MECH 530 Mechatronics System Design

Course Outline - Spring 2007

Department of Mechanical Engineering - American University of Beirut

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Lecture: T,Th 12:30-2:30, **Mechatronics Lab**.

What is Mechatronics?

Mechatronics field is defined as the interaction of mechanics (Mechanical Engineering), electronics (Electrical Engineering) and computing (Computer Science) which, combined, make possible the generation of simpler, more economical, reliable and versatile systems.
The word "mechatronics" was first coined by Mr. Tetsuro Moria, a senior engineer of a Japanese company, Yaskawa, in 1969. Mechatronics may alternatively be referred to as "electromechanical systems".

Course Description

This course is an introduction to Mechatronics, or the interfacing of mechanical and electrical systems. Focus is on embedded controllers (Motorola HCS12) and their programming, power and interfacing electronics, actuators, sensors, and integration of these components to create a complete functional mechatronic system.
Much of this course is a self-study course. We will cover the basics in lecture, but it is essential that you keep up with the outside reading. Do not fall behind!
Students will work in teams to produce lab assignments and final computer-controlled electromechanical projects.

Textbook

Alciatore D.G. and Histand M.B., ***Introduction to Mechatronics and Measurement Systems***, McGraw-Hill, 3rd ed., 2006.

References Books (for Specific Topics)

Mini-robot construction

- J. L. Jones and A. M. Flynn, ***Mobile Robots: Inspiration to Implementation***, 2nd Edition, A K Peters, Ltd., Wellesley, MA, 1999.

Electronics

- P. Horowitz and W. Hill, ***The Art of Electronics***, 2nd Ed., Cambridge University Press, Cambridge, UK, 1989.

Mechatronics

- Smaili A. and Mrad F., ***Applied Mechatronics***, Oxford University, 2007.
- Bishop R.H. The Mechatronics Handbook , CRC Press, 2002. Available online at `www.engnetbase.com`
- Webster J.G. Measurement, Instrumentation, and Sensors Handbook, CRC Press, 1999. Available online at `www.engnetbase.com`
- Borenstein J., Everett H.R., and Feng L., ***Where am I? Systems and Methods for Mobile Robot Positioning***, Electronic copies of this report in its entirety can be downloaded from `http://www-personal.umich.edu/~johannb/shared/pos96rep.pdf`

- Stiffler, A.K., ***Design with Microprocessors for Mechanical Engineers***, McGraw Hill, New York, 1992.

Motorolla HCS12

- Valvano J.W., ***Embedded Microcomputer Systems: Real Time Interfacing***, Brooks-Cole, 2000.
- Huang H.W., ***The HCS12/9S12: An Introduction to Software & Hardware Interfacing***, Thomson Delmar Learning, 2005.
- Barrett S., Pack D., ***Embedded Systems Design and Applications with the 68HC12 and HCS12***, Prentice Hall, 2005.
- Stiffler A.K., ***Design with Microprocessors for Mechanical Engineers***, McGraw-Hill, 1992.

Microchip PIC

- Peatman J.B., ***Designing with PIC Microcontrollers***, Prentice-Hall Inc., NY, 1998.
- Predko M., ***Programming and customizing the PIC Microcontroller***, Mc-Graw Hill, NY, 1998.

Course Topics

1. Introduction to Mechatronics and Intelligent Machines.
2. Numbering Systems and Arithmetic.
3. Foundations of passive circuits and semiconductor electronics.
4. Digital circuits, combinational logic and Boolean algebra.
5. Data acquisition and signal conditioning, A/D and D/A conversion.
6. HCS12 microcontroller architecture and interfacing.
7. Assembly language programming.
8. Programmable timer and interrupts.
9. Review of modern sensors, application of sensors in mechanical engineering.
10. Review of actuators, mechanical actuation, DC and stepper motors.
11. Synthesis of a mechatronic system.

Projects and Lab Assignments

Mechatronic projects and assignments are essential elements of this course. All students are required to complete them. These deliverables are a great opportunity to gain a hands-on experience in designing and building a mechatronic system. The intent of this course is also to provide the student with a cooperative working experience within a team. During the first week of class, the class will be divided into teams of two or three students.

Attendance and Homework Policies

Attendance at every class is required. Everyone is recommended to actively participate in the class. Unannounced Pop Quizzes on previously covered material may be given. Missed exams will incur a 10% penalty. NO make-up exams will be allowed.
Throughout the term homework will be assigned. This may come from the text or be instructor supplied. **Individual** homework assignments will be collected at the specified due date. NO late homework will be accepted.
Lab Assignments and Projects will be given to each team. NO late reports will be accepted.

Grading

Final grades will be based on the breakdown below:

Individual points **(70%)**

Homework	10%
Exams and quizzes	30%
Final exam	25%
Attendance and Instructor's discretion	5%

Team points **(30%)**

Lab assignments and projects	30%

Lab and Project Development Environment

Each team will be given an MCU Student Learning Kit (MCUSLK) consisting of:

- MCU Development Module (CSM12C32), a small board containing a MCS912C32 microcontroller.
- MCU Project Board, into which the MCU Module is inserted. The Project Board provides power, I/O connections, and solderless breadboard area, and a BDM debug pod for debugging the MCU Module.
- Power supply, serial cables, BDM cable.
- Freescale/Metrowerks CodeWarrior Integrated Development Environment (IDE) for a Windows PC. Each computer has a copy of Metrowerks CodeWarrior installed.
- In addition, teams will be provided various other parts that will help in their assignments and projects.

The freedom to use the lab facility also entails the responsibility to take good care of it. Please let us know if something is wrong with any of the equipment, and be careful to leave the lab equipments ready for the next person to use. When you leave, please be sure equipments other than computers are powered off.

Academic Conduct

Students are expected to practice and uphold standards of academic integrity and honesty. Examples of dishonesty: cheating in exams and homework; Plagiarizing the work of others. However, legitimate collaboration and team working is encouraged but academic dishonesty will not be tolerated.

Course Objectives

Students will gain the following knowledge and skills from this course:

1. Gain a more complete understanding of basic electrical circuits and electronic devices (ABET outcomes a, c).
2. Understand the role of computer science and electrical engineering in the operation and control of mechanical systems (ABET outcomes a, c, e, k).
3. Be able to program the Freescale (Motorola) HCS12 microcontroller and use its available resources to control target systems (ABET outcome c).
4. Learn the basics of digital electronics (ABET outcomes a, c).
5. Learn the assembly language to program the HCS12 microcontrollers.
6. Learn the basics of sensor and actuator theory, design, and application (ABET outcomes a, c, i).
7. Gain experience designing and constructing basic mechatronic systems (ABET outcome b).
8. Work in teams to develop a working mechatronic device for a specific task (ABET outcome d, g, k).