Final Exam Review

- Topics
  - EINT, PC: maybe
  - SCI: highly unlikely
  - SPI: definitely be on the test
  - DTA: unlikely
  - ATD: definitely be on the final
- Handout will be provided for datasheets information

Serial Peripheral Interface (SPI)

- 1 SPI unit connected to PB3-0
  - PB3: clock out
  - PB2: MISO
  - PB1: MOSI
  - PB0: SS
- Typically the MCU is always in "master mode":
  - PB3, PB1, PB0: output pins
  - PB2: input
- Will not require specific:
  - polarity and phase (best to use 00).
  - Data order (best to use 0)
  - Polling or interrupt method (best to use polling)
- Problems will involve 7SD and shift registers (HC595)
  - Will be required to draw the circuit

Analog to Digital (ATD):

- Be able to draw a conditioning opamp circuit
  - 2 opamps:
    - summing amp for the voltage shift,
    - inverting amp for the voltage scale
  - Derive Vsh, Rf, Rin for the summing (inverting) amp
    - Shift = 0V – Min Signal Voltage
    - Rf/Rin = |shift|
      - Choose any values of Rf, Rin
    - If shift < 0 => Vsh = -1V; otherwise Vsh= 1V
  - Derive Rf, Rin for the inverting amp
    - Rf/Rin = scale = 5/(Max – Min signal voltage)
- Setup the ADC for single conversion
  - See slide 24 on ADC notes

Example problems

SPI :

- 1x7SD is connected to shift register, which is connected to SPI. Draw circuit and write program to display pattern 0-9 with a delay 1sec between each pattern.
- 4x7SD are connected to 2xshift registers, which are connected to SPI. Draw circuit and write program to display pattern 0000-9999 with a delay 1sec between each pattern.

Conditioning circuit:

- Analog signal is between 1.5V and 2V, draw a conditioning circuit that changes signal so that it is between 0V and 5V
  - Solution:

    Summing Amp: shift = 0-1.5 = -1.5

    Vsh = -1V

    Rf/Ri = 1.5 = 15K/10K

    Inverting Amp: scale = 5/(2-1.5) = 5/0.5 = Rf/Ri = 5K/0.5K

- Repeat above for analog signal is between -1.5V and -2V.
- Repeat above for analog signal is between -1.5V and 2V.
- Repeat above for analog signal is between 1.5V and 7V.
- Repeat above for analog signal is between -1.5V and 7V.
  - Solution:

    Summing Amp: shift = 0-(-1.5) = 1.5

    Vsh = 1V

    Rf/Ri = 1.5 = 15K/10K

    Inverting Amp: scale = 5/(7-(-1.5)) = 5/8.5 = Rf/Ri = 5K/8.5K

ADC programming problems:

- Analog temperature sensor to ADC. Te7mperature 0 degrees = 0V, 100 degrees = 5V. Write a program that will read the signal and convert the temperature to degrees.

  Solution:

  Start with the code on slide 25 of ADC notes to get temp as binary conversion, with following changes:

  ```
  DDRF &= 0x7F;  // ADC7 connected to Port F pin 7
  DIDR0 = 0x7F;  // disable digital bufs for all except ADC7 input
  ADMUX = 0x47; // AVCC as reference voltage, ADC7, right justified
  ```

  Conversion: 0V => 0b00 0000 0000 = 0

  5V => 0b11 1111 1111 = 1023

  Degree conversion: 0 => 0 degrees

  5V => 100 degrees

  ```
  temp = (100*temp)/1023;
  ```

- Analog temperature sensor to ADC. Temperature 0 degrees = 0V, 100 degrees = 5V. Write a program that will continue to read the signal and stop when the temperature is 65.

  Solution:

  Use the same code as above embedded in a while loop

```
while (temp != 65)
{

}
```

- Same problem as above except that: Temperature -100 degrees = 0V, 100 degrees = 5V.
  Solution:
  Same code as before, except:
  Degree conversion: 0 => -100 degrees
  5V => 100 degrees
  Rise = 200/1023

  ```
  temp = (200*temp)/1023 - 100;
  ```