

PHYS 319 Midterm

February 14, 2013

Name _____ Student Number _____

You are free to refer to the provided information package, but no other reference materials.

1. For each of the following C language expressions, assumed to be issued one after another, provide the value, **in decimal**, of the variable x (which is an unsigned int).

a) `x = 0x41;` _____

b) `x |= 0x40;` _____

c) `x &= 0x0B;` _____

d) `x = 41 << 2;` _____

(/4)

2. Write a complete well annotated program in assembly that configures MSP430 pins P1.0, P1.2, P1.4, and P1.6 as inputs (with internal pull-up resistors enabled) and pins P1.1, P1.3, P1.5, and P1.7 as outputs. The program should then enter a loop where it reads the values of the input pins (into register R5) and then sets the 4 output pins so they reflect the input values of their neighbours (ie P1.1 should be set to the value found on P1.0. P1.3 should be set to the value found on P1.2, etc). Hints: A) There is an example assembly program in the reference package from which you can extract the “boilerplate.” B) The RLA instruction may be useful here. This can be done in 8 assembly instructions (plus some labels and other boilerplate), but longer programs that will work are acceptable.

(/10)

3. Assuming a 1 MHz SMCLK frequency, modify the following program to create a PWM output with a period of 10 Hz and a duty cycle of 1%. Cross out parts you need to modify and write your modifications in neatly beside. Hint: What is the largest number that fits in a 16 bit register?

```
#include "msp430G2231.h"
void main(void)
{
    WDTCTL = WDTPW + WDTHOLD;
    P1DIR |= BIT2;
    P1SEL |= BIT2;
    TACCR0 = 1000-1;
    TACCTL1 = OUTMOD_7;
    TACCR1 = 250;
    TACTL = TASSEL_2 + MC_1;
    _BIS_SR(LPM0_bits);
}
```

(/6)

4. An MSP 430 launchpad is connected to 7 indicator LEDs on pins P1.0 – P1.6 that are turned on when the corresponding pin output is “High.” A pushbutton switch is connected between P1.7 and ground so that when the button is pushed, P1.7 is grounded; no connection is made when the button is released. Consider the following program, and answer the questions below:

```
#include "msp430g2231.h"
volatile int i=0;
void main(void){
    WDTCTL = WDTPW + WDTHOLD;
    P1DIR = 0x7F; // set P1.0 - P1.6 outputs
    P1REN = 0x80;
    P1IES = 0x80; // interrupt on high to low transition
    P1IE = 0x80; // enable interrupt on P1.7
    P1OUT = 0x80; // pull up on P1.7
    _BIS_SR(LPM4_bits + GIE);
}

#pragma vector = PORT1_VECTOR
__interrupt void button_isr(void){
    i += 1;
    P1OUT = (i | 0x80);
    P1IFG &= ~0x80;
}
}
```

- a) Describe what happens as the button is pushed repeatedly.

(5)

- b) Describe the operation of the program if the second line of the ISR is changed from `P1OUT = (i | 0x80);` to `P1OUT = i;` (perhaps done by accident)

(5)