

**EE 2000 Logic Circuit Design  
Semester A 2014**

Tutorial 1

1. (a) Convert  $(110011.011)_2$  to decimal and octal forms.

**Solution:**

$$\begin{aligned} (110011.011)_2 &= 1 \times 2^5 + 1 \times 2^4 + 1 \times 2^1 + 1 \times 2^0 + 1 \times 2^{-2} + 1 \times 2^{-3} \\ &= 32 + 16 + 2 + 1 + 0.25 + 0.125 \\ &= (51.375)_{10} \end{aligned}$$

$$\begin{aligned} (110\ 011.011)_2 &= (63.3)_8 \end{aligned}$$

- (b) Convert  $(38.75)_{10}$  to binary and hexadecimal forms.

**Solution:**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $(38.75)_{10}$<br><br><div style="display: flex; align-items: center;"> <div style="text-align: right; padding-right: 10px;"> <math display="block">\begin{array}{r} 2 \overline{) 38} \\ 2 \overline{) 19} \\ 2 \overline{) 9} \\ 2 \overline{) 4} \\ 2 \overline{) 2} \\ 2 \overline{) 1} \\ 2 \overline{) 0} \end{array}</math> </div> <div style="text-align: left; padding-left: 10px;"> <p>rem.</p> <p>0</p> <p>1</p> <p>1</p> <p>0</p> <p>0</p> <p>1</p> </div> </div> <p style="text-align: center;"><math>(38)_{10} = (100110)_2</math></p> | $(0.75)_{10}$<br><br><div style="display: flex; align-items: center;"> <div style="text-align: right; padding-right: 10px;"> <math display="block">\begin{array}{r} 0.75 \\ \times \quad 2 \\ \hline 1.50 \\ \times \quad 2 \\ \hline 1.00 \end{array}</math> </div> <div style="text-align: left; padding-left: 10px;"> <p>Digit</p> <p>0.</p> <p>1</p> <p>1</p> </div> </div> <p style="text-align: center;"><math>(0.75)_{10} = (0.11)_2</math></p> |
| <p>Therefore</p> <p><math>(38.75)_{10} = (100110.11)_2</math></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

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| $(38.75)_{10}$<br><br><div style="display: flex; align-items: center;"> <div style="text-align: right; padding-right: 10px;"> <math display="block">\begin{array}{r} 16 \overline{) 38} \\ 16 \overline{) 2} \\ 16 \overline{) 0} \end{array}</math> </div> <div style="text-align: left; padding-left: 10px;"> <p>rem.</p> <p>6</p> <p>2</p> </div> </div> <p style="text-align: center;"><math>(38)_{10} = (26)_{16}</math></p> | $(0.75)_{10}$<br><br><div style="display: flex; align-items: center;"> <div style="text-align: right; padding-right: 10px;"> <math display="block">\begin{array}{r} 0.75 \\ \times \quad 16 \\ \hline 12.00 \end{array}</math> </div> <div style="text-align: left; padding-left: 10px;"> <p>Digit</p> <p>0.</p> <p>12 = C</p> </div> </div> <p style="text-align: center;"><math>(0.75)_{10} = (0.C)_{16}</math></p> |
| <p>Therefore</p> <p><math>(38.75)_{10} = (26.C)_{16}</math></p>                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                       |

- (c) Complete the following table:

| Decimal | Binary                  | Octal             | Hexadecimal |
|---------|-------------------------|-------------------|-------------|
| 27      | 11011                   | 33                | 1B          |
| 237.25  | 11101101.01             | 355.2             | ED.4        |
| 250.8   | 1111 1010.1100 1100 ... | 372.6314 6314 ... | FA.CC ...   |

2. Find the 1's and 2's complements of the following 8-digit binary numbers: 10101110; 10000001. Assume the numbers are positive numbers.

Solution:

Add “ 0” in in front of the binary number “ 0 10101110” to form a sign-magnitude binary. Then covert the 010101110 to:

1's complement: 101010001, 101111110

2's complement: 101010010, 101111111

3. The following 6-bit two's complement integers were found in a computer. What decimal number do they represent?

(a) 000101

(b) 100100

Solution:

(a) The sign bit is 0 (positive number)

The magnitude is 00101.

$$00101_2 = 5_{10}$$

Therefore, 000101 = +5

(b) The sign bit is 1 (negative number)

Step 1) Flip the bits = 011011.

Step 2) Plus one = 011100.

$$\text{Step 3) } 011100_2 = 28_{10}$$

Magnitude = 28

Therefore, 100100 = -28

4. (a) Given:  $X = -12_{(10)}$  and  $Y = -41_{(10)}$ , find  $X + Y$  under a word size of 8 bits.  
(b) Given:  $X = -52_{(10)}$  and  $Y = -17_{(10)}$ , find  $X + Y$  under a word size of 8 bits.

Solution 4(a):

With the size of 8 bits

$$+12 = 0000\ 1100$$

$$+41 = 0010\ 1001$$

1's complement of:

$$-12 = 1111\ 0011$$

$$-41 = 1101\ 0110$$

2's complement of

$$-12 = 1111\ 0100$$

$$-41 = 1101\ 0111$$

$$\begin{array}{r} 1111\ 0100\ (-12) \\ +\ 1101\ 0111\ (-41) \\ \hline 1\ 1100\ 1011 \end{array}$$

$$\hline$$

$$1\ 1100\ 1011$$

$$\text{Sum} = 1100\ 1011$$

Carry out = 1, for 2's complement addition the carry out is omitted and the sum is equal to 1100 1011. Since MSB is 1, the result is a negative number. By repeating 2's complement procedure, 1100 1011  $\rightarrow$  0011 0100 + 1 = 0011 0101 = 53

Therefore the final result represents -53, which agree our result  $(-12) + (-41) = (-53)$

Solution 4(b):

With the size of 8 bits

+52 = 0011 0100

+17 = 0001 0001

1's complement of:

-52 = 1100 1011

-17 = 1110 1110

2's complement of

-52 = 1100 1100

-17 = 1110 1111

$$\begin{array}{r} 1100\ 1100\ (-52) \\ +\ 1110\ 1111\ (-17) \\ \hline 1\ 1011\ 1011 \end{array}$$

Sum = 1011 1011

Carry out = 1, for 2's complement addition the carry out is omitted and the sum is equal to 1011 1011. Since MSB is 1, the result is a negative number. By repeating 2's complement procedure, 1011 1011  $\rightarrow$  0100 0100 + 1 = 0100 0101 = 69

Therefore the final result represents -69, which agree our result  $(-52) + (-17) = (-69)$

5. Determine the value of base x if  $(211)_x = (152)_8$ .

Solution:

$$(211)_x = (152)_8$$

$$2 \cdot x^2 + 1 \cdot x + 1 = 1 \cdot 8^2 + 5 \cdot 8 + 2$$

$$2x^2 + x - 105 = 0$$

$$(2x + 15)(x - 7) = 0$$

$$\therefore x = 7 \text{ (x must be a positive integer so cannot be -7.5)}$$

6. Represent decimal number 8620 in (a) BCD, (b) excess-3 code, (c) 2421 code (*note: normal binary numbers are 8421 code, i.e. the digit weightings are 8, 4, 2, 1*), and (d) as a binary number.

Solution:

$$\begin{aligned} 8620 &= 1000\ 0110\ 0010\ 0000 \text{ (BCD)} \\ &= 1011\ 1001\ 0101\ 0011 \text{ (excess-3)} \\ &= 1110\ 1100(0110)\ 1000(0010)\ 0000 \text{ (2421)} \\ &= 10000110101100 \text{ (binary)} \end{aligned}$$

7. A class has 60 students. They need to be assigned binary roll numbers. How many bits are required?

Solution:

$$\log_2 60 = 5.9 \text{ (rounded)}$$

Therefore, 6 bits are required.