Name_____

CSE 241 Digital Systems February 20, 2009

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) Let x = -382 in sign-magnitude base-10 form. Express x as a 7's-complement base-8 number, using the least number of digits necessary to express x in this way.

1(b) Find the integer part of 1011 ×1110 ÷ 1.1. All numbers here are base-3, and the answer should also be expressed base-3. *Note: parts (a) and (b) are not related.*

(a) $382_{(10)}=3_{(10)}x10^{2}{}_{(10)}+8_{(10)}\ x10_{(10)}+2_{(10)}$
$=3_{(8)}\ x12^{2}{}_{(8)}+10_{(8)}\ x12_{(8)}\ +2_{(8)}$
$=454_{(8)}\quad +120_{(8)}\quad +2_{(8)}$
$=576_{(8)}$
So $x=-576_{(8)}$ and the 7's complement form of x is 201
Note this uses n=3. For n=4 it would be 7201, n=5 77201, etc.

```
(b)      1011                  102012 0 R 10
        x1110            1.1)1122210.0
        10110                 11
       1011                    022
      1011                      22
      1122210                    021
                                  11
                                  100
                                   22
                                    1 0
```

1(a) 201

1(b) 1020120

2(a) Find the signed 1's-complement of the positive binary number 101.1 using n=4 and m=1 (ie. four integer digits and one fractional digit).

2(b) Compute $1001.1_{(2)}$-$101.1_{(2)}$ using signed 1's-complement arithmetic and the results of part (a). Show your work.

(a) To get signed 1's complement just flip the bits in 0101.1, ie. 1010.0, and add the sign 1_s.

(b) To subtract in 1's-complement we add the 1's complement of the subtrahend, which we computed above:

```
                      0s1001.1
                     +1s1010.0
                      --------
                      0s0011.1
   end-around carry:  +  0000.1
                      --------
                         100.0
```

```
  (check: 1001.1
        - 101.1
          ------
          100.0)
```

2(a) 1s1010.0

2(b) 100.0

Name_____

3. **f(x,y,z)=x+(y+(z+(x'yz')')')'**

(a) Simplify f(x,y,z) above to DNF (Disjunctive Normal Form).

(b) Rewrite the DNF from (a) as a minterm canonical form. Either the algebraic formula or the m-notation for the minterm canonical form is ok.

```
(a) f = x+(y+(z+(x'yz')')')'
      = x+(y+(z+x+y'+z)')'          (comp of prod = sum of comps)
      = x+(y+(x+y'+z)')'            (z+z=z, ie. idempotent law )
      = x+(y+x'yz')'                (comp of sum = prod of comps)
      = x+y'                        (y+x'yz'=y, ie. absorption law)

(b) multiply first term in (a) by (y+y')(z+z'), second term by
(x+x')(z+z') then expand and eliminate duplicate terms
  = x(y+y')(z+z')+(x+x')y'(z+z')
  = xyz+xy'z+xyz'+xy'z'+x'y'z+x'y'z'

The first term is row 7 of the truth table for f, second is row 5,
then rows 6, 4, 1 and 0. So in m-notation, f=Σm(0,1,4,5,6,7).
```

3(a)

x+y'

3(b)

xyz+xy'z+xyz'+xy'z'+x'y'z+x'y'z' or
f=Σm(0,1,4,5,6,7)

4. Consider an incomplete Boolean function f(w,x,y,z) such that f=1 when exactly two of its four variables are 1, f=0 when exactly three of them are 1, and we don't care what f is otherwise.

(a) Write a formula for f(w,x,y,z) in CNF (Conjunctive Normal Form).

(b) Sketch a NAND-gate realization of f(w,x,y,z) assuming double-rail logic. Your sketch may include both a-form and b-form NAND gates.

w	x	y	z	f
0	0	0	0	-
0	0	0	1	-
0	0	1	0	-
0	0	1	1	1
0	1	0	0	-
0	1	0	1	1
0	1	1	0	1
0	1	1	1	0
1	0	0	0	-
1	0	0	1	1
1	0	1	0	1
1	0	1	1	0
1	1	0	0	1
1	1	0	1	0
1	1	1	0	0
1	1	1	1	-

4(a)

f(w,x,y,z) = (w+x'+y'+z') (w'+x+y'+z') (w'+x'+y+z') (w'+x'+y'+z)

4(b)