by a student for course credit in more than one course without the permission of all instructors.

Lying/Fabricating: the intentional, unauthorized falsification or invention of any information or citation during an academic task. This includes changing or adding an answer on an examination and resubmitting it to change the grade; inventing data for a laboratory exercise or report.

Facilitating Academic Dishonesty: knowingly allowing or helping another individual to plagiarize, cheat, or fabricate information.

Students must do their own work. In Prof. De Boer's courses students may verbally discuss homework but may not show un-graded papers to each other. Detail on this policy can be found on the web at https://dfdeboer.github.io/S19/HWSTDS19.HTM#DYOW This policy applies to the whole course, not just homework.

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Attendance

Students are expected to be present for every class and laboratory period. Penalties for absence from class are left to the instructor. No designated number of skips is permitted.

Student Responsibility: Students shall notify each professor concerning the reason for absence prior to or immediately upon returning to class or in accordance with the instructor's method of accounting for absences. Students shall notify student services concerning all illnesses.

Unexcused absences are defined as failing to notify the instructor of the reason for the absence, or if the instructor deems the reason as illegitimate.

Faculty initiatives: The instructor may contact student services to check on the illness record of the students. They should also alert student services and contact the student directly concerning excessive absences, and must, if asked, report attendance patterns. Any instructor may, after due warning and according to guidelines established in the class syllabus, penalize the student by reducing the semester grade by a given percentage.

Student Services Responsibility: Normally, student services does not notify instructors concerning student illness. Student services may alert instructors to serious problems. Decisions to inform instructors about serious problems will be made balancing the need to respect confidentiality and the responsibility to keep instructors appropriately informed about their students. Any student with serious problems is strongly advised to work closely with student services and follow the process to insure adequate communication between all parties in as efficient a way as possible.

Excused Absence for Activities: Students have obligations in many realms, so special care shall be taken not to demand commitments for participation in extra-curricular events that cause neglect in other areas. Sponsors/coaches shall inform students from the beginning of the time and effort expected of them. Sponsors/coaches shall demand a minimum of absences from other classes, restrict student involvement to only those crucially involved, and make efforts to choose a time/date for the event that is least invasive of classroom or lab time. In the case of conflicts, resolution shall be the responsibility of the sponsor/coach and the instructor with no penalty to the student (The appeals process outlined in the section titled Complaints Regarding Instruction in the Student Handbook shall be used if needed). The sponsor shall email faculty and student services a list of names, dates, and activities in advance of the event. The student must contact the instructor and make arrangements for any missed work.

Professor De Boer expects to be notified at least a day in advance when you can reasonably be expected to have known that far in advance of a time when you will have to miss a class for a scheduled event of higher priority. In addition to the options listed above, missing classes without notification or for insubstantial reasons could be cause for being classified as an "uncooperative student" which could lead to dismissal from the course.

Late work

Be coachable. Start work early so you can ask questions in class, by telephone, by e-mail, and at the Professor's office. Anything handed in late will be accepted for possible grading, but no grade will be entered in the grade book, the work will not be returned to you, and the empty grade will function as a zero or an "F." Usually the item will never be graded. If, in the judgment of Prof. De Boer, grading the late item might improve the course grade, and if the reasons for the late work are acceptable and if there is no pattern of carelessness, then Prof. De Boer may choose to estimate a grade or actually grade the late work and enter the grade(s) in the grade book. Prof. De Boer may decide to estimate or fully grade a late item at any time after the item is handed in, but usually will do so at the end of the course after all student course activities are complete. Additionally, if a pattern of late work develops, Professor De Boer will warn the student. After that warning if the problem is not resolved, a reduced course grade might result, and/or the student may be classified as "uncooperative" which could lead to dismissal from the course.

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Missed tests, quizzes, exams or other in-class items that are graded

Professor De Boer announces his test schedule and major due dates for projects in the first week of classes. During the first two or three weeks of classes and possibly at other times, if there is good cause, students may negotiate to change the date(s) for the entire class to avoid a conflict for any one student. However, in the week before a test Prof. De Boer is very reluctant to negotiate the date. If you realize that you have a schedule conflict with a test date or other due date, discuss this with Prof. De Boer as soon as possible.

If you are late to a test or quiz you must still finish at the scheduled time.

When an in-class item is missed entirely due to unplanned absence from the classroom Professor De Boer does not give a make-up test or offer extra credit work or similar. If you miss an in-class event entirely (such as a test) the item will go in the grade book as a blank score which will count as an "F." At the end of the semester after all your course work is complete Prof. De Boer will reassess the situation and might choose to estimate what he thinks you might have earned based on any evidence he can find relevant to the situation. If an estimated grade is granted, it may still be discounted to a lower grade than the other tests and items you completed if negligence is a factor. A cell phone alarm accidentally set to PM instead of AM that causes you to miss an exam is an example of negligence. A dead cell-phone battery that causes you to miss the alarm is also negligence. If a test is missed due to illness (fever, nausea, etc., not just a "bad cold") then be sure to report the illness to student services before the test or during the test period or as early as is reasonable. If student services can verify your illness to Prof. De Boer, an estimated grade that is non-punitive will be given at the end of the semester.

Class Participation, Professionalism

Professor De Boer does not routinely grade class participation or professionalism. These are expected. If there is a problem, Prof. De Boer will talk about it privately with you. Lack of these can be a cause for adjusting your course grade downward, even to an "F," but if Professor De Boer has not discussed these matters privately with you, you can assume you are doing well enough that your course grade will not be adjusted due to these matters.

Description of assignments

Homework: Generally, a homework assignment will be due once each week. Expect the assignment to take about six hours to finish. Expect to have to ask for help to finish it. Make use of the telephone, e-mail or office hours to get help from the professor as you need it.

Projects. Some lab time will be available for projects. Much of what is done there involves kinesthetic and judgmental skills in using the equipment well, laying out prototype circuits, and interpreting observations. Situations for each student vary tremendously depending on a multiplicity of factors. It is not efficient to rely on grading as your only feedback for learning in the laboratory. Therefore, ask questions of professor De Boer as things happen. Get your feedback in real time, with no implications for your grade. The actual physical work you do in the laboratory will not be graded, but it will be the foundation for a report that will be graded. You should use the laboratory time as an opportunity to be coached. (Be Coachable.)

Your project grades will depend entirely on your project reports. Write your reports in ASME or IEEE style. The reports will be graded for style, completeness, and accuracy as described in the pamphlet "How to Write a Laboratory Report" which you will be provided to you.

(end of EGR 304 syllabus)