This assignment should be completed by Wednesday, March 5\textsuperscript{th}. \textbf{Note: there is nothing to hand in for this assignment.} In this homework assignment, you will explore:

- Final project ideas
- Serial communication (RS-232, RS-423, RS-422, RS-485, USB)

The assigned reading will be available on the course web site in PDF format.

1. Think about your final project from hardware, firmware, and testing perspectives. Come to class prepared to talk very briefly about your initial final project ideas.

2. Read the sections of the C501 (and optionally the 80C51) manuals which refer to serial communication. Focus the majority of your attention on serial mode 1 and learn how the RI and TI flags in the SCON register may be polled or may be used to generate a serial interrupt.

3. What is the difference between synchronous serial data transmission and asynchronous serial data transmission? You may want to look on the web or in a text for more information regarding this topic.

4. What mode of the 80C51 would you use to transmit asynchronous serial data with eight data bits, one start bit, and one stop bit? What is the purpose of the start bit? What is the purpose of the stop bit?

5. When the serial port on the 80C51 is receiving data, what algorithm does it use to determine if the bit it is receiving is a zero or a one? Does it use the same algorithm for both start bits and data bits?

6. Write initialization code in assembly which will configure the microcontroller to receive and transmit data at 9600 baud using serial mode 1. Assume a clock frequency of 11.0592 MHz and use Timer 1 to generate the baud rate. Write an infinite loop which constantly transmits the character 'U'.

7. MIDI (Musical Instrument Digital Interface) is an asynchronous serial communication protocol. The official MIDI specification requires a 31.25KHz baud rate (+/- 1\%) and one start bit, eight data bits, and one stop bit. Choose an oscillator frequency and serial mode for the 80C51 (Note: the 80C51 does not have Timer 2) which will allow MIDI transmission. Can you use these same values if you want to transmit via RS-232 at 19.2Kbps? Explain.

8. Obtain and read the following document:

9. Obtain and read the following document:
   - Data sheet for the MAX232 RS-232 interface chip
     
     For reference, the Maxim web site is at: http://www.maxim-ic.com/MaximProducts/products.htm.

10. Determine how the charge pump circuitry in the MAX232 provides a +10V and –10V output supply voltage when its supply is only +5V. Briefly describe how the charge pump works. What values should be used for the charge pump capacitors?

(continued on next page)
11. [Optional] Obtain and read the following documents:
   - National Application Note AN-216 "Summary of Well Known Interface Standards".
   - Data sheets for the National DS1488 and DS1489 analog interface chips.
   - Data sheet for the Maxim MAX485E RS-485 interface chip

   Note that the 1488 and 1489 are often used in systems which have both positive and negative voltage supplies, while the MAX232 chips are often used in single voltage supply systems. For reference, the National Semiconductor web site is at: http://www.national.com.

12. [Optional] Describe the advantages and disadvantages of using RS-485 instead of RS-232. Include a description of the benefits that differential transmission has over single-ended transmission. Make sure you understand at a technical level how and why each transmission standard works. Why does differential transmission offer such high data rates as compared to single-ended transmission?


14. [Optional] Read about USB 2.0 at the USB developer's web site: http://www.usb.org/developers. While at that site, review some of the presentations and overview material about USB. Visit other USB web sites, such as http://www.lvr.com/usb.htm and http://www.usb-by-example.com.
   - What are some of the advantages of USB over RS-232 and the standard parallel port?
   - Why does the USB connector have longer power pins and shorter data pins?
   - What is the rated bandwidth of low speed, full speed, and high speed USB devices?
   - Why isn't there a clock signal defined on the USB connector?
   - How much current can a low power USB device draw from the bus?
   - What is USB On-The-Go? What does dual-role mean?