Distributed and Embedded Real-Time Systems (0640751)

Lecture (1)

Distributed and Embedded Real-Time Systems: An Introduction

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Lecture Outline:

- What will you learn? And how?
- Course Objectives:
- Intended learning outcomes
- Prerequisites
- Module outline and timetable
- Reading list
- Assessment

Course Title: Distributed and Embedded Real-Time Systems

- **Prerequisite:** **Microcontroller Interfacing & Programming + Control systems**
- **Instructor:** Prof. Kasim M. Al-Aubidy.
- **Email:** *kma@philadelphia.edu.jo*
- **Semester:** First, 2021-2022
- **Time:** (15:00-18:00) Monday.
- **Office Hours:** (12:00-14:00) Monday.
- Appointments to discuss the course should be made by email.
- **Course Material:** www.philadelphia.edu.jo/

- **Course Description:**

  Mechatronics is the merger of mechanics, electronics and computer concepts. This course involves computer interfacing and programming to control mechanical and electromechanical objects. In this course we will use a microcontroller or a field programmable chip (computer-on-a-chip) to interface with Mechatronics components such as switches, LED's, DC motors, stepper motors, relays, remote controls, and others. It will also present Personal Computers Interface (PCI) through Data Acquisition Cards.

- **Primarily through:**
  - **Lectures:** 45 hours/semester, 3 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 embedded system design project.

Intended Learning Outcomes:

On completing the course, students will e able to have to following skills:

- **Knowledge and understanding**

  A1-Tell the principles of microcontroller-based systems design

  A2-. Mention the design requirements of embedded systems.

- **Intellectual skills**

  B1. Show improved comprehensive quality and innovative ability

  B2. Design and implement a real system based on a single chip microcontroller

- **Professional and practical skills**

  C1. Implement small mechatronics system considering both H/W and S/W requirements for a single-chip design.

  C2. Work with system design development tools such as MATLAB, LABVIEW, PROTEUS or any other available software.

- **General and transferrable skills**

  D1. Use programmable chip to manage operation of a Mechatronics system.

  D2. Choose suitable hardware and software components for a reliable 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:

- Assignments, Project & Presentation: 30%,
- Mid Exam: 30%
- Final Exam: 40%

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:

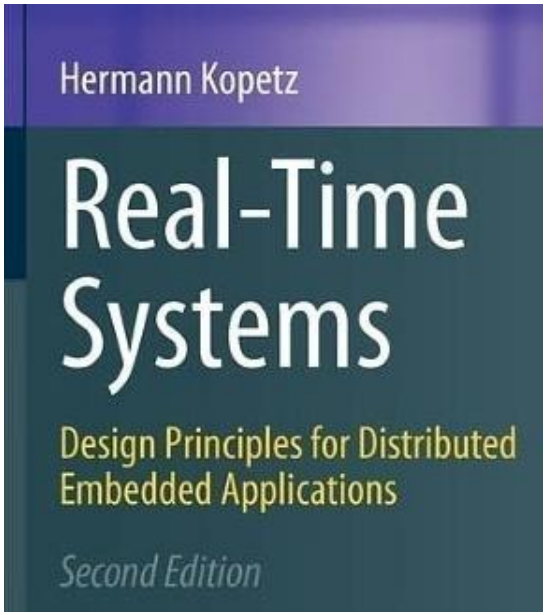
Week	Basic and support material to be covered	HW/Project
1	An introduction to distributed and embedded real-time systems.	
2	Elements and classification of distributed and embedded real-time systems.	
3	Computer control systems; Sequence control, DDC, PID control, Supervisory control, Adaptive control, Intelligent control. Hierarchical and Distributed systems.	Project Selection
4	Real-time environment, Why a distributed solution?	HW1
5	Hardware design requirements; analog, digital, pulse interfacing.	Assignment1
6	Embedded system design requirements; single- chip and single-board design.	Project (Phase1)
7	Microcontroller architecture and interfacing.	HW2

Timetable:

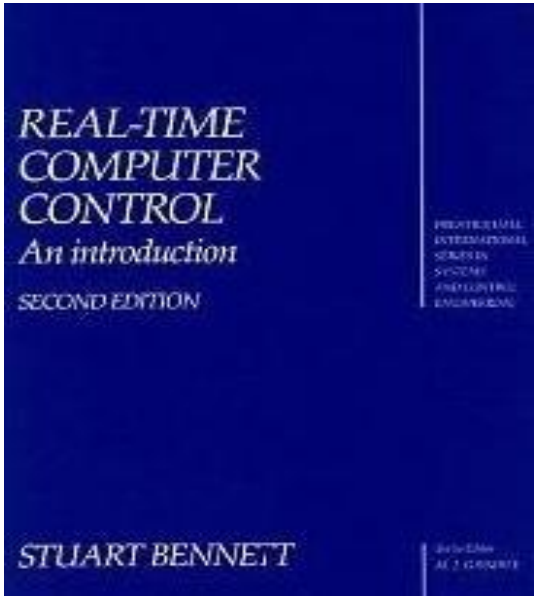
Week	Basic and support material to be covered	
8	Microcontroller programming: instruction sets, timing & subroutines.	Mid Exam
9	Realization of real-time algorithms, Hardware and software co-design.	Assignmentn2
10	Stability analysis of real-time systems.	
11	Real-time communications, Wireless sensor networks.	Assignmentn3
12	Real-time operating systems,	
13	Real-time scheduling.	Project (Phase2)
14	Real-time systems design, Testing, Validating & debugging.	
15	Time-triggered systems	Project (Phase3)
16	Mini Projects of DERTS	Final Exam

Text Books:

1. **Real-Time Systems: Design Principles for Distributed Embedded Applications**,
   By H. Kopetz, Springer-Verlag, USA, 2011,
   ISBN: 1441982361
   - This book comprises most of the lecture notes for the course and is required reading for all students.
   - All selected material in this book is examinable.



2. **Real-Time Computer Control,** By: Stuart Bennett,
   Prentice-Hall, 2nd edition, 1994.
   - This book is optional, but provides further detail on the practical aspects of the course.



Reading List:

1. D. IBRAHIM, Microcontroller Based Applied Digital Control, John Wiley & Sons Ltd, UK, 2006, ISBN: 0-470-86335-8
2. J.W.S. LIN, Real-Time Systems, Prentice Hall, 2000.
3. N. NISSANKE, Real-Time Systems, Prentice Hall, 1997.
4. R.J.A. BUHR & D.L. BAILEY, An Introduction to Real-Time Systems, Prentice Hall, 1999.
5. S. BENNETT & G.S. VIRK, Computer Control of Real-Time Processes, IEE 1990.
6. S. HEATH, Embedded Systems Design, Newness 1999.
7. W. VALVANO, Embedded Microcomputer Systems: Real-Time Interfacing, Brooks-Cole Publisher, 2000.
8. J. COOLING, Software Engineering for Real-Time Systems, Addison Wesley, UK, 2003
9. T. D. Green, EMBEDDED SYSTEMS PROGRAMMING WITH THE PIC16F877, Second Edition, 2008.
10. S. BENNETT & G.S. VIRK, Computer Control of Real-Time Processes, IEE 1990.