

Week - 1

Date : 10-3-2023

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course : Cohort DA A23

Assignment - 1

Number system

- Q1 Write a binary value table for 0 to 10 decimal value

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

$$\begin{array}{r} 2 \mid 2 \\ 1-0 \end{array} \quad \begin{array}{r} 2 \mid 3 \\ 1-1 \end{array} \quad \begin{array}{r} 2 \mid 4 \\ 2 \mid 2-0 \\ 1-0 \end{array} \quad \begin{array}{r} 2 \mid 5 \\ 2 \mid 2-1 \\ 1-0 \end{array} \quad \begin{array}{r} 2 \mid 6 \\ 3-0 \\ 1-1 \end{array} \quad \begin{array}{r} 2 \mid 7 \\ 3-1 \\ 1-1 \end{array} \quad \begin{array}{r} 2 \mid 8 \\ 4-0 \\ 2-0 \\ 1-0 \end{array} \quad \begin{array}{r} 2 \mid 9 \\ 4-1 \\ 2-0 \\ 1-0 \end{array}$$

- Q2. Convert the below numbers from Decimal to binary

a. $(12)_{10} \rightarrow (1100)_2$

$$\begin{array}{r} 2 \mid 12 \\ 6-0 \\ 3-0 \\ 1-1 \end{array} \quad 1100$$

b. $(20)_{10} \rightarrow (10100)_2$

$$\begin{array}{r} 2 \mid 20 \\ 10-0 \\ 5-0 \\ 2-1 \\ 1-0 \end{array} \quad 10100$$

c. $(45)_{10} \rightarrow (101101)_2$

$$\begin{array}{r} 2 \mid 45 \\ 22-1 \\ 11-0 \\ 5-1 \\ 2-1 \\ 1-0 \end{array} \quad 101101$$

①

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

$$\begin{array}{r} 2 | 77 \\ 2 | 38 - 1 \\ 2 | 19 - 0 \\ 2 | 9 - 1 \\ 2 | 4 - 1 \\ 2 | 2 - 0 \\ 2 | 1 - 0 \end{array}$$

↑
 1001101

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

$$\begin{array}{r} 2 | 103 \\ 2 | 51 - 1 \\ 2 | 25 - 1 \\ 2 | 12 - 1 \\ 2 | 6 - 0 \\ 2 | 3 - 0 \\ 2 | 1 - 1 \end{array}$$

1100111

3. What is the octal equivalent of $(99)_{10}$?

$$(99)_{10} \xrightarrow{\div 8} (123266)_8$$

$$\begin{array}{r} 8 | 9910 \\ 8 | 1238 - 6 \\ 8 | 154 - 6 \\ 8 | 19 - 2 \\ 8 | 2 - 3 \end{array}$$

$8^4 \quad 8^3 \quad 8^2 \quad 8^1 \quad 8^0$

2	3	2	6	6
---	---	---	---	---

 4096 512 4 8 1

4. Convert the below numbers from Binary to Decimal

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

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

(2)

$$(1 \times 8) + (1 \times 4) + (0 \times 2) + (1 \times 1)$$

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

$$\begin{array}{r} 2 | 13 \\ 2 | 6 - 1 \\ 2 | 3 - 0 \\ 2 | 1 - 1 \end{array}$$

4b) $(1110)_2 \rightarrow (14)_{10}$

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

$8 \quad 4 \quad 2 \quad 1$

$$(1 \times 8) + (1 \times 4) + (1 \times 2) = 14$$

2	14
2	7 - 0
2	3 - 1
2	1 - 1

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

1	1	1	1	0	1	0	1
128	64	32	16	8	4	2	1

$$(1 \times 128) + (1 \times 64) + (1 \times 32) + (1 \times 16) + (1 \times 4) + (1 \times 1) = 245$$

2	245
2	122 - 1
2	61 - 0
2	30 - 1
2	15 - 0
2	7 - 1
2	3 - 1
2	1 - 1

d) $(0101\ 0101) \rightarrow (85)_{10}$

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

$128 \quad 64 \quad 32 \quad 16 \quad 8 \quad 4 \quad 2 \quad 1$

$$(1 \times 64) + (1 \times 16) + (1 \times 4) + (1 \times 1) = 85$$

2	85
2	42 - 1
2	21 - 0
2	10 - 1
2	5 - 0
2	2 - 1
2	1 - 0

e) $(1000\ 1111)_2 \rightarrow (143)_{10}$

1	0	0	0	1	1	1	1
128	64	32	16	8	4	2	1

$$(1 \times 128) + (1 \times 8) + (1 \times 4) + (1 \times 2) + (1 \times 1) = 143$$

2	143
2	71 - 1
2	35 - 1
2	17 - 1
2	8 - 1
2	4 - 0
2	2 - 0
2	1 - 0

$$5a) (1101)_2 \rightarrow (15)_8$$

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

8 4 2 1

$$(1 \times 8) + (1 \times 4) + (1 \times 1) = 13$$

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

1	1	1	1	1	1	1	1	1	1	1	0
2048	1024	512	256	128	64	32	16	8	4	2	1

$(1 \times 2048) + (1 \times 1024) + (1 \times 512) + (1 \times 256) +$
 $(1 \times 128) + (1 \times 64) + (1 \times 32) + (1 \times 16) +$
 $(1 \times 8) + (1 \times 4) + (1 \times 2) = 4094$.

Mukebunu
check

1	1	5
---	---	---

8 1
8+5 = 13

2	1	3
---	---	---

2 6-1
2 3-0
1-1

$$c) (221201)_3 \rightarrow (694)_{10}$$

3^5	3^4	3^3	3^2	3^1	3^0
2	2	1	2	0	1

243 81 27 9 3 1

$$(2 \times 243) + (2 \times 81) + (1 \times 27) + (2 \times 9) + (0 \times 3) + (1 \times 1)$$

$$486 + 162 + 27 + 18 + 1 = 694$$

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	1-1

$$\begin{array}{r} 12 \\ 486 \\ 162 \\ \hline 27 \\ 19 \end{array}$$

$$\begin{array}{r} 694 \\ . \end{array}$$

$$(76)_8 \rightarrow (62)_{10}$$

8 ¹	8 ⁰
7	6
8	1

$$(7 \times 8) + (6 \times 1) = 56 + 6 = 62$$

5e

$$(231)_8 \rightarrow (111001)_2$$

8 ²	8 ¹	8 ⁰
2	3	1
64	8	1

$$(2 \times 64) + (3 \times 8) + (1 \times 1) = 53$$

$$128 + 24 + 1$$

check

1	0	0	1	1	0	0	1
128	64	32	16	8	4	2	1

= 53

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

$$111001$$

$$8 \overline{)157} \\ \underline{-17} \\ 8$$

$$8 \overline{)153} \\ \underline{-16} \\ 8 \overline{)19} \\ \underline{-16} \\ 3$$

5f.

$$(0 \times F00)_{16} - (-7400)_8$$

16 ⁴	16 ³	16 ²	16 ¹	16 ⁰
0	x	F	0	0

65536 4096 256 16 1
15

$$15 \times 256 = 3840$$

$$\frac{2}{256}$$

$$\begin{array}{r} X15 \\ \hline 1280 \\ 256 - \\ \hline \end{array}$$

$$\begin{array}{r} 8 \overline{)3840} \\ \underline{-240} \\ 8 \overline{)480} \\ \underline{-480} \\ 8 \overline{)60} \\ \underline{-60} \\ 7 - 4 \end{array}$$

check

5	2
7	4
0	0
512	64
16	1

$\frac{3584}{256} = 13840$

$\frac{3840}{256} = 15 - 0$

(5)

A B C D E F

10 11 12 13 14 15

59. $(0 \times DACE)_{16} \rightarrow (56014)_{10}$

$(284BA)_{12} \rightarrow$

16^3	16^2	16^1	16^0
D 13	A 10	C 12	E 14
96	256	16	1

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

$$53248 + 2560 + 192 + 14 = 56014$$

12	56014
12	466 - 10
12	388 - 11
12	32 - 4
12	2 - 8

check

2	8	4	B	A
---	---	---	---	---

$$\begin{array}{r} 20736 \quad 1728 \quad 144 \quad 12 \quad 1 \\ \downarrow \quad \downarrow \quad \downarrow \quad 576 \quad 132 \quad 10 \\ 41472 \quad 13824 \end{array}$$

5h $(0 \times 2B)_{16} \rightarrow (53)_8$

$(0 \boxed{2 \mid B}_{11}) \rightarrow (43)_{10}$

16^3 1

$$(2 \times 16) + (11 \times 1)$$

$$32 + 11 = 43$$

8	43
	5 - 3

check

5	3
8	1

$$\begin{array}{r} 5 \times 8 + 3 \times 1 \\ 40 + 3 = 43 \end{array}$$

16	43
	2 - 11

⑥

6

$$\begin{array}{r} 2 - 11 \\ \hline 16 \\ 43 \end{array}$$

$$40 + 3 = 43$$

$$5 \times 8 + 3 \times 1$$

8	1
5	3

check

$$\begin{array}{r} 5 - 3 \\ \hline 8 \\ 43 \end{array}$$

$$32 + 11 = 43$$

$$(2 \times 16) + (11 \times 1)$$

$$\begin{array}{r} 1 \\ \hline 16 \\ 2 | B_{11} \end{array}$$

$$(43)^{10} \leftarrow (53)^8$$

5h

$$\begin{array}{r} 41472 \ 13824 \\ \uparrow \quad \uparrow \\ 20736 \ 1728 \ 144 \ 12 \ 1 \\ \hline 2 \ 8 \ 4 \ B \ A \end{array}$$

check

$$\begin{array}{r} 2 - 8 \\ \hline 12 \\ 32 - 4 \\ \hline 38 - 8 \\ \hline 11 - 10 \\ \hline 56014 \end{array}$$

$$(13 \times 4096) + (10 \times 256) + (12 \times 16) + (14 \times 1) = 56014$$

$$\begin{array}{r} 4096 \ 256 \ 16 \ 1 \\ \hline 13 \ A \ C \ E \end{array}$$

$$(284BA)^{10} \leftarrow (56014)^{16}$$

A-B-C-D-E-F

5g

6. Convert the following to base 10

a) $(3312)_8 \rightarrow (1738)_{10}$

8^3	8^2	8^1	8^0
3	3	1	2
512	64	8	1

8	1738
8	217 - 2
8	27 - 1
8	3 - 3

$$(3 \times 512) + (3 \times 64) + (1 \times 8) + (2 \times 1)$$

$$1536 + 192 + 8 + 2 = 1738$$

b) $(167)_8 \rightarrow (119)_{10}$

8^2	8^1	8^0
1	6	7
64	8	1

8	119
8	14 - 7
8	1 - 6

$$(1 \times 64) + (6 \times 8) + (7 \times 1)$$

$$64 + 48 + 7 = 119$$

c) $(202103)_9 \rightarrow (119640)_{10}$

9^5	9^4	9^3	9^2	9^1	9^0
2	0	2	1	0	3
59049	6861	729	81	9	1

9	119640
9	13293 - 3
9	1477 - 0
9	164 - 1
9	18 - 2
	2 - 0

$$(2 \times 59049) + (2 \times 729) + (1 \times 81) + (3 \times 1) = 119640$$

d) $(3132334)_{16} \rightarrow ()_{10}$

16^6	16^5	16^4	16^3	16^2	16^1	16^0
3	1	3	2	3	3	4

$$16777216048576655364096256161$$

$$(3 \times 16^6) + (1 \times 16^5) + (3 \times 16^4) + (2 \times 16^3) + (3 \times 16^2) + (3 \times 16^1) + (4 \times 1) \\ = 1266484$$

16	1266484
16	78155 - 4
16	4947 - 3
16	309 - 3
16	19 - 5

d. $(3132334)_{16} \rightarrow (51585844)_{10}$

16^6	16^5	16^4	16^3	16^2	16^1	16^0
3	1	3	2	3	3	4
1	1			4096	256	16
1048576	65536					1

16777216

$$(3 \times 16^6) + (1 \times 16^5) + (3 \times 16^4) + (2 \times 16^3) + \\ (3 \times 16^2) + (3 \times 16^1) + (4 \times 16^0) = (51585844)_{10}$$

16	51585844
16	3224 18 - 4
16	201507 - 3
16	12594 - 3
16	787 - 2
16	49 - 3
	3 - 1

e $(0 \times F2)_{16}$

16^1	16^0
F	2

$$(15 \times 16) + (2 \times 1) = 242$$

16	242
8	15 - 2
	F

Q7

Convert the following

a) $(5610)_{10} \Rightarrow (101011101010)_2$

$$\begin{array}{r} 5610 \\ 2805 - 0 \\ \hline 1402 - 1 \\ \hline 701 - 0 \\ \hline 350 - 1 \\ \hline 175 - 0 \\ \hline 87 - 1 \\ \hline 43 - 1 \\ \hline 21 - 1 \\ \hline 10 - 1 \\ \hline 5 - 0 \\ \hline 2 - 1 \\ \hline 1 - 0 \end{array}$$

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

$$\begin{array}{r} 5610 \\ 701 - 2 \\ \hline 87 - 5 \\ \hline 10 - 7 \\ \hline 1 - 2 \end{array}$$

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

$$\begin{array}{r} 5610 \\ 350 - 10 \\ \hline 21 - 14 \\ \hline 1 - 5 \end{array}$$

convert the following

$$7b. (56)_{10} \Rightarrow (21200210)_3$$

check

2	1	2	0	0	2	1	0
2187	729	243	81	27	9	3	1

$$= 56_{10}$$

$$\begin{array}{r} 5610 \\ 1870 - 0 \\ \hline 6231 \\ 207 - 2 \\ \hline 69 - 0 \\ 23 - 0 \\ \hline 7 - 2 \\ \hline 2 - 1 \end{array}$$

$$7d. (56)_{10} \Rightarrow (32B6)_{12}$$

3	2	B	6
1728	144	12	1

$$\begin{array}{r} 56_{10} \\ 467 - 6 \\ \hline 38 - 11 \\ \hline 3 - 2 \end{array}$$

$$7e. (56)_{10} \Rightarrow (15EA)_{16}$$

1	5	E	A
4096	256	16	1

$$\begin{array}{r} 5610 \\ 350 - 10 \\ \hline 21 - 14 \\ \hline 1 - 5 \end{array}$$

$$7f. (22110)_{10} \Rightarrow \text{(follow)} \rightarrow (1010110001011110)_2$$

1	0	1	0	1	1	0	0	1	0	1	1	1	0
16384	4096	1024	512	256	128	64	32	16	8	4	2		

$$\begin{array}{r} 22110 \\ 11055 - 0 \\ \hline 5527 - 1 \\ 2763 - 1 \\ \hline 1381 - 1 \\ \hline 690 - 1 \\ 345 - 0 \\ \hline 172 - 1 \\ \hline 86 - 0 \end{array}$$

$$g \quad (22110)_{10} = (101002222)_3$$

$$\begin{array}{r} 22110 \\ \hline 3 \\ 7370 \\ \hline 2456-2 \\ \hline 8 \downarrow 8-2 \\ \hline 272-2 \\ \hline 90-2 \\ \hline 30-0 \\ \hline 10-0 \\ \hline 3-1 \\ \hline 1-0 \end{array}$$

$$h \quad (22110)_{10} = (53136)_8$$

$$\begin{array}{r} 226110 \\ \hline 8 \\ 2763-6 \\ \hline 345-3 \\ \hline 43-1 \\ \hline 5-3 \end{array}$$

$$i \quad (22110)_{10} = (10966)_{12}$$

$$\begin{array}{r} 22110 \\ \hline 12 \\ 1892-6 \\ \hline 153-6 \\ \hline 12-9 \\ \hline 1-0 \end{array}$$

$$j \quad (22110)_{10} = (5654)_{16}$$

$$\begin{array}{r} 22110 \\ \hline 16 \\ 1381-4 \\ \hline 86-5 \\ \hline 5-6 \end{array}$$

Perform Binary Addition

$$a. \quad 9 + 12 \quad 9 \rightarrow \begin{array}{r} 1 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 \\ \hline 1 & 0 & 1 & 0 & 1 \end{array} \quad \begin{array}{r} 12 \\ 6-0 \\ 3-0 \\ 1-1 \end{array} \quad \begin{array}{r} 2 \\ 2 \\ 2 \\ 1 \end{array} \quad \begin{array}{r} 9 \\ 4-1 \\ 2-0 \\ 1-0 \end{array}$$

b. $40 + 31$

$$\begin{array}{r}
 40 \\
 31 \\
 \hline
 71
 \end{array}
 \quad
 \begin{array}{r}
 \rightarrow \\
 \rightarrow
 \end{array}
 \quad
 \begin{array}{r}
 1\ 0\ 1\ 0\ 0\ 0 \\
 0\ 1\ 1\ 1\ 1 \\
 \hline
 1\ 0\ 0\ 0\ 1\ 1\ 1 \\
 \hline
 6\ 4\ 3\ 2\ 1\ 6\ 8\ 4\ 2\ 1
 \end{array}$$

$$\begin{array}{r}
 & 8 & 4 & 2 & 1 \\
 & | & | & | & | \\
 1 & 1 & 1 & 0 & \rightarrow 14 \\
 + & 0 & 1 & 0 & 1 \rightarrow 5 \\
 \hline
 1 & 0 & 0 & 1 & 1 & \hline
 & 16 & 2 & 1 & 19
 \end{array}$$

$$d. \quad 11110101 + 01111100$$

128	64	32	16	8	4	2	1	
1	1	1	1	0	1	0	1	$\Rightarrow 245$

$\frac{160}{80}$

$\frac{5}{45}$

0	1	1	1	1	0	0	1	124	
1	0	1	1	0	0	0	1	369	
256	128	64	32	16	8	4	2	1	

$$\begin{array}{r}
 \text{e. } 11000011 + 01011110 \\
 \begin{array}{r}
 \begin{array}{ccccccc}
 128 & 64 & 32 & 16 & 8 & 4 & 2 & 1 \\
 | & | & | & | & | & | & | & | \\
 1 & 1 & 0 & 0 & 0 & 1 & 1 & \rightarrow & 195
 \end{array} \\
 \begin{array}{r}
 01011110 \rightarrow 94 \\
 \hline
 100100001 \\
 \hline
 289
 \end{array}
 \end{array}
 \end{array}$$

9. Binary subtraction,

a) $8 - 3$

$$8 \rightarrow \begin{smallmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 \end{smallmatrix}$$

$$- 3 \rightarrow \begin{smallmatrix} - & & 1 & + \\ \hline 5 & & 0 & 1 \end{smallmatrix}$$

$$\begin{array}{r} 0 \\ 1 \\ 0 \\ 1 \\ \hline 4 & 2 & 1 \end{array}$$

$$\begin{array}{r} 3 \\ 2 \\ 2 \\ 2 \\ \hline 8 & 4 & 2 & 1 \end{array}$$

$$\begin{array}{r} 2 \\ 2 \\ 2 \\ 2 \\ \hline 4 & 2 & 1 & 0 \end{array}$$

$$\begin{array}{r} 2 \\ 2 \\ 2 \\ 2 \\ \hline 1 & 0 \end{array}$$

b) $17 - 11$

$$17 \rightarrow \begin{smallmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 \end{smallmatrix}$$

$$11 \rightarrow \begin{smallmatrix} - & 1 & 0 & 1 \\ \hline 6 & 0 & 1 & 0 \end{smallmatrix}$$

$$\begin{array}{r} 0 \\ 1 \\ 1 \\ 0 \\ \hline 4 & 2 \end{array}$$

$$\begin{array}{r} 1 \\ 1 \\ 2 \\ 2 \\ 2 \\ 2 \\ \hline 17 & 8 & 4 & 2 & 1 \end{array}$$

$$\begin{array}{r} 1 \\ 0 \\ 2 \\ 2 \\ 2 \\ 2 \\ \hline 1 & 0 \end{array}$$

c) $25 - 7$

$$25 \rightarrow \begin{smallmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 \end{smallmatrix}$$

$$7 \rightarrow \begin{smallmatrix} - & 0 & 0 & 1 \\ \hline 18 & 1 & 0 & 0 \end{smallmatrix}$$

$$\begin{array}{r} 1 \\ 0 \\ 0 \\ 1 \\ 0 \\ \hline 16 & 8 & 4 & 2 & 1 \end{array}$$

$$\begin{array}{r} 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ \hline 25 & 12 & 6 & 3 & 1 & 1 \end{array}$$

$$\begin{array}{r} 1 \\ 1 \\ 2 \\ 2 \\ 2 \\ 2 \\ \hline 1 & 1 \end{array}$$

d) $86 - 31$

$$86 \rightarrow \begin{smallmatrix} 1 & 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 & 0 \end{smallmatrix}$$

$$\frac{31}{55} \rightarrow \begin{smallmatrix} - & 0 & 0 & 1 & 1 & 1 & 0 \\ \hline 1 & 1 & 0 & 1 & 1 & 1 \end{smallmatrix}$$

$$\begin{array}{r} 32 \\ 23 \\ 2 \\ 1 \\ \hline 32 & 16 & 8 & 4 & 2 & 1 \end{array}$$

$$\begin{array}{r} 31 \\ 15-1 \\ 7-1 \\ 3-1 \\ 1-1 \\ \hline 86 & 43 & 21 & 10 & 5 & 2 & 1 & 0 \end{array}$$

$$\begin{array}{r} 2 \\ 2 \\ 2 \\ 2 \\ 2 \\ \hline 1 & 1 \end{array}$$

e) $1101\ 0001 - 0100\ 0111$

$$209 \leftarrow \begin{smallmatrix} 1 & 1 & 0 & 1 & 0 & 0 & 1 \\ 128 & 64 & 32 & 16 & 8 & 4 & 2 \end{smallmatrix} \rightarrow$$

$$- 71 \leftarrow \begin{smallmatrix} 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 64 & 32 & 16 & 8 & 4 & 2 \end{smallmatrix}$$

$$\begin{array}{r} 138 \\ 1000\ 1010 \\ \hline \end{array}$$

$$\begin{array}{r} 128 \\ 64 \\ 32 \\ 16 \\ 8 \\ 2 \\ \hline 138 \end{array}$$

(3)

Perform Binary Multiplication

$$12 \times 3 = 36$$

$$\begin{array}{r}
 & 1 & 1 & 0 & 0 \\
 & \times & 1 & 1 & \\
 \hline
 & 1 & 1 & 0 & 0 \\
 & 1 & 1 & 0 & 0 \\
 \hline
 & 1 & 0 & 0 & 1 & 0 & 0 \\
 \hline
 & 3 & 2 & 16 & 8 & 4 & 2 & 1
 \end{array}$$

$$\begin{array}{r}
 2 \mid 3 & 2 \mid 12 \\
 1-1 \quad 2 \mid 6-0 \\
 2 \mid 3-0 \\
 1-1
 \end{array}$$

b) $20 \times 5 = 100$

$$\begin{array}{r}
 & 1 & 0 & 1 & 0 & 0 \\
 & \times & 1 & 0 & 1 \\
 \hline
 & 1 & 0 & 1 & 0 & 0 \\
 & 0 & 0 & 0 & 0 & - \\
 & 1 & 0 & 1 & 0 & 0 \\
 \hline
 & 1 & 1 & 0 & 0 & 1 & 0 & 0 \\
 \hline
 & 6 & 4 & 3 & 2 & 16 & 8 & 4 & 2 & 1
 \end{array}$$

$$\begin{array}{r}
 2 \mid 5 & 2 \mid 20 \\
 2 \mid 2-1 & 2 \mid 10-0 \\
 2 \mid 1-0 & 2 \mid 5-0 \\
 2 \mid 2-1 & 2 \mid 1-0
 \end{array}$$

c) 0111×0010

$$4 \cdot 2^1 \quad 8 \cdot 4 \cdot 2^1$$

$$\begin{array}{r}
 & 0 & 1 & 1 & 1 & \rightarrow 7 \\
 & \times & 0 & 0 & 1 & 0 & \rightarrow \frac{2}{14} \\
 \hline
 & 0 & 0 & 0 & 0 & 0 \\
 & 0 & 1 & 1 & 1 & 0 \\
 & 0 & 0 & 0 & 0 & 0 \\
 & 0 & 0 & 0 & 0 & 0 \\
 \hline
 & 0 & 0 & 0 & 1 & 1 & 0 \\
 \hline
 & 8 & 4 & 2 & 1
 \end{array}$$

(14)

d. $0110\ 0111 \times 101$

5
4
5

$$0110\ 0111 \rightarrow 103$$

$$\begin{array}{r}
 \begin{array}{c} 64 32 16 & 8 4 & 2 & 1 \\ \hline 0110 & 0111 & & \end{array} \\
 \begin{array}{r} \times 101 \\ \hline 1000000000 \\ 0110011100 \\ \hline 1000000011 \\ \hline 515 \end{array}
 \end{array}$$

$$\begin{array}{r}
 \begin{array}{c} 103 \\ \hline 512 \\ 2 \\ 1 \\ \hline 515 \end{array}
 \end{array}$$

e. $1010\ 1010 \times 0101$

$$\begin{array}{r}
 \begin{array}{c} 128 64 32 16 & 8 4 & 2 & 1 \\ \hline 1010 & 1010 & & \end{array} \\
 \begin{array}{r} \times 0101 \\ \hline 1101010010 \\ \hline 850 \end{array}
 \end{array}$$

$$\begin{array}{r}
 \begin{array}{c} 128 \\ 42 \\ \hline 170 \end{array}
 \end{array}$$

II Binary division

a) $15 / 2$

$$\begin{array}{r}
 \begin{array}{c} 15 \\ 2) 1111 (7 \\ -10 \downarrow \\ \hline 011 \\ 10 \downarrow \\ \hline 11 \\ 10 \\ \hline 1 \end{array}
 \end{array}$$

$$\begin{array}{l}
 10 < 11 \\
 10 < 11
 \end{array}$$

$$\begin{array}{r}
 \begin{array}{c} 15 \\ 2) 9-1 \\ 2) 3-1 \\ 2) 1-1 \end{array}
 \end{array}$$

(15)

5

45/5

$$\frac{45}{5} = 9$$

101) $\begin{array}{r} 101101 \\ -101 \\ \hline 01 \end{array}$ (1001)

8421

\downarrow

$\begin{array}{r} 0 \\ 10 \\ 0 \\ \hline 101 \\ 101 \\ \hline 0 \end{array}$

101 < 101

2	45
2	$\overline{22-1}$
2	$\overline{11-0}$
2	$\overline{5-1}$
2	$\overline{2-1}$
2	$\overline{1-0}$

101 > 1

$$1001 = 8 + 1 = 9$$

c) $\frac{121}{14}$

14) $121(8)$

1	4
1	$\overline{42}$
$\underline{9}$	

1110) $\begin{array}{r} 121 \\ \overline{111} \\ 001 \end{array}$ (1000

4

\downarrow

$\begin{array}{r} 000 \\ 10 \\ 0 \\ \hline 100 \\ 0 \\ \hline 100 \\ 0 \end{array}$

1110 < 1111

2	14
2	$\overline{7-0}$
2	$\overline{3-1}$
2	$\overline{1-1}$
2	$\overline{60-1}$
2	$\overline{30-0}$
2	$\overline{15-0}$
2	$\overline{7-1}$
2	$\overline{3-1}$
2	$\overline{1-1}$

$$1001 \rightarrow 9$$

d)

$10 \rightarrow 2$
 $101 \rightarrow 5$
 $101010 \rightarrow 42$
 $11010100 \rightarrow 212$

101) $\begin{array}{r} 11010100 \\ -101 \\ \hline 0011 \\ -0 \\ \hline 110 \\ 101 \\ \hline 0011 \end{array}$ (101010

$32/68421$

$$11010100$$

$$1286432168421$$

$$\begin{array}{r} 1 \\ 128 \\ 64 \\ 20 \\ \hline 212 \end{array}$$

5) $212(42)$

-20	\downarrow
12	
-10	
$\underline{2}$	

$\begin{array}{r} 0 \\ 101 \\ 10x \\ \hline 10 \\ 0 \end{array}$

$10 \rightarrow 2$

(16)

11e)

$$10 \rightarrow 2 \\ 0111 \rightarrow 7$$

$$11000 \rightarrow 24$$

$$10101010 \rightarrow 170$$

$$\begin{array}{r} 170 \\ 0111) 10101010 \\ \hline 01xx \downarrow \\ 0111 \\ 111 \downarrow \\ \hline 00 \\ 0 \downarrow \\ 10 \\ 0 \\ \hline 10 \rightarrow 2 \end{array} \quad \begin{array}{r} 24 \\ (11000) \\ \hline \end{array}$$

$$\begin{array}{r} 6 \\ 10101010 \\ 128 \\ 32 \\ \hline 16 \end{array}$$

$$128 \\ 32 \\ \hline 16 \end{math>$$

$$\begin{array}{r} 7) 170(24 \\ -14 \downarrow \\ \hline 30 \\ -28 \\ \hline 2 \end{array}$$

b. Convert the following floating numbers to binary

$$a. (34.34)_{10} \Rightarrow (?)_2$$

$$\text{Exp } 34 = 10001$$

$$\text{mantissa } 0.34 \times 2 = 0.68 \rightarrow 0$$

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

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

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

$$\begin{array}{r} 34 \\ 2 | 17-0 \\ 2 | 8-1 \\ 2 | 4-0 \\ 2 | 2-0 \\ 2 | 1-0 \end{array}$$

$$(34.34)_{10} = (100010.0101)_2$$

$$b) (125.125)_{10} = (?)_2$$

$$\text{Exp } 125 \rightarrow 111101$$

$$0.125 \times 2 = 0.250 \rightarrow 0$$

$$0.250 \times 2 = 0.500 \rightarrow 0$$

$$0.5 \times 2 = 1.0 \rightarrow 1$$

$$(125.125)_{10} = (111101.001)_{17}$$

$$\begin{array}{r} 125 \\ 2 | 62-1 \\ 2 | 31-0 \\ 2 | 15-1 \\ 2 | 7-1 \\ 2 | 3-1 \\ 2 | 1-1 \end{array}$$

(1)

12) a) Convert the floating numbers to binary

a) $(0.16)_10$

$$\text{Exp} | 0 \rightarrow 101^0$$

$$\text{Mantissa } 0.16 \times 2 = \underline{0.32} \rightarrow 0$$

$$0.32 \times 2 = \underline{0.64} \rightarrow 0$$

$$0.64 \times 2 = \underline{1.28} \rightarrow 1$$

$$0.28 \times 2 = \underline{0.56} \rightarrow 0$$

$$\begin{array}{r} 10 \\ 2 \Big| \\ 5-0 \\ 2 \Big| \\ 2-1 \\ 2 \Big| \\ 1-0 \end{array}$$

$$(0.16)_10 = (1010.0010)_2$$

12 convert the floating numbers to base 3

a) $(34.34)_10 \Rightarrow (1021.1000)_3$

$$0.34 \times 3 = \underline{1.02} \rightarrow 1$$

$$0.02 \times 3 = \underline{0.06} \rightarrow 0$$

$$1.06 \times 3 = 0.18 \rightarrow 0$$

$$0.18 \times 3 = 0.54 \rightarrow 0$$

$$\begin{array}{r} 34 \\ 3 \Big| \\ 11-1 \\ 3 \Big| \\ 3-2 \\ 3 \Big| \\ 1-0 \end{array}$$

b) $(125.125)_10 \Rightarrow (11122.0101)_3$

$$1.25 \times 3 = 0.375 \rightarrow 0$$

$$0.375 \times 3 = \underline{1.125} \rightarrow 1$$

$$1.125 \times 3 = 0.375 \rightarrow 0$$

$$0.375 \times 3 = \underline{1.125} \rightarrow 1$$

$$\begin{array}{r} 125 \\ 3 \Big| \\ 41-2 \\ 3 \Big| \\ 13-2 \\ 3 \Big| \\ 4-1 \\ 3 \Big| \\ 1-1 \end{array}$$

c) $(10.16)_10 \Rightarrow (101.0110)_3$

$$1.6 \times 3 = 0.48 \rightarrow 0$$

$$0.48 \times 3 = \underline{1.44} \rightarrow 1$$

$$1.44 \times 3 = \underline{1.32} \rightarrow 1$$

$$1.32 \times 3 = 0.96 \rightarrow 0$$

$$\begin{array}{r} 10 \\ 3 \Big| \\ 3-1 \\ 3 \Big| \\ 1-0 \end{array}$$

12 Convert floating numbers to Octal (8)

a) $(34.34)_{10} \Rightarrow (42.2560)_8$

$$\begin{aligned} \cdot 34 \times 8 &= 2.72 \rightarrow 2 \\ \cdot 72 \times 8 &= 5.76 \rightarrow 5 \\ \cdot 76 \times 8 &= 6.08 \rightarrow 6 \\ \cdot 08 \times 8 &= 0.64 \rightarrow 0 \end{aligned}$$

$$8 \left| \begin{array}{r} 34 \\ -4-2 \\ \hline \end{array} \right.$$

$$(2 \times \frac{1}{8}) + (5 \times \frac{1}{64}) +$$

$$\frac{6 \times \frac{1}{128}}{512} = 0.339 \approx 0.34$$

b) $(125.125)_{10} \Rightarrow (175.1)_8$

$$8 \left| \begin{array}{r} 125 \\ -15-5 \\ \hline 1-7 \end{array} \right.$$

$$\cdot 125 \times 8 = 1.$$

$$1 \times \frac{1}{8} = 0.125$$

c) $(10.16)_{10} \Rightarrow (12.1217)_8$

$$8 \left| \begin{array}{r} 10 \\ -1-2 \\ \hline \end{array} \right.$$

$$\cdot 16 \times 8 = 1.28 \rightarrow 1$$

$$(1 \times \frac{1}{8}) + (2 \times \frac{1}{8^2}) + (1 \times \frac{1}{8^3})$$

$$\cdot 28 \times 8 = 2.24 \rightarrow 2$$

$$+ (7 \times \frac{1}{8^4})$$

$$\cdot 24 \times 8 = 1.92 \rightarrow 1$$

$$= \frac{655}{4096}$$

$$\cdot 92 \times 8 = 7.36 \rightarrow 7$$

$$= 0.16$$

12 Convert floating numbers to Hexadecimal (16)

a) $(34.34)_{10} \Rightarrow (22.570A)_{16}$

$$16 \left| \begin{array}{r} 34 \\ -2-2 \\ \hline \end{array} \right.$$

$$\cdot 34 \times 16 = 5.44 \rightarrow 5$$

$$\cdot 44 \times 16 = 7.04 \rightarrow 7$$

$$\cdot 04 \times 16 = 0.64 \rightarrow 0$$

$$\cdot 64 \times 16 = 10.24 \rightarrow 10$$

(3)

$$b) (125.125)_{10} \Rightarrow (7D.2E)_{16}$$

$$\begin{array}{r} 125 \\ \hline 16 \quad 7-13 \end{array}$$

$$\cdot 125 \times 16 = \cancel{0}75 \rightarrow 2$$

$$\cdot \cancel{75} \times 16 = 12.0 \rightarrow +2$$

A	B	C	D
10	11	12	13

check

$$\begin{array}{r} 16^1 \quad 16^0 \\ \boxed{7} \quad D \\ \hline 16 \quad 1 \end{array} \cdot \begin{array}{r} 16^{-1} \quad 16^0 \\ \boxed{2} \quad C \\ \hline 16 \quad 56 \end{array}$$

$$(16 \times 7) + 10 = 125$$

$$125$$

$$125$$

$$b) (125.125)_{10} \Rightarrow (7D.2)_{16}$$

$$\begin{array}{r} 125 \\ \hline 16 \quad 7-13 \end{array}$$

7D.

$$\cdot 125 \times 16 = 2$$

check

$$\begin{array}{r} 7 \quad D \\ \hline 16 \quad 1 \end{array} \cdot \begin{array}{r} 2 \\ \hline 16 \end{array} = 125.125$$

$$c) (10.16)_{10} \Rightarrow (A.28F5)_{16}$$

10

$$\cdot 16 \times 16 = 2.56 \rightarrow 2$$

$$\cdot 56 \times 16 = 8.96 \rightarrow 8$$

$$\cdot 96 \times 16 = 15.36 \rightarrow 15$$

$$\cdot 36 \times 16 = 5.76 \rightarrow 5$$

check

$$A \cdot \begin{array}{r} 2 \quad 1 \quad 8 \quad F \quad 5 \\ \hline 16 \quad 16^2 \quad 16^3 \quad 16^4 \end{array}$$

$$= 0.159 \sim 0.16$$

B) What is the largest positive number one can represent in a 12-bit 2's complement code?

Sol Largest positive number in 12 bit $(0111\ 1111\ 111)$

$$\begin{array}{c} \boxed{0\ 1\ 1\ 1} \\ \text{Sign} \\ \downarrow \\ 1792 \end{array} \quad \begin{array}{c} \boxed{1\ 1\ 1\ 1} \\ \text{240} \\ \downarrow \\ 15 \end{array} = (2047)_{10}$$

$$\begin{array}{r} 128 \\ 64 \\ 32 \\ 16 \\ \hline 110 \\ 130 \\ \hline 1024 \\ 512 \\ 256 \\ \hline 1792 \end{array}$$

$$\begin{array}{r} 1792 \\ 240 \\ \hline 15 \\ 2047 \end{array}$$

1's complement

~~$1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0$~~

~~$1024 \\ 512 \\ 256 \\ \hline 1792$~~

~~$2's \text{ complement} = 15 + 1 = 16$~~

~~$1000\ 0000\ 0000$~~

~~$+ 1$~~

~~$(1000\ 0000\ 0001)_2$~~

~~$+ 2047 \xrightarrow{\text{2's complement}} (-11)_{10}$~~

Or

largest positive number

~~1001~~

$\rightarrow 9$

$\rightarrow 99$

~~$1024 \\ 512 \\ 256 \\ \hline 2048$~~

~~$8 - 7 = 1$~~

~~$16 - 15 = 1$~~

~~$32 - 31 = 1$~~

~~$64 - 63 = 1$~~

~~$128 - 127 = 1$~~

~~$256 - 255 = 1$~~

~~$512 - 511 = 1$~~

~~$1024 - 1023 = 1$~~

~~$2048 - 2047 = 1$~~

"CODE/THS 2022"

C → 67

0	1	0	0
---	---	---	---

0	0	1	1
---	---	---	---

O → 79

0	1	0	0
---	---	---	---

1	1	1	1
---	---	---	---

D → 68

0	1	0	0
---	---	---	---

0	1	0	0
---	---	---	---

E → 69

0	1	0	0
---	---	---	---

0	1	0	1
---	---	---	---

I → 47

0	0	1	0
---	---	---	---

1	1	1	1
---	---	---	---

T → 84

0	1	0	1
---	---	---	---

0	1	0	0
---	---	---	---

H → 72

0	1	0	0
---	---	---	---

1	0	0	0
---	---	---	---

S → 83

0	1	0	1
---	---	---	---

0	0	1	1
---	---	---	---

backspace → 32

0	0	1	0
---	---	---	---

0	0	0	0
---	---	---	---

Z → 50

0	0	1	1
---	---	---	---

0	0	1	0
---	---	---	---

O → 48

0	0	1	1
---	---	---	---

0	0	0	0
---	---	---	---

Q15 What is the biggest binary with 5 bits?

$$\begin{array}{l} \boxed{0} \boxed{0} \boxed{0} \boxed{1} \\ \boxed{1} \boxed{1} \boxed{1} \boxed{1} \end{array} = (31)_{10}$$

Q16 $2BFC + 54A7 = (80A3)_{16}$

$$2BFC \rightarrow \begin{array}{r} 2 \boxed{B} \boxed{F} \boxed{C} \\ 11 \quad 15 \quad 12 \end{array} = (11260)_{10} \Rightarrow \underline{1010111111100}$$

$$54A7 \quad \boxed{5} \boxed{4} \boxed{A} \boxed{7}_{10} = (21671)_{10} \Rightarrow \underline{101010010100111}$$

$$\begin{array}{ccccccc} 0 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 1 \\ \hline 1 & 0 & 0 & 0 & 0 & 0 & 1 \end{array}$$

$$10000000011 = (3293)_{10}$$

32768 16384 8192 4096 2048 1024 512 256 128 64 32 16 8 4 2 1

17. Convert the $(ABC7)_{16} \rightarrow (8)_2$
 $(1010\ 1011\ 1100\ 0111)_2$

$$(10 \times 4096) + (11 \times 256) + (12 \times 16) + (7 \times 1) = (43975)_{10}$$

1010 1011 1100 0111

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-
 2 | 1-0-

$$18 \text{ AC74-B7F} = (\text{AOF5})_{16}$$

$$\begin{array}{r}
 10 \quad 11 \quad 22 \quad 6 \quad 16 \quad 20 \\
 | \quad | \quad | \quad | \quad | \quad | \\
 10 \quad 0 \quad 15 \quad 5
 \end{array}
 \rightarrow (44148)_{10} -
 \begin{array}{r}
 1010100011110100 \\
 1011011111111
 \end{array}$$

019 Convert binary fractions to ordinary

$$a) (0.1001)_2 \cdot 1001 \times 2 = 0.2002 \rightarrow 0$$

$$12002 \times 2 = 0.4004 \rightarrow 0$$

$$400.4 \times 2 = 800.8 \rightarrow 0$$

$$8008 \times 2 = 16016 \Rightarrow$$

$$6016 \times 2 = 117032$$

$$2032 \times 2 = 0.10611 \rightarrow$$

$$23 \rightarrow 0$$

19. Convert binary to ordinary fractions:

a) $\begin{array}{|c|c|c|c|c|} \hline & (\frac{1}{2})^4 & (\frac{1}{2})^3 & (\frac{1}{2})^2 & (\frac{1}{2})^1 \\ \hline 0 & . & 1 & 0 & 0 & 1 \\ \hline 1 & & \frac{1}{2} & \frac{1}{4} & \frac{1}{8} & \frac{1}{16} \\ \hline \end{array} = \frac{1}{2} + 0 + 0 + \frac{1}{16} = \frac{9}{16} \Rightarrow (0.1001)_2 = 6.5625_{10}$

b) $\begin{array}{|c|c|c|c|c|c|} \hline & (\frac{1}{2})^4 & (\frac{1}{2})^3 & (\frac{1}{2})^2 & (\frac{1}{2})^1 & \\ \hline 1 & . & 0 & 0 & 1 & 1 \\ \hline 1 & & \frac{1}{2} & \frac{1}{4} & \frac{1}{8} & \frac{1}{16} \\ \hline \end{array} = \frac{1}{8} + \frac{1}{16} = \frac{3}{16} \Rightarrow (1.0011)_2 = (1.1875)_{10}$

c) $\begin{array}{|c|c|c|c|c|c|c|} \hline & (\frac{1}{2})^6 & (\frac{1}{2})^5 & (\frac{1}{2})^4 & (\frac{1}{2})^3 & (\frac{1}{2})^2 & (\frac{1}{2})^1 & \\ \hline 1 & . & 1 & 1 & 1 & 1 & 1 & \\ \hline 1 & & \frac{1}{2} & \frac{1}{4} & \frac{1}{8} & \frac{1}{16} & \\ \hline \end{array} = \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} = \frac{15}{16} \Rightarrow (1.1111)_2 = (1.9375)_{10}$

20. The decimal exp of $\frac{11}{17} = 0.647$.

$$(0.647)_{10} \Rightarrow (0.101001)_2$$

$$0.647 \times 2 = \underline{1.294} \rightarrow 1$$

$$\cdot 294 \times 2 = \underline{0.588} \rightarrow 0$$

$$\cdot 588 \times 2 = \underline{1.176} \rightarrow 1$$

$$\cdot 176 \times 2 = \underline{0.352} \rightarrow 0$$

$$\cdot 352 \times 2 = \underline{0.704} \rightarrow 0$$

$$\cdot 704 \times 2 = \underline{1.408} \rightarrow 1$$

$$21. \frac{3}{11} = 0.2727$$

$$0.2727 \times 2 = \underline{0.5454} \rightarrow 0$$

$$0.5454 \times 2 = \underline{1.0908} \rightarrow 1$$

$$0.0908 \times 2 = \underline{0.1816} \rightarrow 0$$

$$0.1816 \times 2 = \underline{0.3632} \rightarrow 0$$

$$0.3632 \times 2 = \underline{0.7264} \rightarrow 0$$

$$0.7264 \times 2 = \underline{1.4528} \rightarrow 1$$

$$(0.2727)_{10} = (0.010001)_2$$

22 Same as above 