

# PHYS 319 Midterm

February 13, 2014

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 values, in **BOTH hexadecimal AND binary**, of the variable x (which is an unsigned char).

	HEXADECIMAL	BINARY
a) <code>x = 0x12;</code>	0x_____	0b_____
b) <code>x  = 0x40;</code>	0x_____	0b_____
c) <code>x &amp;= ~0x02;</code>	0x_____	0b_____
d) <code>x = 16 &gt;&gt; 2;</code>	0x_____	0b_____

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2. Write a complete well annotated (**all non-empty** lines should be explained) program in assembly that does the following:
  - Configures MSP430 pin P1.0 as an input and pins P1.1 – P1.7 as outputs.
  - Input P1.0 should have the internal pull-up resistor enabled, as P1.0 will be connected to a push button switch that can be used to short to ground.
  - Your program should initialize all of P1.1 – P1.7 to zero and then
  - Enter a loop where it uses P1.1 – P1.7 to output a binary representation of the number of times the button has been pressed (ie. it counts High to Low transitions). After the number of counts reaches the maximum value that can be represented in 7 bits, the count should roll over to 0 and continue counting.

There is an example assembly program in the reference package from which you can extract the 'boilerplate.' (this can be done with 9 assembly instructions + boilerplate and labels). Feel free to write on the back of this page.

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3. a) Annotate the lines of the program below that end with `//`. Add comments to these lines that explain their function.

```
#include "msp430g2231.h"
void main(void)
{
    WDTCTL = WDTPW + WDTHOLD;
    P1DIR |= BIT2;           //
    P1SEL |= BIT2;          //
    TACTL = TASSEL_2 + MC_3; //
    TACCR0 = 5000-1;        //
    TACCTL1 = OUTMOD_2;     //
    TACCR1 = 500;           //
    _BIS_SR(LPM0_bits);     //
}
```

- b) Assuming the SMCLK frequency is 1 MHz, describe the PWM waveform that will be produced by this program: what is the period (in s or ms or  $\mu$ s), what is the duty cycle (% “on” time)? At what value(s) of the timer does the output go on and off?

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4. The program below is an attempt to use an MSP 430 launchpad to toggle the LED attached to pin P1.0 upon pushes of the on-board button (which is on P1.3). This program behaves oddly. It seemed to work for a moment, but pushing the button doesn't appear to do anything most of the time.
- a) Fix the program so that the LED performs as desired.
- b) Explain in a sentence or two why the program did not work as expected.

```
#include "msp430g2231.h"
void main(void) {
    WDTCTL = WDTPW + WDTHOLD;
    P1DIR = 0x01;
    P1OUT = 0x08;
    P1REN = 0x08;
    while(1) {
        while(P1IN == 0);
        while(P1IN == 8);
        P1OUT ^= 1;
    }
}
```

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