EECS 373-F10
Midterm Practice Problems

The exam will be closed book / closed notes, except you may use a copy of the "ARM and Thumb-2 Instruction Set Quick Reference Card" and a basic/scientific calculator.

<u>The midterm will cover the following topics:</u>

1. **Minute Quizzes**
2. **Basics of ARM assembly and EABI-compliant parameter passing conventions**
3. **Accessing memory from C**
4. **Memory buses, architecture, organization, and tradeoffs**
5. **Interfacing memory-mapped peripherals onto a memory bus**
6. **ADC/DAC architectures, operation, transfer functions, and quantization error**
7. **How a SAR ADC converts an input voltage into a binary output work.**
8. **Basics of UART, SPI, and I2C (e.g. master/slave, # lines, voltage, start/stop, etc.)**

Practice Problems:

1. **Minute Quizzes.** Be familiar with the minute quizzes we covered in class.

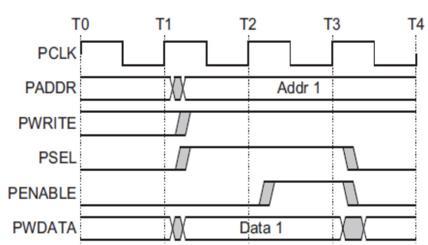
2. **Assembly.** Write an ARM Thumb-2, single-instruction procedure that (i) conforms to the ARM EABI; (ii) adds two 32-bit numbers together, (iii) returns the results, and (vi) has the signature:

```
uint32_t add(uint32_t a, uint32_t b);
```

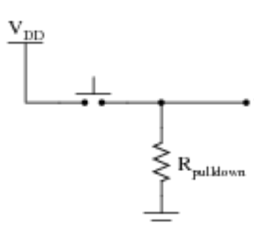
3. **Accessing Memory.** Write a simple C program to add 3 to the contents of memory location `0x20000040` on a 32-bit architecture. You program should not generate any compiler warnings.

4. **C Keywords.** Explain what the `volatile` keyword in C does and why it is necessary, i.e. what could happen if you forget to use it?

5. **Memory Interfacing.** Imagine that you want to attach an LED to the ARM Advanced Peripheral Bus (APB). Sketch out the glue logic needed to interface a D flip-flop (DFF) to the APB. Assume that the PSEL line is the peripheral select (i.e. it goes high when the processor is addressing the DFF) and that the DFF is attached to data bit zero (PWDATA[0]). You should be able to change the value of the DFF by writing this memory location and read the current value of the DFF by reading the location. Assume that the DFF has an enable (ENA) line.



6. **Switch Interfacing.** Imagine that you have a pushbutton switch wired up as follows:



Sketch what Vout will look like when the button is pressed (at t=1) and released (at t=2) for a typical switch. Draw how you would modify the circuit to deal with the problem. Describe how you might deal with this problem in software.

```
Pressed                   _____________
      Button  ______ |                 |________
Released

VDD                              _______
      Vout    _______                          ________
GND

Time                 t=1              t=2
```

7. **Sequential Logic.** Let's say you have a 96 MHz system clock but a particular peripheral device needs an 8 MHz, 50% duty cycle clock. Design a sequential circuit that divides the system clock to generate the clock signal the peripheral device needs.

8. **Serial buses.** The standard-mode I2C specification uses open-drain logic. Under this scheme, bus devices drive the SDA bus line low (to 0 V) but rely on a shared, external pull-up resistor (typically 10 kΩ) to send a high bit (at 3.3V or 5V) by "pulling-up" the bus line. How long will a low-to-high transition take if low is 0 V, VCC is 5 V, a "high" is 70% of VCC (e.g. 3.5 V), the aggregate bus capacitance is 100 pF, and10 kΩ pull-up resistor is being used.

9. **ADC.** Consider the following 3-bit ADC. Draw the conversion transfer function (binary output vs. input voltage) on the top graph. Draw the quantization error transfer function (error voltage vs input voltage) on the bottom graph. Make sure that the transition points are clear. Assume that Vref is 5 V.