Midterm Exam

- Fill in your name:
- This exam is open book and open notes.
- The exam is 70 minutes and worth 70 points. Spend no more than one minute per point.
- Explain your solutions well, but do not write an essay.
1. **(2 points)** Name an application that has been improved by the microprocessor and how it has been improved.

2. **(2 points)** Name an example from class where there exists both a potential hardware and software solution and explain when you would choose each.

3. **(2 points)** What are the main differences between RISC and CISC microprocessor architectures? Give an example microprocessor of each type.

4. **(1 points)** What are privilege modes?
5. **(2 points)** What are the differences between synchronous, semisynchronous, and asynchronous buses? Comment on how they handle wait states, their hardware cost, time penalties, and flexibility.

6. **(3 points)** What is ringing? What causes it? When is it a problem? How is it avoided?

7. **(3 points)** What is crosstalk? What causes it? When is it a problem? How is it avoided?

8. **Bus loading**

   (a) **(2 points)** What is static or dc loading? How do you determine if it is a problem?

   (b) **(2 points)** What is capacitive or ac loading? How do you determine if it is a problem?

   (c) **(1 point)** How do you solve bus loading problems?
9. Interrupts

(a) **(3 points)** What are hardware interrupts? Give an example. What are software interrupts? Give an example. What are the differences in when hardware and software interrupts are handled?

(b) **(2 points)** What is the difference between nonvectored, vectored, and autovectored interrupts?

(c) **(1 point)** What type of interrupt is the 68HC11 RTI interrupt?

(d) **(4 points)** If a microprocessor has an IRQ (interrupt request) and IACK (interrupt acknowledge) pins and uses vectored interrupts, describe the procedure that is taken to service an interrupt.
10. You are a manager at Toaster Co. in charge of the design of the new ToastMaster2000. The key features are as follows:

- A 16-key keyboard for entry of such things as amount of time in which to toast or desired color of toast (white, tan, dark brown, black, etc.).
- A digital detector which indicates presence of toast.
- An analog detector which indicates color of toast.
- An 8-bit speech synthesis chip to give the user such messages as: “Your toast is done”, “Your toast is stuck”, or “Your toast is on fire!”.
- A 1-bit interface to a relay to turn on the heating coil.
- A 68HC11 microcontroller.

(a) **(6 points)** Draw a block diagram for the ToastMaster2000. Include as much detail as possible. Be sure to consider what ports the I/O devices are connected to. Assume that the keyboard is a matrix-style multiplexed keyboard.

(b) **(2 points)** How would the above block diagram be changed for a nonmultiplexed keyboard interface. How many more I/O port bits are required?
(c) **(8 points)** Write pseudo code for the software required for each type of keyboard interface, including debouncing.

(d) **(2 point)** List the advantages and disadvantages of each type of keyboard interface.

(e) **(1 point)** The speech synthesis chip contains messages stored in an on-chip ROM. Assuming simple digitization (no compression), a sample rate of 8 KHz, and a word size of 8 bits, how many seconds of speech can be stored in a 64-Kbit ROM?

(f) **(1 point)** Using linear predictive coding, the data rate is reduced to 1600 bits/s. How many seconds of speech can be stored in a 64-Kbit ROM?
(g) **(10 points)** Write a subroutine in 68HC11 assembly code which when called contains the number of seconds to toast in accumulator A, turns on the heating coil, loops that number of seconds, and turns off the heating coil? (for simplicity assume each instruction takes 1ms).

(h) **(2 points)** What is the disadvantage of using a software loop for a delay? Why would an RTI interrupt be better.

(i) **EXTRA CREDIT** Write the assembly code to time the toasting using an RTI interrupt.
(j) **(1 point)** You are considering replacing the keyboard in the ToastMaster2000 with a touch screen. The screen needs to be a $4 \times 20$ character display and requires a touch screen that can select any single character. If the LED-photosensor approach is used, how many LED-photosensor pairs are required.

(k) **(1 point)** If the resistive-film approach is used, what is the required resolution for the A/D converter that processes the voltage from the film?

(l) **(4 points)** You have hired a consultant to write the software for the ToastMaster2000. She says that she can write it in C in one week and 68HC11 assembly code in four weeks. The C implementation will require an off-chip EPROM which costs $5$ per unit. The assembly code implementation will fit completely onto the on-chip EEPROM. Assume the total cost of the toaster excluding the off-chip EPROM is $40$, the consultant is charging you $2500/week, and there are no other costs. Do you ask her to write it in C or assembly when you expect to sell:

i. 1000 units

ii. 1500 units

iii. 2000 units

iv. 2500 units

(m) **(2 points)** Toaster Co. is designing their new portable ToastMaster2000 for those fast-paced individuals who don't have time for breakfast in the morning. What types of steps will you take in the design to improve the battery life?