Digital Electronics

Number system :-

There are four number systems in arithmetic. they are :-

1) Decimal number system.
2) Binary number system.
3) Hexadecimal number system.
4) Octal number system.

General Rule for representing numbers in any number system is.

$$a_n\ a_{n-1} \ldots\ldots a_2 a_1 a_0 = a_n r^n + a_{n-1} r^{n-1} + \ldots\ldots + a_2 r^2 + a_1 r^1 + a_0 r^0$$

Where,

$a_n, a_{n-1} \ldots\ldots a_0 \rightarrow$ Digits

$a_0 \rightarrow$ LSD - Least Significant Digit

$a_n \rightarrow$ MSD - Most Significant Digit

$r \rightarrow$ Base of number system.

Conversions :-

Binary to Decimal conversion :-

1) $(110111)_2$.

$$(110111)_2 = 1\times2^5 + 1\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 1\times2^0$$
$$= 32 + 16 + 0 + 4 + 2 + 1$$
$$= (55)_{10}$$

ii) $(1101.1011)_2$

$$= 1\times2^3 + 1\times2^2 + 1\times2^1 + 0\times2^0 + 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3} + 1\times2^{-4}$$

$= 16 + 8 + 4 + 0 + 1 + 1/2 + 0 + 1/8 + 1/16$

$= (29.6275)_{10}$

iii) $(10110)_2$ $= 1\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 0\times2^0$

$= 16 + 0 + 4 + 2 + 0$

$= (22)_{10}$

iv) $(10001101)_2$ $= 1\times2^7 + 0\times2^6 + 0\times2^5 + 0\times2^4 + 1\times2^3 + 1\times2^2 + 0\times2^1 + 1\times2^0$

$= 128 + 0 + 0 + 0 + 8 + 4 + 1$

$= (141)_{10}$

v) $(10111.1011)_2$ $= 1\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 1\times2^0 + 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3} + 1\times2^{-4}$

$= 16 + 0 + 4 + 2 + 1 + \frac{1}{2} + 0 + \frac{1}{8} + \frac{1}{16}$

$= 23 + 0.5 + 0.125 + 0.0625$

$= (23.6875)_{10}$

vi) $(0.01\underline{1}011)_2$ $= 0\times2^{-1} + 1\times2^{-2} + 1\times2^{-3} + 0\times2^{-4} + 1\times2^{-5} + 1\times2^{-6}$

$= 0 + \frac{1}{4} + \frac{1}{8} + 0 + \frac{1}{32} + \frac{1}{64}$

$= 0.25 + 0.125 + 0.03125 + 0.015625$

$= (0.421875)_{10}$

vii) $(110111.101)_2$ $= 1\times2^5 + 1\times2^4 + 0\times2^3 + 1\times2^2 + 1\times2^1 + 1\times2^0 + 1\times2^{-1} + 0\times2^{-2} + 1\times2^{-3}$

$= 32 + 16 + 0 + 4 + 2 + 1 + 0.5 + 0 + 0.125$

$= (55.625)_{10}$

Decimal, Binary, Octal and Hexadecimal numbers.

Decimal.	Binary	Octal.	Hexadecimal.
0	0000	0	0
1.	0001	1	1
2.	0010	2.	2.
3.	0011.	3.	3
4	0100	4	4
5	0101.	5	5
6	0110	6	6
7	0111.	7	7
8	1000	10	8
9	1001.	11	9.
10	1010.	12	A
11	1011.	13.	B
12	1100	14	C.
13	1101.	15	D
14	1110	16	E
15	1111.	17.	F.

* Convest $(475.25)_8$ to its decimal equivalent.

$$(475.25)_8 = 4\times8^2 + 7\times8^1 + 5\times8^0 + 2\times8^{-1} + 5\times8^{-2}$$
$$= 256 + 56 + 5 + 2\times\frac{1}{8} + 5\times\frac{1}{64}.$$
$$= (317.32813)_{10}.$$

* $(982.1A)_{16} = (?)_{10}.$

$$= 9\times16^2 + B(11)\times16^1 + 2\times16^0 + 1\times16^{-1} + A(10)\times16^{-2}$$
$$= 2304 + 176 + 2 + 1.\frac{1}{16} + 10.\frac{1}{256}$$
$$= 2304 + 176 + 2 + 0.0625 + 0.039.$$
$$= (2482.1)_{10}.$$

* $(3102.12)_4 = (?)_{10}$.

$= 3\times4^3 + 1\times4^2 + 0\times4^1 + 2\times4^0 + 1\times4^{-1} + 2\times4^{-2}$

$= 192 + 16 + 0 + 2 + \frac{1}{4} + (2)\cdot\frac{1}{16}$

$= (210.375)_{10}$.

* $(614.15)_7 = (?)_{10}$.

$= 6\times7^2 + 1\times7^1 + 4\times7^0 + 1\times7^{-1} + 5\times7^{-2}$.

$= 294 + 7 + 4 + \frac{1}{7} + 5\cdot\frac{1}{49}$.

$= 294 + 7 + 4 + 0.142857 + 0.102$

$= (305.24486)_{10}$.

Decimal to Binary conversion.

* $(29)_{10} = (?)_2$.

$= (11101)_2$.

2 | 29		LSD.
2 | 14	- 1	
2 | 7	- 0	
2 | 3	- 1	
1	- 1	

MSD

* $(25.375)_{10} = (?)_2$.

2 | 25		LSD
2 | 12	- 1	
2 | 6	- 0.	
2 | 3	- 0	
1	- 1.	

MSD.

$\frac{0.375\times2}{0.750} = 0$.

$\frac{0.750\times2}{1.5} = 1$.

Decimal to Octal conversion.

* $(416.12)_{10} = (?)_8$.

$8 \mid 416$
$8 \mid 52 - 6$
$6 - 4$ ↑

$0.12 \times 8 = 0.96 \Rightarrow 0.$
$0.96 \times 8 = 7.68 \Rightarrow 7$
$0.68 \times 8 = 5.44 \Rightarrow 5$
$0.44 \times 8 = 3.52 \Rightarrow 3$
$0.52 \times 8 = 4.16 \Rightarrow 4$ ↓

$$(416.12)_{10} = (640.07534)_8$$

* $(3964.63)_{10} = (7574.50243)_8$.

* $(469)_{10} = (725)_8$

Decimal to Hexadecimal conversion.

* $(3509)_{10} = (?)_{16}$.

$16 \mid 3509$.
$16 \mid 219 - 5.$ ↑
$16 \mid 13 - 11.$ → B
$0 - 13$ → D.

$$(3509)_{10} = (DB5)_{16}.$$

* $(2604.10546875)_{10} = (?)_{16}$.

The whole number part is converted by repeated division by 16.

16 | 2604
16 | 162 — 12 (C)
10 (A) — 2

$(2604)_{10} = (A2C)_{16}$.

* The fraction part is converted by repeated multiplication by 16 and by keeping track of the integer.

0.10546875×16
1.6875 — 1.

0.6875×16
11.00 — 11 (B).

0.00×16
00.

$(0.10546875)_{10} = (.1B)_{16}$.

$(2604.10546875)_{10} = (A2C.1B)_{16}$.

Binary to Octal.

octal number.	Binary equivalent
0	0 0 0
1	0 0 1
2	0 1 0
3	0 1 1
4	1 0 0
5	1 0 1
6	1 1 0
7	1 1 1

* For binary to octal conversion of whole numbers group the given binary number in groups of those three starting from the right most [LSB] and replace each group by the octal number shown in above table.

* For conversion of fraction part, make group of three starting with the left most bit.

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1) $(101111)_2 = (?)_8$

101 , 111
5 7

$\therefore (101111)_2 = (57)_8$

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2) $(1110.01101)_2 = (?)_8$

Whole number

001 , 110
add
1 , 6.

fraction part

011 . 010
add
3 2.

$(1110.01101)_2 = (16.32)_8$

Octal numbers to binary.

* To convert octal to binary, simply replace each octal number by its equivalent.

1) $(724)_8 = (?)_2$.

7	2	4
111	010	100.

$\therefore (724)_8 = (111\,010\,100)_2$.

2) $(365.217)_8 = (?)_2 = (011110101.010001111)_2$

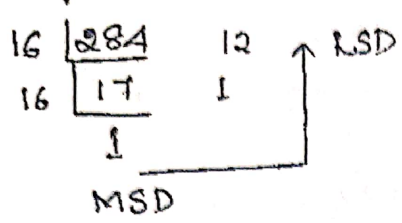
3) $(0.506)_8 = (?)_2 = (0.101000110)_2$.

NUMBER SYSTEM.

1) Convert

i) $(284.65)_{10} = (?)_8 = (?)_{16}$.

Integer part.



Fraction part :

$0.65 \times 16 \rightarrow 10.4 \rightarrow 10 = A$ (MSD)

$0.4 \times 16 \rightarrow 6.4 \rightarrow 6$

$0.4 \times 16 \rightarrow 6.4 \rightarrow 6$ (LSD)

$(284.65)_{10} = (11C.A66)_{16}$.

* $(11C.A66)_{16} = 000,100,011,100 . 101,001,100,110$.

$(11C.A66)_{16} = (0434.5146)_8$.

$\therefore (284.65)_{10} = (434.5146)_8 = (11C.A66)_{16}$.

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ii) Convert $(ABFE) = (?)_2 = (?)_{10}$.

$(ABFE)_{16} = (1010\ 1011\ 1111\ 1110)_2$.

$(ABFE)_{16} = (10 \times 16^3) + (11 \times 16^2) + (15 \times 16^1) + (14 \times 16^0)$

$(ABFE)_{16} = (44030)_{10}$.

$(ABFE)_{16} = (1010101111111110)_2 = (44030)_{10}$.

2) i) $(532.65)_{10} = (?)_{16} = (?)_2$.

June -03, 4M

Integer part:

16 | 532	- 4	↑ LSD
16 | 33	- 1	
2	- 1	

↑MSD.

$(2114)_{16}$.

Fraction part:

$0.65 \times 16. \rightarrow 10$ (MSD)

$0.4 \times 16. \rightarrow 6$

$0.4 \times 16 \rightarrow 6$ (LSD)

$(0.A66)_{16}$.

$\therefore (532.65)_{10} = (2114.A66)_{16}$.

$(.2114.A66)_{16} = (0010\ 0001\ 0100 . 1010 . 0110\ 0110)_2$.

$\therefore (532.65)_{10} = (2114.A66)_{16} = (0010\ 0001\ 0100.1010\ 0110\ 0110)_2$

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ii) $(ABCD)_{16} = (?)_2 = (?)_8$

$(ABCD)_{16} = (1010\ 1011\ 1100\ 1101)_2$.

$(1,010,101,1\ 11,00\ 1,101)_2 = (125715)_8$.

$(ABCD)_{16} = (1010\ 1011\ 1100\ 1101)_2 = (125715)_8$

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3) a) perform the following.

Jan -04, 6M

i) $(57.6)_8 = (?)_2 = (?)_{16}$.

$(57.6)_8 = (101\ 111 . 110)_2 = (2F.C)_{16}$.

ii) $(193)_{16} = (?)_8 = (?)_{10}$.

$(193)_{16} = 0001\ \ 1001\ \ 0011.$

$(193)_{16} = (623)_8$

$(193)_{16} = (1\times16^2) + (9\times16^1) + (3\times16^0) = (403)_{10}$

$(57.6)_8 = (2F.C)_{16} = (403)_{10}$. 1

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4) convert i) $(526.44)_8 = (?)_2 = (?)_{10}$ June -04, 6M

$(526.44)_8 = (101010110).100100)_2$.

$(526.44)_8 = (5\times8^2) + (2\times8^1) + (6\times8^0) + (4\times8^{-1}) + (4\times8^{-2})$

$(526.44)_8 = (342.5625)_{10}$.

$(526.44)_8 = (101\ 010\ 110.100\ 100)_2 = (342.5625)_{10}$.

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ii) $(48350)_{10} = (?)_{16} = (?)_8$

16	48350	14	↑ LSB
16	3021	13	
16	188	12.	
	11 (B).		

MSD.

$(48350)_{10} = (BCDE)_{16}$.

8	48350	
8	6043	6 ↑ LSD
8	755	3
8	94	3
8	11	6
	1.	3.

MSD

$(BCDE)_{16} = (1011\ 1100\ 1101\ 1110)_2$

$= (136336)_8$.

OR.

$(48350)_{10} = (136336)_8$

$(48350)_{10} = (BCDE)_{16} = (136336)_8$.

4) Carryout the following conversion. Jan-05, 6M

i) $(F9AC.508B)_{16} = (?)_{10}$.

F = 15, A = 10, C = 12, D = 13.

$(F9AC.508B)_{16} = (15\times16^3) + (9\times16^2) + (10\times16^1) + (12\times16^0) + (5\times16^{-1}) + (13\times16^{-2}) + (8\times16^{-3}) + (11\times16^{-4})$

$= (63916.36532)_{10}$

ii) $(457.248)_{16} = (?)_{10}$.

$= (4\times8^2) + (5\times8^1) + (7\times8^0) + (2\times8^{-1}) + (4\times8^{-2}) + (8\times8^{-3})$

$(457.248)_{16} = (303.32226)_{10}$

5) convert i) $(2AB.8)_{10} = (?)_{10} = (?)_8$ June-05, 4M

$(2AB.8)_{16} = (?)_1 + 10\times16^1 + (11\times16^0) + (8\times16^{-1})$

$(2AB.8)_{16} = (683.5)_{10}$.

$= 001,0\ 10,1\ 0\ \ 1,011.\ 100,0$

$= 1\ \ 2\ \ 5\ \ 3\ .\ 4\ 0.$

$(2AB.8)_{16} = (1253.40)_8$

$(2AB.8)_{16} = (683.5)_{10} = (1253.40)_8$.

ii) $(764.352)_8 = (?)_{16} = (?)_8$

$(764.352)_8 = 111\ 110\ 100.011\ 101\ 010$

$= 1F4.75$

$(764.352)_8 = (1F4.75)_{16}$

$(764.352)_8 = (1F4.75)_{16} = (111110100.011101010)_2$

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6) Convert the following — Jan-06, 4M

i) $(101010.101)_2 = (?)_{10}$

$= (1\times2^5) + (0\times2^4) + (1\times2^3) + (0\times2^2) + (1\times2^1) + (0\times2^0) + (1\times2^{-1}) + (0\times2^{-2}) + (1\times2^{-3})$

$(101010.101)_2 = (42.625)_{10}$

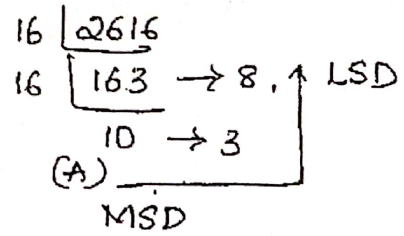
ii) $(7034)_8 = (?)_{10}$

$= (7\times8^3) + (0\times8^2) + (3\times8^1) + (4\times8^0)$

$(7034)_8 = (3612)_{10}$

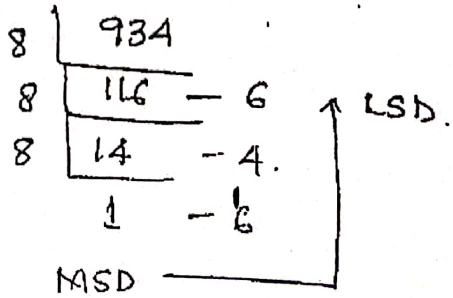
iii) $(2616)_{10} = (?)_{16}$

$(2616)_{10} = (A38)_{16}$



iv) $(934)_{10} = (?)_8$

$(934)_{10} = (1646)_8$



$(A3B)_{16} = (10 \times 16^2) + (3 \times 16^1) + (11 \times 16^0)$ A=10, B=11

$(A3B)_{16} = (2619)_{10}$

ii) $(2F3)_{16} = (?)_{10}$ F=15

$= (2 \times 16^2) + (15 \times 16^1) + (3 \times 16^0)$

$(2F3)_{16} = (755)_{10}$.

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10) solve. June-08, 6M

i) $(0.7642)_{10} = (?)_{12}$

$0.7642 \times 2 = 1.5284 \longrightarrow 1$ (MSD)

$0.5284 \times 2 = 1.0568 \longrightarrow 1$

$0.0568 \times 2 = 0.1136 \longrightarrow 0$

$0.1136 \times 2 = 0.2272 \longrightarrow 0$

$0.2272 \times 2 = 0.4544 \longrightarrow 0$

$0.4544 \times 2 = 0.9088 \longrightarrow 0$

$0.9088 \times 2 = 1.8176 \longrightarrow 1$

$0.8176 \times 2 = 1.6352 \longrightarrow 1$ (LSD)

$(0.7642)_{10} = (0.1100\,0011)_2$

ii) $(ADGCB)_{16} = (?)_8$

$= (1010\ 1101, 0110\ 1100\ 1011)_2$

$(ADGCB)_{10} = (2553313)_2$

iii) $(11011.1011)_2 = (?)_8$.

$= 11,011.101,1$

$3\ \ 3\ \ 5\ \ 4$.

$(11011.1011)_2 = (33.54)_8$

iv) $(1011.11001)_2 = (?)_{10}$.

$= (1\times2^3) + (0\times2^2) + (1\times2^0) + (1\times2^0) + (1\times2^{-1})$
$+ (1\times2^{-2}) + (0\times2^{-3}) + (0\times2^{-4}) + (1\times2^{-5})$

$= (13.78125)_{10}$.

$(1011.11001)_2 = (13.78125)_{10}$.

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11) Convert $(1011001101)_2$ into octal decimal & hexadecimal.

$(1011001101)_2 = (?)_8 = (?)_{10} = (?)_{16}$ June-09, 8M

→ $10,110,011,010 = (2632)_8$.

$2\ \ 6\ \ 3\ \ 2$

→ $101, 1001, 1010 = (59A)_{16}$.

$5\ \ 9\ \ A$

→ $(1\times2^{10}) + (0\times2^9) + (1\times2^8) + (1\times2^7) + (0\times2^6) + (0\times2^5)$
$+ (1\times2^4) + (1\times2^3) + (0\times2^2) + (1\times2^1) + (0\times2^0)$.

$= (1434)_{10}$.

$\therefore (1011001101)_2 = (2632)_8 = (59A)_{16} = (1434)_{10}$.

12) Convert the following binary numbers to decimal numbers.

Jan - 10, 5M

i) $(1101)_2 = (1\times2^3) + (1\times2^2) + (0\times2^1) + (1\times2^0)$.

$= (13)_{10}$.

ii) $(10001)_2 = (1\times2^4) + (0\times2^3) + (0\times2^2) + (0\times2^1) + (1\times2^0)$.

$= (17)_{10}$.

iii) $(10101)_2 = (1\times2^4) + (0\times2^3) + (1\times2^2) + (1\times2^0) + (0\times2^1) + (1\times2^0)$

$= (21)_{10}$.