Distributed and Embedded Real-Time Systems
(0640751)

Lecture (1)

Distributed and Embedded Real-Time Systems: An Introduction

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Philadelphia University-Jordan
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:** Microcomputer interfacing & Programming + Control systems

- **Instructor:** Prof. Kasim M. Al-Aubidy.

- **Email:** qmlone@yahoo.com

- **Semester:** Second, 2014-2015

- **Time:** (14:00-17:00) 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 be able to have the 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!
<table>
<thead>
<tr>
<th>Week</th>
<th>Basic and support material to be covered</th>
<th>HW/Project</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>An introduction to distributed and embedded real-time systems.</td>
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<tr>
<td>2</td>
<td>Elements and classification of distributed and embedded real-time systems.</td>
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<td>3</td>
<td>Computer control systems; Sequence control, DDC, PID control, Supervisory control, Adaptive control, Intelligent control. Hierarchical and Distributed systems.</td>
<td>Project Selection</td>
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<td>4</td>
<td>Real-time environment, Why a distributed solution?</td>
<td>HW1</td>
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<td>5</td>
<td>Hardware design requirements; analog, digital, pulse interfacing.</td>
<td>Assignment 1</td>
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<td>6</td>
<td>Embedded system design requirements; single-chip and single-board design.</td>
<td>Project (Phase 1)</td>
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<td>7</td>
<td>Microcontroller architecture and interfacing.</td>
<td>HW2</td>
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## Timetable:

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<thead>
<tr>
<th>Week</th>
<th>Basic and support material to be covered</th>
<th>Assignment/Project</th>
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</thead>
<tbody>
<tr>
<td>8</td>
<td>Microcontroller programming: instruction sets, timing &amp; subroutines.</td>
<td>Mid Exam</td>
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<tr>
<td>9</td>
<td>Realization of real-time algorithms, Hardware and software co-design.</td>
<td>Assignmentn2</td>
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<td>10</td>
<td>Stability analysis of real-time systems.</td>
<td>Assignmentn3</td>
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<td>11</td>
<td>Real-time communications, Wireless sensor networks.</td>
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<td>12</td>
<td>Real-time operating systems,</td>
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<td>13</td>
<td>Real-time scheduling.</td>
<td>Project (Phase2)</td>
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<tr>
<td>14</td>
<td>Real-time systems design, Testing, Validating &amp; debugging.</td>
<td>Project (Phase3)</td>
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<tr>
<td>15</td>
<td>Time-triggered systems</td>
<td>Final Exam</td>
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<tr>
<td>16</td>
<td>Mini Projects of DERTS</td>
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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,
   – This book is optional, but provides further detail on the practical aspects of the course.
Reading List: