State University of New York at Buffalo

Department of Mechanical and Aerospace Engineering

MAE 476 / 576: Mechatronics
Spring Semester - 2003

Mini Assignment 2 (Part 1)

<u>Theme: Analysis of Different Mechatronic Courses Available</u>

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Teaching Assistant: Chin-Pei Tang

Web Pages of prominent Mechatronics Courses

UNIVERSITY AND COURSE TITLE	WEB ADDRESS
NCSU, *Mechatronics*	http://courses.ncsu.edu:8020/mae534/lec/001/
UC Berkley, *Mechatronics Design Lab*	http://www-inst.eecs.berkeley.edu/~ee192/
Georgia Tech, *Introduction to Mechatronics*	http://www.me.gatech.edu/me/academics/graduate/sem_conv/ME6405.htm
Pennstate University, *Mechatronics Research Lab*	http://www.me.psu.edu/lamancusa/mechatronics/advmech.htm
UIUC, *Introduction to Mechatronics*.	http://robot0.ge.uiuc.edu/~spong/deere/ge393.html
Carnegie Melon University, *Mechatronic Design*	http://www.me.cmu.edu/academics/courses/24778.htm
Stanford University, *Smart Product Design*	http://design.stanford.edu/Courses/me118/html/course.html
North Western University, *Advanced Mechatronics*	http://www.mech.nwu.edu/courses/433/CourseDocs/433_Ad_2002-08-29.pdf
Virginia Tech, *Mechatronics*	http://mechatronics.me.vt.edu/home.html
John Hopkins University, *Mechatronics*	http://custer.me.jhu.edu/mechatronics/syllabus2002.htm

UNIVERSITY	THEORETICAL EMPHASIS/ COURSE STRUCTURE	PRACTICAL EMPHASIS/PROJECT WORK	MICROPROCESSOR USED / HARDWARE USED.
NCSU	Programming in C for embedded systems, analog circuits and electronic components, logic gates. Introduction to microprocessor architecture, sensors and actuators. A/D and D/A conversion and data acquisition, sensor interfacing and signal conditioning, real-time programming concepts, intelligent control fundamentals. Direct digital control implementation, principles of mechatronic design synthesis, and components analysis.	Programming, working with microprocessors, and interfacing sensors and actuators. Laboratory kit will be available. Teams will work on a final design project that is of reasonable complexity.	_
GEORGIA TECH	Choice of embedded computers; choice of level of languages: assembly, high level, object oriented for real-time programming (such as C), Simulink. Analog and digital devices: Op-amp, ADC, DAC, and power transistors Sensors, actuators, and their applications to intelligent manufacturing and mechatronic systems Modeling of various actuators: (DC motors, stepper motors, induction motors), and sensors.	Modeling and control of electro-mechanical systems. Hardware overview, programming, interrupts, on-chip subsystems. Lab and Project 50% Weight age.	16-Bit microprocessor:
PENN STATE UNIVERSITY	To develop a thorough understanding of mechatronic system design (including cost analysis). To gain proficiency in embedding micro-controllers into products. To design and build a working prototype of an intelligent product.	Digital I/O with Basic Stamp II. Digital I/O with PIC Analog Input High Power. Digital Output and Motion Control with DC servo motors. System simulation.	Basic Stamp II

UC BERKLEY	Power electronics, filtering and signal processing, control, electro mechanics. Microcontrollers and real-time embedded software in designing a racing robot.	The class project is to design racing robots which can follow an embedded wire over a curving and self-crossing path at speeds greater than 3 meters per second. The course project requires students to consider real-world constraints such as limited volume, payload, electrical power, processing power and time.	CPU/FPGA board (already built).
CARNEGIE MELON UNIVERSITY	Operational principles and system design issues associated with the spectrum of mechanical, electrical, and microcontroller components. Other topics including mechatronic design methodologies, system modeling, mechanical components, sensor and I/O interfacing, motor control, and microcontroller basics.	It will center on laboratory projects in which small teams of students will configure, design, and implement mechatronic systems.	_
STANFORD	Introduction to electro-mechanical design and embedded systems. Use of microprocessors as components of machines, as opposed to computer control of machines.	First project employs a microprocessor. The second utilizes multiple communicating microprocessors.	Motorola MC68HC11
NORTH WESTERN UNIVERSITY	Electronics: digital & analog refresher (chips and discrete devices) Construction techniques: protoboard, solder board, wire wrap, printed circuit layout. Motor types, controllers; Motor selection: inertia matching and other criteria.	Instrumentation amps / op-amps / filters / analog computation. Real time programming (C under the QNX real-time OS). Sensor interfacing (amplifiers, signal processing, ADCs).	Handyboards/basic stamp.

	Sensor types, sensor selection and sensor interfacing. Digital signal processors (DSP), singleboard x86 CPUs, programmable gate arrays, discrete digital chips, analog computation. Software platforms: Real time operating systems, QNX, threads, timing issues, interrupts, Interprocess communication. Communication protocols: analog, serial RS232 and similar, DeviceNET, USB, Ethernet TCP & UDP	Encoders and motors. Design a digital circuit (referring to datasheets), prototype, printed circuit layout.	
VIRGINIA TECH	VT 84, Analog and digital fundamentals Microcontroller technologies and computer architectures. Signal i/o, PIC A/D Converter Sensors (Tachometers, pots, encoders) Dynamic Modeling, Review. Controller Design. Overview of actuators. PLCs.	PIC assembly programming. Sensors (Infrared, Ultrasonic, Acc's). Control theory, PID review. PM DC motors, stepper motors. Active material actuators. AC motors, gear reducers. PLCs.	PIC Processor.
UIUC	Real-time computing and software interfacing for manufacturing systems. Interfacing of sensors and actuators used in manufacturing systems. Computer interfacing and real-time monitoring of machine tools and robots; Intercomputer communication through network for a manufacturing cell; and human-machine-computer interfaces.	Some projects included Electronic Cam Profile Generator using Linear Actuator & LVDT. Automated Light Tracking System. Simulation of Smart Traffic Lights	_
JOHN HOPKINS UNIVERSITY.	The course is a hands-on, interdisciplinary design project. Design, build, and debug mobile robots.	The project this year was to make a self replicating robot.	_

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Mechatronics MAE 576
Mini Assignment II

1. San Jose State University, One Washington Square • San José, California

- Mechatronics

Course Content: Introduction to Mechatronics, sensors, actuators, Op-Amps, microprocessors, Comparators Signal conditioning, A/D, D/A converters, digital electronics.
http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106pdf/me106syllabus.pdf

- Mechatronics System Design

Course Content: Process Modeling from testing samples, Computer-aided dynamic system control analysis and design. Application and integration of micro-controller for digital process and servo control. Development of smart and intelligent products with micro-controller.
http://info.sjsu.edu/web-dbgen/catalog/courses/ME190.html

- Mechatronic Systems Engineering

Course Content: Introduction of mechatronic systems. Combine hardware, software and system Integration. Subjects include basic circuits, logic gates, OpAmps, encoder/decoder, DC and stepper motor, A/D and D/A, C-language, interfacing and control.
http://info.sjsu.edu/web-dbgen/catalog/courses/ME285.html

All the above courses will be using Basic Stamp II for their Lab exercises.

To summarize all the above courses cover topics of Analog Electronics, Digital Electronics, Motors, Micro controllers.

2. University of Utah, Salt Lake City, Utah

- Mechatronics I Modeling, Actuators and Data Collection

Course Content: Dynamic systems modeling, instrumentation, actuators and computer-based data collection.

- Mechatronics II Mechanical Components and Control Systems

Course Content: Application and Modeling of Actuators, Sensors and Micro controllers to Feed back Control Systems.

http://www.mech.utah.edu/UNDERGRAD/handbook/coursedes.html
http://www.mech.utah.edu/~santosh/mechatronics.html

3. Johns Hopkins University, Baltimore, MD

- Mechatronics
  Course Content: Microcontrollers, Motor Control, Sensors, Power Systems

  http://custer.me.jhu.edu/mechatronics/syllabus.htm
  http://custer.me.jhu.edu/mechatronics/syllabus2000.htm

4. Virginia Tech- Virginia Polytechnic Institute and State University

- Mechatronics
  Course Content: Analog and digital fundamentals, Microcontroller technologies and computer Architectures, PIC processor, Signal Conditioning, Sensors, Motors, PLCs, Dynamic Modeling.
  Lab work includes VT84 board construction, A/D and D/A conversions.

  http://mechatronics.me.vt.edu/syllabus.html

5. Michigan State University, East Lansing, MI

- Mechatronic System Modeling and Simulation
  Course Content: Introduction to Mechatronics, System equations and behavior Modeling and simulation of mechatronic systems, including mechanical, electrical, fluid, power, and other effects. Transducer modeling, including pumps.

- Mechatronic System Design
  Course Content: Application of imbedded microcontrollers to the design of mechatronic systems. Design of software and hardware for systems with mechanical, electrical and fluid components plus imbedded control systems.

http://ntweb1.ais.msu.edu/j4100/scripts/CatalogRequest.asp?SubjectCode=ME&CourseNumber=
http://www.egr.msu.edu/classes/me491-602/clo.html

6. Colorado State University, Fort Collins, CO

- Mechatronics and measurement systems
  Course Content: Electric Circuit Fundamentals, Diodes, Transistors, Op-Amps, Digital electronics, microcontrollers and the PIC, Sensors.

  http://www.engr.colostate.edu/~dga/me307/syllabus.html

7. Carnegie Mellon University, Pittsburg, PA

- Mechatronic Design
  Course Content: Introduction,68HC16 microcontroller, Motors; encoders, drivers, Sensors, Signal conditioning
  The Lab work includes: Microcontroller Battery Meter, MATLAB Simulation of Mechanical Controller, Motor Speed Controller, Ultrasonic Tracker, IR Communication/Tracker, Stair Climbing Demonstration

  http://www.ece.cmu.edu/~fedder/mechatronics/description

8. Massachusetts Institute of Technology, Massachusetts Avenue, Cambridge, MA

- Mechatronics
  Course Content: Design of mechatronic systems, aliasing, quantization, electronic feedback, power amplifiers, digital logic, encoder interfacing, and motor control. Lab work includes Servo Motor Control, Sampling/Aliasing; Signal Processing, Digital Logic Quadrature Encoders, Analog Power Amplifier Design, Brushless Motor Commutation and Control .dSPACE digital signal processors are used.
  http://web.mit.edu/2.737/www/

9. San Diego State University, 5500 Campanile Drive, San Diego, CA
• Mechatronics: Course Contents: Electronics Sensors, programmable logic controllers, PIC devices. They have been working on a couple of projects. These are PLC Experiments, Conveyor Experiments, http://kahuna.sdsu.edu/~mechtron/mechatronics/
10. University of Illinois at Urbana-Champaign, Urbana, IL
• Introduction to Mechatronics Course Content: Interfacing of sensors and actuators used in manufacturing systems; computer interfacing and real-time monitoring of machine tools and robots; intercomputer communication through network for a manufacturing cell; and human-machine-computer interfaces. http://robot0.ge.uiuc.edu/~spong/deere/ge393.html http://robot0.ge.uiuc.edu/~spong/deere/projects.html

All the above courses in general will give a good knowledge about sensors, actuators, controllers, motors, PLCs, microprocessor, their interfacing with different devices, their applications and help develop simple and complex embedded systems .

The numbers against the courses do not signify any thing. There are just serial numbers.

Submitted By:
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MiniHW2_Britto

Mini Assignment #2

University	Microcontroller	Theory	Labs
Pennsylvania State University	Parallax BASIC Stamp II	RLC circuits, diodes, transistors, op amps, active filters, electric motors, sensors, D/A and A/D Conversion, Digital Electronics, PC Board Fabrication, Digital Signal Processing	analyze and design digital TTL circuits, build and trouble-shoot analog and digital circuits connected to single chip microcontrollers using prototype wiring and printed circuit board layout, interface common transducers and actuators to microcontrollers, filter, digitize and analyze electronic signals using analog anti-aliasing filters, A/D converters, FFT and digital filters
Georgia Tech University	Motorola MC68HC11	16-Bit microprocessor: introduction, hardware overview, programming, interrupts, on-chip subsystems, parallel I/O. Choice of embedded computers; choice of level of languages: assembly, high level, object oriented for real-time programming (such as C), Simulink. Analog and digital devices: Op-amp, ADC, DAC, and power transistors. Sensors, actuators, and their applications to intelligent manufacturing and mechatronic systems. Modeling and control of electro-mechanical systems. Modeling of various actuators: (DC motors, stepper motors, induction motors), and sensors (position, velocity, force, tactile, and ultrasonic).	Reverse engineering (design for tomorrow based on today?s and yesterday?s designs). Interfacing host computer with MC68HC11 and sequencing light emitting diodes. Strain gauge data acquisition using A/D conversion. DC motor control using interrupts and pulse width modulation (real-time control).
University of Michigan	Parallax BASIC Stamp	Electronics, Sensors, Actuators, System Dynamics, Control, Analog, System Implementation	Sensors, DC motor, Encoder, Servo, SMA, Solenoid, Stepper
Santa Clara University	Atmega163	Electronics A/D, D/A converters, op-amps, filters, power devices; software program design, event-driven programming; hardware and DC Stepper Motors, solenoids, and robust sensing.	Operational amplifiers and comparators. Controlling a dc motor. Controlling a stepper motor. Finding information in data sheets. Pulse width modulation. Phenomenon encountered with a DC motor. Limitations of purely software techniques.

North Carolina University	Parallax BASIC Stamp	Analog circuits and electronic components, logic gates, introduction to microprocessor architecture, sensors and actuators, A/D and D/A conversion and data acquisition, sensor interfacing and signal conditioning, real-time programming concepts, intelligent control fundamentals, direct digital control implementation, principles of mechatronic design synthesis, and components analysis.	programming, working with microprocessors, and interfacing sensors and actuators
Northwestern University	The Handyboard single-board computer	Introduction to the design of microprocessor-controlled electromechanical systems. Interfacing sensors and actuators to a personal computer and a single-board computer. Electrical and mechanical design, prototyping, and construction. Dissection of a commercial mechatronic product	The Furby (motor control), The Furby (encoder and home switch), The Handyboard single-board computer,Sensors, actuators etc
University of Illinois	Texas instruments TMS320C6711	Mechatronics Computing, DSP Bios and UART, Encoders, DACs, PWMs, Parallel vs Serial Interfacing, Glue logic, Hardware interrupts, Robot control and navigation algorithms etc	Programming a Digital Signal Processor (DSP), Serial Communication, Input/Output with Daughter Card, Motor Control and Straight-Line Robot Driving, Robot Vision
Carnegie Mellon University	Motorola 68HC16	68HC16 microcontroller, basic controls, motor drives, mechanisms, sensors, IR communications, and motion planning	Microcontroller Battery Meter, MATLAB Simulation of Mechanical Controller, Motor Speed Controller, Ultrasonic Tracker, IR Communication/Tracker, Stair Climbing Robot.
Virginia Tech	Microchip PIC16F84	PIC processor and programming, Power amplification, Signal i/o, PIC A/D Converter, Sensors, Dynamic Modeling, Control theory, PM DC motors, stepper motors etc.	VT84, MPLAB, A./D echo to LED array, Using a Cross Compiler, Open-loop PWM code, PID servomotor code.

Mini-Homework #2
Review of other universities' Mechatronics Courses.

University	Microprocessor Used	Theoretical Emphasis	Practical Emphasis	Rating
Union College, Schenectady, NY	80C52-BASIC	Heavy on semiconductor and discrete components. Microcontrollers instroduced at end of course.	Labs lead to final project of interfacing PLC to one-axis machine tool	Too little microcontroller work.
University of Wisconsin	Atmel AVR	Electromechanical Control Systems, Intelligent Interfaces, Web-based controls	Labs leading to web-based control of microcontroller.	Web-based controls sounds interesting, but I don't think the course should revolve around it.
University at California	PC with Labview	Introductory level (100-level course) Analog & Digital Feedback Systems	Introductory Level (100-level course), PC Control through LabView	Too basic. Want to use an actual microcontroller, rather than a PC running LabView.
University if Guelph, Ontario CA	6811 with Handyboard	Discrete components, microcontrollers, sensors, actuators, more	Builds up to Palm pilot robot	Seems to be a very good mix of of all aspects of Mechatronics, building toward an interesting project, the Palm Pilot Robot.
University of Pennsylvania	BASIC Stamp	Microprocessor usage, electro-mechanical design	Team-based final project	Seems to be a good mix, but didn't see anything that would suggest a regular lab.

University	Microprocessor Used	Theoretical Emphasis	Practical Emphasis	Rating
Carnegie-Mellon University	68HC16 / EMAC	Four-bar mechanisms, stepper motors, microcontroller use	Team-based final projects	Final projects look varied and interesting. Project loosely defined, allowing apparent variation.
Stanford University	Microcore-11	System design, electro-mechanical devices, microcontrollers	Labs leading to Individual robot projects	Very interesting ideas for projects! Head to head competition sounds great! Lots of pics and video. Worth a look.
Northwestern University	6811 with Handyboard	C programming, discrete components, digital design, sensors, actuators, etc.	Includes reverse engineering a Furby, final project for students.	Always wondered what was in a Furby.
University of Detroit-Mercy	BASIC Stamp	Mechatronic systems, microcontrollers, sensors, actuators, digital principals.	Labs with autonomous ground vehicle	Project not inspiring.
John Hopkins University’	BASIC Stamp	Short lecture schedule, projects seem to take over lectures midway through semester.	Project: Autonomous Blimp	Too few lectures.

MiniHW2_Eddy

Colorado State University http://www.engr.colostate.edu/~dga/me307.html
ME307 Mechatronics and Measurement Systems
Topics:
Electric circuit fundamentals.
Signal processing & control
Digital electronics (number systems, logic)
PIC Microcontroller
Data collection and conversion
Sensors, actuators, motors.
Signal conditioning
Implementation:
12 Laboratory sessions with comprehensive coverage of course material.
Final Project
Comments:
This seems to be a very comprehensive course.

Virginia Tech http://mechatronics.me.vt.edu/default.htm
ME 4734 Mechatronics
Topics:
A/D conversion
PIC C and assembly programming
Power amplification
Signal i/o, PIC A/D Converter
Sensors, motors and other actuators
Control theory, PLCs
Dynamic Modeling
Implementation:
Lab section: use MPLAB software, PICC C Lite compiler, VT84 boards, and PID motor controller
Final Project
Comments:

MiniHW2_Eddy

Carnegie Melon http://www.ece.cmu.edu/~fedder/mechatronics/Syllabus.html#description
Mechatronic Design
Topics:
Use of 68HC16 microcontroller.
Motors, encoders, drivers.
Controls, Sensors.
Mechanisms, mobile platforms.
Stair-climbing, brainstorming.
communication protocols.
Motion planning, cooperative robotics.
Implementation:
Course includes 5 laboratories and a main project involving a stair climbing device.
Comments:

San Jose University http://www.engr.sjsu.edu/bjfurman/courses/ME106/ME106courseinfoFall02.htm
ME 106 Fundamentals of Mechatronics
Topics:
Analog and digital electronics
Sensors, transducers, actuators
Microprocessors. Use of Basic Stamp.
Op-Amps, Comparitors
A/D-D/A conversion, Signal conditioning
Logical Circuits
Motor sizing and selection
Implementation:
9 or 10 Laboratory sessions
Semester Long Team Project – Previous examples: smoke detector, little sojourner, widget sorter
Comments:

MiniHW2_Eddy

MIT http://web.mit.edu/2.737/www/
2.737 Mechatronics
Topics:
Servo Motor Control
Sampling/Aliasing; Signal Processing
Digital Logic; Quadrature Encoders
Analog Power Amplifier Design
Brushless Motor Commutation and Control
Servo Motor Control
Implementation:
Course is centered around labs.
Use breadboards.
Class project: Past examples – polar coord plotter, laser light show.
Comments:

Northwestern University http://lims.mech.nwu.edu/~lynch/courses/ME395/
ME 395 Introduction to Mechatronics
Topics:
Interfacing sensors and actuators to a personal computer and a single-board computer
Electrical and mechanical design, prototyping, and construction
Mostly self-taught class. Instructor provides reference material and lab guidance.
Implementation:
Dissection of a commercial mechatronic product
Final computer-controlled electromechanical project
Laboratory Section, use of breadboards, motors, etc.
Comments:

Santa Clara University http://mech143.engr.scu.edu/materials.html
Mech 143 Introduction to Mechatronics
Topics:
A/D, D/A convertion
Op-amps, filters
Power devices
Software program design, event-driven programming
Hardware and DC Stepper Motors, solenoids
Robust sensing
Implementation:
Laboratory component
Atmel AVRStudio 4.0 - Assembler and Programmer for Atmel AVR processors AVR-GCC (2001-12-14a) - C compiler for AVR processors PonyProg2000 2.05 Serial/Parallel port device programmer. Programs AVR processors, serial EEPROMs, PIC microcontrollers, etc
Course project – ex: Creation of mini racecar that navigates a track and makes pit-stops.
Comments:

Union College http://cs.union.edu/~krouglin/mer180/
MER-180 Mechatronics Design
Topics:
Design Philosophy, Number Systems
Semiconductors, Diodes, Transistors, Op-Amps
Logic Design
Interfacing, Actuators, Sensors
Microcontrollers + programming
Implementation:
Lab Sections
Final Project involving control of a simple machine tool
Comments:

MiniHW2_Eddy

University of Nebraska - Lincoln http://robots.unl.edu/course_info/
MECH 498/898 Mechatronic Systems Design
Topics:
Electrical and Mechanical Physical Modeling and Simulation
Computers and Micro-controllers
Analog / Digital Electronics
Power Electronics
Sensors, Transducers, Actuators
Implementation:
Lab Section making use of Basic Stamp II
Open ended final project. Examples: Automatic towel dispenser, automatic trash can, motion follower.
Comments:

Penn State University http://www.me.psu.edu/lamancusa/mechatronics/advmech.htm
ME 597D Advanced Mechatronics
Topics:
Sensors
Motion Control
System Modeling
MicroComputer Architecture
PIC Processors
Serial Data Communication
Discrete Digital Control
Implementation:
Lab Section making use of Basic Stamp II
Final Project but little information about details.
Comments:

MiniHW2_Gavirneni

Though a variety of courses are being offered in Mechatronics in the area of North America, with some a major in it, the universities that are offering this course at an individual level are found to be relatively few in my observation. (Considering a course on Robotics cannot be detailed under mechatronics) The list of Universities that had offered or offering Mechatronics with their course website addresses presently are:

1. Virginia Tech Poly and State University:
Mechatronics.me.vt.edu/default.htm
Syllabus is at: http://www.mechatronics.me.vt.edu/syllabus.html

It has got a good structure of course and lab in the end arriving at a project. The course focuses on V84 proto type board construction, PIC processor assembly programming, sensors, actuators, real time systems, etc. Web is provided with all reference material for the processor, board, and text books and also with the previous project listings. (fall 2002)

2. Carnegie Mellon : http://www.ece.cmu.edu/~fedder/mechatronics/Syllabus.html
This course was offered during spring 1998. Stair-case Climbing-Robot making was the aim of the class. Good emphasis was given for both theory and practice.

3. John Hopkins University: http://caesar.me.jhu.edu/mechatronics/syllabus.doc
It was Graduate course subtitled as Branching Robot. The course details were not clearly laid out But it includes lectures on Dynamics, Simulation and Pseudo-Code. Suggested textbooks have been given. No microprocessor was separately listed for the course and project.

4. University of California, Riverside:
http://www.engr.ucr.edu/~hkim/Mechatronics/syllabus.pdf

The course was introduction to Mechatronics. It was offered for winter 2002. Theory covered all the fundamental electronic devices and working and some mechanical topics like stress, strain, vibration, sensors and actuators and motors. Lab experiments are conducted using equipment like PCI-1200 converters, 24 bit converter, and PWM amplifier.

5. Tennessee Tech University
http://www.tntech.edu/me/courses/Canfield/me4370/

The special feature of the course is its project titled Robot Wars that was Robot war competition between the robots from different teams in the class. The aim was to built robots that must be capable of traversing and finding its way through an unknown terrain filled with corridors, hazardous obstacles and an open arena to deliver your team flag to its destination.

6. Santa Clara University, Canada
http://mech143.engr.scu.edu/course.html

This class will be based on a similar one-quarter mechatronics class at Stanford University. Atmel STK500 is used for lab experiments.

7. University of Manitoba, Canada.
http://www.umanitoba.ca/cgi-bin/faculties/engineering/courses/outline.cgi?dept_no=025&course_no=490

This course is titled as Mechatronics System Design. The course is integration of mechanical, electronic and software components towards building mechatronic devices.

8. University of Toronto, Canada.
http://www.control.utoronto.ca/~omidj/Teaching/outline.htm

The course is on Analog and Digital Electronics for Mechatronics. It consists both lab and theory. It has no final project and computer programming for the circuits. As the title suggests focuses Electronics equipment of Mechatronics.

9.NC State University.
http://courses.ncsu.edu:8020/mae534/lec/001/course_info.html

In addition to normal course structure of mechatronics it also includes design theory.

10. Kettering University
http://www.kettering.edu/~jhargrov/mechatrn/me-480.htm1

Course contains all the elements to design a project. Lab covers experiments for all the course structure. There is no final project.

11. San Jose State University
N:\Mechatronic course listings\Mechatronic Systems Engineering.htm

It is a fundamental course on mehatronics for undergraduates. Not much details are found.

12. University of Michigan
http://www.egr.msu.edu/classes/me491-602/

It is a course on Mechatronic Modeling and Simulation. Does not contain Mechatronic lab. Includes a design project.

MiniHW2_Gavirneni

College or University	Microprocessor	Emphasis on theory	Practical Emphasis	Any other Remaks
Tennessee Tech Univeristy	HC12 Microcontroller	Well	Lab details are not to be found in detail. But good	Final project demo is inspiriting being a war simulation betn robots.
Virginia Tech	PIC processor V84 board	Well structured course	Good	Both theory and practicals are coordinated.
Carnegie Mellon	68HC16 microcontroller	Good	Well.	More practical emphasis is given.
John Hopkins	Not mentioned	Fair, complete details are not to be found	Mainly focused on practical construction of a Branching Robot	Design and simulation starts early in the course.
Rensselar Polytechnic Institute	-----	Well	Good	It is design oriented. No demo project
University of California, Riverside	Not mentioned Other devices used are : PCI-1200 (AD/DA converters) PWM amplifier (LMD18200)	Well	Well	Two projects have been done finally C programming was used
Kettering University	Not mentioned any specific processor	Good. But all topics are not specified in deetail	Lab experiments are ok. It lacks a final project.	Reverse Engineering was done in first session of lab
San Jose State University	Not found	Good	fair	Not much details are found. No project
University of Manitoba	Not specified	fair	fair	Design oriented
Santa Clara University	Not specified	Contents are Good.	Good	Variety of projects are to be found

MiniHW2_Gavirneni

Nicholas Gill- Mini Assignment 2

Disclaimer: The assignment was to find what other universities offer in Mechatronics. Many universities do not have a compact form for examining course offerings- some lack certain required specifics for this assignment. I included some incomplete universities here because I feel they are interesting for particular reasons.

1. McGill University
http://www.mcgill.ca/mecheng/undergrad/curriculum/mechatronics/
Students in this option must take the following four (4) required courses:

MECH-413	Control Systems
MECH-554	Microprocessors for Mech. Sys.
MECH-557	Mechatronics Design
MECH-572	Introduction to Robotics

And two of the following:

MECH-528	Product Design
MECH-541	Kinematics Synthesis
MECH-573	Mechanics of Robotic Systems
MECH-576	Computer Graphics and Geometric Modelling
ECSE-502	Control Engineering

MECH-557 Mechatronics Design
3 credits

(Prerequisites: ECSE-461, MECH-383 and MECH-412) Team project course on the design, modeling, model validation, and control of complete mechatronic systems, constructed with modern sensors, actuators, real time.

McGill University was included in my report because they have an entire Mechatronics degree option. Their course descriptions do not have which electronics package they are using. I attached a course description to show the amount of available information. I feel this is a great offering for students and is noteworthy.

2. University of Vermont
http://mechatronics.me.vt.edu/default.htm

Construction of the VT84 PC board

What to know before you begin

This section covers the construction of the VT84 prototyping board. The VT84 is a versatile development system for the Microchip PIC16F84 processor. Its capabilities include:

Spring 2002 Student Project Summary:

- Auto Etch-A-Sketch ;Auto Video Stabilizer; Automatic Card Dealer; Automatic Golf Ball Tee ;Drinking Cup Stabilizer;Glass Bottle Sorter;Light Follower

Nicholas Gill- Mini Assignment 2

- Morphing Wing Sports Ball Pump;Submarine Fin Control;Traction Control System

The Mechatronics course and laboratory are designed to cater to both mechanical and electrical engineering students exploring areas outside of the normal core curricula. Because of this, the prerequisites are different for each discipline. The **prerequisites** are:

Mechanical Engineering Students:
ME 3514 (System Dynamics)
Electrical and Computer Engineering Students:
ECpE 3714 (Circuits, Signals, and Systems)

This class seems very similar to the UB class. They are using the Vt84 prototyping board and the pic16F84 microchip. They have labs and a class session. In the end of the class there is a final project.

3. University of Utah
http://www.mech.utah.edu/~me3200/
The University of Utah uses the Lego robot kit. It uses a C programming system on the IC4 PIC. They are also using the handy board.

This class has labs and a classroom setting. The curriculum, in the second half of the class focuses more on systems design with Bode plots and developing differential equations. It is important to note that this is a two-semester class. I like this because it doesn't force a student to major in Mechatronics, but rather get a sampling of what Mechatronics can offer.

4. University of Michigan
http://www.egr.msu.edu/classes/me491-602/clo.html
MEA 491/602 Mechatronic system Modelling and Simulation

This class is theoretical. There are no labs. The main focus is on developing and modifying multi-port systems.

5. University of San Jose
http://www.engr.sjsu.edu/bjfurman/mechatronics/courses.htm
This school, like McGill University, has a large course offering for Mechatronics. There are over ten courses listed in Mechatronics design.

One class is very similar to ours at UB. MAE 106 uses the Basic stamp. They do several labs and a final project. One interesting focus they have is motor selection.

6. NC state University

MAE 534: Mechatronics Design (S, D) Principles of Mechatronics Design, review of logic gates, microprocessor architecture, sensors and actuators, A/D and D/A conversion techniques, real-time multi-tasking programming concepts, direct digital control implementation. "Hands-on" experience through several laboratory assignments and final team project.

This school, like many schools, does not list the exact specifics of the course, but the class seems very similar the UB class. There are labs with a class lecture.

7. Kettering University
http://www.gmi.edu/~jhargrov/mechatrn/mechatrn.htm

This class is MAE 480. It uses the Toshiba TLCS-900H "microprocessor trainer and evaluation board". LED, LCD's, Sensors, Actuators, and Instrumentation are the main topics of the 7 labs. The programming language is in C.

8. Georgia Institute of Technology
http://www.me.gatech.edu/me/academics/graduate/sem_conv/ME6405.htm
Topics:

- 16-Bit microprocessor: introduction, hardware overview, programming, interrupts, on-chip subsystems, parallel I/O
- Choice of embedded computers; choice of level of languages: assembly, high level, object oriented for real-time programming (such as C), Simulink
- Analog and digital devices: Op-amp, ADC, DAC, and power transistors
- Sensors, actuators, and their applications to intelligent manufacturing and mechatronic systems
- Modelling and control of electro-mechanical systems
- Modelling of various actuators: (DC motors, stepper motors, induction motors), and sensors (position, velocity, force, tactile, and ultrasonic)

The syllabus for ME 6405 does not list which IC or programming language is used. There are similar topics covered as in the UB class. One common theme in most classes that our class does not have is systems modelling. All MEA students at UB must take SYS 336, and it is most likely not necessary to repeat the information for this class.

9. Stanford University
http://design.stanford.edu/Courses/me118/me118.html

MEA 118, at Stanford University, has an array of different microchips and processors, because the equipment for the lab was donated by several different companies. The specifics for this course are not public. There is a lab and a lecture for this class. It is offered to both electrical and mechanical engineers.

10. University of Waterloo from Canada
http://www.me.uwaterloo.ca/~mechatro/

I end with the University of Waterloo. They offer a whole Mechatronics major that is interdisciplinary with electrical, and computer engineers. There is a list of course offerings that focus on systems, computers, electronics, and mechanics, but I cannot get specific information on any of the courses.

Assignment 2

Mechatronics courses in North America

No	University	Course Description	Rating (Out of five)
1	Massachusetts Institute of technology 2.737 Mechatronics	Computer hard disk drive is an example of a complex mechatronic system discussed in this course. Includes topics such as aliasing, quantization, electronic feedback, power amplifiers, digital logic, encoder interfacing, and motor control. Lab facilities feature dSPACE digital signal processors which are programmed through Simulink used for this course. Includes group project. Details of microprocessor used are not mentioned on the website.	*****
2	Virginia Tech ME/ECpE 4734 Mechatronics	VT84 board & PIC16F84 processor used, Includes term project, PIC assembly & C programming, Control theory review, PLC and real time systems	*****
3	University of Maryland, College Park ENME 489L Mechatronics	Includes a project with constrains, like payload, power etc., sensor design, research and businesses in Japan in mechatronics, labs and demos of motor drives, sensors, mills, lathes, Image craft C, EPROM code. Details of microprocessor used are not mentioned on the web site.	*****
4	University of Texas Austin ME 348/392Q Introduction to Mechatronics II	Includes lab, final project, M68HC11 microcontroller, digital logic, discrete components, combinatorial and sequential logic, serial and parallel communications, LabVIEW™ graphical user environment for data acquisition and computer control	*****
5	University of Illinois Urbana Champaign ME 468. Modeling and Control of Electro-Mechanical Systems	Course emphasizes more on control theories of a mechatronic system. Topics include, Fundamental electrical and mechanical laws needed for a general dynamical machine model, power electronics for control of electrical machines, control objectives for electrical machine systems in typical applications (actuators, automated vehicles, robotics, variable speed	*****

		drives), potential of the microprocessors and the VLSI technology for the real time implementation of control techniques. Details of microprocessor used and lab are not mentioned on the web site.	
6	Georgia Institute of Technology ME 6405 Introduction to Mechatronics	16-Bit microprocessor used, includes modeling of various actuators and sensors, assembly, high level, object oriented techniques for real-time programming. Group project 30 %, and lab.	****
7	Texas A & M, College Station 667 Mechatronics	Analysis and applications of computerized machinery, actuators and sensors, high level programming languages, A/D and D/A converters, PWM, real time control, Includes a term project, Details of microprocessor used is not mentioned	****
8	University of California LA 163A Introduction to Computer-Controlled Machines (class) 163C. Robotics and Motion Control Laboratory (Lab)	Have separate courses for lab and class. Course includes motion and command generation, servo-controller design, and computer/machine interfacing, Lab includes robotic devices and articulated machines, programming of industrial robots. Details of microprocessor used are not mentioned on the web site.	****
9	NC State University MAE 534 Mechatronics Design	Microprocessor used is not mentioned on website. Programming in C for embedded systems, analog circuits and electronic components, real-time programming concepts, intelligent control fundamentals, direct digital control implementation, principles of mechatronic design synthesis, and components analysis. Also includes group project and lab	****
10	University of Washington ME477 Embedded Computing in Mechanical Systems	Assembly language programming, interfaces, and communications. Particular emphasis on design of hardware and software interfaces for real-time interaction with mechanical systems. Microprocessor used is not mentioned on website. Includes lab.	****

Mechatronics course in North American Universities

Mechatronics Assignment 2
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	University	Website	Uc used	*Theoretical emphasis	Practical emphasis
1	Rutgers	http://cronos.rutgers.edu/~mavro/robot/525syllabus.htm	not mentioned	50%	50%
2	Stanford	http://design.stanford.edu/Courses/me118/html/course.html	not mentioned	35%	65% Good Projects
3	Virginia Tech	http://mechatronics.me.vt.edu/home.html GOOD COURSE	PIC	45%	55%
4	Carnegie Mellon	http://www.ece.cmu.edu/~fedder/mechatronics/Syllabus.html#outline	68HC16	0%	100%
5	Univ of Wisconsin Madison	http://mechatronics.me.wisc.edu/me601/default.htm	ATMEL 8535	more	less
6	Univ of Pennsylvania	http://www.cis.upenn.edu/~jpo/Courses/MEAM410/	BASIC Stamp II	equal	equal
7	University of Massachusetts	http://www.ecs.umass.edu/mie/courses/fall2002/mie402/402_2002Fall_Syllabus.pdf		20%	80%
8	Penn State	http://www.me.psu.edu/lamancusa/mechatronics/advmech.htm GOOD COURSE	PIC, Basic Stamp II	50%	50%
9	Colorado State University	http://www.engr.colostate.edu/~dga/me307.html	PIC	60%	40%
10	Washington State University	http://www.mme.wsu.edu/academics/courses/syllabi/me/me401.html	not mentioned	40%	60%
11	University of Delaware	http://www.cis.udel.edu/~chester/courses/685.html	PIC 16F876	more	less

* Analysis of theoretical and Practical emphasis is dependent on the grading policy.

MAE 476 Mini Assignment 2

	University	Link	Notes
1	John Hopkins University	http://caesar.me.jhu.edu/mechatronics/syllabus2000.htm	Use Mindstorm Kit. Final project is to design a Brachiating Robot.
2	Univ. of Pittsburgh	http://fie.engrng.pitt.edu/fie95/4a1/4a13/4a13.htm	3 mini projects and 1 final project where in a group of 4 people each student chips in with $75 to do the project
3	Univ. of Illinois, Urbana Champaign	http://motion.csl.uiuc.edu/~bullo/ge330/description/	9 labs about various robot parts + 1 final Project which can be chosen by the group.
4	Carnegie Mellon	http://www.ece.cmu.edu/~fedder/mechatronics/Syllabus.html	Use 68HC16 microcontroller. 5 small projects and final project dealing with Stair Climbing Demonstration
5	Colorado State Univ.	http://www.engr.colostate.edu/~dga/me307.html	More theoretical course. Have 3 exams, A small lab every week and one final project. Use PIC Microcontroller.
6	Univ. of California, Berkeley	http://www-inst.eecs.berkeley.edu/~ee192/	Spend the whole semester building a race car and they complete with each other to see who builds the best one. Funded by National Semiconductor.
7	Univ. of Utah	http://www.mech.utah.edu/~me3200/	Use a Motorola 68HC11 Microcontroller. Equal balance between practical & theoretical. 40% Labs, 60% HW's & Exams.
8	Virginia Tech.	http://mechatronics.me.vt.edu/Labs/labs.html	Use PIC microprocessor and have 5 labs over the semester + 1 final project which the students get to pick.
9	Tennessee Tech.	http://www.tntech.edu/me/courses/Canfield/me4370/	Use HC12 A/D converter system. Equal theoretical & practical emphasis. Final project is to design a robot to compete in Robot wars!
10	RPI	http://www.rpi.edu/~craigk/Coursework/S&A_Course_Introduction.PDF	10 lab assignments. No group work and no final project.

MiniHW2_Kandula

RANK	***NAME OF THE UNIVERISTY***	***WEB PAGE***	***PROCESSOR USED***	***ANALYSIS***
1	Stanford Univeristy	http://cdr.stanford.edu/spdl/	MC68HC11	More emphasis on projects. Has more course content which is divided into 3 quarters. But contains more basic mechatronics in first quarter.
2	Colarado state university	http://www.engr.colostate.edu/~dga/me307.html	Use a PIC controller (did not mention anything specific)	Have a lab session with quizzes and tests.More emphasis on lab and implementation.
3	Carnegie mellon university	http://www.ece.cmu.edu/~fedder/mechatronics/	Use 68HC16 microcontroller	Grading is involved only with lab work and project. No class work assignments. Very practical grading.
4	Virginia Tech	http://mechatronics.me.vt.edu/	Use VT84 prototyping board	Varied lab projects and course content is more precise than general
5	California Polytechnic State University	http://me.calpoly.edu/mecha/mecha.html	MC 6802	Has more emphasis on theory more than lab. Lab is not included and more focus is on programming microcontrollers in specialization for mechanical engineers.
6	University of Utah	http://www.mech.utah.edu/~me3200/	Motorola 68HC11	Has two parts for the course in order to make a more extensive lab understanding and knowledge of mechatronics.
7	Northwestern university	http://lims.mech.northwestern.edu/~lynch/courses/ME333/2003/	68HC11 and 68HC16	Has more generalized course offering. Includes lab with more different variety of projects being done
8	John hopkins University	**http://custer.me.jhu.edu/html/mechatronics.html**	**CPU of the lego mindstroms kit** **Product name H8/3292**	Their course objective for spring 2002 was to develop a self – replicating robot. They do different projects in different semesters.

MiniHW2_Kandula

9	University of Nebraska lincoln	http://robots.unl.edu/classes/498/	Use Parallax Micro-controller (Model: basic stamp II)	Course content is of primary importance in grading even though a good lab scheduling is observed. Has more theoretical emphasis rather than lab experiments
10	Santa clara university	http://mech143.engr.scu.edu/course.html	ATMEL STK 500	Has more emphasis on course work. Has less varied projects. Included lab sessions.

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MECHATRONICS- MAE576
MINI-ASSIGNMENT #2

Submitted by: Gaurav Kimothi
UB Person No.: 3059-5804
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MiniHW2_Kimothi

Criteria / University	Theoretical Emphasis	Practical Emphasis	Microprocessor/Microcontroller Used	Web Page
San Jose State University	Good	Average	Basic Stamp	http://www.engr.sjsu.edu/bjfurman/mechatronics/courses.htm
University of Utah	Too High	Average	Not specified	http://www.mech.utah.edu/~santosh/mechatronics.html
Virginia Tech	Average	Average	PIC16F84 microcontroller	http://mechatronics.me.vt.edu/default.htm
Carnegie Mellon University	Average	Good	68HC16 microcontroller	http://www.ece.cmu.edu/~fedder/mechatronics/Syllabus.html#description
John Hopkins University	Below average	Good	Not specified	http://custer.me.jhu.edu/html/mechatronics.html
North Carolina State University	Good	Good	Not specified	http://courses.ncsu.edu:8020/mae534/lec/001/
Colorado State University	Good	Average	Not specified	http://www.engr.colostate.edu/~dga/me307.html
San Diego State University	Below average	Average	Not specified	http://kahuna.sdsu.edu/~mechtron/mechatronics/
Michigan State University	Good	Below average	Not specified	http://www.egr.msu.edu/classes/me491-602/clo.html
Kettering University	Average	Average	Not specified	http://www.gmi.edu/~jhargrov/mechatrn/mechatrn.htm

Universities	**Theoretical emphasis, Microprocessor used.**	**Practical emphasis**
The Ohio State University.	Emphasis Introduction to multi-domain systems. Mechanical, thermal, fluid, electrical, electronic, electro-mechanical system dynamics. Emphasis on modeling and simulation of hybrid systems using modern computer-aided tools.	Emphasis on ion gas sensing, use of exhaust gas sensors, transmission shift control, hybrid vehicle control strategies. Testing, evaluation, and application of solid state gas sensors.
Michigan State University	Real time digital measurement, control programming for mechanical engineering systems	Analog to digital and Digital to analog converters, Time/counters, Closed loop and Open loop controls, and instrument interfaces.
Clemson state university	Concepts of design, appropriate dynamic system modeling, analysis, sensors, actuating devices, and real-time microprocessor interfacing and control.	Mechatronics integrates control, sensors, actuators and computers to create a variety of electromechanical products; Case studies, simulation and projects are used to exemplify the system design principles.
University of Colorado, at Boulder.	Explores design principles of robot manipulators, including grippers, control systems, sensing techniques, and robot applications. Microprocessor interfacing and control. Addresses issues of micro-electro-mechanical systems (MEMS) modeling, design, and fabrication.	Emphasizes the design and fabrication of sensors and actuators due to significance of these devices in optics, medical instruments, navigation components, communications, and robotics. Various optical instruments are available to verify the electromechanical behavior of fabricated MEMS in real time as a function of environmental temperature and pressure. For temporal response studies, an optical interferometer is available

Massachusetts Institute of Technology.	Control theory and application, modeling, system theory, optics, quantum computing, information technology and applications.	Electromechanical models, dissipateors, transformers, gyrators. Modification of system characteristics using feedback. State observers, Kalman filters. Modeling/performance trade-offs in control system design. Emphasis on application of techniques to physical systems.
University of Illinois at Urbana	Control objectives for electrical machine systems in typical applications (actuators, automated vehicles, robotics, variable speed drives) Feedback linearization techniques for achieving control objectives. Nonlinear composite control techniques as applied to electrical machines Comparison of feedback linearization techniques and nonlinear composite control techniques in terms of accuracy and measurement requirements Time scale separation in dynamical models of electrical machines (together with the power electronics support) Potential of the microprocessors and the VLSI technology for the real time implementation of control techniques.	MEMS sensors and actuators are employed to study materials´ behavior at nano meter scale. The objective is to understand the mechanisms of deformation and strengthening of metals at small scale. The non-linear dynamical response of MEMS actuators subjected to light pressure. Mechanotransduction of single living cells subjected to mechanical force by MEMS actuators. The response of the cell is measured by MEMS force sensors. The equipment consist of a custom made probe stations with 12K magnification, image acquisition and processing hardware and software, TV-VCR, a complete cell culture facility.
University of Waterloo, Ontario.	Review of modeling and approximation of dynamic systems. Review of classical control theory. Electronic realization of control elements and compensations: ideal and real PID. Introduction to microcontrollers. Elements of digital control theory: sampling theorem, z-transform and digital filters. Kinematics: coordinate frames and transformations, forward and inverse kinematics 7	Review of computer interfacing, power amplifiers, sequential logic, encoders, and motor control. The course involves practical projects and significant laboratory usage. physical configuration & workspace, joint position measurement and control, robot controller operation 7 Programming: motion types & applications, digital I/O and program flow control 7 Sensor-based operation: seam tracking & force feedback control Machine