Name_____

CSE 241 Digital Systems February 25, 2011

Hourly Exam #1

Instructions: Write your name on the top of each sheet. Show all work in the space provided, writing your answers in the answer box at the bottom of each page. No calculators or other electronic devices allowed. 50 min closed book.

1(a) Find the product of $1001011_{(2)}$ and $1110_{(2)}$. Express the result in hexidecimal (base-16).

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1(b) Convert the base-3 number 201.21 to base-6. Use any method.

```
(a)        1001011
            x 1110
           10010110
          1001011
         1001011  _
        10000011010  grouping 4-bits this is 0100 0001 1010
                     Which in hex is            4    1    A
```

$$201.21_{(3)} = 2_{(3)}x10^{2}_{(3)}+1_{(3)}x10^{0}_{(3)}+2x10^{-1}_{(3)}+1x10^{-2}_{(3)}$$
$$= 2_{(6)}x3^{2}_{(6)}+1_{(6)}x3^{0}_{(6)}+2x3^{-1}_{(6)}+1x3^{-2}_{(6)}$$
$$= 2_{(6)}x13_{(6)}+1_{(6)}x1_{(6)}+(2/3)_{(6)}+(1/13)_{(6)}$$
$$= 30_{(6)}+ 1_{(6)}+ 0.4_{(6)}+ 0.04_{(6)}$$
$$=31.44_{(6)}$$

1(a) 41A

1(b) 31.44

2(a) Compute $140.2_{(5)}$ - $213.0_{(5)}$ Use signed 5's-complements subtraction, and express the result as a signed 5's-complement number.

2(b) What is the distance on the number line between the base-9 signed 9's-complement number 1_s700 and the offset origin? Write your answer as a decimal number.

(a) 4's-comp of 213.0 is 231.4, so 5's-comp is 231.4+0.1=232.0

Reversing the sign and adding the complement (base-5):

$$\begin{array}{rr} & 0_s140.2 \\ + & \underline{1_s232.0} \\ & 1_s422.2 \end{array}$$

(b) For any r's-complement representation of the form $1_sX_{(r)}$, $X_{(r)}$ is the distance from the offset origin. Converting to decimal, $700_{(9)} = 7x9^2 = 567_{(10)}$.

2(a) $1_s422.2$

2(b) 567

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3. Let f(x,y,z)=g(x,y)+h(y,z) where g=∑m(1,3), and h=ΠM(1,3).

(a) Write f(x,y,z) above in CNF (Conjunctive Normal Form).

(b) Explain the general difference between how Disjunctive Normal Form (DNF) and minterm Canonical Form (CF) are defined. One or two sentences is adequate. Illustrate your explanation by giving an example of a DNF which is not a minterm CF.

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f(x,y,z) = g(x,y)   + h(y,z)
         = x'y + xy + (y+z')(y'+z')
         = (x+x')y + yy'+yz'+y'z'+z'z'
         = y + (y+y'+1)z'
         = y + z'
```

So f(x,y,z)=(y+z') is the desired CNF. Note this f is in both CNF and is in DNF also. It is both a sum of products (y and z' are products of just a single factor each) and a product of sums ((y+z') is a sum and f is a product containing just that single factor (y+z')).

3(a) f(x,y,z) = (y+z')

3(b) DNF is defined as any sum of products of literals. Minterm CF is any DNF in which <u>all</u> the literals appear in <u>each</u> product term. An example of a DNF which is not a minterm CF is the answer to (a) above. The x-literal (x or x') is missing from f(x,y,z).

4. **f(w,x,y,z) = x(y+z′)+w(x+y′)+((w+x′)′+(y+z′)′)′**

(a) Sketch the logic diagram which realizes this Boolean function. Assume double rail logic. Work directly from the expression above, do not first simplify or expand f. For compound complements draw either bubbles or NOT-gates.

(b) Sketch a logic diagram which realizes the same f(w,x,y,z) using only NAND gates. You can use both a-form and b-form NAND gates in your answer.

(a) The bubbles can also be shown as NOT-gates.

(b) Bubbles must appear at each OR-gate input and AND-gate output. Added bubbles are shown in red. Bubbles to the inputs of the OR-gate in the second column of gates and to the last input in the third column can be slid over from the outputs of the gates in the previous column, so no correction NOT-gates needed.