



MC

Module-1

PART-A

1.) Explain decimal number system and how to convert decimal numbers to binary, octal and hexadecimal numbers with examples.

Sol:

PART-A

① The decimal number system is the standard system for denoting integer and non-integers numbers. It is also called the base-10 system because it is based on 10 digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

CONVERT DECIMAL TO BINARY

To convert a decimal number (Base-2) you repeatedly divide the number by 2 and record the remainder. The BINARY is the sequence of remainders read from bottom to top

Ex:-

- ① $25 \div 2 = 12 \quad r=1$
- ② $12 \div 2 = 6 \quad r=0$
- ③ $6 \div 2 = 3 \quad r=0$
- ④ $3 \div 2 = 1 \quad r=1$
- ⑤ $1 \div 2 = 0 \quad r=1$

∴ The remainders from top to bottom, 25 binary is 1101

Converting Decimal to Octal

To convert a decimal number to octal (base-8) you repeatedly divide the number by 8 and record the remainder. The octal number is the sequence of remainders read from bottom to top.

e.g:- convert to octal

$$\textcircled{1} \quad 25 \div 8 = 3, r = 1$$

$$\textcircled{2} \quad 3 \div 8 = 0, r = 3$$

CONVERTING DECIMAL TO HEXADECIMAL

To convert a decimal number to hexadecimal (base-16), you repeatedly divide the number by 16 and record the remainder. The hexadecimal number is the sequence of remainders read from bottom to top. Hexadecimal digits include 0-9 and A-F (where A=10, B=11, .., F=15).

e.g:- convert 25 to hexadecimal

$$\textcircled{1} \quad 25 \div 16 = 1, r = 9$$

$$\textcircled{2} \quad 1 \div 16 = 0, r = 1$$

∴ the remainders from bottom to top, 25 is hexadecimal 19.

2.) Explain binary number system and how to convert binary numbers to decimal, octal and hexadecimal numbers with examples.

Sol:

①

② The binary number system is a base-2 numeral system ~~so~~ that uses only two digits: 0 and 1, each digit in a binary number is called a bit. Binary numbers are commonly used in computer science and digital electronics because they are easy to implement with digital circuitry.

Converting Binary to Decimal

To convert a binary number to a decimal number, you multiply each bit by 2 raised to the power of its position, counting from right to left starting at 0.

Eg:- Convert 1010 (binary) to decimal

① 1010

- ② Multiply each bit by 2 raised to its position:
- o (1 times $2^3 = 8$)
 - o (0 times $2^2 = 0$)
 - o (1 times $2^1 = 2$)
 - o (0 times $2^0 = 0$)

- ③ Add results: $(8 + 0 + 2 + 0 = 10)$
so, 10₁₀ is binary 10 in decimal

converting Binary to octal

To convert a binary number to an octal number, group the binary digits into sets of three starting from the right. Add leading zeros if necessary.

ex: convert 1010 (binary) to octal

① 001010

② Convert each group to its octal equivalent

$$\circ 001 = 1$$

$$\circ 010 = 2$$

③ Results: 12

so, 1010 in binary is 12 octal.

Converting Binary to Hexadecimal

To convert a binary number to a hexadecimal number, group the binary digits into sets of four, starting from the right. Add leading zeroes if necessary.

ex:- convert 1010 (binary) to Hexadecimal.

① 1010

② convert each group to its hexadecimal equivalent:

01010 = A

③ results : A

So, 1010 in binary is A in hexadecimal.

3) Explain octal number system and how to convert octal numbers to binary, decimal and hexadecimal numbers with examples

Sol:

③ sol The octal number system is a base-8 system, which means it uses eight digits: 0, 1, 2, 3, 4, 5, 6 & 7. Each digit in an octal number represents a power of 8.

Converting Octal to BINARY

To convert an octal number to binary, replace each octal digit with its 3-bit binary equivalent.

Ex:- convert 57_8 to binary

$$05_8 = 101_2$$

$$07_8 = 111_2$$

$$\therefore 57_8 = 101111_2$$

Converting Octal to decimal

To convert an octal number to decimal, multiply each digit by 8 raised to the power of its position (Starting from 0) and sum of the results

Ex:- Converting 57_8 to decimal

① $0 \ 5 \times 8^1 = 40$

$0 \ 7 \times 8^0 = 7$

② Sum of the Values: $57_8 = 407_{10} = 47_{10}$

Converting Octal to Hexadecimal

To convert an octal number to hexadecimal, first convert it to binary, then group the binary digits into sets of four (Starting from the right), and convert each group to its hexadecimal equivalent.

Ex: Convert 57_8 to hexadecimal

① Convert to binary: $57_8 = 10111_2$

② Convert into sets of four: $1011 \ 11$ (add leading zeroes if necessary: $0010 \ 1111$)

③ Convert each group to hexadecimal

$0 \ 0010 = 2$

$0 \ 1111 = f$

④ $57_8 = 2f_{10}$

5) Explain gray code and how to convert binary number to gray code and vice versa with neat examples.

Sol:

⑤ Gray code also known as reflected binary code, is a binary numeral system where two successive values differ in only one bit. This property makes Gray code useful in error correction, digital communications and Karnaugh maps.

Converting Binary to Gray code

- ⑥ To convert a binary number to Gray code follow these steps
- ① The most Significant Bit (MSB) of the Gray code is the same as the MSB of the binary number.
- ② For the remaining bits, each bit of the Gray code is obtained by XORing the corresponding binary bit with the previous bit.

e.g: convert binary 100110 → (BCD)

$$\begin{array}{r} 1 0 0 1 1 0 \\ \downarrow \vee \vee \vee \downarrow \downarrow \\ 1 1 0 1 0 1 \end{array}$$

Gray to Binary

$$\begin{array}{r} 1 1 0 1 0 1 \\ \vee \vee \vee \vee \vee \partial \vee \\ 1 1 0 1 1 0 \end{array}$$

6) Explain decimal number system and convert following numbers to decimal a)
(10101)₂ b) (111.101)₂ c) (4057.06)₈ d) (A0F9.0EB)₁₆

Sol:

$$a, (10101)_2$$

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

$$= \frac{13}{\Rightarrow}$$

$$b, (111.101)_2$$

$$1 \times 2^2 + 1 \times 2 + 1 \times 2^0 + 1 \times 2^{-1} + 0 + 1 \times 2^{-3}$$

$$4 + 2 + 1 + \frac{1}{2} + \frac{1}{8}$$

$$7 + .1 + \frac{5}{8}$$

$$\begin{array}{r} 8 + 5 \\ \hline 8 \end{array} = \frac{69}{8}$$

$$(4057.06)_8 \rightarrow (\quad)_{10}$$

$$4 \times 8^3 + 0 + 5 \times 8^1 + 07 + 0 + 6 \times 8^{-2}$$

$$2048 + 40 + 7 + \frac{6}{64} - \frac{3}{32}$$

$$= \frac{67043}{32} = (2095.09375)_{10}$$

$$(A^3 0^2 F^1 9^0 . 0^1 E^2 B^3)_{16} \rightarrow (\quad)_{10}$$

$$16 \times 10 \times 16^3 + 0 + 15 \times 16 + 9 + 0 + 14 \times 16^{-2} + 11 \times 16^{-3}$$

~~400960 +~~

$$65776 + 9 + \frac{14}{16^2} + \frac{11}{16^3}$$

$$16^3 \times \frac{65785}{16^3} + \frac{14}{256} + \frac{11}{4096}$$

$$= 65785.00610351563$$

7) Explain octal number system and convert following numbers to octal a)

(101111010110.110110011)₂ b) (10101111001.0111)₂ c) (378.93)₁₀ d)

(B9F.AE)16

Sol:

a, $\left(\begin{array}{r} 101 \\ \times 5 \\ \hline 111 \end{array} \right) \quad \left(\begin{array}{r} 110 \\ \times 2 \\ \hline 110 \end{array} \right) \quad \left(\begin{array}{r} 110 \\ \times 6 \\ \hline 110 \end{array} \right) \quad \left(\begin{array}{r} 110 \\ \times 6 \\ \hline 110 \end{array} \right) \quad \left(\begin{array}{r} 110 \\ \times 6 \\ \hline 110 \end{array} \right) \quad \left(\begin{array}{r} 110 \\ \times 3 \\ \hline 110 \end{array} \right)$

$\rightarrow ()_8$

5 7 2 6 . 6 6 3

b, $\left(\begin{array}{r} 10101111001 \\ \times 5 \\ \hline 111010001001 \\ \times 7 \\ \hline 111010001001 \\ \times 9 \\ \hline 111010001001 \\ \times 7 \\ \hline 111010001001 \end{array} \right)_2$

c, $(378.93)_{10} \rightarrow ()_2$
 $()_{10} \rightarrow ()_2 \rightarrow ()_2$

$$\begin{array}{r} 8 | 378 \\ 8 | 47 \\ \hline 5 \end{array}$$

$$(572)_8 \rightarrow \underline{101} \underline{111} \underline{010}$$

d) $(B9F.AE)_{16} \rightarrow$

It's 9 is 10 in 16

$$\begin{array}{r} 16 \mid 11915 \\ \hline 16 \quad 744 \\ \hline 16 \quad 244 \\ \hline 16 \quad 2 \end{array}$$

$$0.1014 \times 16 = 1.62$$

$$0.62 \times 16 = 9.92$$

$$0.92 \times 16 = 14.72$$

$$0.72 \times 16 = 11.52$$

$$0.52 \times 16 = 8.32$$

$$\begin{array}{ccccccc} 2 & 14 & 8 & 11 \\ (2 & E & 8 & B) \\ + & 9 & E & 10 & 8 \end{array}$$

- 8) Explain hexadecimal number system and convert following numbers to hexadecimal
a) $(1011011011)_2$ b) $(0101111011.011111)_2$ c) $(2598.675)_{10}$ d) $(756.603)_8$

Sol:

a) $(1011011011)_2$

$\begin{array}{c} 1011011011 \\ \swarrow \searrow \swarrow \searrow \\ 5 \quad 5 \quad B \end{array}$

b) $(0101111011.011111)_2$

$\begin{array}{c} 0101111011.011111 \\ \swarrow \searrow \swarrow \searrow \swarrow \searrow \\ 5 \quad 7 \quad 9 \quad 7 \end{array}$

c) given $(2598.675)_{10}$

9) Explain binary number system and convert following numbers to binary a)
(52)₁₀ b) (105.15) c) (367.52)₈ d) (3A9E.B0D)₁₆

Sol:

④ So a.) Decimal to Binary: (52)₁₀

$$\begin{array}{l} 52 \div 2 = 26 \quad r=0 \\ 26 \div 2 = 13 \quad r=0 \\ 13 \div 2 = 6 \quad r=1 \\ 6 \div 2 = 3 \quad r=0 \\ 3 \div 2 = 1 \quad r=1 \\ 1 \div 2 \quad r=1 \end{array}$$

$$\therefore (52)_{10} = (110100)_2.$$

b.) Decimal to binary: (105.15)₁₀

$$\begin{array}{l} 105 \div 2 = 52 \quad r=1 \\ 52 \div 2 = 26 \quad r=0 \\ 26 \div 2 = 13 \quad r=0 \\ 13 \div 2 = 6 \quad r=1 \\ 6 \div 2 = 3 \quad r=0 \\ 3 \div 2 = 1 \quad r=1 \\ 1 \div 2 = 0 \quad r=1 \end{array}$$

$$\therefore (105)_{10} = (1101001)_2.$$

(c) Octal to Binary : $(367.5)_8$

$$0 \ 3 = 011$$

$$0 \ 6 = 110$$

$$0 \ 7 = 111$$

$$0 \ 5 = 101$$

$$0 \ 2 = 010$$

$$\therefore (367.5)_8 = (011110111.101010)_2$$

d.) $(3a.e.b0d)_{16}$

$$0 \ 3 = 011$$

$$0 \ a = 1010$$

$$0 \ e = 1001$$

$$0 \ b = 1110$$

$$0 \ d = 1011$$

$$0 \ 0 = 0000$$

$$0 \ d = 1101$$

$$\therefore (3a.e.b0d)_{16} = (0011101001110.10110000110)$$

10) Explain gray code representation and convert following binary to gray code a)

(10100101)₂ b) (101000101)₂ c) (111000111)₂ d) (100001000)₂

Sol:

10.) (a) (10100101)₂

10100101

10100 101
↓↓↓↓↓ ↓↓↓

11101111 ~~→ Gray code~~ → 11101111

(b) (101000101)₂

101000101
↓↓↓↓↓↓↓

11100111 ~~→ Gray code~~ → ~~11100111~~

(c) (111000111)₂

111000111
↓↓↓↓↓↓↓

100100100

Gray code → 100100100

(100001000)₂

100001000 ↓↓↓↓↓↓↓	→ Gray Code → 1100
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PART -B

- 1) Convert the following binary numbers to decimal numbers. a) 10011 b)
101010 c) 1011011 d) 010001

Sol:

PART -B

① a) 10011

$$\begin{aligned} \text{sol } & 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 \\ & = 16 + 0 + 0 + 2 + 1 = 19 \\ & \text{decimal: } 19 \end{aligned}$$

b.) 101010

$$\begin{aligned} & 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 \\ & = 32 + 0 + 8 + 0 + 2 + 0 = 42 \\ & \text{decimal: } 42 \end{aligned}$$

c.) 1011011

$$\begin{aligned} & 1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + \\ & = 64 + 0 + 16 + 8 + 2 + 1 = 91 \\ & \text{decimal: } 91 \end{aligned}$$

d.) 010001

$$\begin{aligned} & 0 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \\ & = 0 + 16 + 0 + 0 + 0 + 1 = 17 \\ & \text{decimal: } 17 \end{aligned}$$

2) Determine whether the following statements are true or false. Show work that supports your answer.

a) $(1001)_2 < (5)_{10}$

b) $(0111)_2 = (111)_{10}$

c) $(0011)_2 > (2)_{10}$

d) $(1001)_2 > (1101)_2$

Sol:

② a)

a) $(1001)_2 < (5)_{10}$

convert $(1001)_2$ binary to decimal

$$1001_2 = 1 \cdot 2^3 + 0 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0$$

$$= 8 + 0 + 0 + 1$$

$$= 9_{10}$$

Compare 9_{10} and 5_{10}

9 > 5

$$(b) (011)_2 = (111)_{10}$$

Convert $(0111)_2$ (binary) to decimal:

$$0111_2 = 0 \cdot 2^3 + 1 \cdot 2^2 + 1 \cdot 2^1 + 1 \cdot 2^0 = 0 + 4 + 2 + 1 = 7_{10}$$

Compare 7_{10} with 111_{10} :

$$7 \neq 111$$

So, $(0111)_2 = (111)_{10}$ is false.

$$(c) (0011)_2 > 2(10)$$

Convert $(0011)_2$ (binary) to decimal:

~~$$0011_2 = 0 \cdot 2^3 + 0 \cdot 2^2 + 1 \cdot 2^1 + 1 \cdot 2^0 = 0 + 0 + 2 + 1 = 3_{10}$$~~

$$2(10) = 2 \times 10 = 20$$

Compare 3_{10} with 20 :

$$3 < 20$$

So, $(0011)_2 > 2(10)$ is false.

$$(d) (1001)_2 > (1101)_2$$

Convert both $(1001)_2$ and $(1101)_2$ to decimal

$$1001_2 = 1 \cdot 2^3 + 0 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 = 9_{10}$$

$$1101_2 = 1 \cdot 2^3 + 1 \cdot 2^2 + 0 \cdot 2^1 + 1 \cdot 2^0 = 13_{10}$$

Compare 9_{10} and 13_{10} :

$$9 < 13$$

3) Convert the following decimal numbers to hexadecimal numbers. a. 412 b. 93

Sol:

③ a.) 412

b.) 412

412 in decimal is 19C in hexadecimal

b.) 93

93 in decimal is 5D in hexadecimal.

4) Convert the following hexadecimal numbers to decimal numbers. a. 7116 b.

DE016 c. ABC16 d. 100116

Sol:

(a) a. 71_{16}

$$7 \times 16^1 + 1 \times 16^0 = 7 \times 16 + 1 = 112 + 1 \\ = 113_{10}$$

b) $D60_{16}$

$$D \times 16^2 + E \times 16^1 + 0 \times 16^0$$

In hexadecimal $D=13$ & $E=14$

$$13 \times 16^2 + 14 \times 16^1 + 0 \times 16^0 = 13 \times 256 + 14 \times 16 \\ = 3328 + 224 = 3552_{10}$$

c.) ABC_{16}

$$A \times 16^2 + B \times 16^1 + C \times 16^0$$

In hexadecimal $A=10$, $B=11$, $C=12$

$$10 \times 16^2 + 11 \times 16^1 + 12 \times 16^0 = 10 \times 256 + 11 \times 16 + 12 \\ = 2560 + 176 + 12 \\ = 2748_{10}$$

d.) 1001_{16}

$$1 \times 16^3 + 0 \times 16^2 + 0 \times 16^1 + 1 \times 16^0 = \\ = 1 \times 4096 + 0 \times 256 + 0 \times 16 + 1 \\ = 4096 + 1 \\ = 4097_{10}$$

5) Convert the following decimal numbers into positive binary numbers. a. 99 b.

73 c. 213 d. 128

Sol:

5)

a.) 99

$$99 \div 2 = 49 \quad r=1$$

$$49 \div 2 = 24 \quad r=1$$

$$24 \div 2 = 12 \quad r=0$$

$$12 \div 2 = 6 \quad r=0$$

$$6 \div 2 = 3 \quad r=0$$

$$3 \div 2 = 1 \quad r=1$$

$$1 \div 2 = 0 \quad r=1$$

$\therefore 99(\text{decimal}) = 1100011(\text{binary})$.

b.) 73

$$73 \div 2 = 36 \quad r=1$$

$$36 \div 2 = 18 \quad r=0$$

$$18 \div 2 = 9 \quad r=0$$

$$9 \div 2 = 4 \quad r=1$$

$$4 \div 2 = 2 \quad r=0$$

$$2 \div 2 = 1 \quad r=0$$

$$1 \div 2 = 0 \quad r=1$$

$\therefore 73(\text{decimal}) = 1001001(\text{binary})$.

c) 213

$$213 \div 2 = 106 \quad r=1$$

$$106 \div 2 = 53 \quad r=0$$

$$53 \div 2 = 26 \quad r=1$$

$$26 \div 2 = 13 \quad r=0$$

$$13 \div 2 = 6 \quad r=1$$

$$6 \div 2 = 3 \quad r=0$$

$$3 \div 2 = 1 \quad r=1$$

$$1 \div 2 = 0 \quad r=1$$

13 (decimal) = ~~10101~~

= 11010101
(binary)

a) 128

$$128 \div 2 = 64 \quad r=0$$

$$64 \div 2 = 32 \quad r=0$$

$$32 \div 2 = 16 \quad r=0$$

$$16 \div 2 = 8 \quad r=0$$

$$8 \div 2 = 4 \quad r=0$$

$$4 \div 2 = 2 \quad r=0$$

$$2 \div 2 = 1 \quad r=0$$

$$1 \div 2 = 0 \quad r=1$$

128 (decimal)

= 10000000 (binary).

6) Convert the following binary numbers into decimal numbers. a. 10101010 b. 11001100 c. 11110000 d. 11111111

Sol:

⑥ a.) 10101010

$$0 \times 2^0 = 0$$

$$1 \times 2^1 = 2$$

$$0 \times 2^2 = 0$$

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

$$0 \times 2^4 = 0$$

$$1 \times 2^5 = 32$$

$$0 \times 2^6 = 0$$

$$1 \times 2^7 = 128$$

$$\therefore 10101010_2 = 128 + 0 + 32 + 0 + 8 + 0 + 2 + 0 \\ = \underline{\underline{170}}_{10}$$

b.) 11001100

$$0 \times 2^0 = 0$$

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

$$0 \times 2^2 = 0$$

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

$$0 \times 2^4 = 0$$

$$0 \times 2^5 = 0$$

$$1 \times 2^6 = 64$$

$$\cancel{0} 1 \times 2^7 = \cancel{128} 128$$

$$11001100_2 = 1\cancel{28} + 64 + 0 + 0 + 8 + 4 + 0 + 0 \\ = 204_{10}$$

c.) 11110000

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

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

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

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

$$0 \times 2^4 = 0$$

$$0 \times 2^5 = 0$$

$$0 \times 2^6 = 0$$

$$0 \times 2^7 = 0$$

d.) 111000

$$= 0 + 4 + 8 + 16 + 0 + 0 + 0$$

$$= 24_{10}$$

d.) 111111

$$111111_2 = 258_{10}$$

7) Convert the following hexadecimal numbers into binary numbers. a. AD b. F8

c. C5 d. B9

Sol:

a.) AD

$$A \overset{\text{hex}}{\underset{\text{bin}}{=}} 10 \text{ (binary)}$$

$$D \overset{\text{hex}}{\underset{\text{bin}}{=}} 1101 \text{ (binary)}$$

$$\therefore AD \text{ (hex)} = 10101101 \text{ (binary)}$$

b.) F8

$$F \text{ (hex)} = 1111 \text{ (binary)} \quad f \overset{\text{hex}}{\underset{\text{bin}}{=}} 1111 \text{ (hex)}$$

$$8 \text{ (hex)} = 1000 \text{ (binary)} \quad 8 \overset{\text{hex}}{\underset{\text{bin}}{=}} 1000 \text{ (hex)}$$

c.) C5

$$C \text{ (hex)} = 1100 \text{ (binary)}$$

$$5 \text{ (hex)} = 0101 \text{ (binary)}$$

$$C5 \overset{\text{hex}}{\underset{\text{bin}}{=}} 11000101 \text{ (binary)}$$

d.) B9

$$B \text{ (hex)} = 1011 \text{ (binary)}$$

$$9 \text{ (hex)} = 1001 \text{ (binary)}$$

$$B9 \text{ (hex)} = 10111001 \text{ (binary)}$$

8) Convert the following hexadecimal numbers into decimal numbers. a. A6 b. B0 c. F1 d. E4

Sol:

⑧

a.) A₁₆

$$A = 10 \quad 6 = 6$$

$$10 \times 16^1 + 6 \times 16^0$$

$$= 10 \times 16 + 6 \times 1 = 160 + 6 = 166$$

∴ A₁₆ = 166 in decimal

b.)

b.) B₁₆

$$B = 11$$

$$0 = 0$$

$$= 11 \times 16^1 + 0 \times 16^0$$

$$= 11 \times 16 + 0 \times 1 = 176 + 0 = 176$$

∴ B₁₆ = 176 in decimal

c. F1₁₆

$$F = 15 \quad 1 = 1$$

$$= 15 \times 16 + 1 \times 1 = 240 + 1 = 241$$

∴ F₁₆ = 241 in decimal

d.) E₁₆

$$E = 14$$

$$4 = 4$$

$$= 14 \times 16 \times 4 \times 1$$

$$= 224 + 4 = 228$$

E₁₆ = 228 in decimal

9) Convert each of the following binary numbers to octal, decimal, and hexadecimal formats. a. (111011101)₂ b. (10101010111)₂ c. (111100000)₂

Sol:

① a.) $(111011101)_2$

Octal

$$111_2 = 7_8$$

$$011_2 = 3_8$$

$$101_2 = 5_8$$

$$\therefore (111011101)_2 = (735)_8$$

② Decimal

$$\begin{aligned}(111011101)_2 &= 1 \times 2^8 + 1 \times 2^7 + 1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 \\ &\quad + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \\ &= 256 + 128 + 64 + 16 + 8 + 4 + 1 = 477_{10}\end{aligned}$$

③ Hexadecimal

$$011_2 = 7_{16}$$

$$011_2 = 7_{16}$$

$$01_2 = 1_{16}$$

$$\therefore (111011101)_2 = (771)_{16}$$

$$b.) (10101010111)_2$$

~~Octal~~ Octal

$$001_2 = 1_8$$

$$010_2 = 2_8$$

$$101_2 = 5_8$$

$$011_2 = 3_8$$

$$\therefore (10101010111)_2 = (1235)_8$$

Decimal

$$\begin{aligned}(10101010111)_2 &= 1 \times 2^{10} + 0 \times 2^9 + 1 \times 2^8 + 0 \times 2^7 + 1 \times 2^6 \\&\quad + 0 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 \\&\quad + 1 \times 2^0 \\&= 1024 + 256 + 64 + 16 + 4 + 2 + 1 \\&= 1367_{10}\end{aligned}$$

③ Hexadecimal

$$\text{Q) } \cancel{1001} + 0001_2 = 1_{16}$$

$$0101_2 = 5_{16}$$

$$0101_2 = 5_{16}$$

$$11_2 = 3_{16}$$

$$\therefore (10101010111)_2 = (1857)_{16}$$

$$\text{Q) } (1111\ 0000)_2$$

$$111 = 7_8$$

$$100 = 4_8$$

$$000 = 0_8$$

$$\therefore (1111\ 0000)_2 = (740)_8$$

Decimal

$$(1111\ 0000)_2 = 1 \times 2^8 + 1 \times 2^7 + 1 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 0 \times 2^3 \\ + 0 \times 2^2 + 0 \times 2^1 + 0 \times 2^0 \\ = 256 + 128 + 64 + 32 \\ = 480_{10}$$

③ Hexadecimal

$$111_2 = f_{16}$$

$$0000_2 = 0_{16}$$

$$\therefore (1111\ 0000) = (1E0)_{16}$$

10) Convert each of the following octal numbers to binary, decimal, and hexadecimal formats. a. (3754)₈ b. (7777)₈ c. (247)₈

Sol:

⑩ a.) ~~(3+54)~~₈

Binary

$$3 \rightarrow 011, 7 \rightarrow 111, 5 \rightarrow 101, 4 \rightarrow 100$$

$$(3754)_8 = 011\ 111\ 101\ 100_2$$

Decimal

$$3 \times 8^3 + 7 \times 8^2 + 5 \times 8^1 + 4 \times 8^0$$

$$= 3 \times 512 + 7 \times 64 + 5 \times 8 + 4 = 1536 + 448 + 40 + 4 \\ = 2098$$

$$80(3754)_8 = (2098)_{10}$$

Hexadecimal

$$0111\ 1101\ 100_2 = 7E4_{16}$$

$$80(3754)_8 = (7E4)_{16}$$

b) $(7777)_8$

~~Binary~~

$$7_8 = 111_2, \quad 7_8 = 111_2, \quad 7_8 = 111_2, \quad 7_8 = 111_2$$
$$\text{so } (7777)_8 = 11111111111_2$$

Decimal

$$7 \times 8^3 + 7 \times 8^2 + 7 \times 8^1 + 7 \times 8^0 \\ = 7 \times 512 + 7 \times 64 + 7 \times 8 + 7 = 3584 + 448 + 56 + 7 \\ = 4095$$

$$\text{so } (7777)_8 = (4095)_{10}$$

Hexadecimal

$$11111111111_2 = \text{ffff}_{16}$$

$$(7777)_8 = (\text{ffff})_{16}$$

c.) $(247)_8$

$$2_8 = 010_2, 4_8 = 100_2, 7_8 = 111_2$$

$$\text{So } (247)_8 = 010100111_2.$$

Decimal

$$2 \times 8^2 + 4 \times 8^1 + 7 \times 8^0$$

$$= 2 \times 64 + 4 \times 8 + 7 = 128 + 32 + 7 = 167$$

$$\text{So } (247)_8 = (167)_{10}$$

Hexadecimal

$$010100111_2 = 5B3_{16}$$

$$\text{So } (247)_8 = (\cancel{5B}53)_{16}.$$

11) Convert each of the following decimal numbers to binary, octal, and hexadecimal formats. a. (3479)₁₀ b. (642)₁₀ c. (555)₁₀

Sol:

① a.) $(3479)_{10}$

Binary: $(110110010111)_2$

Octal: $(6627)_8$

Hexadecimal: $(D9F)_{16}$

b.) $(642)_{10}$

Binary: $(1010000010)_2$

Octal: $(1202)_8$

Hexadecimal: $(282)_{16}$

c.) $(555)_{10}$

Binary: $(1000101011)_2$

Octal: $(1053)_8$

Hexadecimal: $(22B)_{16}$

12) Convert each of the following hexadecimal numbers to binary, octal, and decimal formats.

a. (4FB2)₁₆ b. (88BAE)₁₆ c. (DC4)₁₆

Sol:

⑫ a.) (4FB2)₁₆

Binary: 10011110110010₂

Octal: 4766₈

Decimal: 20402₁₀

b.) (88BAE)₁₆

Binary: 1000100010110101110₂

Octal: 2105656₈

Decimal: 560046₁₀

c.) (DC4)₁₆

Binary: 11011000100₂

Octal: 6704₈

Decimal: 3524₁₀

13) Convert each of the following binary numbers to octal, decimal, and hexadecimal formats. a. (111011101)₂ b. (10101010111)₂ c. (111100000)₂

Sol:

- ⑬ a.) (111011101)₂
Octal: 735
Decimal: 477
Hexadecimal: 1DD
- b.) (10101010111)₂
Octal: 2527
Decimal: 1367
Hexadecimal: 557
- c.) (11110000)₂
Octal: 740
Decimal: 480
Hexadecimal: 1E0

14) Convert each of the following octal numbers to binary, decimal, and hexadecimal formats. a. (3754)₈ b. (7777)₈ c. (247)₈

Sol:

⑭ Same as per the Question 10

15) Convert each of the following decimal numbers to binary, octal, and hexadecimal formats. a. (3479)₁₀ b. (555)₁₀ c. (642)₁₀

Sol:

⑮ Same as per the Question 11

16) Convert each of the following hexadecimal numbers to binary, octal, and decimal formats. a. (4FB2)₁₆ b. (88BAE)₁₆ c. (DC4)₁₆

Sol:

⑯ Same as Per the Question 12

17) Convert the following binary numbers to decimal numbers a. 0.1101 b. 0.11001 c. 0.00111 d. 0.01011

Sol:

⑰ a.) $(0.1101)_2$

$$\begin{aligned}0.1101 &= 2^{-1} \times 1 + 2^{-2} \times 1 + 2^{-3} \times 0 + 2^{-4} \times 1 \\&= \underline{\underline{0\left(\frac{1}{2}\right)}} + \underline{\underline{\left(\frac{1}{4}\right)}} + 0\underline{\underline{\left(\frac{1}{16}\right)}} \\&= 0.8125\end{aligned}$$

b.) 0.11001

$$\begin{aligned}0.11001_2 &= 1 \times 2^{-1} + 1 \times 2^{-2} + 0 \times 2^{-3} + 1 \times 2^{-4} + 1 \times 2^{-5} \\&= 0.5 + 0.25 + 0 + 0.0625 + 0.03125 \\&= 0.78125_{10}\end{aligned}$$

c.) 0.00111

$$\begin{aligned}0.00111_2 &= 0 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3} + 1 \times 2^{-4} + 1 \times 2^{-5} \\&= 0 + 0 + 0.125 + 0.0625 + 0.03125 \\&= 0.21875_{10}\end{aligned}$$

d.) ~~0.01011~~

$$\begin{aligned}0.01011_2 &= 0 \times 2^{-1} + 1 \times 2^{-2} + 0 \times 2^{-3} + 1 \times 2^{-4} + 1 \times 2^{-5} \\&= 0 + 0.25 + 0 + 0.0625 + 0.03125 \\&= 0.34375_{10}\end{aligned}$$

18) Convert the following binary numbers to decimal numbers: a. 11010.11 b. 10111.011 c. 110101.0111 d. 11010101.10111

Sol:

⑧ a.) 11010.11

$$1 \times 2^4 = 16$$

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

$$0 \times 2^2 = 0$$

$$1 \times 2^1 = 2$$

$$0 \times 2^0 = 0$$

$$= 16 + 8 + 0 + 2 + 0 = 26$$

Fractional Part

$$1 \times 2^{-5} = 0.5$$

$$1 \times 2^{-2} = 0.25$$

$$0.5 + 0.25 = 0.75$$

$$\therefore \text{Decimal Value: } 26 + 0.75 = 26.75$$

b.) 10111.011

Integer Part

$$1 \times 2^4 = 16$$

$$0 \times 2^3 = 0$$

$$1 \times 2^2 = 4$$

$$1 \times 2^1 = 2$$

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

$$= 16 + 0 + 4 + 2 + 1 = 23$$

Fractional Part

$$0 \times 2^{-1} = 0$$

$$1 \times 2^{-2} = 0.25$$

$$1 \times 2^{-3} = 0.125$$

$$= 0 + 0.25 + 0.125 = 0.375$$

$$\therefore \text{Decimal Value} = 23.375$$

2 1 0 0 1 . 0 1

Initial Band

5 3

$$1 \times 2^4 = 16$$

$$0 \times 2^3 = 0$$

$$1 \times 2^2 = 4$$

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

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

$$= 32 + 16 + 0 + 4 + 0 + 1 = 53$$

Fractional Part

$$0 \times 2^{-1} = 0$$

$$1 \times 2^{-2} = 0.25$$

$$1 \times 2^{-3} = 0.125$$

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

$$= 0 + 0.25 + 0.125 + 0.0625 = 0.4375$$

$$\text{Decimal Value} = 53 + 0.4375 = 53.4375$$

a.) 11010101.10111

Integer Part

$$1 \times 2^7 = 128$$

$$1 \times 2^6 = 64$$

$$0 \times 2^5 = 0$$

$$1 \times 2^4 = 16$$

$$0 \times 2^3 = 0$$

$$1 \times 2^2 = 4$$

$$1 \times 2^1 = 2$$

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

$$= 128 + 64 + 0 + 16 + 0 + 4 + 2 + 1 = 215$$

Fractional Part

$$1 \times 2^{-1} = 0.5$$

$$0 \times 2^{-2} = 0$$

$$1 \times 2^{-3} = 0.125$$

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

$$1 \times 2^{-5} = 0.03125$$

$$= 0.5 + 0 + 0.125 + 0.0625 + 0.03125 = 0.71875$$

$$\text{Decimal Value} = 215 + 0.71875 = 215.71875$$

19) Convert the following decimal numbers to binary numbers: a. 0.25 b. 0.21875

c. 0.28125 d. 0.59375

Sol:

⑨

a) 0.25

$0.25 \times 2 = 0.5 \rightarrow$ Integer Part: 0

$0.5 \times 2 = 1.0 \rightarrow$ Integer Part: 1

So 0.25 in binary is 0.01

b) 0.21875

$0.21875 \times 2 = 0.4375 \rightarrow$ Integer Part: 0

$0.4375 \times 2 = 0.875 \rightarrow$ Integer Part: 0

$0.875 \times 2 = 1.75 \rightarrow$ Integer Part: 1

$0.75 \times 2 = 1.5 \rightarrow$ Integer Part: 1

$0.5 \times 2 = 1.0 \rightarrow$ Integer Part: 1

So 0.21875 in binary is 0.00111.

c.) 0.28125

$$0.28125 \times 2 = 0.5625 \rightarrow \text{Integer Part: } 0$$

$$0.5625 \times 2 = 1.125 \rightarrow \text{Integer Part: } 1$$

$$0.125 \times 2 = 0.25 \rightarrow \text{Integer Part: } 0$$

$$0.25 \times 2 = 0.5 \rightarrow \text{Integer Part: } 1$$

$$0.5 \times 2 = 1.0 \rightarrow \text{Integer Part: } 1$$

~~So 0.593~~

So 0.28125 in binary is 0.01001.

d.) 0.59375

$$0.59375 \times 2 = 1.875 \rightarrow \text{Integer Part: } 1$$

$$0.1875 \times 2 = 0.375 \rightarrow \text{Integer Part: } 0$$

$$0.375 \times 2 = 0.75 \rightarrow \text{Integer Part: } 0$$

$$0.75 \times 2 = 1.5 \rightarrow \text{Integer Part: } 1$$

$$0.5 \times 2 = 1.0 \rightarrow \text{Integer Part: } 1$$

So, 0.59375 in binary is 0.10011.

20) Convert the following binary number to gray code: a. 010001110 b.
100111111 c. 010100010 d. 00011101001

Sol:

20) a.) 0100111010
 VVVUVUVV
 011010001

b.) 1001111111
 VVVUVUVUV
 1101000000

c.) 010100010
 VUVUVUVUV
 01110011

d.) 00011101001
 VVVUVUVV
 00010011101

