[**Closed book/notes/calculator**] Show all of your work clearly in the space provided. Be sure to **read each problem carefully**. Note that the exam is double sided.

1. (10 points) Describe the steps (in english) necessary to set up the ATmega32 to use the Timer/-Counter0 subsystem to periodically (say every 20ms) send the contents of R22 to PORTB while allowing other code to run while allowing other code to run when not sending the contents of R22 to PORTB.

2. (5 points) Explain how the status register must be altered in order for ADC interrupts to be enabled.

3. (10 points) The interrupt jump table should make use of the RJMP instruction. What bad things will happen if the RCALL instruction is used instead of the RJMP instruction?

4. (10 points) As best as you can, describe the various modes of operation available on the ATmega32's analog to digital subsystem.

5.

(a) (5 points) What affect does the RET instruction have on the stack pointer?

(b) (5 points) What affect does the RET instruction have on the contents of the stack?

(c) (5 points) How does the RETI instruction differ from the RET instruction?

6. (25 points) Explain in English, pseudocode, or flowchart how to implement an interrupt service routine (labelled adcISR) that toggles the the LEDs (turns them on if they were off and vice versa) whenever the value of the most recent analog to digital conversion differs from the previous value by at least 2.5 volts.

You may assume that the ADC subsystem has already been configured with:

- ADMUX = 0b01100000
- ADCSRA = 0b11001111
- SFIOR = 0b00000000
- SREG = 0b10000000
- The label prevValue refers to a reserved byte of data memory that can be used for storing one byte of data.
- The interrupt jump vector for the ADC interrupt contains: RJMP adcISR

7. (25 points) Write a complete program that makes use of lcdInit, lcdDataWrite, and lcdCmd-Write to display the following string: "**CS280 Exam II**".
The string should be stored in program memory. You may assume that the LCD functions are located in LCDlibrary.asm (be sure to include it in your code).

Additional work area for any problem. Clearly identify to which problem the work on this page is related.