Lecture (1)

Real-Time Systems: An Introduction

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Philadelphia University
Summer Semester, 2011
Lecture Outline:

- What will you learn? And how?
- Course Objectives:
- Intended learning outcomes
- Prerequisites
- Module outline and timetable
- Reading list
- Assessment
Course Title: REAL-TIME SYSTEMS (630581)

- **Prerequisite:** Embedded Systems Design (630470)
- **Instructor:** Prof. Kasim M. Al-Aubidy.
- **Email:** qmlone@yahoo.com
- **Semester:** Summer 2010-2011
- **Time:** (8:00-9:00)am, Sunday to Thursday.
- **Office Hours:** (13:15-14:15)pm, Sunday to Thursday.
- Appointments to discuss the course should be made by email.
- **Course Material:** www.philadelphia.edu.jo/
What will you learn? And how?

- PRINCIPLES OF REAL-TIME SYSTEMS
- CONCEPTS OF COMPUTER CONTROL
- HARDWARE REQUIREMENTS FOR REAL-TIME SYSTEMS
- REAL-TIME COMPUTER CONTROL.
- LANGUAGE FOR REAL-TIME APPLICATIONS.
- REAL-TIME SOFTWARE & PROGRAM DESIGN.
- OPERATING SYSTEMS FOR REAL-TIME APPLICATIONS.

» Primarily through:

- Lectures: 45 hours/semester, 6 hours/week.
- Homework and programming assignments:
- Semester project: project for each student

» We will also discuss student projects.
Course Objectives:
The main objective of this course is to:

- Provide a general introduction to real-time computer control systems.
- Provide examples of real-time systems including functionality and implementation platforms.
- Study computer control strategies and their implementation techniques.
- Describe and exemplify design parameters for real-time systems including execution time, implementation, communication & user interface.
- Study a range of methodologies for specifying and designing real time systems.
- Understand hardware and software design and implementation of real-time systems.
- Describe and apply systems engineering methods and techniques in the design and analysis of real-time systems.

- The course will involve a real-time system design project.
Intended Learning Outcomes:

By the end of this course participants should be able to:

- Clearly differentiate the different issues that arise in designing soft and hard real-time, concurrent, reactive, safety-critical and embedded systems.
- Explain the various concepts of time that arise in real-time systems.
- Analyze and apply a variety of scheduling mechanisms suitable for soft and hard real-time systems. Conduct simple performance and schedulability analysis to demonstrate that a system can successfully meet real-time constraints.
- Explain the additional problems that arise in developing distributed and networked real-time systems.
- Describe the design and implementation of systems that support real-time applications. Justify and critique facilities provided by real-time operating systems and networks.
- Design, construct and analyze a small, concurrent, reactive, real-time system. Select and use appropriate engineering techniques, and explain the effect of your design decisions on the behavior of the system.
Prerequisites:

• Students are expected to be familiar with, microprocessors and microcontrollers, embedded system design, sensors and actuators, control systems, systems design and implementation, programming with machine language and C++.

• Some basic familiarity with; systems modeling and simulation techniques; discrete mathematics.
Grades:
- Homework and Quizzes: 10%, (3 Quizzes & 3 HWs)
- Semester Project: 10%
- First Exam: 15%
- Second Exam: 15%
- Final Exam: 50%

Projects:
- Define your own project and write a proposal
- Experimental investigation requires a programming project and a final report.
- Final report contents: Project title, Objective, Introduction, Hardware design, Software design, Conclusion, References.
- Team projects are allowed, but they must be significant!
### Timetable:

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<th>Week</th>
<th>Basic and support material to be covered</th>
<th>HW/Quizzes</th>
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| 1    | • An introduction to real-time computer systems.  
     • Elements of a real-time microcontroller-based system. |            |
| 2    | • Classification of RTS, Time constraints, Classification of programs.  
     • Computer Control concepts; Sequence control, DDC, PID control,  
     Adaptive control, Supervisory control, | Quiz 1  
     HW1 |
| 3    | • Centralized control, Hierarchical systems, Distributed systems.  
     • Hardware requirements for real-time systems: Analog I/O interfacing. | 1st Exam |
| 4    | • Digital and Pulse I/O interfacing.  
     • Data Acquisition and Data Distribution system design. | Quiz 2  
     HW2 |
| 5    | • Implementation of real-time algorithms.  
     • Realization of real-time algorithms using single processors or more.  
     • Stability analysis of real-time systems. | HW3  
     2nd Exam |
| 6    | • Software design of real-time systems. | Quiz 3 |
| 7    | • Operating systems for real-time applications: Features of RTOSs,  
     • Scheduling: concepts & implementation. | Project  
     Submission |
| 8    | • Mini Projects using Microcontrollers. | Final Exam |
Text Books:

   - This book comprises the lecture notes for the course and is required reading for all students.
   - All selected material in this book is examinable.

   - This book is optional, but provides further detail on the practical aspects of the course.
Reading List: