BCA Part –I

Paper- 7

Topic: Number Systems

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TOPICS

- Octal
- Hexadecimal
- Number conversion

Other Number Systems

- Octal and hex are a convenient way to represent binary numbers, as used by computers.
- Computer mechanics often need to write out binary quantities, but in practice writing out a binary number such as

Other Number Systems

- 1001001101010001

  is tedious, and prone to errors.
- Therefore, binary quantities are written in a base-8 ("octal") or, much more commonly, a base-16 ("hexadecimal" or "hex") number format.

Octal Number Systems

- Base = 8 or ‘o’ or ‘Oct’
- 8 symbols: { 0, 1, 2, 3, 4, 5, 6, 7}
- Example 123, 567, 7654 etc

~~846~~ This is incorrect why?

- How to represent a Decimal Number using a Octal Number System ?

Octal Number Systems

- Divide the decimal number repeatedly by 8
- Example

$246_{10} = (\ )_8$?

Divide-by -8	Quotient	Remainder	Octal digit
246 / 8	30	6	Lower digit = 6
30 / 8	3	6	Second digit =6
3 / 8	0	3	Third digit =3

Answer = 366_8

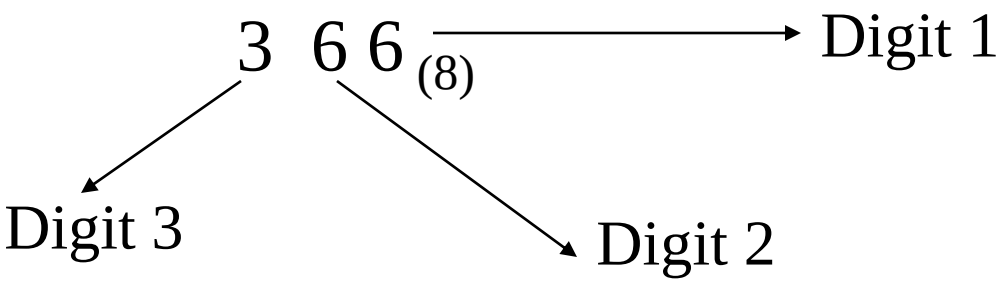
Octal Number Systems

- How to convert 366_8 back to Decimal ?
- Use this table and multiply the digits with the position values

Digit 8	Digit 7	Digit 6	Digit 5	Digit 4	Digit 3	Digit 2	Digit 1
8^7	8^6	8^5	8^4	8^3	8^2	8^1	8^0
……	……	32768	4096	512	64	8	1

Octal Number Systems

- How to convert 366_8 back to Decimal ?
- Consider the above number



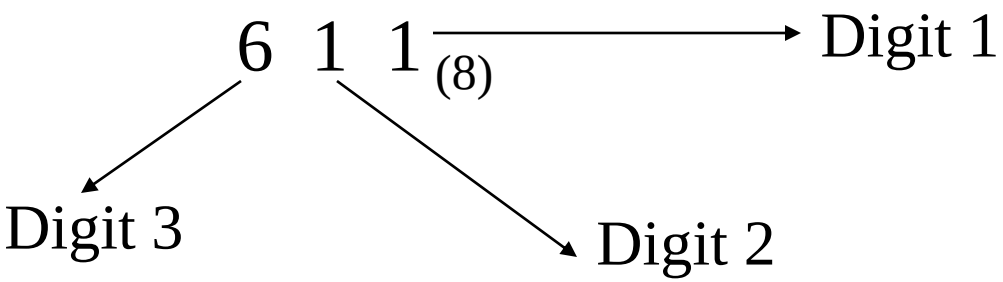
$3 \times 8^2 + 6 \times 8^1 + 6 \times 8^0 = 3 \times 64 + 6 \times 8 + 6 \times 1$

$= 192 + 48 + 6$

$= 246$

Octal Number Systems

- Example Convert 611_8
- Consider the above number



$6 \times 8^2 + 1 \times 8^1 + 1 \times 8^0 = 6 \times 64 + 1 \times 8 + 1 \times 1$

$= 384 + 8 + 1$

$= 393$

Octal Number Systems

- Convert 393 to octal

Divide-by -8	Quotient	Remainder	Octal digit
393 / 8	49	1	Lower digit = 1
49 / 8	6	1	Second digit =1
6 / 8	0	6	Third digit =6

Answer = 611_8

Hexadecimal Number Systems

- Base = 16 or ‘H’ or ‘Hex’

  16 symbols: { 0, 1, 2, 3, 4, 5, 6, 7,8,9 }

  { 10=A, 11=B, 12=C, 13=D, 14=E, 15= F}

Hexadecimal Number Systems

- {0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F} It uses 6 Letters !
- Example AB12, 876F, FFFF etc

- How to represent a Decimal Number using a Hexadecimal Number System ?

Hex Number Systems

- Repeated Division by 16
- Example

$213_{10} = (\ )_{16}$?

Divide-by -16	Quotient	Remainder	Hex digit
213 / 16	13	5	Lower digit = 5
13 / 16	0	13	Second digit =D

Answer = $D5_{16}$

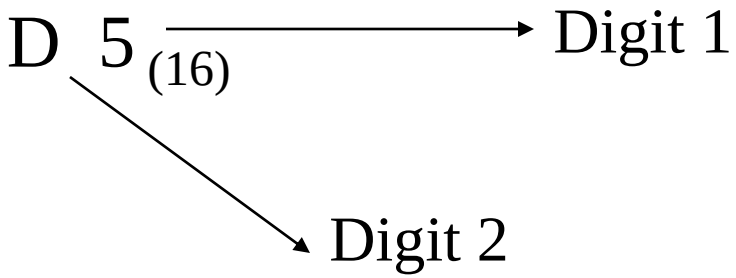
Hex Number Systems

- How to convert $D5_{16}$ back to Decimal ?
- Use this table and multiply the digits with the position values

Digit 8	Digit 7	Digit 6	Digit 5	Digit 4	Digit 3	Digit 2	Digit 1
16^7	16^6	16^5	16^4	16^3	16^2	16^1	16^0
……	……	…..	……	4096	256	16	1

Hex Number Systems

- How to convert $D5_{16}$ back to Decimal ?
- Consider the above number



$$D \times 16^1 + 5 \times 16^0 = 13 \times 16 + 5 \times 1$$
$$= 208 + 5$$
$$= 213$$

Binary Number Systems

- A single bit can represent two states:0 1
- Therefore, if you take two bits, you can use them to represent four unique states:

  00, 01, 10, & 11

- And, if you have three bits, then you can use them to represent eight unique states:

  000, 001, 010, 011, 100, 101, 110, & 111

Binary Number Systems

•And, if you have three bits, then you can use them to represent eight unique states:

These have a perfect correspondence to Octal

000 = Octal 0	100 = Octal 4
001 = Octal 1	101 = Octal 5
010 = Octal 2	110 = Octal 6
011 = Octal 3	111 = Octal 7

Binary Number Systems

•With every bit you add, you double the number of states you can represent. Therefore, the expression for the number of states with *n* bits is 2^n. Most computers operate on information in groups of 8 bits,

Binary Number Systems

- A unit of four bits, or half an octet, is often called a *nibble* (or *nybble*). It can encode 16 different values, such as the numbers 0 to 15. Any arbitrary sequence of bits could be used in principle,

Binary Number Systems

, but in practice the most common scheme is:

0000 = decimal 00 hex 0	1000 = decimal 08 hex 8
0001 = decimal 01 hex 1	1001 = decimal 09 hex 9
0010 = decimal 02 hex 2	1010 = decimal 10 hex A
0011 = decimal 03 hex 3	1011 = decimal 11 hex B
0100 = decimal 04 hex 4	1100 = decimal 12 hex C
0101 = decimal 05 hex 5	1101 = decimal 13 hex D
0110 = decimal 06 hex 6	1110 = decimal 14 hex E
0111 = decimal 07 hex 7	1111 = decimal 15 hex F

These have perfect correspondence to Hex

Convert Binary to Hex

- Group into 4's starting at least significant symbol (if the number of bits is not evenly divisible by 4, then add 0's at the most significant end)
- write 1 hex digit for each group

Convert Binary to Hex

Example: Convert 1001 1110 0111 0000 to Hex

After grouping follow the procedure as discussed in the previous section use the symbols of Hex number system like 13=E

1001	1110	0111	0000
9	E	7	0

Convert Binary to Hex

Example: Convert 100 1010 011 0000 to Hex

10	0101	0011	0000

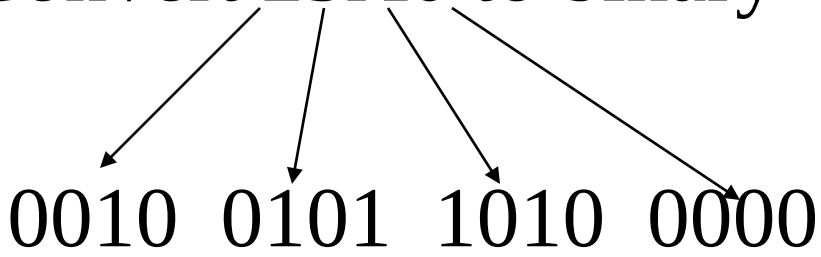
This group has only two bits, to make it a group of 4 bits add zeros in MSB position

0010	0101	0011	0000
2	5	3	0

Convert Hex to Binary

- For each of the Hex digit write its binary equivalent (use 4 bits to represent)
- Example

Convert 25A0 to binary



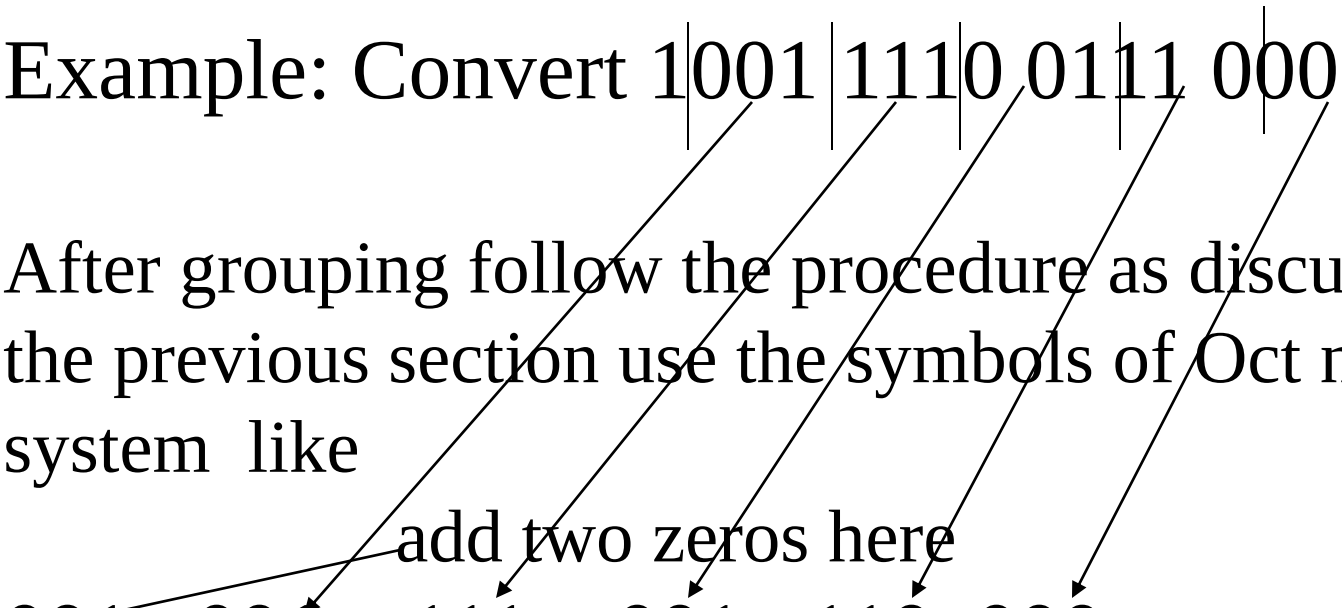
Convert Binary to Octal

- Group into 3's starting at least significant symbol (if the number of bits is not evenly divisible by 3, then add 0's at the most significant end)
- write 1 octal digit for each group

Convert Binary to Octal

Example: Convert 1001 1110 0111 0000 to Oct

After grouping follow the procedure as discussed in the previous section use the symbols of Oct number system like



Answer = 117160_8

Convert Octal to Binary

- For each of the Octal digit write its binary equivalent
- Example

Convert 2570 to binary