Final exam
ECE 203
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You may not use books, notes, or calculators when completing this exam. Please show your work. Please look over all the problems now and ask questions if any of them are not clear. Manage your time. It's better to have good answers for all questions than a wonderful answer to only one question. Read the questions carefully and note the number of points each question is worth.

Good luck!

1. **(5 pts.)** Write a subroutine that multiplies two numbers. You may use the attached PIC instruction set reference sheet. The subroutine must have the following interface:

Algorithm 1 MULTW: Calculate the product of two integers

Require: FSR contains the address of x
Require: W contains the value y
Ensure: The value in W is set to $x \cdot y$
Ensure: The value in FSR is unchanged
Ensure: The value at the address in FSR is unchanged

Registers 0x20–0x40 are reserved for your use.

Hint: If you don't know where to start, return to fundamentals. Multiply two binary numbers by hand and observe the algorithm you are following.

2. **(1 pts.)** Number encodings

   (a) If you use a NOR gate to detect when an eight-bit two's-complement operand is zero, how many inputs must the NOR gate have?

   (b) If you use a NOR gate to detect when an eight-bit sign-magnitude complement operand is zero, how many inputs must the NOR gate have?

3. **(5 pts.)** The truth table for a *Fat Adder* follows. Use this device to build a multiplier that accepts two three-bit operands and produces a six-bit result.

a	b	c	d	f	g	h
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	0	1
0	0	1	1	1	0	0
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	1	0	0
0	1	1	1	1	0	1
1	0	0	0	0	0	1
1	0	0	1	0	1	0
1	0	1	0	1	0	0
1	0	1	1	1	0	1
1	1	0	0	0	1	0
1	1	0	1	0	1	1
1	1	1	0	1	0	1
1	1	1	1	1	1	0

4. **(1 pts.)** If one were to start from a PIC microcontroller with four banks of registers and convert it to a microcontroller with the same number of registers but with only one bank, how much longer (in bits) would file register instructions such as ADDWF become?

5. **(5 pts.)** Derive the state diagram, state table, and state assignment of a single-input, single-output finite state machine that outputs a one if and only if it has observed an input sequence corresponding to the following regular expression:

$$0(0+110)1(00+1)1^{+} \tag{1}$$

6. **(1 pts.)** Using, at most, one sentence, describe the main difference between ASCII and Unicode.

7. **(5 pts.)** Find a minimal two-level expression for the following function using whichever technique is most convenient to you. Show your work.

$$f(a,b,c,d) = \overline{a}\left(\overline{c}\left(b+\overline{d}\right)\right) + ac \tag{2}$$

Have a good break!

Email me or stop by if you want to know where to learn more about computer engineering.