University of Nevada, Reno

UNIVERSITY OF NEVADA, RENO
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
CPE 406/606 - REAL TIME COMPUTING SYSTEMS
Spring 2014

Catalog Data:
Principles of real time computing with applications to process control and laboratory data acquisition. Introduction to real time languages and operating systems. A number of computing projects are to be completed for credit using laboratory hardware and software.

Textbook: Beginning Sensor Networks with Arduino and Raspberry Pi [Paperback] by Charles Bell

http://www.amazon.com/gp/product/1430258241/ref=oh_details_o06_s00_i00?ie=UTF8&psc=1

References:

MicroC/OS-II: The Real-Time Kernel, Jean J. Labrosse, Second Edition, CMP Books, 2002.
Real-Time Programming: A Guide to 32-bit embedded Development, R Grehan, R. Moote, & I. Cyliax, Addison Wesley, 1998.

Instructor: Dwight Egbert, Professor of Computer Science

Office Hours: 11:30AM-1:00PM – Monday & Wednesday, or by appointment, SEM 322, (775) 784-6952, egbert@cse.unr.edu

Academic Success Services:
Your student fees cover usage of the Math Center (784-4433 or www.unr.edu/mathcenter/), Tutoring Center (784-6801 or www.unr.edu/tutoring/), and University Writing Center (784-6030 or www.unr.edu/writing_center/. These centers support your classroom learning; it is your responsibility to take advantage of their services. Keep in mind that seeking help outside of class is the sign of a responsible and successful student.

If you have a disability for which you will need to request accommodations, please contact me or Mary Zabel at the Disability Resource Center (Thompson Student Services – room 100, 784-6000, or www.unr.edu/drc/), as soon as possible to arrange for appropriate accommodations.

Surreptitious or covert video-taping of class or unauthorized audio recording of class is prohibited by law and by Board of Regents policy. This class may be videotaped or audio recorded only with the written permission of the instructor. In order to accommodate students with disabilities, some students may have been given permission to record class lectures and discussions. Therefore, students should understand that their comments during class may be recorded.

Goals:
This course is designed to provide the basic principles of real time computing systems and to give students hands-on experience with commercially available real time operating systems such as QNX, Windows CE & embedded NT, embedded Linux, eCos, and MicroC/OS-II real time kernels.

Prerequisites by Topic:
1. Boolean Algebra and Combinatorial Logic
3. Basic understanding of microprocessors.
4. C/C++ Programming Experience
5. Basic WINDOWS & UNIX skills.
6. Peripheral interface adapters.
7. Basic understanding of timing diagrams.

Topics:
1. Introduction to Embedded Systems.
2. Introduction to Real-Time Systems.
3. MicroC/OS II and FRTOS as Example RTOSs.
4. Software Design Tools.
5. Input/Output Systems.
6. Interrupt Processed Input/Output.

7. Microprocessor-Based Communications. 8. Timers.

Application Projects:

1. Basic I/O (Serial & Parallel) 2. Analog Voltage I/O - ADC and DAC
3. Critically timed applications 4. Interrupt Service Routines
5. Use of Timers 6. Free RTOS real time operating system
7. MicroC/OS II real time operating system 8. Stepper Motors

Computer Usage:

The laboratory projects will be designed and built using the one of the sample real time operatiing systems.

Laboratory Projects:

Each student will design and build several real-time applications as assigned. The projects will be documented with a typewritten paper which will include a brief description of the project objectives, design approach, problems encountered, and lessons learned. This will be followed by a detailed and annotated block diagram of the software and any circuits used. Each interface application will constitute one or more homework assignments.

Student Participation:

Students are expected to attend all classes and read all of the assigned sections of the textbook. Often, material will not be covered in both lectures and reading assignments. Thus, both are essential to a full understanding of the course content. Also, completion of homework is essential. Homework will be due each TUESDAY, or the next following class if there is no Tuesday class.

LATE HOMEWORK WILL BE ACCEPTED FOR AT MOST 50% CREDIT.

Students are encouraged to study together, but each person must prepare his or her solutions and have a firm understanding of any work turned in. When you put your name on your homework you are stating that it is your own work and not the work of another person. As a reminder of UNR academic standards, please read http://www.cis.unr.edu/ecatalog/Default.aspx?article_list_id=25995%20 defining these standards. Specifically, the following: "*Plagiarism is defined as submitting the language, ideas, thoughts or work of another as one's own; or assisting in the act of plagiarism by allowing one's work to be used in this fashion*." This means that if another student asks to borrow your work to copy - JUST SAY NO - or you are participating in plagiarism.

Course Outcomes:

The course outcomes are skills and abilities students should have acquired by the end of the course. These outcomes are defined in terms of the ABET Accreditation Criterion 3 Program Outcomes which are relevant to this course. All Criterion 3 Outcomes are listed below and those relevant to this course are identified in the following Table.
Engineering programs must demonstrate that their graduates have:

1. an ability to apply knowledge of computing, mathematics, science, and engineering.
2. an ability to design and conduct experiments, as well as to analyze and interpret data.
3. an ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs, within realistic constraints specific to the field.
4. an ability to function effectively on multi-disciplinary teams.
5. an ability to analyze a problem, and identify, formulate and use the appropriate computing and engineering requirements for obtaining its solution.
6. an understanding of professional, ethical, legal, security and social issues and responsibilities.
7. an ability to communicate effectively with a range of audiences.
8. the broad education necessary to analyze the local and global impact of computing and engineering solutions on individuals, organizations, and society.
9. a recognition of the need for, and an ability to engage in continuing professional development and life-long learning.
10. a knowledge of contemporary issues.
11. an ability to use current techniques, skills, and tools necessary for computing and engineering practice.
12. an ability to apply mathematical foundations, algorithmic principles, and computer science and engineering theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices.
13. an ability to apply design and development principles in the construction of software systems or computer systems of varying complexity.

ABET Criterion 3 Outcomes	Course Outcomes	Assessment Methods/Metrics	CS Program Objectives Impacted	CIE Program Objectives Impacted
2	Students demonstrate that they can design experiments for evaluating real time computing systems and their time responses.	Students must be able to design and perform real time tests for different computer and software systems and compare the timing results.	2, 3	1, 3
5	Students demonstrate that they can apply fundamental concepts through the design and implementation of specific applications.	Students must be able to implement design specifications for several real time system applications and test the system performance.	2, 3	1, 3
9	Students demonstrate that they are aware of existing real time operating systems and the nature of os evolution and revision.	Students demonstrate on quizzes and examinations their understanding of current technology trends and the rapid rate of change of these trends.	4	4
11	Students demonstrate that they can implement design specifications using several hardware and software platforms.	Students must be able to use specific real time development tools for project implementations.	3	1, 2

Students enrolled in CPE 606:

1. Graduate students will achieve a deeper understanding of the material presented to the combined group through several course activities including special meetings, a design paper, a research paper, and an oral presentation of their research results.

2. Graduate students are expected to perform at a level which demonstrates active interest and initiative in searching out knowledge of embedded game technology. This means that for each common assignment the graduate students are expected to demonstrate that they have mastered the concepts involve in the assignment. They are also expected to have examined some consequences of the real time computing technology being studied and searched out others' comments on these consequences.

3. Graduate students meet as a group with the course instructor approximately once per month for discussion of research methodologies and appropriateness of specific journals and conference proceedings for source material. Further, each graduate student meets individually with the course instructor approximately once per month.

4. Graduate students must complete a real time computing project of their choice which integrates hardware and software. An example of such a project would be the implementation of a real time operating system (RTOS) not otherwise used in the course and perform timing tests between this new RTOS and the RTOS being used in class.

5. These items 1 through 7 demonstrate the opportunities which graduate students have in this course for work at a higher academic level.

6. Graduate student work will be graded based upon the criteria defined in item 2 above. The assignments must be completed successfully and the student must demonstrate that he or she understands the context within which the assignment material exists in the larger field of real time computing systems.

7. Graduate students are required to complete a research paper which details the evolution of a chosen aspect of real time computing technology and give an oral presentation of their results to the class. This research paper must include appropriate references from the scientific journals which have presented each step in the development of the technology as it evolved.

For example, the pivotal paper describing the development of computer generated sound is: *The Synthesis of Complex Audio Spectra by Means of Frequency Modulation*, by John M. Chowning, Stanford Artificial Intelligence Laboratory, Stanford, California, J*OURNAL OF THE AUDIO ENGINEERING SOCIETY*, pp 526-534, 1973. The abstract for this paper is included below.

> "A new application of the well-known process of frequency modulation is shown to result in a surprising control of audio spectra. The technique provides a means of great simplicity to control the spectral components and their evolution in time. Such dynamic spectra are diverse in their subjective impressions and include sounds both known and unknown."

The experience gained from preparing the research paper will contribute directly to graduate student capabilities for thesis and dissertation preparation.

Course Grade Structure:
Each course activity will contribute to the course grade as shown below. All activities will be graded on a scale of 0-100 points, and the final course grade will be determined as shown below . All quizzes and exams given in this course will be closed notes and closed books. Only calculators and materials handed out at the time of the exam may be used. Normally, plus/minus grades are not given in this class. The instructor reserves the right to assign plus/minus grades under special circumstances involving borderline grades based upon class participation. Your grade will never be lower than defined below unless you have an excessive number of un-excused absences from class, however, positive class participation can be used as a basis for raising your grade.

HOMEWORK AND QUIZZES	50%	HOMEWORK AND QUIZZES	40%
MID-TERM EXAM	25%	MID-TERM EXAM	15%
FINAL EXAM	25%	FINAL EXAM	15%
		Research Paper	15%
		Design Paper	15%
= COURSE GRADE	100%	= COURSE GRADE	100%

90 - 100 points = A
80 – 89.9 points = B
65 – 79.9 points = C
50 – 64.9 points = D
00 – 49.9 points = F