

Number System Assignment-1

1. Write a Binary values table for 0 to 10 decimal values?

Decimal	Binary
0	0
1	01
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

2. Convert the below numbers from Decimal to Binary:

a. 12

2	12
2	6 - 0
2	3 - 0
	1 - 1

$$(12)_{10} = (1100)_2$$

b. 20

2	20
2	10 - 0
2	5 - 0
2	2 - 1
	1 - 0

$$(20)_{10} = (10100)_2$$

c. 45

2	45
2	$22 - 1$
2	$11 - 0$
2	$5 - 1$
2	$2 - 1$
	$1 - 0$

$$(45)_{10} = (101101)_2$$

c. 77

2	77
2	$38 - 1$
2	$19 - 0$
2	$9 - 1$
2	$4 - 1$
2	$2 - 0$
2	$1 - 0$

$$(77)_{10} = (1001101)_2$$

d. 103

2	103
2	$51 - 1$
2	$25 - 1$
2	$12 - 1$
2	$6 - 0$
2	$3 - 0$
	$1 - 1$

$$(103)_{10} = (1100111)_2$$

3. What is the Octal equivalent of $(9910)_{10} = (23266)_8$

8	9910
8	1238 - 6
8	154 - 6
8	19 - 2
8	2 - 3

$$(9910)_{10} = (23266)_8$$

4. Convert the below numbers from Binary to Decimal:

a. $(1101)_2 = (13)_{10}$

1	1	0	1
$2^3 \times 1$	$2^2 \times 1$	$2^1 \times 0$	$2^0 \times 1$

$$8+4+0+1= 13$$

b. $1110 = (14)_{10}$

1	1	1	0
$2^3 \times 1$	$2^2 \times 1$	$2^1 \times 1$	$2^0 \times 0$

$$8+4+2+0 = 14$$

c. $1111\ 0101 = (245)_{10}$

1	1	1	1	0	1	0	1
$2^7 \times 1$	$2^6 \times 1$	$2^5 \times 1$	$2^4 \times 1$	$2^3 \times 0$	$2^2 \times 1$	$2^1 \times 0$	$2^0 \times 1$

$$128+64+32+16+4+1 = 245$$

d. $0101\ 0101 = (85)_{10}$

0	1	0	1	0	1	0	1
$2^7 \times 0$	$2^6 \times 1$	$2^5 \times 0$	$2^4 \times 1$	$2^3 \times 0$	$2^2 \times 1$	$2^1 \times 0$	$2^0 \times 1$

$$64+16+4+1= 85$$

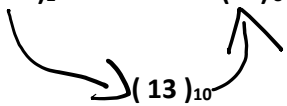
e. $1000\ 1111 = (143)_{10}$

1	0	0	0	1	1	1	1
$2^7 \times 1$	$2^6 \times 0$	$2^5 \times 0$	$2^4 \times 0$	$2^3 \times 1$	$2^2 \times 1$	$2^1 \times 1$	$2^0 \times 1$

$$128+8+4+2+1= 143$$

5. Convert the following numbers to base indicated and vice-versa (Cross-Verify)

a. $(1101)_2 \Rightarrow (15)_8$



1	1	0	1
$2^3 \times 1$	$2^2 \times 1$	$2^1 \times 0$	$2^0 \times 1$

$$8+4+0+1=13$$

$$\Rightarrow (1101)_2 = (13)_{10}$$

8	13
8	8-5
	1

$$\Rightarrow (13)_{10} = (15)_8$$

Cross Verification

$$(15)_8$$

$$(8^1 \times 1) + (8^0 \times 5) = (13)_{10}$$

$$\Rightarrow (15)_8 = (13)_{10}$$

2	13
2	6-1
2	3-0
	1-1

$$\Rightarrow (13)_{10} = (1101)_2$$

b. $(1111\ 1111\ 1110)_2 \Rightarrow (4094)_{10}$

1	1	1	1	1	1	1	1	1	1	1	1
$2^{11} \times 1$	$2^{10} \times 1$	$2^9 \times 1$	$2^8 \times 1$	$2^7 \times 1$	$2^6 \times 1$	$2^5 \times 1$	$2^4 \times 1$	$2^3 \times 1$	$2^2 \times 1$	$2^1 \times 1$	$2^0 \times 0$

$$(2^{11} \times 1) + (2^{10} \times 1) + (2^9 \times 1) + (2^8 \times 1) + (2^7 \times 1) + (2^6 \times 1) + (2^5 \times 1) + (2^4 \times 1) + (2^3 \times 1) + (2^2 \times 1) + (2^1 \times 1) + (2^0 \times 0)$$

$$\Rightarrow \text{SUM} = (4094)_{10}$$

c. $(221201)_3 \Rightarrow (649)_{10}$

2	2	1	2	0	1
$3^5 \times 2$	$3^4 \times 2$	$3^3 \times 1$	$3^2 \times 2$	$3^1 \times 0$	$3^0 \times 1$

$$(3^5 \times 2) + (3^4 \times 2) + (3^3 \times 1) + (3^2 \times 2) + (3^1 \times 0) + (3^0 \times 1)$$

$\Rightarrow \text{SUM} = (649)_{10}$

d. $(76)_8 \Rightarrow (62)_{10}$

7	6
$8^1 \times 7$	$8^0 \times 6$

SUM: $56 + 6 \Rightarrow (62)_{10}$

e. $(231)_8 \Rightarrow (10011001)_2$
 $\searrow (153)_{10}$

$$(8^2 \times 2) + (8^1 \times 3) + (8^0 \times 1) = (153)_{10}$$

$\Rightarrow (231)_8 = (153)_{10}$

2	153
2	76 -1
2	38 - 0
2	19 - 0
2	9 - 1
2	4 - 1
2	2 - 0
2	1 - 0

$\Rightarrow (153)_{10} = (10011001)_2$

Cross verification

$$\rightarrow (2^7 \times 1) + (2^4 \times 1) + (2^3 \times 1) + (2^0 \times 1) = (153)_{10}$$

8	153
8	19 -1
	2-3

$$\rightarrow (153)_{10} = (231)_8$$

f. $(0xF00)_{16} \Rightarrow (7400)_8$

$$(3840)_{10}$$

(F) 15×16^2	0×16^1	0×16^0
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$$\rightarrow \text{SUM: } (0xF00)_{16} = (3840)_{10}$$

8	3840
8	480 -0
8	60-0
8	7-4

$$(3840)_{10} = (7400)_8$$

Cross Verification

$$\rightarrow (8^3 \times 7) + (8^2 \times 4) + (8^1 \times 0) + (8^0 \times 0) = (3840)_{10}$$

16	3840
16	240-0
16	15-0

$$\rightarrow (3840)_{10} = (F00)_{16}$$

g. $(0xDACE)_{16} \Rightarrow (284BA)_{12}$

D(13)	A(10)	C(12)	E (14)
$16^3 \times 13$	$16^2 \times 10$	$16^1 \times 12$	$16^0 \times 14$

$$\rightarrow \text{SUM} = (56014)_{10}$$

12	56014
12	4667-10
12	388-11
12	32-4
12	2-8

$$\rightarrow (56014)_{10} = (284BA)_{12}$$

Cross Verification

2	8	4	B(11)	A (10)
$12^4 \times 2$	$12^3 \times 8$	$12^2 \times 4$	$12^1 \times 11$	$12^0 \times 10$

$$\rightarrow \text{SUM} = (56014)_{10}$$

16	56014
16	3500-14
16	218-12
	13-10

$$\rightarrow (56014)_{10} = (DACE)_{16}$$

$$\text{h. } (0x2B)_{16} \Rightarrow ()_8$$

$$\rightarrow (16^1 \times 2) + (16^0 \times 11) = (43)_{10}$$

8	43
	5-3

$$\rightarrow (43)_{10} = (53)_8$$

Cross verification

$$\rightarrow (8^1 \times 5) + (8^0 \times 3) = (43)_{10}$$

16	43
	2-11

$$\rightarrow (43)_{10} = (2B)_{16}$$

6. Convert the following numbers to the base 10 :

a. $(3312)_8$

$8^3 \times 3$	$8^2 \times 3$	$8^1 \times 1$	$8^0 \times 2$
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→ SUM = $(1738)_{10}$

b. $(167)_8$

$8^2 \times 1$	$8^1 \times 6$	$8^0 \times 7$
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→ SUM = $(119)_{10}$

c. $(202103)_9$

$9^5 \times 2$	$9^4 \times 0$	$9^3 \times 2$	$9^2 \times 1$	$9^1 \times 0$	$9^0 \times 3$
----------------	----------------	----------------	----------------	----------------	----------------

→ SUM = $(119640)_{10}$

d. $(3132334)_{16}$

$16^6 \times 3$	$16^5 \times 1$	$16^4 \times 3$	$16^3 \times 2$	$16^2 \times 3$	$16^1 \times 3$	$16^0 \times 4$
-----------------	-----------------	-----------------	-----------------	-----------------	-----------------	-----------------

→ SUM = $(51585844)_{10}$

e. $(0xF2)_{16}$

(F) 15×16^1	2×16^0
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→ SUM = $(242)_{10}$

7. Convert the following base 10 numbers to the base Indicated:

a. $(5610)_{10} \Rightarrow (1010111101010)_2$

2	5610
2	2850-0
2	1402-1
2	701-0
2	350-1
2	175-0
2	87-1
2	43-1
2	21-1
2	10-1
2	5-0
2	2-1
	1-0

b. $(5610)_{10} \Rightarrow (21200210)_3$

3	5610
3	1870-0
3	623-1
3	207-2
3	69-0
3	23-0
3	7-2
3	2-1

c. $(5610)_{10} \Rightarrow (12752)_8$

8	5610
8	701-2
8	87-5
8	10-7
8	1-2

d. $(5610)_{10} \Rightarrow (32B6)_{12}$

12	5610
12	467-6
12	38-11
12	3-2

e. $(5610)_{10} \Rightarrow (15EA)_{16}$

16	5610
16	350-10
16	21-14
16	1-5

f. $(22110)_{10} \Rightarrow (101011001011110)_2$

2	22110
2	11055-0
2	5527-1
2	2763-1
2	1381-1
2	690-1
2	345-0
2	172-1
2	86-0
2	43-0
2	21-1
2	10-1
2	5-0
2	2-1
2	1-0

g. $(22110)_{10} \Rightarrow (1010022220)_3$

3	22110
3	7370-0
3	2456-2
3	818-2
3	272-2
3	90-2
3	30-0
3	10-0
3	3-1
3	1-0

h. $(22110)_{10} \Rightarrow (53136)_8$

8	22110
8	2763-6
8	345-3
8	43-1
8	5-3

i. $(22110)_{10} \Rightarrow (10966)_{12}$

12	22110
12	1842-6
12	153-6
12	12-9
	1-0

j. $(22110)_{10} \Rightarrow (565E)_{16}$

16	22110
16	1381-14
16	86-5
16	5-6

8. Perform Binary Addition on the below numbers:

a. $9 + 12$

$$\begin{array}{r} (9)_{10} \Rightarrow (1001)_2 \\ (12)_{10} \Rightarrow (1100)_2 \\ \hline (21)_{10} = (10101)_2 \end{array}$$

b. $40 + 31$

$$\begin{array}{r} (40)_{10} = (101000)_2 \\ (31)_{10} = (11111)_2 \\ \hline (71)_{10} = (1000111)_2 \end{array}$$

c. $1110 + 0101$

$$\begin{array}{r} 1110 \\ 0101 \\ \hline 10011 \end{array}$$

d. $1111\ 0101 + 0111\ 1100$

$$\begin{array}{r} 1111\ 0101 \\ + 0111\ 1100 \\ \hline 10111\ 0001 \end{array}$$

e. $1100\ 0011 + 0101\ 1110$

$$\begin{array}{r} 1100\ 0011 \\ + 0101\ 1110 \\ \hline 10010\ 0001 \end{array}$$

9. Perform Binary Subtraction on the below numbers:

a. $8 - 3$

$$\begin{array}{r} (8)_{10} = 1000 \\ - (3)_{10} = -0011 \\ \hline (5)_{10} = 0101 // \end{array}$$

b. $17 - 11$

$$\begin{array}{r} 17 = 10001 \\ - 11 = -0010 \\ \hline 6 = 0110 // \end{array}$$

c. $25 - 7$

$$\begin{array}{r} 25 = 11001 \\ - 7 = -0011 \\ \hline 18 = 10010 // \end{array}$$

d. $86 - 31$

$$\begin{array}{r} 86 = 1010110 \\ - 31 = -001111 \\ \hline 55 = 110111 // \end{array}$$

e. $1101\ 0001 - 0100\ 0111$

$$\begin{array}{r} 1101\ 0001 \\ - 0100\ 0111 \\ \hline 1000\ 1010 // \end{array}$$

10. Perform Binary Multiplication on the below numbers:

a. 12×3

$$\begin{array}{r} 12 = 1100 \\ \times 3 = 011 \\ \hline 36 = 100100 // \end{array}$$

b. 20×5

$$\begin{array}{r} 20 = 10100 \\ \times 5 = 0101 \\ \hline 100 = 1100100 // \end{array}$$

c. 0111×0010

$$\begin{array}{r}
 0111 \\
 x 0010 \\
 \hline
 0000 \\
 0111x \\
 0000xx \\
 0000xxx \\
 \hline
 1110
 \end{array}$$

d. $0110 \ 0111 \times 101$

$$\begin{array}{r}
 0110 \ 0111 \\
 x 101 \\
 \hline
 0110 \ 0111 \\
 0000 \ 0000x \\
 0110 \ 0111xx \\
 \hline
 100000011
 \end{array}$$

e. $1010 \ 1010 \times 0101 \rightarrow 170 \times 5 = 850$

$$\begin{array}{r}
 1010 \ 1010 \\
 x 0101 \\
 \hline
 10101010 \\
 00000000x \\
 10101010xx \\
 00000000xxx \\
 \hline
 01101010010 \rightarrow 850
 \end{array}$$

11. Perform Binary Division on the below numbers:

a. $15 / 2 = 7 \rightarrow 1111/10 = 111 \text{ remainder} = 1$

$$\begin{array}{r}
 10 \) \ 1111 \ (\ 1110 \\
 10 \\
 \hline
 11 \\
 10 \\
 \hline
 11 \\
 10 \\
 \hline
 1
 \end{array}$$

b. $45 / 5 = 9 \rightarrow 101101/101 = 1001$

$$\begin{array}{r}
 101 \) \ 101101 \ (\ 1001 \\
 101 \\
 \hline
 01 \\
 00 \\
 \hline
 10 \\
 0 \\
 \hline
 101 \\
 101 \\
 \hline
 0
 \end{array}$$

c. $121 / 14 = 8 \Rightarrow 1111001/1110 = 1000$
remainder=9

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1110) 1111001 ( 1000
      1110
      -----
        10
         0
        -----
         100
          0
         -----
          1001
           0
          -----
            1001

```

d. $1101\ 0100 / 101 \Rightarrow 212/5 = 42$
remainder =2

```

101) 11010100 ( 101010
      101
      -----
        11
         00
        -----
         110
          101
          -----
           110
            101
            -----
              10
               0
              -----

```

e. $1010\ 1010 / 0111 \Rightarrow 11000 \Rightarrow 170/7 = 24$ remainder= 2

```

0111) 1010 1010 ( 11000
      0111
      -----
        0111
        0111
        -----
          00
           0
          -----
           010
            0000
            -----
              10

```

12. Convert the following floating numbers to binary, base 3, octal, and hexadecimal. Any fractions that do not terminate should be truncated to 4 digits in the fractional part.

a. $(34.34)_{10} \rightarrow (100010.01011)_2 \rightarrow (1021.1000)_3 \rightarrow (42.2560)_8 \rightarrow (22.570)_{16}$

$$34 = (100010)_2$$

$$0.34 \times 2 = 0.68 \Rightarrow 0$$

$$0.68 \times 2 = 1.36 \Rightarrow 1$$

$$0.36 \times 2 = 0.72 \Rightarrow 0$$

$$0.72 \times 2 = 1.44 \Rightarrow 1$$

$$0.44 \times 2 = 0.88 \Rightarrow 1$$

$$34 = (1021)_3$$

0.34×3	$= 1.02$	1
0.02×3	$= 0.06$	0
0.06×3	$= 0.18$	0
0.18×3	$= 0.54$	0

$$34 = (42)_8$$

0.34×8	$= 2.72$	2
0.72×8	$= 5.76$	5
0.76×8	$= 6.08$	6
0.08×8	$= 0.64$	0

$$34 = (22)_{16}$$

0.34×16	$= 5.44$	5
0.44×16	$= 7.06$	7
0.06×16	$= 0.96$	0

b. $(125.125)_{10}$

$(125.125)_{10} \rightarrow (1111101.001)_2 \rightarrow (11122.0101)_3 \rightarrow (175.1)_8 \rightarrow (7D.2)_{16}$

$$125 = (1111101)_2$$

0.125×2	$= 0.250$	0
0.250×2	$= 0.500$	0
0.500×2	$= 1.00$	1

$$125 = (11122)_3$$

0.125×3	$= 0.375$	0
0.375×3	$= 1.125$	1
0.125×3	$= 0.375$	0
0.375×3	$= 0.125$	1

$$125 = (175)_8$$

0.125×8	$= 1$	1
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$$125 = (7D)_{16}$$

0.125×16	$= 2$	2
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c. $(10.16)_{10}$

. $(10.16)_{10} \rightarrow (1010.0010)_2 \rightarrow (101.0110)_3 \rightarrow (12.1217)_8 \rightarrow (A.28F5)_{16}$

$10 = (1010)_2$

0.16x2	= 0.32	0
0.32x2	=0.64	0
0.64x2	=1.28	1
0.28x2	= 0.56	0

$10 = (101.)_3$

0.16x3	= 0.48	0
0.48x3	=1.44	1
0.44x3	=1.32	1
0.32x3	= 0.96	0

$10 = (12)_8$

0.16x8	= 1.28	1
0.28x8	=2.24	2
0.24x8	=1.92	1
0.92x8	= 7.36	7

$10 = (A)_{16}$

0.16x16	= 2.56	2
0.56x16	=8.96	8
0.96x16	=15.36	15
0.36x16	= 5.76	5

13. What is the largest positive number one can represent in a 12-bit 2's complement code? Write your result in binary and decimal?

In a n-bit 2's complement, the most significant bit represents the sign of the number

Thus, the MSB of the 12 bit number will be 0(positive sign)

→ the largest positive number one can represent in a 12-bit 2's complement code is

$$0111\ 1111\ 1111 = (2047)_{10}$$

14. What are the 8-bit patterns used to represent each of the characters in the string "CODE/THS 2022"?

(Only represent the characters between the quotation marks.)

****Note:** There is space between THS and 2022.

Char	HEX()	Dec	Binary
C	43	67	01000011
O	4F	79	01001111
D	44	68	01000100
E	45	69	01000101
/	2F	47	00101111
T	54	84	01010100
H	48	72	01001000
S	53	83	01010011
	20	32	00100000
2	32	50	00110010
0	48	30	00110000
2	32	50	00110010
2	32	50	00110010

The 8 bit pattern :

01000011 01001111 01000100 01000101 00101111 01010100 01001000

01010011 00100000 00110010 00110000 00110010 00110010

15. What is the biggest binary number you can write with 5 bits?

$2^4 \times 1$	$2^3 \times 1$	$2^2 \times 1$	$2^1 \times 1$	$2^0 \times 1$
----------------	----------------	----------------	----------------	----------------

Biggest binary number with 5 bits is $(11111)_2 = (31)_{10}$

16. In hex, 2BFC + 54A7 ?

$$\begin{array}{rcl}
 \begin{array}{r}
 54A7 \\
 +2BFC \\
 \hline
 \end{array} & \begin{array}{l}
 (54A7)_{16} = (21671)_{10} \\
 (2BFC)_{16} = +(11260)_{10} \\
 \hline
 \end{array} & \\
 (80A3)_{16} & \xrightarrow{\text{=====}} & (32931)_{10}
 \end{array}$$

17. Convert the hex number ABC7 to binary?

$$(ABC7)_{16} \Rightarrow (1010101111000111)_2$$

$$(43975)_{10}$$

A	B	C	7	SUM
$16^3 \times 10$	$16^2 \times 11$	$16^1 \times 12$	$16^0 \times 7$	$(43975)_{10}$

2	43975
2	21987-1
2	10993-1
2	5496-1
2	2748-0
2	1374-0
2	687-0
2	343-1
2	171-1
2	85-1
2	42-1
2	21-0
2	10-1
2	5-0
2	2-1
	1-0

18. In hex, AC74 – B3F?

$$\begin{array}{r}
 \text{A C 7 4} \\
 - \text{B 3 F} \\
 \hline
 \text{(A 1 3 5)}_{16}
 \end{array}
 \quad \Rightarrow \quad
 \begin{array}{r}
 (\text{AC74})_{16} = (44148)_{10} \\
 (\text{B3F})_{16} = - (2879)_{10} \\
 \hline
 (41269)_{10}
 \end{array}$$

19. Convert the following binary fractions to ordinary fractions

a. $(0.1001)_2 = (0.5625)_{10} \rightarrow 9/16$

0	.	1	0	0	1
0	.	$1 \times 1/2^1$	$0 \times 1/2^2$	$0 \times 1/2^3$	$1 \times 1/2^4$

$\rightarrow 0.5 + 0 + 0 + 0.0625 = (0.5625)_{10}$

b. $1.0011 = (1.1875)_{10} \rightarrow 19/16$

1	.	0	0	1	1
1	.	$0 \times 1/2^1$	$0 \times 1/2^2$	$1 \times 1/2^3$	$1 \times 1/2^4$

$\rightarrow 2^0 \times 1 = 1$

$\rightarrow 0 + 0 + 0.125 + 0.0625 = 1.1875$

c. $1.1111 = (1.9375)_{10}$

1	.	1	1	1	1
1	.	$1 \times 1/2^1$	$1 \times 1/2^2$	$1 \times 1/2^3$	$1 \times 1/2^4$

$\rightarrow 2^0 \times 1 = 1$

$\rightarrow 0.5 + 0.25 + 0.125 + 0.0625 = 1.9375$

20. The decimal expansion of 11/17 is 0.647. Find the binary expansion of the fraction 11/17.

$0.647 \times 2 = 1.294 \rightarrow 1$

$0.294 \times 2 = 0.588 \rightarrow 0$

$0.588 \times 2 = 1.176 \rightarrow 1$

$0.176 \times 2 = 0.352 \rightarrow 0$

$0.352 \times 2 = 0.704 \rightarrow 0$

$0.704 \times 2 = 1.408 \rightarrow 1$

$0.408 \times 2 = 0.816 \rightarrow 0$

$0.816 \times 2 = 1.632 \rightarrow 1$

Binary expansion up to 8 digits = 0.10100101

21. The decimal expansion of $3/11$ is 0.2727. Find the binary expansion of the fraction $3/11$.

$$0.2727 \times 2 = 0.5454 \rightarrow 0$$

$$0.5454 \times 2 = 1.0908 \rightarrow 1$$

$$0.0908 \times 2 = 0.1816 \rightarrow 0$$

$$0.1816 \times 2 = 0.3632 \rightarrow 0$$

$$0.3632 \times 2 = 0.7264 \rightarrow 0$$

$$0.7264 \times 2 = 1.4528 \rightarrow 1$$

$$0.4528 \times 2 = 0.9056 \rightarrow 0$$

$$0.9056 \times 2 = 1.8112 \rightarrow 1$$

Binary expansion up to 8 digits = 0.01000101