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

   $$2 \mid 12$$
   $$2 \mid 6 - 0$$
   $$2 \mid 3 - 0$$
   $$1 - 1$$

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

   b. 20

   $$2 \mid 20$$
   $$2 \mid 10 - 0$$
   $$2 \mid 5 - 0$$
   $$2 \mid 2 - 1$$
   $$1 - 0$$

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

c. 45

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

$(45)_{10} = (101111)_2$

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 = $(246)_{10}$

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 0

128+64+32+16+0+4+2+0 = 246

d. 0101 0101 = $(75)_{10}$

0	1	0	1	0	1	0	1
2^7 x 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

0+64+0+16+0+4+0+1= 85
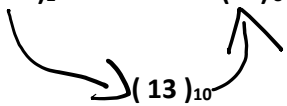
e. 1000 1111 = $(143)_{10}$

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

128+0+0+0+8+4+2+1= 143

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

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

$(13)_{10}$

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

➔ $(1101)_2$ = $(13)_{10}$

8	13
8	8 -5
	1

➔$(13)_{10}$ = $(15)_8$

Cross Verification

$(15)_8$

$(8^1 x1) + (8^0 x5) = (13)_{10}$

➔$(15)_8$ = $(13)_{10}$

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} x 1	2^{10} x 1	2^9 x 1	2^8 x 1	2^7 x 1	2^6 x 1	2^5 x 1	2^4 x 1	2^3 x 1	2^2 x 1	2^1 x 1	2^0 x 0

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

➔SUM =$(4094)_{10}$

c. (221201) $_3$ => (649) $_{10}$

2	2	1	2	0	1
3^5 x 2	3^4 x 2	3^3 x 1	3^2 x 2	3^1 x 0	3^0 x 1
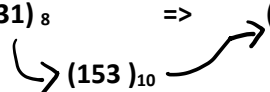
(3^5 x 2)+(3^4 x 2)+(3^3 x 1)+(3^2 x 1)+(3^1 x 0)+(3^0 x 1)

➔SUM=(649)$_{10}$

d. (76) $_8$ => (62) $_{10}$

7	6
8^1 x7	8^0 x6

SUM: 56+6➔(62)$_{10}$

e.   (231) $_8$ =>   (10011001) $_2$

              ➔ (153)$_{10}$

(8^2 x2)+(8^1 x3) + (8^0 x1) = (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 x 16^2	0 x 16^1	0 x 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 x 13	16^2 x 10	16^1 x 12	16^0 x 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 x 2	12^3 x 8	12^2 x 4	12^1 x 11	12^0 x 10

➔SUM = $(56014)_{10}$

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

➔ $(56014)_{10} = (DACE)_{16}$

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

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

8	43
	5 -3

➔$(43)_{10} = (53)_8$

Cross verification

➔$(8^1$ x 5)+ $(8^0$ x 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 $=(118640)_{10}$

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 $=(832730)_{10}$

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. $(5610)_{10} => (1001100010)_2$

2	5610
2	285-0
2	152-1
2	76-0
2	38-0
2	19-0
2	9-1
2	4-1
2	2-0
2	1-0

b. $(5610)_{10} => (21200212)_3$

3	5610
3	1870
3	623-2
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. $(5610)_{10} => (32116)_{12}$

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. $(22110)_{10} => (101010011001110)_2$

2	22110
2	11055-0
2	5527-1
2	2713-1
2	1356-1
2	678-0
2	339-0
2	169-1
2	84-1
2	42-0
2	21-0
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. $(22110)_{10} => (53103)_8$

8	22110
8	2760-3
8	345-0
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
-----------
 1 0111 0001
```

e. 1100 0011 + 0101 1110

```
  1100 0011
+ 0101 1110
-----------
 1 0010 0001
```

9. Perform Binary Subtraction on the below numbers:

a. 8 – 3

$(8)_{10} = 1000$

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

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

b. 17 - 11

$17 = 10001$

$-11 = 1011$

$6 \quad 0110$ //

c. 25 – 7

$25 = 11001$

$-7 = 111$

$18 = 10010$ //

d. 86 - 31

$86 = 1010110$

$-31 = 11111$

$55 \quad 110111$ //

e. 1101 0001 - 0100 0111

1101 0001

0100 0111

1000 1010 //

10. Perform Binary Multiplication on the below numbers:

a. 12 x 3

$12 = 1100$

$\times 3 = 011$

36

1100
1100 x
0000 xx

100100 //

b. 20 x 5

20
$\times 5$
100

10100
101

10100
00000 x
10100 xx

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. $(125.125)_{10}$

. $(125.125)_{10}$ ➔ $(1111101.001)_2$ ➔ $(1122.0100)_3$ ➔ $(158.0767)_8$ ➔ $(7D.1F7C)_{16}$

$125 = (1111101)_2$

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

$125 = (11122)_3$

0.123x3	= 0.369	0
0.369x3	=1.107	1
0.107x3	=0.321	0
0.321x3	= 0.963	0

$125 = (175)_8$

0.123x8	= 0.984	0
0.984x8	=7.872	7
0.872x8	=6.976	6
0.976x8	= 7.808	7

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

0.123x16	= 1.968	1
0.968x16	=15.488	F
0.488x16	=7.808	7
0.808x16	= 12.928	C

c. $(10.16)_{10}$

. $(10.16)_{10}$ ➔ $(1010.0010)_2$ ➔ $(31.1000)_3$ ➔ $(12.2212)_8$ ➔ $(A.570A)_{16}$

$10 = (1010)_2$　　　　**$10 = (101.)_3$**　　　　**$10 = (12)_8$**

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

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

0.34x8	= 2.27	2
0.27x8	=2.16	2
0.16x8	=1.28	1
0.18x8	= 2.24	2

$10 = (A)_{16}$

0.34x16	= 5.44	5
0.44x16	=7.04	7
0.04x16	=0.64	0
0.64x16	= 10.24	10

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 = $(1023)_{10}$

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 ?

```
    5 4 A 7              (54A7)₁₆  =  (21671)₁₀
   +2 B F C              (2BFC)₁₆  = +(11260)₁₀
   ----------------                 ----------------
    (8 0 A 3)₁₆   =====➔            (32931)₁₀
```

17. Convert the hex number ABC7 to binary?

$(ABC7)_{16}$ => $(1111100101111)_2$

$(43975)_{10}$

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	1993-1
2	996-1
2	498-1
2	249-0
2	124-1
2	62-0
2	31-0
2	15-1
2	7-1
2	3-1
2	1-1

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

→ $2^0 \times 1 = 1$

→ 0+0+0.125+0.0625 = 1.1875

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

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

→ $2^0 \times 1 = 1$

→ 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