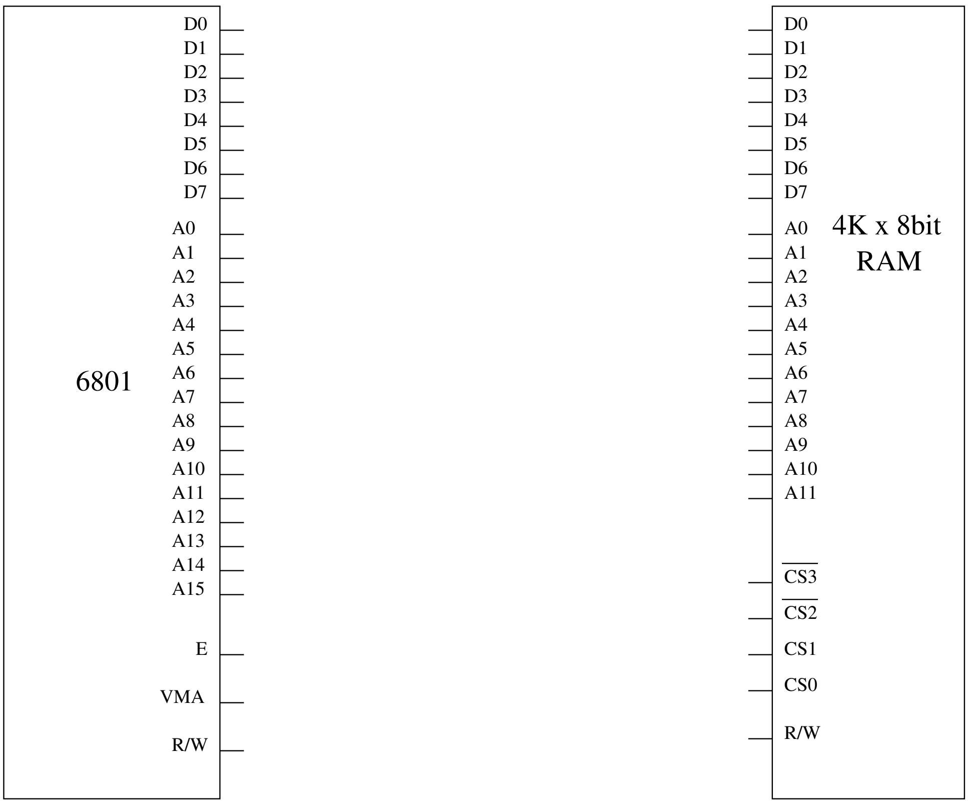
CSE 421 Midterm Examination
Spring 2003-2004

1 Connecting a RAM Module *(20 points)*

Your task in this question is to connect a single 4K by 8-bit RAM module to a 6801 CPU. The fictitious RAM chip in this question has 8 data lines and 12 address lines. It also has R/W input, and 4 chip select inputs. The chip select lines CS0 CS1 are active high, while CS2 and CS3 are active low.

Show all necessary connections in the figure below (with lines!) so that the memory chip responds to addresses between $\$A000$ and $\$BFFF$. That is an 8K range in total; which is twice the memory size of the chip; you should arrange the connections so that regions $\$A000 - \$AFFF$ and $\$B000 - \$BFFF$ are mirror images of each other.

Note that the RAM should be enabled only when both VMA and E outputs of the CPU are high. **You may use two-input NAND gates as necessary.**



2 PIA Connection *(15 points)*

The connections between a 6821 PIA and a 6801 CPU is shown in the figure below. The additional gates used are NOR gates. Regarding the connections shown in the figure, answer the following:

a. Give the address range which the PIA will respond to:

b. Give the lowest memory location that can be used to reach Data/Direction Register A:

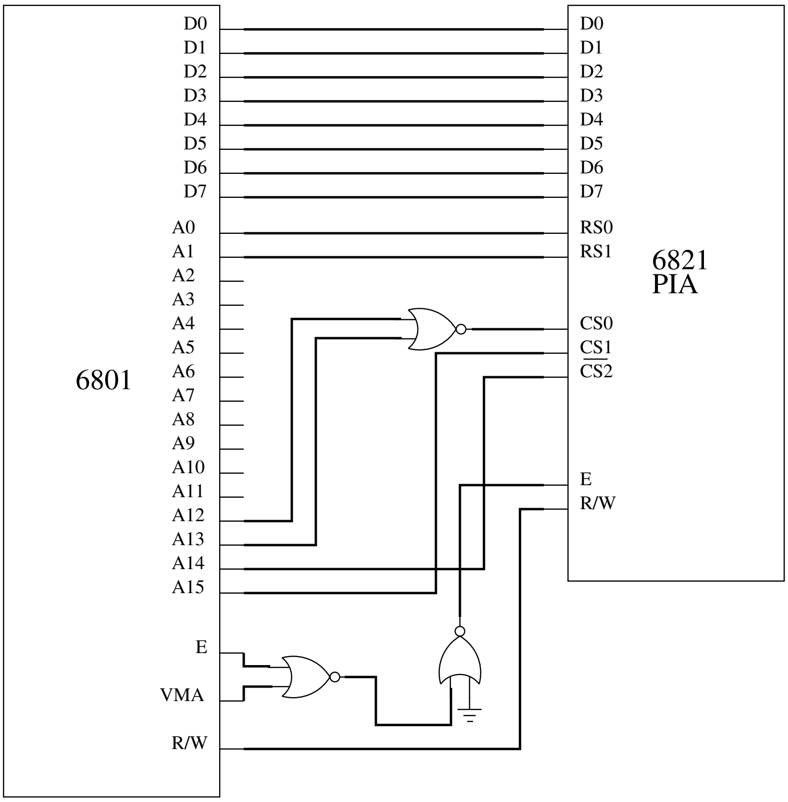
c. Give the lowest memory location that can be used to reach Control/Status Register A:

d. Give the lowest memory location that can be used to reach Data/Direction Register B:

e. Give the lowest memory location that can be used to reach Control/Status Register B:

f. How many distinct memory addresses can be used to reach Data/Direction Register A?

g. Give two more addresses in addition to the one in part (a) that can be used for Data/Direction Register A:



3 Led Temperature Display *(25 points)*

In the figure, the connections between a temperature sensor and a 6821 PIA are shown. The temperature sensor is a static part that has 6 output lines that gives the temperature out as a six-bit number in degrees Celsius. An output of 0 corresponds to 0°C, and an output of 63 corresponds to 63°C. (That is the maximum range with six bits.) The six output bits are connected to Port A of the PIA as shown in the figure. DA6 and DA7 are grounded.

In Port B of the PIA, a LED (Light Emitting Diode) is connected to each pin. The connections on the CPU side are not shown, but all connections are present, and the PIA base address is mapped to $2000.

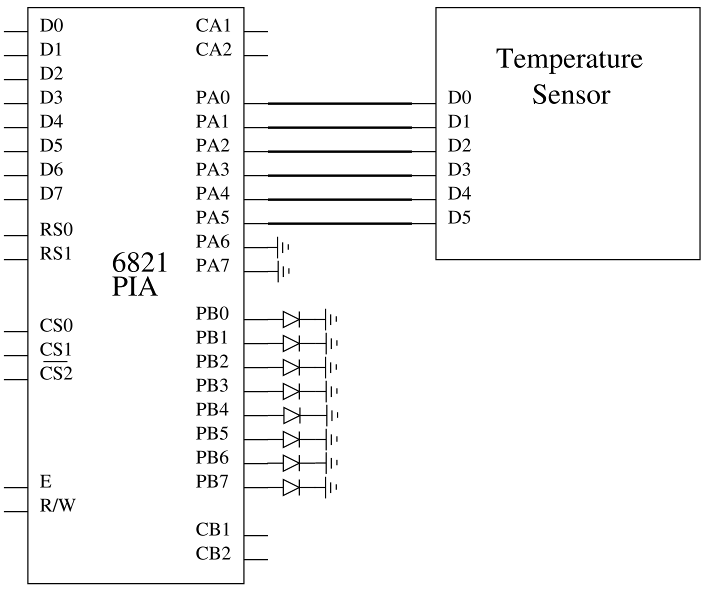
Write an assembly program to accomplish the following:

a. Initialize the PIA properly to read from the temperature sensor and provide output to the LEDs.

b. Every 15 seconds (accurate to a millisecond, assuming the clock speed is 1MHz), read the temperature from the sensor.

c. We wish to implement a line-like display of the temperature using the eight LEDs. The actions to be taken depending on the temperature reading are given below:

Temperature range	LEDs that should be ON
$T < 16$	All LEDs OFF
$16 \leq T \leq 17$	LED 0
$18 \leq T \leq 19$	LEDs 0, 1
$20 \leq T \leq 21$	LEDs 0, 1, 2
$22 \leq T \leq 23$	LEDs 0, 1, 2, 3
$24 \leq T \leq 25$	LEDs 0, 1, 2, 3, 4
$26 \leq T \leq 27$	LEDs 0, 1, 2, 3, 4, 5
$28 \leq T \leq 29$	LEDs 0, 1, 2, 3, 4, 5, 6
$T \geq 30$	All LEDs ON



Answer to question 3:

4 A/D & D/A Conversion *(15 points)*

a. In a digital control application, we need to use an analog-to-digital converter for input. We wish to be able to measure voltages in the range 0 to 12 V, with a precision of 0.01V or better. How many output bits should the A/D converter have?

b. In order to provide output to an analog device, we need to generate voltages in the range of 0 to 3V. Given we are using an 8-bit D/A converter, what is the smallest voltage difference we can control?

5 Serial Communication *(25 points)*

An ACIA has been connected to a serial terminal. The terminal sends typed characters to the ACIA, and displays characters transmitted by the ACIA on the monitor.

The ACIA has been set up, and the control register is known to contain $95.

a. What is the communication mode? (Data bits, parity bits, stop bits?)

b. The communication is known to be running at 9600 bits per second. What is the frequency of the clock driving the ACIA?

c. Under what conditions (given the lines are properly connected) will the ACIA interrupt the CPU?

d. Every time a character is received from the terminal, it must be sent back so that the terminal user can see what he is typing. Write a proper routine to handle this case. You can assume that the reception rate is slow enough that the transmit register is guaranteed to be empty when a character is received by the ACIA.