ECE 3724 Fall 2005 Test #4 – Jones / Reese (**circle one to indicate your section**)

Net ID: _____ (no names, please)

You may use only the provided reference materials. You may use a calculator, either a four-function or a scientific calculator. You may not use a programmable calculator. The test is worth is 100 pts, you are given 1 pt for free. For any required I2C functionality, use subroutine calls *i2c_start(), i2c_rstart(), i2c_stop, i2c_put(char byte), char i2c_get(char ackbit)*. If you use *i2c_put*, you must pass in as an argument the byte that is to be written to the I2C bus. If you use *i2c_get*, you must pass in an as argument the bit value to be sent back as the acknowledge bit value. You also have *DelayUs()* and *DelayMs()* functions available. Show all your work in any computations done or formulas used.

Part I: (75 pts)

a. (15 pts). The code fragment below performs I2C operations to a 24LC515 serial EEPROM. Answer the questions in the box in the right.

```
char buf[3];

i2c_start();
i2c_put(0xA4);
i2c_put(0x78);
i2c_put(0x4A);
i2c_restart();
i2c_put(0xA5);
buf[0]=i2c_get(0);
buf[1]=i2c_get(0);
buf[2]=i2c_get(1);
i2c_stop();
i2c_start(0xAC);
i2c_put(0x40);
i2c_put(0x01);
i2c_put(buf[1]);
i2c_put(buf[0]);
i2c_put(0x30);
i2c_stop();
```

1. What values are the A1, A0 lines on the EEPROM tied to (give as either VDD or GND for each)?

2. What locations in the SERIAL EEPROM are read? Give answers in hex.

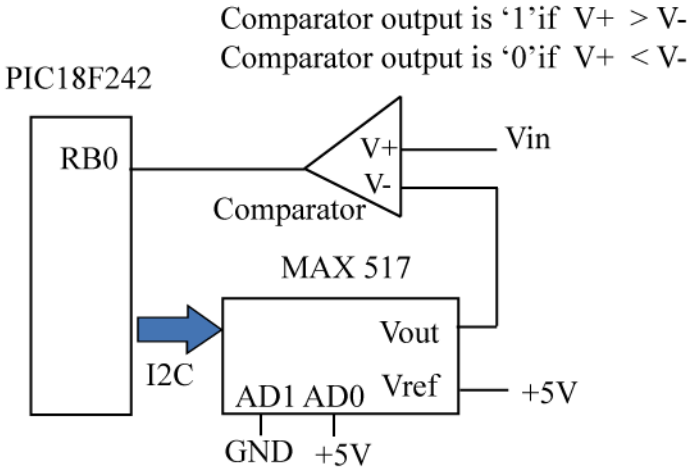
3.What locations in the SERIAL EEPROM are modified? Your answer(s) must be in the form of either "The value 0x?? is written to location 0x????", or "The content of location 0x???? is transferred to location 0x????". In each case, 'location 0x????' is a location in the EEPROM. Give all values in hex.

b. (15 pts) Write a C function named **`char adc_check()`** that performs a PIC18 A/D conversion on both the AD0 and AD1 channels. The function return value is:

- '1' if AD0 > AD1 by 1.0 V or more
- '2' if AD1 > AD0 by 1.0 V or more
- '0' if | AD1 – AD0 | < 1.0 V.

Assume a VREF of 5 V, that the ADC is configured for left justification, and that we are only interested in the upper 8-bits of the conversion. Do not assume that a particular channel is selected on entering the function. Delay for 20 us before beginning a conversion after selecting a channel.

c. (15 pts) Reference the diagram below. Write a C function named **`char range_check()`** that returns a '1' value if 3. 5V <= Vin < 4. 5V using the MAX517 DAC and the RB0 input as shown below. Use the I2C functions to communicate with the MAX517 DAC. The comparator output is '1' if V+ > V-; the comparator output is '0' if V- < V+.



d. (10 pts) Write C code that will configure the PIC18F242 TIMER2 to generate a periodic interrupt every 1 ms assuming an FOSC of 20 MHz. The interrupt must be fully enabled! Show the calculations first, then show the code.

e. (10 pts) Assume that TIMER2 has been configured to generate a periodic interrupt and that a low-true pushbutton switch is tied to RB1 (the RB1 input is '0' if the pushbutton is pressed). Write an ISR that will set the semaphore BUTTON_PRESSED to a '1' and disable the TIMER2 interrupt if the RB1 input is detected as low for five CONSECUTIVE TIMER2 interrupt periods.

f. (10 pts) Write C code that will configure the CCP1 output and the PWM module of the PIC18 to generate a square wave with 500 us period and a 25% duty cycle assuming an FOSC of 20 MHz. Show the calculations first, then show the code.

Part II: (24 pts) Answer 6 out of the next 8 questions. Cross out the 2 questions that you do not want graded. Each question is worth 4 pts.

1. How many clock cycles will an N-bit successive-approximation ADC require for a conversion? How many clock cycles will an N-bit flash ADC require for a conversion?

2. Write a C code fragment that will poll for end-of-write on the LC515 serial EEPROM. Use the I2C functions and assume that both A1, A0 on the EEPROM are tied low.

3. How many comparators are used in a 4-bit flash ADC? How many resistors are used in the resistor ladder of a 4-bit flash ADC?

4. Draw a diagram that shows a PIC microcontroller connected to two different LC515 serial EEPROMs devices. Label all of the pins.

5. On the PIC18, assume a PWM output is being generated using the PWM module. If the PR2 register contains a value of 0xF0, draw the PWM waveforms for CCPR1H values of 0x30, 0x78, and 0xC0. Your three waveforms must be drawn to the same scale and must illustrate the approximate duty cycles of the waveforms.

6. Assume an I2C write transaction that consists of the I2C address byte, followed by four data bytes. What is the total number of I2C bit times involved? Assume that the start and stop conditions each count as one bit time. Show work done in these computations.

7. Given a 9 bit DAC, and a reference voltage of 4.096 V, what is the expected output voltage change on the DAC output if the input code is changed by 1 Least Significant Bit? Give the answer in **millivolts**.

8. For an FOSC of 4 MHZ, what is the fastest ADC clock configuration (other than the internal oscillator) that can be selected and still not violate the 1.6 us minimum period constraint? Show your work.