

MCHE 470: Robotics
Fall 2013 – Final Exam
Friday, 12/13, 5:00pm – 7:30pm

- Basic I/O
 - Analog vs Digital (conceptually)
 - Analog-to-Digital Conversion
 - Effect of number of bits on resolution (8bit vs 10bit)
 - Basic equation/relationship between analog and digital in ADC
 - What pins on the RedBoard are analog? Digital?
 - Digital I/O
 - Switches, etc that are on/off (0 or 5V typically)
 - PWM
 - How does it approximate analog?
 - What is duty cycle?
 - Serial Communication
 - Basic understanding
 - What are the parameters we have to set?
 - Baud rate = speed
 - Stop bit = are we finished?
 - Parity = rarely used, don't worry about it
 - Number of data bits = actual data, 7 or 8 bits typical

- Arduino Programming
 - Data types
 - Names
 - Range of possible values
 - How is a variable declared?
 - What is the basic setup of an Arduino program?
 - What does setup() do?
 - How about loop()?
 - Know variable scope within a sketch (Arduino program)
 - How are functions defined?
 - Basics of control structures
 - What are the comparison operators?
 - If... else
 - Switch... case
 - For loops
 - While loops
 - Do-while loops
 - Serial Comm. with Serial Monitor

- Why is it useful?
 - How to set up?
 - Basic Arduino functions
 - pinMode
 - analogRead
 - analogWrite (actually PWM)
 - digitalRead
 - digitalWrite
- Design
 - House of Quality
 - Specification Sheet
 - Function Tree
 - Morphological Chart
 - Evaluation Matrices (1st, 2nd, and 3rd level)
- Controls Overview
 - What's the basic purpose of each block in a generic block diagram?
 - P, PD, and PID control
 - What's the basic setup?
 - What is the function of each of the gains? (the table we talked through in class)
 - How can we choose/tune the gains? (Ziegler-Nichols is one way)
- Command Generation
 - What is a bang-bang input?
 - What is a bang-coast-bang input?
 - When should I use either?
 - What's the relationship between bang-bang and bang-coast-bang force commands and resulting velocity and position?
 - What are the problems when these commands are issued to flexible systems?
- Command Generation for Flexible Systems
 - How can we reduce vibration?
 - Move slow
 - Intelligently design commands
 - Input Shaping
 - Impulse response explanation
 - How do you convolve a series of impulses with a command?
 - How is input shaping implemented?
 - What is the tradeoff between shaper duration and robustness to changes in frequency?
- Sensors and Sensing

- Encoders
- Gyroscopes
- Accelerometers
- Inertial Measurement Units (IMU)
- GPS
- What are "general" sensors concerns?
- What are the issues with changing domains (pos \leftrightarrow accel)?
- Sensor Processing
 - Running Average
 - Moving Average
 - Exponential Moving Average
 - Lowpass filtering

- Machine Vision
 - What are some applications?
 - What are the components of exposure triangle?
 - What is depth of field? What affects it? Why?
 - How are images digitized? How are they represented to the computer?
 - How do image sensors detect color?
 - Color spaces?
 - RGB
 - HSV/HSL
 - CMYK
 - YCbCr
 - Filtering
 - Blurring to improve?
 - Box filtering

- Machine Stability
 - What is a support polygon?
 - Know the different stability margins
 - COM projection (How does this change on an incline?)
 - Energy Stability Margin
 - How does the "optimal" configuration different between these two?
 - How can we use these stability margin?
 - Machine safety (aerial lifts, etc)
 - Walking robots

- Tracking Control
 - What is plant inversion?
 - What are the problems with plant inversion?
 - What is the basic idea of the Zero Phase Error Tracking Controller (ZPETC)?
 - What is the basic idea of a Repetitive Learning Controller?

- What are the effects of increasing the learning gain in a Repetitive Learning Controller?

- Machine Learning
 - What are some example applications?
 - What are some possible features to use for text classification?
 - What is the difference between supervised and unsupervised learning?
 - What is the k-Nearest Neighbor (kNN) algorithm?
 - What is k-Means Clustering?
 - Be able to show the kNN and k-Means processes graphically
 - What are potential problems of kNN and k-Means Clustering?