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
	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
	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 x 1	**2^2 x 1**	**2^1 x 0**	**2^0 x 1**

8+4+0+1= 13

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

1	**1**	**1**	**0**
2^3 x 1	**2^2 x 1**	**2^1 x 1**	**2^0 x 0**

8+4+2+0 = 14

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

1	**1**	**1**	**1**	**0**	**1**	**0**	**1**
2^7 x 1	**2^6 x 1**	**2^5 x 1**	**2^4 x 1**	**2^3 x 0**	**2^2 x 1**	**2^1 x 0**	**2^0 x 1**

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

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

0	**1**	**0**	**1**	**0**	**1**	**0**	**1**
2^7x 0	**2^6 x 1**	**2^5 x 0**	**2^4 x 1**	**2^3 x 0**	**2^2 x 1**	**2^1 x 0**	**2^0 x 1**

64+16+4+1= 85

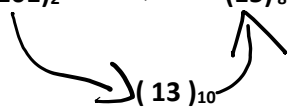
e. 1000 1111 = $(143)_{10}$

1	**0**	**0**	**0**	**1**	**1**	**1**	**1**
2^7x 1	**2^6x 0**	**2^5x 0**	**2^4 x 0**	**2^3x 1**	**2^2 x 1**	**2^1 x 1**	**2^0x 1**

128+8+4+2+1= 143

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

a. $(1101)_2$ => $(15)_8$



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

➔ $(1101)_2 = (13)_{10}$

8	13
8	8 -5
	1

➔$(13)_{10} = (15)_8$

Cross Verification

$(15)_8$

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

➔$(15)_8 = (13)_{10}$

2	13
2	6 -1
2	3– 0
	1 -1

➔$(13)_{10} = (1101)_2$

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

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

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

➔SUM =$(4094)_{10}$

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

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

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

➔SUM=$(649)_{10}$

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

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

SUM: 56+6➔$(62)_{10}$

e. $(231)_8 \Rightarrow (10011001)_2$

$(153)_{10}$

$(8^2 \times 2)+(8^1 \times 3) + (8^0 \times 1) = (153)_{10}$
➔$(231)_8 = (153)_{10}$

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

➔$(153)_{10}$ = (10011001)

Cross verification

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

8	**153**
8	**19 -1**
	2-3

➔$(153)_{10} = (231)_8$

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

$(3840)_{10}$

(F) 15×16^2	**0×16^1**	**0×16^0**

➔SUM: $(0xF00)_{16} = (3840)_{10}$

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

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

Cross Verification

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

16	**3840**
16	**240-0**
16	**15-0**

➔$(3840)_{10} = (F00)_{16}$

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

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

➔SUM = $(56014)_{10}$

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

➔$(56014)_{10} = (284BA)_{12}$

Cross Verification

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

➔SUM = $(56014)_{10}$

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

➔ $(56014)_{10} = (DACE)_{16}$

h. $(0x2B)_{16}$ => $(\ )_8$

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

8	43
	5 -3

➔$(43)_{10} = (53)_8$

Cross verification

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

16	43
	2 -11

➔ $(43)_{10} = (2B)_{16}$

6. **Convert the following numbers to the base 10 :**

   a. **$(3312)_8$**

$8^3 \times 3$	$8^2 \times 3$	$8^1 \times 1$	$8^0 \times 2$

➔**SUM =$(1738)_{10}$**

   b. **$(167)_8$**

$8^2 \times 1$	$8^1 \times 6$	$8^0 \times 7$

➔**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

➔**SUM =$(242)_{10}$**

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

   a. **$(5610)_{10}$ => $(1010111101010)_2$**

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. **$(5610)_{10}$ => $(21200210)_3$**

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

c. $(5610)_{10}$ => (12752) $_{8}$

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

d. $(5610)_{10}$ =>$(32B6)_{12}$

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

e. $(5610)_{10}$ => $(15EA)_{16}$

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

f. $(22110)_{10}$=> $(101011001011110)_{2}$

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. $(22110)_{10}$ => $(1010022220)_{3}$

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. $(22110)_{10}$ => $(53136)_{8}$

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

i. $(22110)_{10}$ => $(10966)_{12}$

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

j. $(22110)_{10}$ => $(565E)_{16}$

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

8. **Perform Binary Addition on the below numbers:**

a. 9 + 12

$(9)_{10} \Rightarrow (1001)_2$

$(12)_{10} \Rightarrow (1100)_2$

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

```
 1001
+1100
10101
```

b. 40 + 31

$(40)_{10} = (101000)_2$

$(31)_{10} = (11111)_2$

$(71)_{10} = (1000111)_2$

```
 101000
+ 11111
1000111
```

c. 1110 + 0101

```
 1110
 0101
10011
```

d. 1111 0101 + 0111 1100

```
 1111 0101
+0111 1100
10111 0001
```

e. 1100 0011 + 0101 1110

```
 1100 0011
+0101 1110
10010 0001
```

9. Perform Binary Subtraction on the below numbers:

a. 8 – 3

$(8)_{10} = 1000$

$-(3)_{10} = -0011$

$(5)_{10}$ 0101 //

b. 17 - 11

$17 = 10001$

$-11 = 1011$

6 0110 //

c. 25 – 7

$25 = 11001$

$-7 = 111$

$18 = 10010$ //

d. 86 - 31

$86 = 1010110$

$-31 = 11111$

55 11 0111 //

e. 1101 0001 - 0100 0111

1101 0001

0100 0111

1000 1010 //

10. Perform Binary Multiplication on the below numbers:

a. 12 x 3

$12 = 1100$

$x3 = 011$

36

1100

1100x

0000xx

100100 //

b. 20 x 5

20

x5

100

10100

101

10100

00000x

1010xx

1100100 //

c. 0111 x 0010

```
        0111
x       0010
-----------------------
        0000
       0111x
      0000xx
     0000xxx
-----------------------------
        1110
```

d. 0110 0111 x 101

```
      0110 0111
x        101
---------------------------------
      0110 0111
     0000 0000x
    0110 0111xx
-----------------------------------
   1000000011
```

e. 1010 1010 x 0101 ➔ 170 x 5 = 850

```
          1010 1010
          x    0101
-------------------------------------------
          10101010
         00000000x
        10101010xx
       00000000xxx
-------------------------------------------
      01101010010 ➔850
-------------------------------------------
```

11. Perform Binary Division on the below numbers:

a. 15 / 2 = 7 ➔ 1111/10 = 111 remainder = 1

```
10 ) 1111 ( 1110
     10
---------------
     11
     10
---------------
      11
      10
-------------------
       1
```

b. 45 / 5 = 9 ➔101101/101 = 1001

```
101) 101101 ( 1001
     101
------------
     01
     00
-------------
      10
       0
-------------
      101
      101
-------------
        0
```

c. 121 / 14 = 8 ➔ 1111001/1110 = 1000 remainder= 9

d. 1101 0100 / 101 ➔ 212/5 =42 remainder =2

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

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

e. 1010 1010 / 0111 ➔ 11000 ==➔ 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. $(34.34)_{10}$ ➔ $(100010.01011)_2$ ➔ $(1021.1000)_3$ ➔ $(42.2560)_8$ ➔ $(22.570)_{16}$

$34 = (100010)_2$

0.34 x 2 = 0.68 => 0

0.68 x 2 = 1.36 => 1

0.36 x 2 = 0.72 => 0

0.72 x 2 = 1.44=> 1

0.44 x 2 = 0.88 => 1

$34 = (1021)_3$

0.34x3	= 1.02	1
0.02x3	=0.06	0
0.06x3	=0.18	0
0.18x3	= 0.54	0

$34 = (42)_8$

0.34x8	= 2.72	2
0.72x8	=5.76	5
0.76x8	=6.08	6
0.08x8	= 0.64	0

$34 = (22)_{16}$

0.34x16	= 5.44	5
0.44x16	=7.06	7
0.06x16	=0.96	0

b. $(125.125)_{10}$

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

$125 = (1111101)_2$

0.125x2	= 0.250	0
0.250x2	=0.500	0
0.500x2	=1.00	1

$125 = (11122)_3$

0.125x3	= 0.375	0
0.375x3	=1.125	1
0.125x3	=0.375	0
0.375x3	= 0.125	1

$125 = (175)_8$

0.125x8	= 1	1

$125 = (7D)_{16}$

0.125x16	= 2	2

c. $(10.16)_{10}$

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

$10 = (1010)_2$

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 x 1	2^3 x 1	2^2 x 1	2^1 x 1	2^0 x 1

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

16. In hex, 2BFC + 54A7 ?

$(54A7)_{16} = (21671)_{10}$

$+(2BFC)_{16} = +(11260)_{10}$

$(8\ 0\ A\ 3)_{16}$ =====➔ $(32931)_{10}$

17. Convert the hex number ABC7 to binary?

$(ABC7)_{16}$ => $(1010101111000111)_2$

$(43975)_{10}$

A	B	C	7	SUM
16^3 X 10	16^2 X 11	16^1 X 12	16^0 X 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?

A C 7 4 $(AC74)_{16}$ = $(44148)_{10}$

\- B 3 F $(B3F)_{16}$ = - $(2879)_{10}$

$(A\ 1\ 3\ 5)_{16}$ =====➔ $(41269)_{10}$

19. Convert the following binary fractions to ordinary fractions

a. $(0.1001)_2 = (0.5625)_{10}$ ➔9/16

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

➔$0.5+0+0+0.0625 = (0.5625)_{10}$

b. $1.0011 = (1.1875)_{10}$ ➔ 19/16

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

➔ $2^0 x1 = 1$

➔ $0+0+0.125+0.0625 = 1.1875$

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

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

➔ $2^0 x1 = 1$

➔ $0.5+0.25+0.125+0.0625 = 1.9375$

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

0.647 x 2 = 1.294 ➔1

0.294 x 2 = 0.588 ➔0

0.588 x 2 = 1.176 ➔1

0.176 x 2 = 0.352 ➔0

0.352 x 2 = 0.704 ➔0

0.704 x 2 = 1.408 ➔1

0.408 x 2 = 0.816 ➔0

0.816 x 2 = 1.632 ➔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 x 2 = 0.5454 ➔0

0.5454 x 2 = 1.0908 ➔1

0.0908 x 2 = 0.1816 ➔0

0.1816 x 2 = 0.3632 ➔0

0.3632 x 2 = 0.7264 ➔0

0.7264x 2 = 1.4528 ➔1

0.4528x 2 = 0.9056 ➔0

0.9056x 2 = 1.8112 ➔1

Binary expansion up to 8 digits = 0.01000101