Name: _____ Student #: _____ Signature: _____

Time limit: 60 min. Calculators not allowed. All programming questions relate to the NIOS II processor.

1. (2 marks) Use logic gates to design a 2 to 1 multiplexer. Label inputs: *A*, *B*, and *SELECT* and output:
    Y?

2. (5 marks) Draw and label the diagram of a single port **256x8** read write memory chip. Ensure that the memory chip includes **an active low chip select line, all address lines, all data lines, a read line and a write line**. The memory is to be interfaced to a system with a **16-bit address space (use a NAND gate to perform the address decoding)** and this block of memory is to span the address range **0x1F00 to 0x1FFF**.

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3. (1 mark) A faster clock speed translates into a faster computer. Give one example of a limitation that may prevent the clock speed of a computer from being increased to 10x the normal clock rate.

4. (1 mark) Write a single line of assembly code to divide the **signed** value stored in register r4 by 16 and store the result in register r5 using a shift instruction:

5. (1 mark) Convert the following decimal value to BCD (show result in binary):

   94058390_{10} =

6. (5 marks) In the lab you see the following program listing. Carefully examine this listing and answer the questions that follow. *Each question refers to a specific line in the listing*

```
.EQU STORAGE, 0x00001000
# ===== start of code =====
      movia   r6, Y          #line 1
      stw     r6, 0(r6)      #line 2
      or      r6, r0, r0     #line 3
# ===== more code here=====
.ORG STORAGE
W:    .word  9, 8, 7
X:    .half 6, 5
Y:    .skip 4
```

a) The instruction at line 1 (movia) is an alias for what instruction(s)?

b) What binary instruction is generated by the assembler for the instruction at line 3?

c) What value is stored by the instruction at line 2 (assuming line 1 has already executed)?

d) What is the purpose of the instruction at line 3?
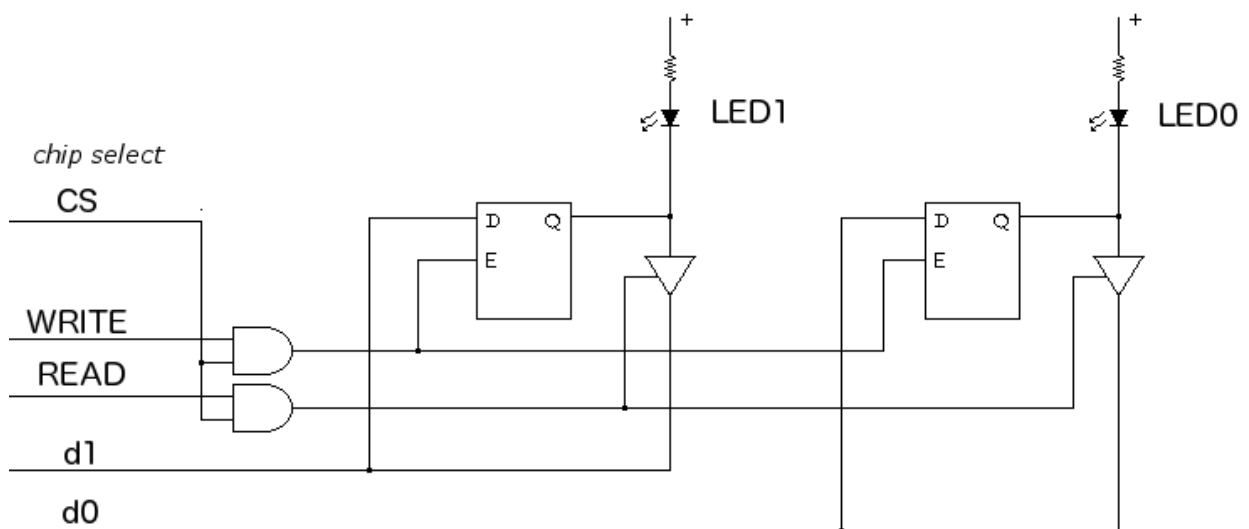
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7. (5 marks) In each of the separate C-language code segments below, give the final value of a.

unsigned int a=1, b=2; if(!b) a++;	a =

unsigned int a=4, b=2;
while(b) b = 3;
a = 0;
	a =

unsigned int a=3, *b;
  b = &a;
*b = 0;
	a =

unsigned int a;
a = 5;
a = a | 0x0010;
	a =

unsigned int a=3, b=8; while(b){b = b>>1; a++;}	a =

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8. (5 marks) Draw a timing diagram showing the signals (CS, WRITE, READ, d1, and d0) as the following sequence of events occurs:

   - Assume both LEDs are off to start and all five signals are zero
   - LED1 is turned on while LED0 is turned off
   - The data bus (d1 and d0) is used to communicate data to other components not shown
   - LED0 is turned on while LED1 is turned off
   - Both LEDs are turned off
   - At end of timing diagram the state of both LEDs is put onto the data bus

CS

WRITE

READ

d1

d0