Final Preparation
Final Exam

- Our final period is scheduled for 8:00-10:00 am Friday, May 8th

- Plan: to have an on-line version of the exam
  - Still expect to require 2 hours of work
  - Will release Wednesday morning (the 6th)
  - Due on Friday at noon.

- 1/3: midterm material
  - See lecture notes for midterm preparation

- 2/3: material since midterm
Exam Parameters

• May use personal notes, the book and anything that I have released (web site or Canvas)

• The expectation is that other resources are off limits (including human resources)
Exam Parameters

• Old exams are available, and are split into sections

• Expect similar sections:
  – Each section will either appear either as a Canvas Quiz or as a hand-written set of answers that will be submitted to Gradescope
  – The Canvas sections will be independent of one-another, but you will have one attempt at them
Sources of Material

- Zyante book and other assigned readings
- In-class and Zyante exercises
- Lecture notes
- Exams from prior years (both midterms and finals are available)
Pre-Midterm Material

• Number Representations (binary, hex, decimal)
• Arithmetic: adding, multiplying, incrementing, decrementing and shifting (<< and >>)
• Bit-wise operators: &, |, ~, ^
• Digital to analog conversion
• Analog to digital conversion
• Analog comparators
• Digital I/O on the Teensy processors
• Basic circuits: LEDs, resistors, switches
• Motor control: H-bridges; PWM
• FSM basics
New Material

- Finite State Machines for control
- Signed numbers
- Fixed point math
- Proportional-derivative control
- Serial communication
- Performing multiple tasks and scheduling
- Interrupts and interrupt service routines
- System safety & watchdog timers
Finite State Machines for Control

• FSMs for mission-level control
• Events:
  – Sensor-driven
  – Internally-driven (e.g., a counter)
• Actions
  – External effects
  – Setting commands for lower-level controllers (e.g., position or velocity goals)
  – Resetting counters
  – Printing
Representing Negative Integers

• Two’s complement representation
• Taking the negative of an integer
Fixed Point Math

- Converting between floating point and fixed point representations
- Addition, subtraction, multiplication and division of fixed point numbers

- Why do we do fixed point math?
Proportional-Derivative Control

- Key PD control equation
- Meaning of the gains
- Phase plots
Serial Communication

• Synchronous vs asynchronous communication
• For asynchronous:
  – Start bit for synchronization
• Communication buffers
• ASCII representation: translation of bits to glyphs
Performing Multiple Tasks

With PeriodicAction, we can define multiple, semi-independent code blocks (*tasks*)

- Naturally partition for the code
- Different tasks can be executed at different frequencies
- Some communication between tasks through global variables
Task States

- Waiting
- Ready
- Running
Scheduling

We focused on non-preemptive scheduling

• Priority-based scheduling
  – Fixed priority
  – Shortest WCET first
  – Highest frequency first

• Round-robin scheduling
Interrupts

• What are they?
• Interrupt service routines. Examples:
  – Pulse Width Modulation (PWM) generation (see slides)
  – Producing digital signals of various frequencies (e.g., can introduce software counters, too)
  – Using an ISR to ensure that a main-program task executed at a very regular period
Safety and Watchdog Timers

Watchdog:

- Hardware counter that causes the processor to reset once it reaches a critical value
- The code’s job is to reset the counter fast enough to prevent this from happening ("feeding the dog")
- If the code does become stuck due to a bug or hardware problem, it is guaranteed that an ISR will be called (even resetting the processor)
C Code

• Be prepared to read (and possibly fix) simple C code
• Look to lecture discussions of code and your projects as you prepare