ME353 Mechatronics

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Office Hours:
TBA
(Appointment suggested)

Class Schedule:
9AM-10AM Wednesdays - 505NAB
9AM-10AM Thursdays –505NAB
Group Meetings TBD

Specific Course Information:

Catalog Description: Topics include computer architecture, PIC processor overview, dynamic modeling, sensors, data acquisition,digital PID control theory, and utilization of assembly language to code the controller. Students will design, build and test a controller board and present a final prototype of a control system. Engineeringeconomics will be introduced and integrated into the final project.

Prerequisite: ME 151 or ECE 121 or ChE 152

Goals:

1. Application of fundamental mechatronics topics
2. Reinforce problem-solving skills through system design and analysis
3. Develop professional attributes through the project design process

Prerequisites by Topic: Control Systems, Computer Programming

Grading/Deliverables:

- Individual
  - Participation (class attendance and group participation)
  - Leadership as rotating team lead
  - Homework
- Group
  - Pricing/parts report
  - Sketches/ technical illustrations/ CAD
  - Photo documentation of the build process
  - Weekly meeting minutes
  - Formal technical paper (1 per group)
  - Final robot

Use of Electronic Devices
No cellphones may be used during the class periods at any time (cellphones must be turned off). You may take hand written notes or use a laptop (absolutely no email/social media during class).

Disability Accommodations
Students seeking accommodations due to a condition covered by the Americans with Disabilities Act are required to formally self-identify through the Office of Dean of Students. The Dean of Students will work with the students to clarify requested accommodations. It is the student's responsibility to speak directly to me to see how their accommodations can be met.

Medical Absences
Students who have medical excuses for missing class should contact the Dean of Students promptly. Students will be required to provide the Dean of Students with documentation from a medical provider justifying the absence. The Dean of Students will inform me when an absence is due to a valid medical issue/condition so that the absence can be considered excused. It is important to note that even with excused medical absences; a student is still responsible for completing all of the course requirements. If a student's absences have resulted in their missing vital components of in-class discussions and experiences, students may be required to withdraw from a course and retake it even with valid medical excuses. This is entirely at the discretion of the faculty member teaching the course. In addition to communicating with the Dean of Students, students must remain in regular communication with the faculty teaching the course when they need to miss a class.

Materials:
DLD kits
Robot parts (group expense)
No required text book.
Recommended Reading:

- Mechatronics, Mechanical System Interfacing
  David Auslander and Carl Kempf - Prentice Hall 1996
- The C Programming Language (second edition)
  Brian Kernighan and Dennis Ritchie - Prentice Hall, Inc., 1988
- Introduction to Electrical Engineering (Second Edition)
  C.R. Paul, S.A. Nasar, L.E. Unnewehr - McGraw Hill 1992
- The Art of Electronics (Second Edition)
  Horowitz & Hill – Cambridge University Press 1998

Schedule

Date	Lecture 1	Lecture 2	Project Progress (Due)	Report
17-Jan	Introduction and Overview	Systems/design	Semester Starts	
24-Jan	Introduction to Boolean Algebra	sketching/elctromechanical elements	form groups, Brainstorming	
31-Jan	Boolean Algebra (CDL/KM)	Motors	Brainstorming, initial sketches	
8-Feb	Boolean Algebra (LBD)	Physical Logic and Transistors	Vendors Spec'ed, refined sketches due	
14-Feb	Boolean Algebra (PAL, PLA,memory)	Sensors	Technical Illustrations and Cost Report	
21-Feb	Synchronous Systems	Drivers	CAD drawings done, and parts received	Rough Outline
1-Mar	DLD Basics	Signals, Data Handling	Machining started	
7-Mar	DLD	DLD	Major machining done / DLD project 1	Detailed Outline
14-Mar	**Spring Break**			
21-Mar	PIC Basics	Computer Architecture	All machining done / DLD project 2	Rough Draft
28-Mar	Assembly Flow/ Polling	Assembly / Counting Program	Robot assembled / PIC project 1	
4-Apr	Assembly A->D	Assembly Interrupts / PWM	PIC project 2	Revised Draft 1
11-Apr	C18 libraries	C18 intro	PIC project 3	Revised Draft 2
18-Apr	C18 pwm	C18 a/d	PIC, sensor/motor -driver working	
25-Apr	PID on a PIC	demonstrations	Robot avoiding ring edge	
2-May	**finals**	**finals**	Final Robot	Final Report

Term Project

Project Overview:

To design and fabricate a small, wheeled, robot for competition in a robot sumo contest. (rules to follow)

Suggested Parts Vendors:

www.mcmaster.com McMaster Carr, Suppliers of industrial supplies and raw materials
www.digikey.com DigiKey, everything electrical or electronic
www.newark.com Newark electronics, everything electrical or electronic
www.sparkfun.com novel and rare, but useful, electronics for prototyping
www.robotcombat.com/store.html Robot Marketplace, Suppliers of Battlebot parts
www.towerhobbies.com Tower Hobbies, Suppliers of R/C vehicles and parts
banebots.com/ Bane Robots, suppliers of high torque mini-motors
www.lynxmotion.com/ Lynx Motion, high torque small motors, wheels, hubs

Suggested Research:

Start looking at toys and R/C cars. Drive trains can be tricky, and these products have already found inexpensive solutions. Also, look on the Internet at various robots that other colleges have made. I suggest looking at the IEEE Micromouse competition, Battlebots (Antweight division), and sumo robot contests for inspiration. Also speak with previous years' students to gain from their successes and failures.

Rules and Regulations:

Spirit of the Problem:

- The goal of the competition is for one robot to push the other robot out of the “ring”.

Competition Rules:

- The “ring” will be approximately 3ft by 3ft square, and made from neoprene rubber (mcmaster # 9455K62 - ASTM D2000 BC).
- The opponents will be placed at one of three starting positions (straight on, 45 degrees, and 90 degrees from opponent) within the ring.
- When signaled, the teams will activate their robots simultaneously.
- The robot will attempt to locate the other robot and push it out of the ring.
- The robot is considered “out of the ring” when more than half of the robot is no longer within the main area of the ring.
- If neither robot has won after 1 minute (or when both teams agree on a draw), the round is considered a draw.
- Bumps and imperfections will be less than 1/8” at any single spot and no more than 1/2” over the entire area.

Cost

- The total cost of the robots components may be no more than $200.
- The cost is calculated as 1/100 the cost to build 100 robots. (NOTE: the cost is NOT what you pay. It is a quoted cost of materials.)
- Materials donated, found, etc must be accounted for at quoted prices for the total cost of the robot.
- Basic electronics package can be assumed to be valued at $25

Size

- The robot may be no larger than 10"x10"x6"

Weight

- The robot may weigh no more than 5 lbs (with all batteries, motors, etc.)

Motors

- Motors may not have a stall current of more than 4.5A (each).
  - **NOTE**: Stall current must be documented.

Power supply

- The motor power supply must be a combination of AAA, AA or C cells, providing a maximum of 14V (they must be NiCd or NiMH).
- The power supply for electronics may be at the team's discretion, and may feed from the same power supply as the motors.

Electronics

- The robot must be controlled by one or more 18F4520 PICs. No other programmable chip is allowed.
- The robot will sense the border of the ring with one or more supplied IR sensors.
- The robot may (though not necessarily) employ additional sensors, but these must be accounted for in the total cost.
- No external control of any sort is allowed.
- The robot MUST have an easy to access kill-switch. This MUST cut ALL current to ALL parts (motors, electronics, logic etc.)

Restrictions

- No liquids, gels, compressed gases, or hazardous substances may be employed (except within circuitry, NiCd, or NiMH batteries. No lithium-ion or lead acid batteries)
- No electrical or mechanical weapons are permitted.
- No lasers may be employed. (This includes sensors.)
- The robot may not purposefully damage the other robot (this includes reasonably foreseeable "accidents").
- You may not damage the ring in any way. (this includes, but is not limited to, residue from glue or tape)

On Site Documentation (must be available the day BEFORE the competition):

- Manifest of all parts and materials.
- MSDS sheets for all materials.
- RoHS status for all circuity.
- Documented amperage limits of drivers.
- Documented maximum amperage draw for motors.