VM552 Mechatronic Systems Design
Summer 2017

Course Instructor

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Teaching Assistant (GSI)

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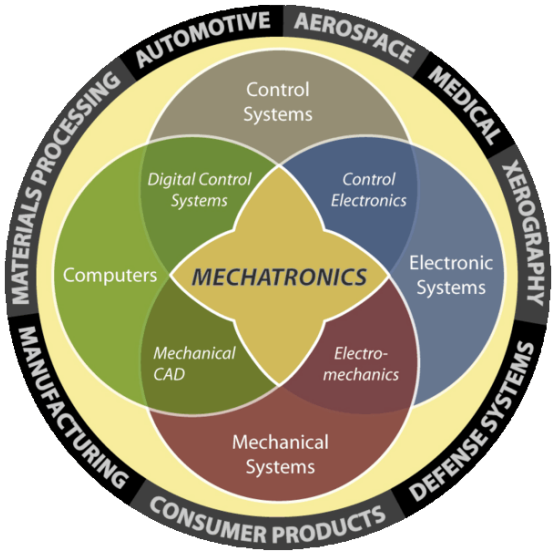
Course Description

'Mechatronic Systems Design' is the synergistic combination of mechanical disciplines, controls, electronics and computers in the design of high-performance machines, devices or processes. This course reviews principles of modeling, interfacing and signal conditions for motion sensors and actuators; modeling, analysis and design of digital control systems; simulation and prototyping of real-time closed-loop computer control of electromechanical systems; Hands - on design project provides extensive coverage of mechanical components and assembly, sensors and actuators, electrical drives, signal conditioning circuits, modeling and simulation tools, data acquisition hardware and software, and microprocessors.



Aerial Venn diagram from RPI's website describes the various fields that make up Mechatronics

Lectures

Mon 10:00-11:40am; Wed 10:00-11:40am
Location is TBD now.

Instructor Office Hours

Mon 2:00-3:40pm; Wed 2:00-3:40pm

Course Pre-requisites

VM360-Modeling, Analysis and Control of Dynamic Systems
VM461-Automatic Control
(or Instructor's approval)

Textbook

The lecture will be based on instructor's notes. **Textbook is not required.** However, the following textbook can be a good reference:

David G. Alciatore, Michael B. Histand. "Introduction to Mechatronics and Measurement Systems", International Edition 2007, McGraw-Hill Education (Asia), ISBN-13: 978-007-125407-6.

Teaching Schedule (Tentative: subject to adjustment)

No.	Date	Lectures and Exams	Labs
1	May 15	Introduction: overview of Mechatronics, new trends; design project.	N/A
2	May 17	Sensors: Analog position measurement	
3	May 22	Sensors: digital position measurement, hall sensor, and accelerometers; quantization error	
4	May 24	Sensors: Kalman filter, load cell, machine vision, and sensor fusion	
5	May 27	Actuators: relay, voice Coil, brushless DC motor, electric Angle.	
6	May 31	Actuators: pulse Width Module (PWM), speed Control of BLDC, variable-frequency motor control	
7	June 5	Actuators: DQ transform and vector control	
8	June 7	Actuators: DQ model of a 3-phase AC motor, optimized motor design, interactive analysis, motor selection	
9	June 12	Driver: overview of Power Electronics: main metric, switching devices, system	

		configuration	
10	June 14	#**Invited lecture:** design of electric motors given by prof. Lin Feng, Department of electrical engineering.	
-	June 19	Lab 1	
-	June 21	Lab 1	
11	June 26	#**Special lecture:** concept, design, and implementation of a power electronic circuit: DC-DC converter	N/A
-	June 28	**Mid Term Examination**	
12	July 3	Analog signal processing: circuits using op. amps	Lab2 (DC motor)
13	July 5	Digital signal processing: TTL&CMOS, Flip-flops, Quantizing Theory, AD/DA conversions	
14	July 10	Digital Control Systems Analysis: preliminary discussion, control configuration, a case study on discretization	N/A
15	July 13	Digital Control Systems Analysis: impulse function and sampling, the relationship between z and s operators, stability and frequency response of a discrete-time system	
16	July 17	Digital Controller Design: Control architectures, Typical control configurations, Feedback and feedforward control	Lab3 (Inverted Pendulum)
17	July 19	#**Special lecture:** the modeling and control of a self-balanced bicycle; Digital Controller Design: Feedforward control (cont.), Controller design procedure, Tradeoff among stability, time response and robustness	
18	July 24	Digital Controller Design: The importance of Modeling-A Case study, the design of controllers	N/A
19	July 26	Course review	
-	Aug. 1	Student presentation#1	
-	Aug. 3	Student presentation#2	
-	Aug. 7	Q&A	
-	Aug. 9	**Final exam**	

Grading Policy

15 points – Homework
10 points – Quiz
15 points – Design Project
25 points – Midterm Exam
35 points – Final Exam
Note: Class attendance is not required; however, it is highly recommended. Based on SJTU's academic regulations, attendance will be randomly taken at least 5 times.

Design Project (subject to changes)

The design project will be one of the major thrusts of the course. The project will demonstrate all aspects of the course for a specific problem. Independent modeling, analysis, design and integration of a mechatronic system for an inverted pendulum wheel by team will be required.

The design project is planned to start in Week 7 and will continue until week 12 (six weeks in all). New teams of approximately three to four members each will be formed during Week 6. Teaching assistants will give detailed introduction and explanation on all the necessary knowledge that is not able to cover in the lectures due to the time limitation.