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