Homework Assignment 13
Worksheet: Digital Strain Gauge

Notes
1. The following assignments will be performed using Altera’s MaxPlusII software. This software is available in the Physics Department computer lab.

2. This week’s assignment is to design a digital scale using the strain gauge and the Altera project board. To modify our strain gauge system to be digitally read out, one needs a way to show an analog voltage on a digital display. One such technique is to use Successive Approximation Analog-to-Digital conversion.

3. In the Successive Approximation technique one compares the output of a DAC to the unknown voltage. Both voltages are fed into a comparator which returns 1 if the DAC output is higher than the unknown voltage and 0 if the DAC output is lower than the unknown output. The DAC voltage is changed until the voltage hovers near the unknown voltage.

4. The technique is very similar to a counter-ramp ADC except that the conversion time is significantly shorter. In the Successive Approximation technique, one first turns on the MSB. If the comparator output is 1, then that bit is turned off, otherwise it is left on. Each bit in turn, from the most to least significant is then tested. After all bits have been tested, the resulting value should be very close to the the unknown voltage.

Procedure
1. Design a circuit which will determine the unknown voltage value which results from the strain gauge. It should have the following features:
   - Input from the comparator to indicate whether the DAC value is higher or lower than the unknown voltage.
   - Outputs to drive the DAC (8 separate bits).
   - Display in hex the 8 bit value of the DAC on the two 7-segment displays.
   - Start when a pushbutton is depressed and stop when the final value is achieved. Each time the pushbutton is pressed, the circuit should be able to run through its sequence. You may want to display the output value from each step.
   - Be able to run using either of two clocks. A clock which runs at 1 Hz and a faster one that runs at 100 Hz. The slow clock is useful for debugging since you can watch each transition. The default 25 MHz clock is too fast for the DAC on the Altera board.

2. Below are some hints which you may find helpful.
   - You may want to use a counter to keep track of which step you are taking.
   - Use flip flops to store the value of the SAR.
   - You can use mathematical expressions to turn on and off a given bit.
   - This assignment lends itself better to a series of if..then statements rather than to a state machine.

Note: The comparator and the DAC are located on the UofA project board. This circuit just has to use the output from the comparator and provide the inputs to the DAC.