ME142 Mechatronics
Spring 2017 Offering
School of Engineering, University of California, Merced
SYLLABUS

Synopsis:
Mechatronics is a synergistic combination of precision mechanics, electronics, controls, and computer engineering, combined through a process of integrated design. A mechatronics engineer needs to be able to handle a wide range of technologies in sensors, actuators, interface hardware, control systems, analog and digital electronics, software engineering, and concurrent design. It is not possible to provide an in-depth coverage of all these technologies in a single one semester course. The course will introduce key topics of the field of Mechatronics, as useful for both students and practicing professionals. Various concepts will be illustrated through worked examples and exercises. Case studies of Mechatronics will be provided to illustrate the integrated design process, which is involved. This course is lab-intensive. 150 min. lectures per week (two 75 min. lectures) and 3 hours lab session per week. 3 extra hours for self-study (book reading, home works, literature review, report writing etc.)

Catalog Description (page 160 of 2011-2013 UC Merced General Catalog)

> ME142: Mechatronics [4]. Introduction to electro-mechanical systems controlled by microcontroller technology. The course covers theory, design and construction of smart systems; closely coupled and fully integrated products and systems; the synergistic integration of sensors, interfaces, actuators, microcontrollers, control and information technology. Prerequisite: ENGR 057 and ENGR 065. Letter grade only. Laboratory included.

Prerequisites by Topic:

- ENGR057: Statics and Dynamics
- ENGR065: Circuit Theory

Textbook:
De Silva, C.W., *Mechatronics—A Foundation Course*, Taylor & Francis, CRC Press, Boca Raton, FL, 2010.
http://www.amazon.com/Mechatronics-Foundation-Clarence-W-Silva/dp/1420082116
http://www.crcpress.com/product/isbn/9781420082111

Reference Textbook:
David G. Alciatore and Michael B. Histand."Introduction to Mechatronics and Measurement Systems" Fourth Edition, 2012.ISBN-13 9780077396923http://highered.mcgraw-hill.com/sites/0073380237/ (http://mechatronics.colostate.edu)

Instructor:
YangQuan Chen, Director of MESA LAB http://mechatronics.ucmerced.edu/
Email: ychen53@ucmerced.eduOffice: SE2-273; Phone (209)228-4672

Lectures: Wed Fri 2:30-3:45pm @ CLSSRM 116

Office Hours: Wed Fri 1:30-2:30pm AND 3:45-5pm @ SE2-273. (Jointly held with TAs)

TAs:
Sina Dehghan (sdehghan@ucmerced.edu) and TBD

TAs Office Hour: Wed Fri 1:30-2:30pm AND 3:45-5pm @ SE2-273.

Labs:

LAB W	9:00-11:50am	SCIENG 172
LAB F	9:00-11:50am	SCIENG 172
LAB M	4:30-7:20pm	SCIENG 172
LAB W	7:30-10:20pm	SCIENG 172

Course Outline

Week 01 (Tue: Jan. 18, 2017, Jan. 20, 2017)
- Introduction to mechatronics (Chap. 01)

Week 02, 03, 04
- Mechatronics basic elements and components (Chap. 02, Secs. 4.3 &4.6, Sec. 8.7)

Week 05, 06, 07
- Signals and systems, modeling and simulation (Chap. 03, Chap 04)

Week 08, 09
- Control systems (Chap. 09)

Week 10
- Spring Break (Take home mid-term exam)

Week 11, 12, 13
- Sampled-data controls, Sensors (Chaps. 5 and 6)

Week 14, 15
- Actuators (Chap. 7)

Week 16
- Advanced controls in mechatronics (IMP/DOB/PID autotuner) and examples

Week 17
- Final exam

EXAM R 11:30-2:30pm CLSSRM 116 11-MAY

Grading policy

- Attendance (quizzes): 10%
- Lab: 30%
- Homework: 20%
- Mid-term Exam: 10%
- Final Exam: 30%

Grade Distribution

Grade	Total Scores (%)
A+	99+
A	95 - 99
A-	90 - 94
B+	87 - 89
B	83 - 86
B-	80 - 82
C+	77 - 79
C	73 - 76
C-	70 - 72
D+	67 - 69
D	63 - 66
D-	60 - 62
F	< 60

Late submissions

No late submission will be considered/counted.

CROPS: We will be using CROPS for posting the syllabus, lecture notes, assignments, lab documents, announcements, and grades.
https://catcourses.ucmerced.edu/courses/6803

Course Objectives:

ME142 Mechatronics [4] will introduce basic theoretical concepts and practical methods for electro-mechanical systems controlled by microcontroller technology. The course covers modeling, analysis and design (MAD) as well as rapid prototyping of smart systems; closely coupled and fully integrated products and systems; the synergistic integration of sensors, interfaces, actuators, microcontrollers, control and information technology.

Course Goals:

1. To develop a synergistic view of mechatronics design that involves mechanical engineering, electronic engineering, control systems and computer systems.
2. To develop an understanding of the fundamental laws and elements of mechatronics components (electric, mechanical, thermal, fluid circuits.)
3. To establish basic modeling skills using ordinary differential equation (ODE) as well as state space form and transfer function form;

4. To develop skills in performing several basic analysis tasks for dynamic signals and systems including time domain and frequency domain analysis;
5. To develop basic closed-loop control system concepts such as stability, stability margins, model based controller design and PID controller and tuning;
6. To develop entry level knowledge in sampling process and digital control basics.
7. To develop key knowledge needed for proper application of sensors in general and motion sensors in particular;
8. To develop key knowledge needed for proper application of actuators in general and motion actuators in particular;
9. To develop hands-on experience in closed-loop real-time mechatronics control systems rapid-prototyping using a dedicated embedded system platform and MATLAB/Simulink.

Learning Outcomes:

1. To be able to identify the necessity of applying mechatronics synergistic design process;
2. To be able to derive from first principle of the governing ordinary differential equations for modeling purpose for basic mechatronic systems including basic electric, mechanical, thermal and fluid circuits;
3. To be able to perform basic signals and linear time-invariant systems analysis such as Laplace and inverse Laplace transform, zeros/poles, impulse and step responses, stability using Routh table and complex plane pole plot, Bode plot, Nyquist plot;
4. Learn how to perform opamp circuit analysis and canonical system realization of SISO (single-input-single-output) transfer functions using opamps.
5. To be able to perform basic closed-loop control systems property analysis including closed-loop stability analysis, step response steady-state error analysis, gain/phase margin analysis, bandwidth determination and sampling frequency selection;
6. To be able to translate time-domain step response specifications into closed-loop transfer function form (natural frequency and damping ratio) for model based controller design;
7. To be able to design and tune PID controller based on reaction curve measurement and Ziegler-Nichols tuning table with solid understanding on integrator windup and anti-windup, bumpless transfer (AWBT);
8. To be able to decide sampling frequency based on sampling theorem and understand consequences of sampling, aliasing effect, and anti-aliasing filtering.
9. To grasp knowledge needed for proper application of sensors in general and motion sensors in particular;
10. To grasp key knowledge needed for proper application of actuators in general and motion actuators in particular;
11. To develop hand-on experience in closed-loop real-time mechatronics control systems rapid-prototyping using a dedicated embedded system platform and MATLAB/Simulink.
12. To be able to work as a team to complete a full mechatronics project cycle of MAD (modeling, analysis and design) and with proper project report writing and presentation experience.
13. To have an updated knowledge of the future of advanced mechatronics embedded systems and automation (MESA).

Course Policies: 1. NO CELL PHONES are allowed during lecture. 2. Be on time to class. Tardiness is discouraged. 3. No late assignments will be accepted. Medical or family emergency will be considered on case-by-case basis. 4. No make-up exams. If you miss the exam, a zero score will be assigned to the missed exam. No electronic devices other than a calculator will be allowed. 5. If you miss a class due to personal emergency or medical reasons, please be sure to inform the instructor by e-mail in advance. 6. Homework assignments are to be submitted by the due date/time. You should keep a record of your homework in HW notebooks or HW binder and be ready to present it upon request. You may discuss homework problems with your classmates, but you are responsible for your own work. 7. You are encouraged to read the sections in the textbooks related to the covered topics prior to the lecture as well as after. 8. After an assignment grade has been posted online, students must see the instructor within one week if they wish to discuss the assignment and their work. 9. University's rules on academic honesty concerning exams and individual assignments will be strictly enforced. See UC Conduct Standards: http://studentconduct.ucmerced.edu/sites/studentconduct.ucmerced.edu/files/page/documents/code_of_conduct_600_and_700.pdf

Academic DishonestyStatement:a. Each student in this course is expected to abide by the University of California, Merced's Academic Honesty Policy. Any work submitted by a student in this course for academic credit will be the student's *own* work. b. You are encouraged to studytogether and to discuss information and concepts covered in lecture and the sections with other students. You can give "consulting" help to or receive "consulting" help from such students. However, this permissible cooperation should never involve one student having possession of a copy of all or part of work done by someone else, in the form of an e mail, an e mail attachment file, a diskette, or a hard copy. Should copying occur, both the student who copied work from another student and the student who gave material to be copied will both automatically receive a zero for the assignment. Penalty for violation of this Policy can also be extended to include failure of the course and University disciplinary action. c. During examinations, you must do your own work. Talking or discussion is not permitted during the examinations, nor may you compare papers, copy from others, or collaborate in any way. Any collaborative behavior during the examinations will result in failure of the exam, and may lead to failure of the course and University disciplinary action.
http://studentconduct.ucmerced.edu/sites/studentconduct.ucmerced.edu/files/page/documents/academic_honesty_-_800.pdf

Disability Statement:
Accommodations for Students with Disabilities: The University of California Mercedis committed to ensuring equal academic opportunities and inclusion for students with disabilities based on the principles of independent living, accessible universal design and diversity. Any student who feels he or she may need an accommodation based on the impact of a disability should contact me privately to discuss his or her specific needs. Also contact Disability Services at (209) 228-7884 as soon as possible to become registered and thereby ensure that such accommodations are implemented in a timely fashion.

Appendix: **ME142 “Mechatronics” Spring 2017 LAB**

Outline of ME142 “Mechatronics” LAB

(Originally prepared by Brandon Stark, Spring 2017, subject to changes in future offerings)