

name \_\_\_\_\_

## ICS 331 Midterm Solution

Open book, open notes, closed computer, closed electronics

### 1. Circuit Design (4 pts)

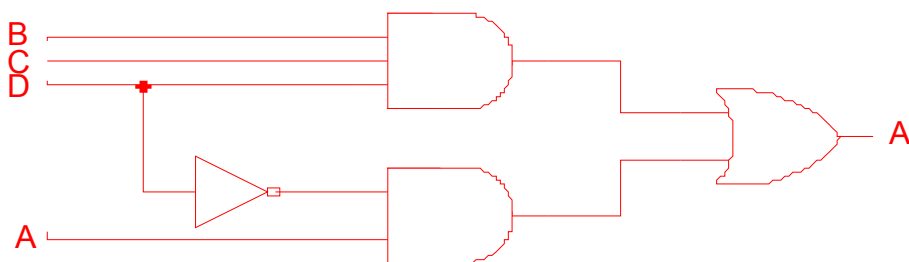
Design a circuit to generate the MSB of a 4-bit decade counter. In a decade counter, the 4 bits ABCD (A is the MSB and D is the LSB), count from 0000 to 0001 to 0010 to 0011 to 0100 to 0101 to 0110 to 0111 to 1000 to 1001 (decimal 9) and then back to 0000. First draw the truth table for bit A' (the new value for A given the old values of A, B, C, and D). Next draw the Karnaugh Map for bit A' (note that impossible input values like ABCD=1111 are “don't care” states). Next give a minimal equation for bit A'. Finally design and draw a circuit to compute bit A'.

A	B	C	D	A'
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	1
1	0	0	0	1
1	0	0	1	0

AB \ CD	00	01	11	10
00			1	1
01			1	
11		1	1	1
10			1	1

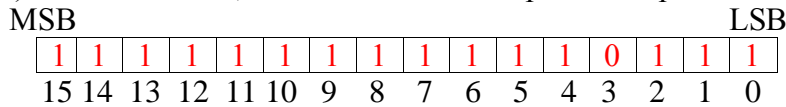
Green areas are “don't care” (i.e., they can be either 0 or 1).

$$A' = BCD + A\bar{D}$$



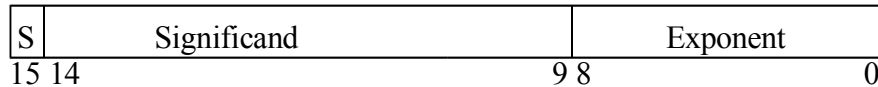
**2. Number Representation (4 pts)**

a) In a 16-bit word, what is the two's complement representation of -9?

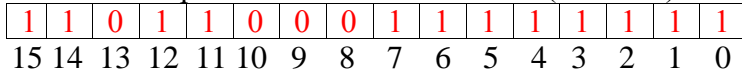


9 in binary is 1001; reverse all bits to get 1111111111110110; add 1 to get 1111111111110111

Some computer represents floating-point numbers in the following representation with normalized Significant and the Exponent biased excess-255 (i.e., a real exponent of 0 is represented as 255, a real exponent of 1 is represented as 256 and a real exponent of -1 is represented as 254):



b) What is the representation of decimal -1.7 (-1.7E+0)?



decimal	binary
1.7	
<u>-1</u>	1
.7	
<u>-.5</u>	0.1
.2	
<u>-.125</u>	0.001
.075	
<u>-.0625</u>	0.0001
.0125	

Neither .03125 (binary 0.00001) nor .015625 (binary 0.000001) can be subtracted from .0125, so the binary equivalent of decimal 1.7 is 1+0.1+0.001+0.0001 = 1.101100  
 Drop the initial 1 to get 101100 for the Significant.  
 1.101100 is already in normal form with exponent 0, so the Exponent is 255+0=255, which in binary is 11111111. Finally, fitting that into 9 bits gives 01111111 for the Exponent.

c) What is the relative error of the representation of -1.7 (-1.7E+0)? Note relative error is the error divided by the actual number, which is a percentage.

.0125/1.7 = .74%

**3. Error Detection and Correction (4 pts)**

a. What is the minimum Hamming distance of the following set of code words?

1000110001001000  
0110001110011001      5  
0010011001001100  
1001001001001001

b. What is the Hamming code for data 01010100 with even parity?

010100101000

c. Given the Hamming code 100100100100 with even parity, which bit, if any is in error and what are the correct data bits?

no error, data bits are: 10010100

d. Using the binary pattern, 1101, compute the CRC for information byte 111010110101.

```
1101) 111010110101000
      +1101
        1110
         +1101
           1111
            +1101
              1001
               +1101
                 1000
                  +1101
                    1011
                     +1101
                       1100
                        +1101
                          100
```

So the CRC checksum is 100 and the CRC message is 111010110101100