BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI - K. K. BIRLA GOA CAMPUS

DIGITAL DESIGN Tutorial 1

Ex 1: Convert to hexadecimal and then to binary:

1. $(757.25)_{10}$
2. $(1063.5)_{10}$

Ex 2: Convert to base 6: $(3BA.25)_{14}$ (do all of the arithmetic in decimal).

Ex 3: Add the following numbers in binary using 2's complement to represent negative numbers. Use a word length of 6 bits (including sign) and indicate if an overflow occurs.

1. 21 + 11
2. (-14) + (-32)
3. (-25) + 18
4. (-12) + 13
5. (-11) + (-21)

Ex 4: Devise a scheme for converting base 3 numbers directly to base 9. Use your method to convert the following number to base 9: $(1110212.20211)_3$

Ex 5: Construct a table for 7-3-2-1 weighted code and write 3659 using this code.

Ex 6: Assume three digits are used to represent positive integers and also assume the fol- lowing operations are correct. Determine the base of the numbers. Did any of the additions overflow?

1. 654 + 013 = 000
2. 024 + 043 + 013 + 033 = 223
3. 024 + 043 + 013 + 033 = 201

Ex 7: Is it possible to construct a 5-3-1-1 weighted code? A 6-4-1-1 weighted code? Justify your answers.

Ex 8: Is it possible to construct a 5-4-1-1 weighted code? A 6-3-2-1 weighted code? Justify your answers.

Ex : 1

①

16	756	
	47	4
	2	15

$$\cdot 25 \times 16 = 4 \cdot 0$$

$$(756)_{10} = (2F4)_{16}$$

$$(0.25)_{10} = (0.4)_{16}$$

$$\therefore (756.25)_{10} = (2F4.4)_{16}$$

②

16	1063	
	66	7
	4	2

$$0.5 \times 16 = 8 \cdot 0$$

$$(1063)_{10} = (427)_{16}$$

$$(0.5)_{10} = (0.8)_{16}$$

$$\therefore (1063.5)_{10} = (427.8)_{16}$$

Ex : 2

$$(3BA.25)_{14} = 3 \times 14^{2} + 11 \times 14^{1} + 10 \times 14^{0} + 2 \times 14^{-1} + 5 \times 14^{-2}$$

$$= 588 + 154 + 10 + 0.142857 + 0.0255102$$

$$= (752.1684)_{10}$$

6	752	
	125	2
	20	5
	3	2

$$0.1684 \times 6 = \underline{1}.0104$$

$$0.0104 \times 6 = \underline{0}.0624$$

$$0.0624 \times 6 = \underline{0}.3744$$

$$0.3744 \times 6 = \underline{2}.2464$$

$$0.2464 \times 6 = \underline{1}.4784$$

$$0.4784 \times 6 = \underline{\underline{2}}.8704$$

$$0.8704 \times 6 = \underline{\underline{5}}.2224$$

$$(752)_{10} = (3252)_6$$

$$(0.1684)_{10} = (0.1002125\ldots)_6$$

$$\therefore (752.1684)_{10} = (3252.1002125\ldots)_6$$

Ex: 3

① $(21)_{10} = 10101 = (010101)_2$

$(11)_{10} = 1011 = (001011)_2$

$$\begin{array}{rcl} 21 & = & 0\ 1\ 0\ 1\ 0\ 1 \\ +\ 11 & = & 0\ 0\ 1\ 0\ 1\ 1 \\ \hline & & 1\ 0\ 0\ 0\ 0\ 0 \end{array}$$

wrong answer because of overflow

(carry in and carry out of sign bit are different)

② $(14)_{10} = 1110 = (001110)_2$

$\therefore (-14)_{10} = (110010)_2$

$(-32)_{10} = (100000)_2$

(Range is $-2^{(n-1)}$ to $(2^{(n-1)} - 1)$)

$$
\begin{array}{lccccccc}
\therefore \quad -14 & = & 1 & 1 & 0 & 0 & 1 & 0 \\
+ \quad -32 & = & 1 & 0 & 0 & 0 & 0 & 0 \\
\hline
 & \boxed{1} & 0 & 1 & 0 & 0 & 1 & 0
\end{array}
$$

↑ sign bit

Result is not correct because of overflow.

(Carry in and carry out of sign bit are different)

(3) $(25)_{10} = 11001 = (011001)_2$

$\therefore (-25)_{10} = (100111)_2$

$(18)_2 = 10010 = (010010)_2$

$$
\begin{array}{lcccccc}
-25 = & 1 & 0 & 0 & 1 & 1 & 1 \\
+ \quad 18 = & 0 & 1 & 0 & 0 & 1 & 0 \\
\hline
 & 1 & 1 & 1 & 0 & 0 & 1
\end{array}
$$

MSB = 1. Hence result is -ve

No overflow (Carry in and carry out of sign bit are same)

It is in 2's complement format

$\therefore$ Answer is $-(000111) = \underline{\underline{(-7)_{10}}}$

④ $(12)_{10} = 1100 = (001100)_2$

$(-12)_{10} = (110100)_2$

$(13)_{10} = 1101 = (001101)_2$

$$
\begin{array}{rcrrrrrrr}
 & -12 & = & & 1 & 1 & 0 & 1 & 0 & 0 \\
+ & 13 & = & & 0 & 0 & 1 & 1 & 0 & 1 \\
\hline
 & & & \boxed{1} & 0 & 0 & 0 & 0 & 0 & 1
\end{array}
$$

Discard carry

MSB = 0. Result is +ve

$\therefore$ Answer is $+(000001)_2 = (+1)_{10}$

⑤ $(11)_{10} = 1011 = (001011)_2$

$(-11)_{10} = (110101)_2$

$(21)_{10} = 10101 = (010101)_2$

$(-21)_{10} = (101011)_2$

$$
\begin{array}{rcrrrrrrr}
 & -11 & = & & 1 & 1 & 0 & 1 & 0 & 1 \\
+ & -21 & = & & 1 & 0 & 1 & 0 & 1 & 1 \\
\hline
 & & & \boxed{1} & 1 & 0 & 0 & 0 & 0 & 0
\end{array}
$$

Discard

MSB = 1 Result is negative

$\therefore$ Answer is $-(1\ 0\ 0\ 0\ 0\ 0)_2 = \underline{\underline{(-32)_{10}}}$

Ex 4

Base 3	Base 9
00	0
01	1
02	2
10	3
11	4
12	5
20	6
21	7
22	8

$$\underline{1}\ \underline{1\ 1}\ \underline{0\ 2}\ \underline{1\ 2}\ .\ \underline{2\ 0}\ \underline{2\ 1}\ \underline{1}$$

$$\underline{\underline{(1\quad 4\quad 2\quad 5\ .\ 6\quad 7\quad 3)_9}}$$

Ex: 5

	7	3	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
		OR		
	0	1	0	0
4	0	1	0	1
5	0	1	1	0
6	0	1	1	1
7	1	0	0	0
8	1	0	0	1
9	1	0	1	0

$$3659 = \underbrace{0\,0\,1\,1}_{3}\quad \underbrace{0\,1\,1\,1}_{6}\quad \underbrace{0\,1\,1\,0}_{5}\quad \underbrace{1\,0\,1\,0}_{9}$$

OR

$$\underbrace{0\,1\,0\,0}_{3}\quad \underbrace{0\,1\,1\,1}_{6}\quad \underbrace{0\,1\,1\,0}_{5}\quad \underbrace{1\,0\,1\,0}_{9}$$

Ex: 6

① 6 5 4 + 0 1 3 = 667

But answer is 000

So it is base 7 system

$$\begin{array}{r} 6\ 5\ 4 \\ +\ 0\ 1\ 3 \\ \hline \boxed{1}\ 0\ 0\ 0 \end{array}$$

discarded.

overflow

②
$$\begin{array}{ccc} 0 & 2 & 4 \\ 0 & 4 & 3 \\ 0 & 1 & 3 \\ 0 & 3 & 3 \\ \hline 0 & \underline{\underline{10}} & \underline{13} \end{array}$$

Answer is 2 2 3

carry from

Reminder after

Reminder after

previous addition | conversion | Conversion

Base must be 5   No overflow

3

0	2	4
0	4	3
0	1	3
0	3	3
0	10	13

Answer is   2   0   1

Carry from previous   Reminder   Reminder

Base must be 6. No overflow

Ex: 7   5-3-1-1 can be weighted code. All digits from 0 to 9 can be encoded. But 6-4-1-1 is not because 3 can not be encoded.

Ex: 8   6-3-2-1 is weighted code
5-4-1-1 is not 3 and 8 can not be encoded.