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

Decimal value	Binary value
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
10	1010

(2) Convert the below number from Decimal to binary.

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

Binary to decimal = 1 1 0 0

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

$8 + 4 + 0 + 0 = (12)_{10}$ Ans

2	12
2	6 – 0
2	3 – 0
	1 – 1

2. (b) $(20)_{10} = (10100)_2$

Binary to decimal

$= 1\ 0\ 1\ 0\ 0$

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

$16 + 0 + 4 + 0 + 0 = (20)_{10}$ Ans

2	20
2	10 – 0
2	5 – 0
2	2 – 1
	1 – 0

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

Binary to decimal

$= 1\ 0\ 1\ 1\ 0\ 1$

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

$32 + 0 + 8 + 4 + 0 + 1$

$= (45)_{10}$ Ans

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

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

Binary to decimal

$= 1\ 0\ 0\ 1\ 1\ 0\ 1$

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

$64 + 0 + 0 + 8 + 4 + 0 + 1 = (77)_{10}$ Ans

2	77
2	38 – 1
2	19 – 0
2	9 – 1
2	4 – 1
2	2 – 0
	1 – 0

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

Binary to decimal

$= 1\ 1\ 0\ 0\ 1\ 1\ 1$

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

$= 64 + 32 + 0 + 0 + 4 + 2 + 1$

$= (103)_{10}$ Ans

2	103
2	51 – 1
2	25 – 1
2	12 – 1
2	6 – 0
2	3 – 0
	1 – 1

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

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

$= (23266)_8$

4. Convert the below numbers from Binary to Decimal

a) $(1101)_2 = 1\ 1\ 0\ 1$
$2^3\times1\ \ 2^2\times1\ \ 2^1\times0\ \ 2^0\times1$
$8+4+0+1$
$= \underline{(13)_{10}}$

b) $(1110)_2 = 1\ 1\ 1\ 0$
$2^3\times1\ \ 2^2\times1\ \ 2^1\times1\ \ 2^0\times1$
$8+4+2+0 = \underline{(14)_{10}}$

c) $(1111\ 0101)_2 = 1\ 1\ 1\ 1\ 0\ 1\ 0\ 1$
$2^7\times1\ \ 2^6\times1\ \ 2^5\times1\ \ 2^4\times1\ \ 2^3\times0\ \ 2^2\times1\ \ 2^1\times0\ \ 2^0\times1$
$= 128+64+32+16+0+4+0+1$
$= \underline{(245)_{10}}$

d) $(01010101)_2 = 0\ 1\ 0\ 1\ 0\ 1\ 0\ 1$
$2^7\times0\ \ 2^6\times1\ \ 2^5\times0\ \ 2^4\times1\ \ 2^3\times0\ \ 2^2\times1\ \ 2^1\times0\ \ 2^0\times1$
$0+64+0+16+0+4+0+1$
$= \underline{(85)_{10}}$

e) $(10001111)_2 = 1\ 0\ 0\ 0\ 1\ 1\ 1\ 1$
$2^7\times1\ \ 2^6\times0\ \ 2^5\times0\ \ 2^4\times0\ \ 2^3\times1\ \ 2^2\times1\ \ 2^1\times1\ \ 2^0\times1$
$128+0+0+0+8+4+2+1$
$= (243)_{10}$

5. Convert the following numbers to base indicated and vice-versa (cross-verify)

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

$= 1\ 1\ 0\ 1$

$8^3\times1\ \ 8^2\times1\ \ 8^1\times0\ \ 8^0\times1$

$512+64+0+1$

$= 577$

Cross-verification

$(1101)_2$.

8	577
8	72–1
8	9–0
	1–1

b) $(1111.1111\ 1110)_2 \Rightarrow ( )_{10}$

$= 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 1\ 0$

$= 2^{11}\times1\ \ 2^{10}\times1\ \ 2^9\times1\ \ 2^8\times1\ \ 2^7\times1\ \ 2^6\times1\ \ 2^5\times1\ \ 2^4\times1\ \ 2^3\times1\ \ 2^2\times1\ \ 2^1\times1\ \ 2^0\times0$

$= 2048+1024+512+256+128+64+32+16+8+4+2+0$

$= (4094)_{10}$

c) Cross verification

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

2	4094
2	2047–0
2	1023–1
2	511–1
2	255–1
2	127–1
2	63–1
2	31–1
2	15–1
2	7–1
2	3–1
	1–1

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

$= 2 \quad 2 \quad 1 \quad 2 \quad 0 \quad 1$

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

$486 + 162 + 27 + 18 + 0 + 1 = (694)_{10}$.

Decimal to binary.

$(694)_{10} = (1010110110)_2$.

2	694
2	347 – 0
2	173 – 1
2	86 – 1
2	43 – 0
2	21 – 1
2	10 – 1
2	5 – 0
2	2 – 1
	1 – 0

Cross verification

Now, dividing decimal by 3.

3	694
3	231 – 1
3	77 – 0
3	25 – 2
3	8 – 1
	2 – 2

which is $(221201)_3$

d) $(76)_8 = (\ )_{10}$

$7 \quad 6$

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

$= 56 + 6 = (62)_{10}$

Cross verification

8	62
	7 – 6

$= (76)_8$

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

octal to decimal

2 3 1

$8^2\times2 \quad 8^1\times3 \quad 8^0\times1 = 128+24+1 = (153)_{10}$

Decimal to binary

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

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

cross verification.

$(10011001)_2$

$= 2^7\times1 + 2^4\times1 + 2^3\times1 + 2^0\times1 = 128+16+8+1$

$= \underline{(153)_{10}}$

(f) $(0XF00)_{16} \Rightarrow (\ )_8$

hexadecimal to decimal

F 0 0

$16^2\times15 \quad 16^1\times0 \quad 16^0\times0 = 256\times15 = (3840)_{10}$

Decimal to Octal

$(3840)_{10} \Rightarrow (7400)_8$

8	3840
8	480 – 0
8	60 – 0
	7 – 4

cross verification

7 4 0 0 $)_8$

$8^3\times7 \quad 8^2\times4 \quad 8^1\times0 \quad 8^0\times0 = 3584+256$

$= (3840)_{10}$

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

converting hexadecimal to decimal.

$= 16^3 \times D + 16^2 \times A + 16^1 \times C + 16^0 \times E$

$= 4096 \times 13 + 256 \times 10 + 16 \times 12 + 1 \times 14$

$= 53248 + 2560 + 192 + 14 = (56014)_{10}$

Decimal to base 12

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

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

Cross verification

2 8 4 11 10

$12^4 \times 2 \quad 12^3 \times 8 \quad 12^2 \times 4 \quad 12^1 \times 11 \quad 12^0 \times 10$

$= 41472 + 13824 + 576 + 132 + 10 = \underline{(56014)_{10}}$

b) $(0x2B)_{16} \Rightarrow (\ )_8$

Converting hexadecimal to decimal

2 11

$16^1 \times 2 \quad 16^0 \times 11 \quad = 32 + 11 = (43)_{10}$.

Decimal to octal.

$(43)_{10} \Rightarrow (53)_8$

8	43	
	5	-3

Cross verification.

5 3

$8^1 \times 5 \quad 8^0 \times 3 \quad = 40 + 3$

$= (43)_{10}$

6. Convert the following numbers the base 10.

a) $(3312)_8$

Converting into decimal

3 3 1 2

$8^3 \times 3 \quad 8^2 \times 3 \quad 8^1 \times 1 \quad 8^0 \times 2 = 512 \times 3 + 192 + 8 + 2$

$= 1536 + 202 = (1738)_{10}$

b) $(167)_8$

converting into decimal

1 6 7

$8^2 \times 1 \quad 8^1 \times 6 \quad 8^0 \times 7 = 64 + 48 + 7 = (119)_{10}$

c) $(202103)_9$ converting into decimal.

2 0 2 . 1 0 3

$9^5 \times 2 \quad 9^4 \times 0 \quad 9^3 \times 2 \quad 9^2 \times 1 \quad 9^1 \times 0 \quad 9^0 \times 3 = 118098 + 0 + 1458 + 81 + 0 + 3$

$= (119640)_{10}$

d) $(3132334)_{16}$

Converting into decimal

$= 3 \quad 1 \quad 3 \quad 2 \quad 3 \quad 3 \quad 4$

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

$= 16777216 \times 3 + 1048576 + 65536 \times 3 + 4096 \times 2 + 256 \times 3 + 48 + 4 = (51585844)_{10}$

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

converting into decimal

15 2

$16^1 \times 15 \quad 16^0 \times 2$

$= 240 + 2 = \underline{(242)_{10}}$

7. Convert the following base 10 numbers to the base indicated.

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

Dividing by base 2

2	5610
2	2805 – 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

$(5610)_{10} \Rightarrow (1010111010101010)_2$

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

Dividing by base 3

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

$= (21200210)_3$

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

Dividing by base 8

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

$= (12752)_8$

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

dividing by base 12.

$(32B6)_{12}$

12	5610
12	467 – 6
12	38 – 11
	3 – 2

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

dividing by base 16

$(15EA)_{16}$

16	5610
16	350 – 10
16	21 – 14
	1 – 5

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

Converting into binary

$= (101011001011110)_2$.

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
	1 – 0

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

dividing by 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
	1 – 0

$= (1010022220)_3$

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

converting into Octal

$= (53136)_8$

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

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

Dividing by 12.

$(10966)_{12}$.

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

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

Dividing by 16.

$(565E)_{16}$

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

⑧. Perform binary Addition on the below numbers:

a) $9 + 12 = 1001 + 1100$

$= 10101$

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

2	9
2	4-1
2	2-0
	1-0

b) $40 + 31 = 101000 + 11111$

$= 1000111$

2	31
2	15-1
2	7-1
2	3-1
	1-1

2	40
2	20-0
2	10-0
2	5-0
2	2-1
	1-0

c) $1110 + 0101$

$= 10011$

d) 1111 01.01 + 0111.1100

= 10100101.0001

e) 1100 0.011 + 0101 1110

= 10000 00001.

(9.) Perform binary subtraction on the below numbers -

a) 8 - 3 = 1000 - 0011 = 0101

b) 17 - 11 = 10001
- 1011
0110

c) 25 - 7 = 11001
- 00111
10010

d) 86 - 31 = 1 1 1 1 1
1 0 1 0 1 1 0
- 0 0 1 1 1 1 1
1 1 0 1 1 1

e) 1 1 1 1
1101 0001
- 0100 0111
1000 1000

10. Perform Binary multiplication on the below numbers.

a) 12 x 3 = 36 ⇒ 1100 x 11

⇒ 100100

```
  1100
 x 11
------
  1100
 1100
------
100100
```

b) 20 x 5 = 100 ⇒ 10100 x 101

= 1100100

```
  10100
 x 101
-------
  10100
 00000
10100
-------
1100100
```

c) 0111 x 0010

```
  0111
 x0010
------
  0000
 0111
0000
0000
--------
00011100
```

d) 0110 0111 x 101.

```
 0110 0111
      x101
-----------
 0110 0111
0000 0000
0110 0111
-----------
100000 0111
```

(e) 10101010 x 01101

```
  10101010
x 01101
--------
  10101010
 00000000
10101010
00000000
--------
1101010010
```

11. Perform binary Division on the below numbers:

a) 15/2

$\Rightarrow (15)_{10} \Rightarrow (1111)_2$ and $(2)_{10} \Rightarrow 10$

Now, 10)1111(111

```
 -10
 ---
  011
 -10
 ---
  011
 -10
 ---
  01
```

Quotient - 111

Remainder - 01

b) 45/5 $\Rightarrow (45)_{10} \Rightarrow (101101)_2$ and $(5)_{10} \Rightarrow (101)_2$.

Now, 101)101101(1001

```
 -101
 ----
  0001
    101
  ----
     X
```

Quotient - 1001

Remainder - 0

c) 121/14

$(121)_{10} \Rightarrow (1111001)_2$

$(14)_{10} \Rightarrow (1110)_2$

Now,

```
1110)1111001(1000
     1110
     ----
     0001001
```

Quotient - 1000

Remainder - 01001

d) 1101 0100/101

```
101)1101 0100(10101010
   101
   ---
   0011 0
    101
    ---
    0110
     101
     ---
     0010
```

Quotient - 01010100

Remainder - 10

e) 1010 1010/0111

```
      11000
0111)10101010(
   -111
   ----
   00111
    -111
    ----
    0000010
```

Quotient - 011000

Remainder - 10

Q. Convert the following floating numbers

a) $(34.34)_{10}$.

Here 34 is exponent and .34 is Mantissa

Converting exponent to Binary

$(34)_{10} = (100010)_2$.

Mantissa part

$0.34 \times 2 = 0.68\ (0)$

$0.68 \times 2 = 1.36\ (1)$

$0.36 \times 2 = 0.72\ (0)$

$0.72 \times 2 = 1.44\ (1)$

Therefore $(100010.0101)_2$.

b) $(125.125)_{10}$.

Exponent $(125)_{10} = (1111101)_2$

mantissa $(.125)_{10} =$

$= (.001)_2$

$.125 \times 2 = 0.250\ (0)$

$0.25 \times 2 = 0.5\ (0)$

$0.5 \times 2 = 1.0\ (1)$

Therefore $(1111101.001)_2$.

c) $(10.16)_{10}$

Exponent $(10)_{10} = (1010)_2$

Mantissa $(.16)_{10} = (0010)_2$

Therefore $(1010.0010)_2$

$0.16 \times 2 = .32\ (0)$

$.32 \times 2 = 0.64\ (0)$

$.64 \times 2 = 1.28\ (1)$

$.28 \times 2 = .56\ (0)$

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.

Ans. Largest positive number in n-bit's 2's complement is $2^{n-1}-1$.

in 12-bit 2's complement $= 2^{12-1}-1$.

$= 2^{11}-1 = 2048-1$

In decimal. $= 2047$

In Binary = 0111 1111 1111

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

Sol^n :- From the ASCII Table

character	ASCII value	Binary
C	67	0100 0011
O	79	0100 1111
D	68	0100 0100
E	69	0100 0101
/	47	1011 11
I	84	1010 100
H	72	1001 000
S	83	1010 011
	8	1000
sp	50	110010
2	48	110000
0	50	110010
2	50	110010
2		

Hence the string CODE/THS2022 is represented as 01000011010011111
01000100010001010011111010101100
01001000010100711000010000011007 0
00110000001100100011001 0.

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

Sol^{n} :- biggest binary number with 5 bits is $(11111)_2$.

$(2^5-1) = 32-1 = \underline{31}$

(6.) In hex, 2BFC+54A7??

2 B F C + 5 4 A 7

$16^3\times2$ $16^2\times11$ $16^1\times15$ $16^0\times12$ $16^3\times5$ $16^2\times4$ $16^1\times10$ $16^0\times7$

$4096\times2+256\times11+240+12$ $4096\times5+256\times4+160+7$

$11260 + 21671 = 32931$.

Converting in hexa

$(80A3)_{16}$.

16 | 32931
16 | 2058 - 3
16 | 128 - 10
8 - 0

17. Convert hex number ABC7 to binary?

Converting ABC7 into decimal.

A B C 7

$16^3\times10$ $16^2\times11$ $16^1\times12$ $16^0\times7$

$= 4096\times10+256\times11+16\times12+7 =$

$= 40960+2816+192+7 = 43975$

$(43975)_{10}$ into $(\ )_2$

$= (1010101111000111)_2$.

18. In hex, AC74 − B3F ?.

Converting into decimal.

A C 7 4 − B 3 F

$(16^3 \times 10 + 16^2 \times 12 + 16^1 \times 7 + 16^0 \times 4) - (16^2 \times 11 + 16^1 \times 3 + 16^0 \times 15)$

$(40960 + 3072 + 112 + 4) - (2816 + 48 + 15)$

$44148 - 2879 = (41269)_{10}$

$(41269)_{10} \Rightarrow$ ~~$(ABB5)_{16}$~~

$\Rightarrow (A135)_{16}$

16 | 41269
16 | 2579 – 5
16 | 161 – B
10 – A

19. Convert the following binary fractions to ordinary fractions.

a) 0.1001

$= \frac{0.5625}{10000} = \frac{9}{16}$.

$1 \times 2^{-1} = 0.5$
$0 \times 2^{-2} = 0$
$0 \times 2^{-3} = 0$
$1 \times 2^{-4} = 0.0625$

b) 1.0011.

Exponent : 1. Mantissa : 0011.

ordinary fraction is $\frac{1.750}{1000} = \frac{7}{4}$

$1 \times 2^{-3} = 0.125$
$1 \times 2^{-4} = 0.625$
total = 0.750

c) 1.1111.

Exponent : 1, Mantissa : 1111.

total = 0.9375

ordinary fraction = $\frac{16.9375}{10000} = \frac{27}{16}$

$1 \times 2^{-1} = 0.5$
$1 \times 2^{-2} = 0.25$
$1 \times 2^{-3} = 0.125$
$1 \times 2^{-4} = 0.625$

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

$0.647 \Rightarrow$ Binary Expression

$(0.647)_{10} \Rightarrow (0.1\ 0\ 1\ 0\ 1)_2$.

$0.647 \times 2 = 1.294$
$0.294 \times 2 = 0.588$
$0.588 \times 2 = 1.176$
$0.176 \times 2 = 0.352$

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

$0.2727 \Rightarrow$ Binary Expression

$= (0.0100)_2$.

$0.2727 \times 2 = 0.5454$
$0.5454 \times 2 = 1.0908$
$0.0908 \times 2 = 0.1816$
$0.1816 \times 2 = 0.3632$