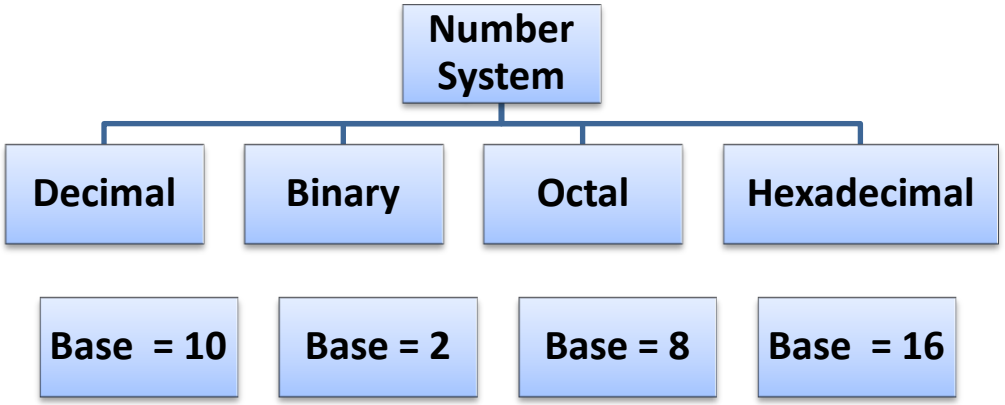
LECTURE 1

NUMBER SYSTEM

Number System

- **There are 4 number systems which are in the syllabus**



Decimal System

- The base (r) of decimal is 10.
- It means there are 10 unique digits to represent any number in decimal systems
- These Unique digits are
- 0, 1 ,2, 3, 4, 5, 6, 7, 8, 9
- For example $(32456872.23)_{10}$

Binary System

- The base (r) of Binary is 2.
- It means there are 2 unique digits to represent any number in binary systems
- These unique digits are
- 0 and 1
- For example $(101010)_2$

Octal System

- The base (r) of octal is 8.
- It means there are 8 unique digits to represent any number in octal systems
- These unique digits are
- 0, 1, 2, 3, 4, 5, 6, 7
- For example $(32015.23)_8$
- Note : $(320\mathbf{8}15)_8$ can not be an octal number because any digit greater than7 is not allowed in octal system.

Hexa Decimal System

- The base (r) of Hexa Decimal is 16.
- It means there are 16 unique digits to represent any number in hexa decimal systems.
- These Unique digits are
- 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- A = 10
- B = 11
- C = 12
- D = 13
- E = 14
- F = 15
- For example $(123ABC.DE2)_{16}$

CONVERSION

FROM ANY BASE(R) TO DECIMAL

From any base(r) to Decimal

- Any base (r) means any number system
- There is an unique method to convert from any base to decimal. Lets Explore
- Lets suppose the number is

  $(P\ \ Q\ \ R\ .\ X\ \ Y\ \ Z)_r$ where r is the base
- P Q R is the integral part and X Y Z is fractional part.
- Where r = {2, 8, 16}

Unique Method

$(P\ \ Q\ \ R\ .\ X\ \ Y\ \ Z)_r$ to Decimal

Lets Convert

Write the number with space it will ease the calculation while writing in copy

$$(P \quad Q \quad R\ .\ X \quad Y \quad Z \quad)_r$$

$$r^2 \quad r^1 \quad r^0 \quad r^{-1} \quad r^{-2} \quad r^{-3}$$

$$(P \times r^2 + Q \times r^1 + R \times r^0 + X \times r^{-1} + Y \times r^{-2} + Z \times r^{-3})_{10}$$

Note: Do not put decimal point.

Binary to Decimal

$(1010.1101)_2 = (\ ?\ )_{10}$

$(\ 1\quad 0\quad 1\quad 0\ .\ 1\quad 1\quad 0\quad 1\ )_2$

$(\ 2^3\quad 2^2\quad 2^1\quad 2^0\quad 2^{-1}\quad 2^{-2}\quad 2^{-3}\quad 2^{-4}\ )$

$(1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 + 1 \times 2^{-1} + 1 \times 2^{-2} + 0 \times 2^{-3} + 1 \times 2^{-4})_{10}$

$(8 + 0 + 2 + 0 + 0.5 + 0.25 + 0 + 0.0625)_{10}$

$$(1010.1101)_2 = (10.825)_{10}$$

Binary to Decimal

$(10101101)_2 = (\ ?\ )_{10}$

$(\ 1 \quad 0 \quad 1 \quad 0 \quad 1 \quad 1 \quad 0 \quad 1\ )_2$

$(\ 2^7 \quad 2^6 \quad 2^5 \quad 2^4 \quad 2^3 \quad 2^2 \quad 2^1 \quad 2^0\ )$

$(1 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0)_{10}$

$(128 + 0 + 32 + 0 + 8 + 4 + 0 + 1)_{10}$

$$(10101101)_2 = (173)_{10}$$

Binary to Decimal

$(1010)_2 = (\ ?\ )_{10}$

$$(\ 1 \quad 0 \quad 1 \quad 0\ )_2$$

$$2^3 \quad 2^2 \quad 2^1 \quad 2^0\ )$$

$$(1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0)_{10}$$

$$(8 + 0 + 2 + 0)_{10}$$

$$\boxed{(1010)_2 = (10)_{10}}$$

Binary to Decimal

$(.1010)_2 = (\ ?\ )_{10}$

$$(\ .1 \quad 0 \quad 1 \quad 0\ )_2$$

$$2^{-1} \quad 2^{-2} \quad 2^{-3} \quad 2^{-4}\ )$$

$$(1 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} + 0 \times 2^{-4})_{10}$$

$$(1 \times \frac{1}{2} + 0 \times \frac{1}{4} + 1 \times \frac{1}{8} + 0 \times \frac{1}{16})_{10}$$

$$(\frac{1}{2} + 0 + \frac{1}{8} + 0)_{10}$$

$$(0.5 + 0 + 0.125 + 0)_{10}$$

$$\mathbf{(.1010)_2 = (0.625)_{10}}$$

Octal to Decimal

Octal to Decimal

$(2305.2651)_8 = (\ ?\ )_{10}$

$(\ 2 \quad 3 \quad 0 \quad 5\ .\ 2 \quad 6 \quad 5 \quad 1\ )_8$

$(\ 8^3 \quad 8^2 \quad 8^1 \quad 8^0 \quad 8^{-1} \quad 8^{-2} \quad 8^{-3} \quad 8^{-4}\ )_8$

$(2 \times 8^3 + 3 \times 8^2 + 0 \times 8^1 + 5 \times 8^0 + 2 \times 8^{-1} + 6 \times 8^{-2} + 5 \times 8^{-3} + 1 \times 8^{-4})_{10}$

$(1024 + 192 + 0 + 5 + 0.25 + 0.015625 + 0.09375 + .00024414)_{10}$

$$(2305.2651)_8 = (1221.134619)_{10}$$

Octal to Decimal

$(763.45)_8 = (\ ?\ )_{10}$

$(\ 7 \quad 6 \quad 3\ .\ 4 \quad 5\ )_8$

$(\ 8^2 \quad 8^1 \quad 8^0 \quad 8^{-1} \quad 8^{-2}\ )_8$

$(\ 7 \times 8^2 + 6 \times 8^1 + 3 \times 8^0 + 4 \times 8^{-1} + 5 \times 8^{-2}\ )_{10}$

$(\ 7 \times 64 + 6 \times 8 + 3 \times 1 + 4 \times 0.125 + 5 \times 0.015625\ )$

$$(763.45)_8 = (499.578125)_{10}$$

Octal to Decimal

$(467)_8 = (\ ?\ )_{10}$

$(\ 4 \qquad 6 \qquad 7)_8$

$(\ 8^2 \qquad 8^1 \qquad 8^0\ )\ 8$

$(\ 4 \times 8^2 + 6 \times 8^1 + 7 \times 8^0\ )_{10}$

$(\ 4 \times 64 + 6 \times 8 + 7 \times 1)_{10}$

$(\ 256 + 48 + 7\ )_{10} = (\ 311)_{10}$

$$(467)_8 = (311)_{10}$$

Octal to Decimal

$(.342)_8 = (\ ?\ )_{10}$

$(\ .3 \quad 4 \quad 2)_8$

$(\ 8^{-1} \quad 8^{-2} \quad 8^{-3}\ )\ 8$

$(\ 3 \times 8^{-1} + 4 \times 8^{-2} + 2 \times 8^{-3}\ )_{10}$

$(\ 3 \times 0.125 + 4 \times 0.015625 + 2 \times 0.00195)_{10}$

$(\ 0.0375 + 0.0625 + 0.0039\ )_{10} = (\ 0.4414)_{10}$

$$(.342)_8 = (0.4414)_{10}$$

HexaDecimal to Decimal

Hexa Decimal to Decimal

$(2AB5.DEF2)_{16} = (\ ?\ )10$

2 10 11 5 13 14 15 1

$(\ 2\ A\ B\ 5\ .\ D\ E\ F\ 1\ )_{16}$

$(\ 16^{3}\ 16^{2}\ 16^{1}\ 16^{0}\ 16^{-1}\ 16^{-2}\ 16^{-3}\ 16^{-4}\ )_{16}$

$(2 \times 16^{3} + A \times 16^{2} + B \times 16^{1} + 5 \times 16^{0} + D \times 16^{-1} + E \times 16^{-2} + F \times 16^{-3} + 1 \times 16^{-4})_{10}$

$(2 \times 16^{3} + 10 \times 16^{2} + 11 \times 16^{1} + 5 \times 16^{0} + 13 \times 16^{-1} + 14 \times 16^{-2} + 15 \times 16^{-3} + 1 \times 16^{-4})_{10}$

$(8192 + 2560 + 176 + 5 + 0.8125 + 0.0546875 + 0.003662109 + 0.000015258)_{10}$

$(2AB5.DEF2)_{16} = \mathbf{(10933.87086)_{10}}$

Hexa Decimal to Decimal

$(ABC.75)_{16} = (\ ?\ )10$

10 11 12 7 5

$(A\ \ B\ \ C\ .\ \ 7\ \ 5)_{16}$

$(16^{2}\ \ 16^{1}\ \ 16^{0}\ \ 16^{-1}\ \ 16^{-2})16$

$(A \times 16^{2} + B \times 16^{1} + C \times 16^{0} + 7 \times 16^{-1} + 5 \times 16^{-2})_{10}$

$(10 \times 16^{2} + 11 \times 16^{1} + 12 \times 16^{0} + 7 \times 16^{-1} + 5 \times 16^{-2})_{10}$

$(2560 + 176 + 12 + 7 \times 0.0625 + 5 \times 0.00390625)_{10}$

$$(ABC.75)_{16} = (2748.457031)_{10}$$

$(2560 + 176 + 12 + 0.4735 + 0.01953125)_{10} = (2748.457031)_{10}$

Hexa Decimal to Decimal

$(765)_{16} = (\ ?\ )10$

$(\ 7 \quad 6 \quad 5\ )_{16}$

$(\ 16^{2} \quad 16^{1} \quad 16^{0}$

$(7 \times 16^{2} + 6 \times 16^{1} + 5 \times 16^{0})_{10}$

$(7 \times 256 + 6 \times 16 + 5 \times 1)_{10}$

$(1792 + 96 + 5)_{10} = (1893)_{10}$

$$(765)_{16} = (1893)_{10}$$

Hexa Decimal to Decimal

$(.ECE)_{16} = (\ ?\ )10$

14 12 14

$(\ .E \quad C \quad E\ )_{16}$

$(\ 16^{-1} \quad 16^{-2} \quad 16^{-3}\ )$

$(E \times 16^{-1} + C \times 16^{-2} + E \times 16^{-3})_{10}$

$(14 \times 16^{-1} + 12 \times 16^{-2} + 14 \times 16^{-3})_{10}$

$(14 \times 0.625 + 12 \times 0.00390625 + 14 \times 0.00024414\ )_{10}$

$(0.875 + 0.046875 + 0.003417968\ )_{10} = (0.925292968)_{10}$

$$(.ECE)_{16} = (0.925292968)_{10}$$