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# JKSSB

# Junior Engineer

## Electrical

Jammu and Kashmir Services Selection Board (JKSSB)

## Volume - 4

## Digital Electronics

SIERRA INNOVATIONS

# Table of Content

# 1 CHAPTER Number Systems & Binary Arithmetic

## THEORY

## 1.1 Introduction

A decimal number system is said to be base 10 because it uses 10 digits (0 to 9).

A binary number system has base 2 because it uses 2 digits (0 and 1).

Any number to the base 'r' uses r digits from 0 to (r – 1). If the value of base $r \leq 10$, r digits are taken from decimal number system. If the value of base $r > 10$ the letters of alphabets are used in addition to 10 decimal digits (0 to 9).

**Ex.:** Hexadecimal system have base 16 and it requires 16 digits. Out of sixteen digits, 10 digits are taken from decimal number system while remaining 6 digits (10-15) are represented by letters (A to F) respectively.

## 1.2 Type of Number Systems

- Binary number system (Base-2)
- Octal number system (Base-8)
- Decimal number system (Base-10)
- Hexadecimal number system (Base-16)



### *1.2.1 Binary Number System*

This number system uses 0 and 1 as digits. Its radix or base is 2. Binary number system consists of only two digits i.e. 0 and 1. In binary number system, each digit is called a bit, the group of four bits is called a nibble and group of 8 bits is called a byte. The highest decimal number represented by n digit number is $2^n - 1$. For example, with 4 bit binary number, highest decimal number represented is

$$2^4 - 1 = 15$$

**(i) Decimal to Binary Conversion :** A decimal number can be converted into binary number dividing the decimal number by two progressively until quotient zero is obtained. Binary number is obtained by taking remainder of each division in reverse order with first remainder as LSB and last remainder as MSB.

If decimal number is a fraction, its binary equivalent is obtained by multiplying the number progressively by 2 with carry generated as binary digit. First carry is taken as MSB and last carry as LSB.

***Example 1 :*** Convert the $(117)_{10}$ into binary.

***Solution :***

| | Quotient | Remainder | |
|---|---|---|---|
| 2 | 117 | | |
| 2 | 58 | 1 | LSB ↑ |
| 2 | 29 | 0 | |
| 2 | 14 | 1 | |
| 2 | 7 | 0 | |
| 2 | 3 | 1 | |
| 2 | 1 | 1 | |
| | 0 | 1 | MSB |

$$(117)_{10} = (1110101)_2$$

***Example 2 :*** Convert the $(0.61)_{10}$ into binary.

***Solution :***

Conversion of 0.61 in to Binary

| | |
|---|---|
| $0.61 \times 2 = 1.22$ | (MSB) 1 ↓ |
| $0.22 \times 2 = 0.44$ | 0 |
| $0.44 \times 2 = 0.88$ | 0 |
| $0.88 \times 2 = 1.76$ | 1 |

only upto 4 or 5 digits

$\Rightarrow$ $$(0.61)_{10} = (0.1001)_2$$

**(ii) Binary to Decimal Conversion :** $(\ldots.\ X_4\ X_3\ X_2\ X_1\ X_0.X_{-1}\ X_{-2}\ X_{-3}\ldots..)$

**Decimal equation :** $[(\ldots.\ X_3\, r^3 + X_2\, r^2 + X_1\, r^1 + X_0\, r^0\ ).(\ X_{-1}\, r^{-1} + X_{-2}\, r^{-2} + X_{-3}\, r^{-3} + \ldots..)]$

For binary number system, $r = 2$

**Ex.:** $(101101.001)_2 = (X)_{10}$

$$(1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0).(0 \times 2^{-1} + 0 \times 2^{-2} + 1 \times 2^{-3})$$

$$[1 + 0 + 4 + 8 + 0 + 32].\left[\frac{1}{8}\right] = (45.125)_{10}$$

### *1.2.2 Octal Number System*

This number system uses 0, 1, 2, 3, 4, 5, 6 and 7 as digits. Its radix or base is 8.

**(i) Conversion from Decimal to Octal :** Absolute (Integral value) : An absolute decimal number is converted into octal number by dividing the number by 8 progressively as in binary system.

**Fractional number :** A fractional number be converted to octal number by multiplying the number by 8 progressively as in case of binary system.

**(ii) Conversion from Octal to Decimal :** A number with radix or base 'r' can be converted to its decimal equivalent by multiplying each digit by its respective weight and adding the products.

**Ex.:** $(467.32)_8 = (X)_{10}$

For octal number system, $r = 8$

$$X = (7 \times 8^0 + 6 \times 8^1 + 4 \times 8^2).(3 \times 8^{-1} + 2 \times 8^{-2})$$

$$= (7 + 48 + 256).\left(\frac{3}{8} + \frac{2}{64}\right)$$

$$= 311.(0.375 + 0.03125)$$

$$= (311.406)_{10}$$

### *1.2.3 Decimal Number System*

Decimal number system consists of 10 digits

i.e. 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

The base or radix of this number system is 10.

Digits = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and base = 10.

### *1.2.4 Hexadecimal Number System*

Hexadecimal number system consists of 16 digits

i.e. 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E and F.

The base or radix of this number system is 16.

Digits = 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F and base = 16.

**(i) Conversion from Decimal to Hexadecimal**

**(a) Integral Part :** An absolute decimal number is converted to hexadecimal number by dividing the number by 16 progressively in similar manner as in binary number system.

**(b) Decimal Part / Fractional Part :** A fractional decimal number is converted to hexadecimal number by multiplying the number by 16 progressively in similar manner as in binary number system.

**(ii) Conversion from Hexadecimal to Decimal :** A hexadecimal number can be converted to its decimal equivalent by multiplying each digit by its respective weight and adding all the products.

***Example 3 :*** $(B7AF.3E)_{16} = (X)_{10}$ find the value of X.

***Solution :***

$$X = (11 \times 16^3 + 7 \times 16^2 + 10 \times 16^1 + 15 \times 16^0).\left(\frac{3}{16} + \frac{14}{16^2}\right)$$

$$= (11 \times 4096 + 7 \times 256 + 10 \times 16 + 15 \times 1).\left(\frac{3}{16} + \frac{14}{256}\right)$$

$$= (45056 + 1792 + 160 + 15).(0.1875 + 0.0546)$$

$$= (47023.242)_{10}$$

## 1.3 Conversion of Number System

### *1.3.1 Binary to Hexadecimal*

Binary to Hexadecimal conversion is obtained by making group of four bits to left and right of decimal point. Then each group is replaced by its hexadecimal equivalent number.

### *1.3.2 Hexadecimal to Binary*

Hexadecimal to binary conversion is obtained by replacing each digit by its binary equivalent of four bits.

**Ex.:** $(1A3.BA)_{16} = \left(\underbrace{0001}_{1}\underbrace{1010}_{A}\underbrace{0011}_{3}.\underbrace{1011}_{B}\underbrace{1010}_{A}\right)_2$

### *1.3.3 Binary to Octal Conversion*

A binary number can be converted to its octal equivalent by making group of three bits to left and right of decimal point. Then each group is replaced by its octal equivalent number.

**Ex.:** $(1\,0\,1\;1\,1\,0\;0\,1\,0\,.\,0\,0\,1\;1)_2 = (X)_8$

5 6 2 . 1 4

$$X = 562.14$$

### *1.3.4 Octal to Binary Conversion*

Octal to binary conversion is obtained by replacing each digit by its binary equivalent of three bits.

**Ex.:** $(462.71)_8 = (X)_2$

$$X = 100\ 110\ 010\ .\ 111\ \ 001$$

### *1.3.5 Hexadecimal to Octal Conversion*

Hexadecimal to octal conversion is obtained by converting hexadecimal to binary and then from binary to octal number.

### *1.3.6 Octal to Hexadecimal Conversion*

Octal to hexadecimal conversion is obtained by converting octal to binary and then from binary to hexadecimal number.

**Table of Different Number System**

| Decimal | Binary | Octal | Hexadecimal |
|---|---|---|---|
| 0 | 0000 | 00 | 0 |
| 1 | 0001 | 01 | 1 |
| 2 | 0010 | 02 | 2 |
| 3 | 0011 | 03 | 3 |
| 4 | 0100 | 04 | 4 |
| 5 | 0101 | 05 | 5 |
| 6 | 0110 | 06 | 6 |
| 7 | 0111 | 07 | 7 |
| 8 | 1000 | 10 | 8 |
| 9 | 1001 | 11 | 9 |
| 10 | 1010 | 12 | A |
| 11 | 1011 | 13 | B |
| 12 | 1100 | 14 | C |
| 13 | 1101 | 15 | D |
| 14 | 1110 | 16 | E |
| 15 | 1111 | 17 | F |

## 1.4 CODES

Codes are symbolic representation of discrete information, which may be present in the form of number, letters or physical quantities. These symbols are used to communicate information to computers.

**Note :**

(i) Maximum number of distinct quantities using n bits = $2^n$.

(ii) Each digit of decimal number system is represented by a four digit code in weighted and non weighted codes. Except Gray code.

### *1.4.1 Weighted Binary Codes*

These are the codes in which each symbol position is assigned a weight. In weighted binary code, each bit is multiplied by its weight indicated in code to get the decimal equivalent of the code.

e.g. BCD (8421), 7421, 5421, 5211, 4221, 3321, 2421, $84\bar{2}\bar{1}$, $74\bar{2}\bar{1}$.

***Example 4 :*** Convert $(8)_{10}$ in 7421, 5421, 5211, 4221, 3321, 2421, 8421, $74\bar{2}\bar{1}$ codes.

***Solution :***

(a) $(8)_{10} = 7 + 1 = (1001)_{7421}$

(b) $(8)_{10} = 5 + 2 + 1 = (1011)_{5421}$

(c) $(8)_{10} = 5 + 2 + 1 = (1101)_{5211} = (1110)_{5211}$

(d) $(8)_{10} = 4 + 2 + 2 = (1110)_{4221}$

(e) $(8)_{10} = 3 + 3 + 2 = (1110)_{3321}$

(f) $(8)_{10} = 2 + 4 + 2 = (1110)_{2421}$

(g) $(8)_{10} = 8 + 0 + 0 + 0 = (1000)_{8421}$

(h) $(8)_{10} = 7 + 4 - 2 - 1 = (1111)_{74\bar{2}\bar{1}}$

**Note :**

**Self complement :** If '0' is complement of '9', 1 is complement of '8', 2 is of 7, 3 is of 6, 4 is of 5, Then code is called self complement code.

Example of self complement codes is 5211, 4221, 3321, 2421, $84\bar{2}\bar{1}$.

Representation of $(8)_{10}$ in 5211 code

- $(1110)_{5211} = (8)_{10}$
- $(1101)_{5211} = (8)_{10}$

  Both are correct.
- For self complementary, '1' should be complement of code of '8'.

### *1.4.2 Non Weighted Codes*

Non-weighted codes are codes which are not positionally weighted, excess-3 code and gray codes are example of non-weighted codes.

**(i) Excess-3 :** Excess-3 code is obtained by adding 0011 to each BCD code of decimal numbers.

| e.g. | decimal | BCD | Excess-3 |
|---|---|---|---|
| | 0 | 0000 | 0011 |
| | 1 | 0001 | 0100 |
| | 2 | 0010 | 0101 |
| | : | : | : |
| | 9 | 1001 | 1100 |

**Note :** Excess-3 code is self complementing code.

**(ii) Gray code :** In gray code, every new code differs from the previous code only by a single bit. That is why, it is also called Reflected code. It can be used for measurment of shaft speed.

**Note :** It is also called unit distance code or minimum change code.

### *1.4.3 Alpha Numeric Codes*

**(i)** **ASCII** (American Standard code for Information Interchange) : It is a 7 bit code. It is most commonly used in microcomputers. This code represents a character with seven bits, which can be stored as one byte with one bit used.

**(ii)** **ISCII** (Indian Standard code for Information Interchange)

**(iii)** **EBCDIC (ebb. see-dic) :** It uses eight bits for character and ninth bit for parity.

**(iv)** **Hollerith Code :** It is used in punch cards used for storage of information

**(v)** **Morse Code :** It is used in Telegraph.

**(vi)** **Tele Type Writter** (TTW)

### *1.4.4 Error Detecting and Correcting Codes*

**(i)** **Parity Check Code :** This code detects single bit error which changes parity of information. Errors with more than one bit cannot be detected with this code.

**(ii)** **Hamming Code :** This code detects as well as corrects the error in an information. This code transmits additional parity bits in addition to information bits. These parity bits are used to detect and correct the error.

### *1.4.5 Error Detecting Code*

**(i) Even Parity Method :** In this method, the value of parity is added so that total number of 1's in code group (including parity bit) is even.

Parity = 0 or 1

**(ii) Odd Parity Method :** In this method, the value of parity is added so that total number of 1's in code group (including parity bit) is odd.

**Ex.:** (1011) $\rightarrow$ odd

(11000) $\rightarrow$ even

## 1.5 Code Conversions

**(i)** **Decimal to BCD conversion :** Decimal to BCD conversion is obtained by replacing each digit of decimal number by its binary equivalent.

(ii) **Binary to BCD conversion :** Binary to BCD code conversion is possible by converting binary to decimal and then from decimal to its BCD equivalent.

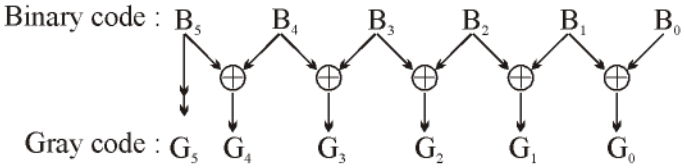
(iii) **BCD to Binary conversion :** BCD to binary conversion is obtained by converting the BCD to decimal and then decimal to its binary equivalent.

(iv) **BCD to Excess-3 conversion :** BCD to excess-3 code conversion is obtained by adding 0011 to each BCD coded digit.

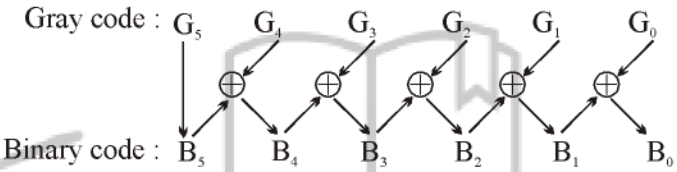
(v) **Excess-3 to BCD conversion :** Each (Excess-3 code) – 0011 = BCD

Excess-3 to BCD code conversion is obtained by substracting 0011 from excess-3 code of each digit.

(vi) **Binary to gray code conversion :** Binary to gray code conversion is obtained by using rules as shown under.




(vii) **Gray to binary code conversion :** Gray to binary code conversion is obtained by using rules as shown under.




## 1.6 Binary Arithmetic

**(i) Binary Addition**

| $A_0$ | $B_0$ | Sum | Carry |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |



**(ii) Binary Subtraction**

| $A_0$ | $B_0$ | Difference | Borrow |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 |

## 1.7 Number Representation in Binary Number System

### *1.7.1 Sign Magnitude Representation*

Left most bit represents sign.

For example $\underbrace{B_{n-1}}_{\text{Sign}}\underbrace{B_{n-2}B_{n-3}.............B_2B_1B_0}_{\text{Magnitude}}$

**Note :** Range = $-(2^{n-1}-1)$ to $+(2^{n-1}-1)$

***Example 5 :*** Find sign Magnitude representation of $(-20)_{10}$ and $(+20)_{10}$.

***Solution :***

$$-20 \Rightarrow \underbrace{1}_{-}\ \underbrace{1\,0\,1\,0\,0}_{20}$$

$$+20 \Rightarrow \underbrace{0}_{+}\ \underbrace{1\,0\,1\,0\,0}_{20}$$

***Example 6 :*** Find sign magnitude representation of $(-0)_{10}$ and $(+0)_{10}$.

***Solution :***

$$-0 \Rightarrow 1000$$

$$+0 \Rightarrow 0000$$

**Note :** Zero has two distinct representation in sign magnitude representation.

### *1.7.2 One's Complement Representation*

When each bit of number is complemented, resulting number is one's complement of original number. One's complement of a number gives its negative number.

**Note :** Range = $-(2^{n-1}-1)$ to $+(2^{n-1}-1)$.

***Example 7 :*** Find the one's complement of $(-20)_{10}$.

***Solution :***

$$(+20)_{10} \Rightarrow (00010100)_2 \text{ original number}$$

$$(-20)_{10} \Rightarrow (11101011)_2 \text{ one's complement}$$

***Example 8 :*** Find the one's complement of $(-0)_{10}$ and $(+0)_{10}$.

***Solution :***

$$(+0)_{10} \Rightarrow (0000)_2$$

$$(-0)_{10} \Rightarrow (1000)_2$$

Two distinct representation of zero.

**Note :**

- 1's complement representation of zero has two distinct representations.
- 1's complement of a number gives original number.

### *1.7.3 Two's Complement Representation*

2's complement of a number = 1's complement of the number + 1

**Note :** 2's complement has unique representation of zero.

**Ex.:**

$$\begin{array}{r} (0)_{10} = (0\,0\,0\,0)_2 \\ 1\,1\,1\,1 \\ +1 \\ \hline \end{array}$$

Final carry ignored → $\boxed{1}$0000    2's complement

**Note :** Range → $-2^{n-1}$ to $(2^{n-1}-1)$.

***Example 9 :*** Find 2's complement representation of $(-37)_{10}$.

***Solution :***

$$(+37)_{10} = (00100101)_2$$

2's complement representation of $(-37)_{10}$ = 1's complement of $(00100101)_2 + 1$

$= (11011010)_2 + 1$

$= (11011011)_2$

## 1.8 r's Complement & (r-1)'s Complement

**(i) r's complement :** r's complement of a positive number 'N' of n digits in integral part = $r^n - N$

Where, r = radix or base

n = number of digits in integral part of the number.

**Ex.:**

(1) 10's complement of $(52520)_{10}$ is

$10^5 - 52520 = 47480$ here n = 5 and r = 10

(2) 10's complement of $(0.3267)_{10}$ is

$(10^0 - 0.3267) = 0.6733$ here n = 0 and r = 10

(3) 2's complement of $(101100)_2$ is

$(2^6)_{10} - (101100)_2 = (1000000)_2 - (101100)_2 = 010100$

(4) 2's complement of $(0.0110)_2$ is

$2^0 - 0.0110 = 1 - 0.0110 = (0.1010)_2$

**(ii) (r – 1)'s complement :** $(r^n)$'s complement of a number N with 'n' digits in integral part and m digits in fractional part is $(r^n - r^{-m} - N)$.

**Ex.:** 9's complement of $(52520)_{10}$ is $(10^5 - 10^{-0} - 52520) = 47479$ [n = 5, m = 0]

**Note :** Complement of complement of a number restore the original number.

**(iii) Subtraction using r's complement :** Let M – N is subtraction to be found. Both are of base r:

**Steps :**

(a) Add the minuend M to the r's complement of the subtrahend N.

(b) Inspect for an end carry

- If an end carry occurs discard it and result is positive.
- If an end carry does not occur, result is negative and is r's complement of true result.

**(iv) Subtraction using (r – 1)'s complement :** Let M – N is found with (r – 1)'s complement.

(a) Add minuend M to (r – 1)'s complement of subtrahend N.

(b) Inspect for an end carry

- If an end carry is generated, add it to the sum and result is positive and in its true form.
- If an end carry is not generated, result is negative and in its (r – 1)'s complement form.

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# OBJECTIVE QUESTIONS

**1.** The binary number 00001011 when represented in BCD format, is given by
(a) 00001011 (b) 10111011
(c) 00010001 (d) 10001000

**2.** When two numbers are added in excess-3 code and the sum is less than 9, then in order to get the correct answer it is necessary to
(a) subtract 0011 from the sum
(b) add 0011 to the sum
(c) subtract 0110 from the sum
(d) add 0110 to the sum

**3.** Gray code of the decimal number 13 is
(a) 1010 (b) 1101
(c) 1011 (d) 1001

**4.** The binary representation 100110 is numerically equivalent to
(a) the decimal representation 46
(b) the octal representation 46
(c) the octal representation 26
(d) the decimal representation 26

**5.** The number 7F in Hexadecimal number system is equivalent to the decimal number
(a) 255 (b) 256
(c) 128 (d) 127

**6.** Decimal 43 in Hexadecimal and BCD number system is respectively
(a) B2, 0100 0011 (b) 2B, 0100 0011
(c) 2B, 0011 0100 (d) B2, 0100 0100

**7.** The decimal value 0.25
(a) is equivalent to the binary value 0.1
(b) is equivalent to the binary value 0.01
(c) is equivalent to the binary value 0.00111
(d) cannot be represented precisely in binary

**8.** Which of the following operations do result is $(EA)_{16}$ ?
1. $(AB)_{16} - (3F)_{16}$
2. $(BC)_{16} - (CB)_{16}$
3. $(FE)_{16} - (14)_{16}$

Select the correct answer using the code give below
(a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3

**9.** What is the Gray code word for the binary number 101011 ?
(a) 101011 (b) 110101
(c) 011111 (d) 111110

**10.** How many 1's are present in the binary representation of
$(4 \times 4096) + (9 \times 256) + (7 \times 16) + 5$
(a) 8 (b) 9
(c) 10 (d) 11

**11.** Match List-I (Binary) with List-II (Decimal) and select the correct answer using the codes given below the lists

| List-I | List-II |
|---|---|
| A. 10101010 | 1. 128 |
| B. 11110000 | 2. 240 |
| C. 10001000 | 3. 170 |
| D. 10000000 | 4. 136 |

**Codes :**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 3 | 2 | 4 | 1 |
| (b) | 2 | 3 | 1 | 4 |
| (c) | 2 | 4 | 1 | 3 |
| (d) | 3 | 1 | 2 | 4 |

**12.** What is the octal equivalent of decimal 0.3125?
(a) 0.42 (b) 0.3125
(c) 0.24 (d) 0.12

**13.** Match List-I (Octal) with List-II (Binary) and select the correct answer using the codes given below the lists:

| List-I | List-II |
|---|---|
| A. 75 | 1. 010110 |
| B. 65 | 2. 110101 |
| C. 37 | 3. 111101 |
| D. 26 | 4. 011111 |

**Codes :**

| | A | B | C | D |
|---|---|---|---|---|
| (a) | 3 | 1 | 4 | 2 |
| (b) | 2 | 1 | 3 | 4 |
| (c) | 3 | 2 | 4 | 1 |
| (d) | 4 | 2 | 3 | 1 |

**14.** In hexadecimal arithmetic, the result of $(77)_{16} - (3B)_{16}$ is equal to

(a) $3D_{16}$ (b) $3C_{16}$

(c) $60_{16}$ (d) $73_{16}$

**15.** The decimal equivalent of hexadecimal number 2A0F is

(a) 17670 (b) 17607

(c) 17067 (d) 10767

**16.** The binary equivalent of hexadecimal number 4F2D is

(a) 0101 1111 0010 1100

(b) 0100 1111 0010 1100

(c) 0100 1110 0010 1101

(d) 0100 1111 0010 1101

**17.** Match list-I (Hexadecimal) with list-II (Octal) and select the correct answer by using the codes given below the lists

| **List-I** | **List-II** |
|---|---|
| A. 68 | 1. 150 |
| B. 8C | 2. 214 |
| C. 4F | 3. 117 |
| D. 5D | 4. 135 |

**Codes :**

| | **A** | **B** | **C** | **D** |
|---|---|---|---|---|
| (a) | 3 | 1 | 4 | 2 |
| (b) | 1 | 2 | 3 | 4 |
| (c) | 3 | 2 | 4 | 1 |
| (d) | 4 | 1 | 2 | 3 |

**18.** F's complement of $(2BFD)_{16}$ is

(a) E 304 (b) D 403

(c) D 402 (d) C 403

**19.** Given $(125)_R = (203)_5$, the value of radix R will be

(a) 16 (b) 10

(c) 8 (d) 6

**20.** If $(327)_9 = (X)_5$ then the value of X is given by

(a) 327 (b) 268

(c) 2033 (d) 3302

**21.** Which of the following is a self-complementing code?

(a) 8421 code (b) Excess 3 code

(c) Pure binary code (d) Gray code

**22.** The parity bit is added for (purpose)

(a) coding (b) indexing

(c) error-detection (d) controlling

**23.** Which one of the following is a non-valid BCD code?

(a) 0111 1001 (b) 0101 1011

(c) 0100 (d) 0100 1001

**24.** Which of the following statement is true?

(a) ICs are always linear

(b) Digital circuits are linear circuits

(c) AND gate is a logic circuit whose output is equal to its highest input

(d) In a four-input AND circuit, all input must be UP for the output to be UP

**25.** A three-input NAND gate is to be used as an inverter. Which one of the following measures will achieve better results?

(a) The two inputs not used are kept open

(b) The two inputs not used are connected to ground ("0" level)

(c) The two inputs not used are connected to logic ("1" level)

(d) None of the above

**26.** How is inversion achieved using EX-OR gate?

(a) Giving input signal to the two input lines of the gate tied together

(b) Giving input to one input line and logic zero to the other line

(c) Giving input to one input line and logic one to the other line

(d) Inversion cannot be achieved using EX-OR gate

**27.** An equivalent 2's complement representation of the 2's complement number 1101 is

(a) 110100 (b) 001101

(c) 110111 (d) 111101

**28.** 2's complement representation of a 16-bit number (one sign bit and 15 magnitude bits) is FFFF. Its magnitude in decimal representation is

(a) 0 (b) 1

(c) 32, 767 (d) 65, 535

**29.** The greatest negative number which can be stored in a 8-bit register using 2's complement arithmetic is

(a) –256 (b) –255

(c) –127 (d) –128

**30.** Which of the following binary number is equal to octal number 66.3

(a) 101101.100 (b) 1101111.111

(c) 111111.1111 (d) 110110.011

**31.** Gray code for number 7 is

(a) 1100 (b) 1001

(c) 0110 (d) 0100

**32.** The binary number 111 represents

(a) –3 in sign magnitude system and –1 in two's complement system

(b) 7 in signs magnitude system and –1 in two's complement system

(c) –3 in sign magnitude system and –3 in two's complement system

(d) 7 in signs magnitude system and –3 in two's complement system.

**33.** The binary number 101 represents

(a) –3 in two's complement system

(b) 7 in sign magnitude system

(c) –5 in two's complement system

(d) –2 in sign magnitude system

**34.** The 2's complement of the binary number 1101100 in BCD is

(a) 12 (b) 13

(c) 14 (d) 15

**35.** The minimum decimal equivalent of the number 11C.0 is

(a) 183 (b) 284

(c) 268 (d) 269

**36.** A signed integer has been stored in a byte using 2's complement format. We wish to store the same integer in 16-bit word. We should copy the original byte to the less significant byte of the word and fill the more significant byte with

(a) 0

(b) 1

(c) equal to the MSB of the original byte

(d) complement of the MSB of the original byte

**37.** Which of the following hexagonal sum is equivalent to hexadecimal A8 H ?

(a) 2CH + 4FH (b) 5EH + 1AH

(c) 3BH + 6DH (d) 5AH + 2CH

**38.** With 2's complement representation the range of values that can be represented on the data bus of an 8-bit microprocessor is given by

(a) –128 to +127 (b) –128 to +128

(c) –127 to +128 (d) –256 to +256

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# ANSWERS WITH EXPLANATIONS

**1.** ***Ans. (c)***

The binary number 00001011 represents decimal number is 11.

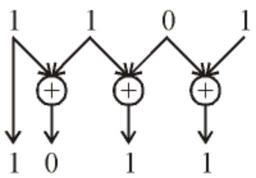
And BCD representation is 0001 0001

**2.** ***Ans. (a)***

When two numbers are added in excess-3 code and the sum is less than 9 then in order to get the correct answer it is necessary to subtract 0011 from the sum.

**3.** ***Ans. (c)***

Binary equivalent of 13 is 1101. Now we convert this binary number to Gray code as follows




Hence $(13)_{10} = (1011)_G$

**4.** ***Ans. (b)***

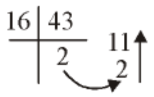
$$(100110)_2 = 1 \times 2^5 + 0 + 0 + 1 \times 2^2 + 1 \times 2^1 + 0$$
$$= 32 + 4 + 2$$
$$= (38)_{10}$$

Hence $(100110)_2 = (46)_8$

**5.** ***Ans. (d)***

$$(7F)_{16} = 7 \times 16^1 + F \times 16^\circ$$
$$= 7 \times 16^1 + 15 \times 1$$
$$= 112 + 15$$
$$= (127)_{10}$$

**6.** ***Ans. (b)***




$$(43)_{10} = (x)_{16}$$
$$= (2B)$$

$\therefore \quad (43)_{10} = (2\ B)_{16}$

BCD equivalent of 43 is 0100 0011

**7.** ***Ans. (b)***

| | Integer |
|---|---|
| $0.25 \times 2 = 0.50$ | 0 |
| $0.50 \times 2 = 1.00$ | 1 |
| $0.00 \times 2 = 0.00$ | 0 |

$\therefore \quad (0.25)_{10} = (0.01)_2$

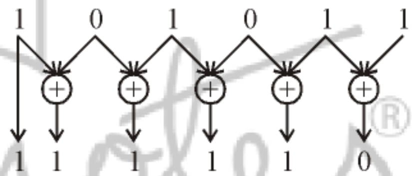
**8.** ***Ans. (b)***

1. $(AB)_{16} + (3F)_{16} = (171)_{10} - (63)_{10}$
   $= (234)_{10} = EA$

2. $(BC)_{16} - (CB)_{16} = (188)_{10} - (203)_{10}$
   $= -(15)_{10} = -F$

3. $(FE)_{16} - (14)_{16} = (254)_{10} - (20)_{10}$
   $= (234)_{10} = EA$

**9.** ***Ans. (d)***




$\therefore \quad (101011)_2 = (111110)_G$

**10.** ***Ans. (a)***

We have to find out the number of l's in the binary representation of

$(4 \times 4096) + (9 \times 256) + (7 \times 16) + 5$

This is a decimal number

Now, we can write this decimal number as

$4 \times 16^3 + 9 \times 16^2 + 7 \times 16^1 + 5 \times 16^0 = (4975)_{16}$

then we convert this hexadecimal number as

$(4 \quad 9 \quad 7 \quad 5)_{16}$
↓ ↓ ↓ ↓
$(0100\ 1001\ 0111\ 0101)_2$

Then total number of l's are 8.

**11.** ***Ans. (a)***

(A) $(10101010)_2$

then its decimal equivalent will be

$$N = 1 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 0 \times 2^0$$

$$\Rightarrow N = 1 \times 2^7 + 1 \times 2^5 + 1 \times 2^3 + 1 \times 2^1$$

$$\Rightarrow N = 128 + 32 + 8 + 2 = (170)_{10}$$

(B) $(11110000)_2$

then its decimal equivalent will be

$$N = 1 \times 2^7 + 1 \times 2^6 + 1 \times 2^5 + 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$$

$$\Rightarrow N = 1 \times 2^7 + 1 \times 2^6 + 1 \times 2^5 + 1 \times 2^4$$

$$\Rightarrow N = (240)_{10}$$

(C) $(10001000)_2$

then its decimal equivalent will be

$$N = 1 \times 2^7 + 0 \times 2^6 + 0 \times 2^5 \; 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$$

$$N = 1 \times 128 + 1 \times 8$$
$$= 128 + 8$$
$$= (136)_{10}$$

(D) $(1\ 0\ 0\ 0\ 0\ 0\ 0\ 0)_2$

then its decimal equivalent will be

$$N = 1 \times 2^7 + 0 \times 2^6 + 0 \times 2^5 + 0 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 0 \times 2^0$$

$$N = 1 \times 2^7$$
$$= (128)_{10}$$

**12.** ***Ans (c)***

A fractional decimal number is converted to its equivalent octal number by successive multiplication by 8 as follows

| | Generated Integer |
|---|---|
| $0.3125 \times 8 = 2.5000$ | 2 |
| $.5000 \times 8 = 4.0000$ | 4 |
| $.0000 \times 8 = 0.0000$ | 0 ↓ |

The process is terminated when zeros or significant digits are obtained.

Thus octal equivalent of $(0.3125)_{10}$ is $(0.24)_8$

**13.** ***Ans. (c)***

For obtaining the binary equivalent of an octal number, significant digit in the given number replaced by its 3 bit binary equivalent.

(a) $(75)_8 = 75 = (111101)_2$

(b) $(65)_8 = 65 = (110101)_2$

(c) $(37)_8 = 37 = (011111)_2$

(d) $(26)_8 = 26 = (010110)_2$

**14.** ***Ans. (b)***

**Method I :**

$$(77)_{16} = 7 \times 16^1 + 7 \times 16^0 = 112 + 7 = (119)_{10}$$

$$(3B)_{16} = 3 \times 16^1 + B \times 16^0 = 3 \times 16^1 + 11 \times 16^0 = 48 + 11 = (59)_{10}$$

$$(77)_{16} - (3B)_{16} = (119)_{10} - (59)_{10} = (60)_{10}$$

Now we can convert 60 from decimal to hexadecimal by dividing it by 16.

16 | 60
16 | 3 — 12
3

↑ $= (3C)_{16}$

**Method II :**

→16
  7 7
– 3 B
  3 C

| |
|---|
| 16 + 7 = 23 |
| 7 – B = 23 – B |
| = 23 – 11 = 12 = C |

$\therefore (77)_{16} - (3B)_{16} = (3C)_{16}$

**Note :** The operation is same as that in decimal except that here 16 is used instead of 10.

**15.** ***Ans. (d)***

The conversion from hexadecimal to a decimal number can be carried out by multiplying each significant digit of the hexadecimal by its respective weight and adding the products

$$2 \times 16^3 + A \times 16^2 + 0 \times 16^1 + 15 \times 16^0$$
$$= 2 \times 16^3 + A \times 16^2 + 0 \times 16^1 + F \times 16^0$$
$$= 8192 + 2560 + 0 + 15$$
$$= (10767)_{10}$$

**16.** ***Ans. (d)***

To convert a hexadecimal number into its binary equivalent, each significant digit in the gives number is replaced by its 4 bit binary equivalent

$(4F2D)_{16} \rightarrow (x)_2$

4 F 2 D

0100 1111 0010 1101

$= (0\ 1\ 0\ 0\ 1\ 1\ 1\ 1\ 0\ 0\ 1\ 0\ 1\ 1\ 0\ 1)_2$

**Note :** For Hexadecimal to binary, we use the ratio 8 : 4 : 2 : 1.

**17.** ***Ans. (b)***

To convert a hexadecimal number to octal, the following steps can be applied

(i) Convert the given hexadecimal to its binary equivalent.

(ii) From groups of 3 bits, starting from LSB.

(iii) Write the equivalent octal number for each group of 3 bits.

**18.** ***Ans. (c)***

In hexadecimal system F represents 15

F's complement is obtained by subtracting each digit of the given number from 15.

$(2BFD)_{hex} = (2BFD)_{16}$

FFFF

– 2BFD

D402

Hence F's complement of $(2BFD)_{16}$ is D402

**19.** ***Ans. (d)***

$$(125)_R = (203)_5$$

We convert both sides into decimal equivalents

$$1 \times R^2 + 2R^1 + 5 \times R^0 = 2 \times 5^2 + 3 \times 5^0$$

$$R^2 + 2R + 5 = 50 + 3$$

$$R^2 + 2R - 48 = 0$$

$$R^2 + 8R - 6R - 48 = 0$$

$$R(R + 8) - 6(R + 8) = 0$$

$$R = 6, -8$$

Hence positive value of R is 6 which is radix.

**20.** ***Ans. (c)***

$$(327)_9 = (X)_5$$

To get value of x, we first convert left side into its decimal equivalent.

$$(327)_9 = 3 \times 9^2 + 2 \times 9^1 \times 7 \times 9^0$$
$$= 243 + 18 + 7$$
$$= (268)_{10}$$

Now we convert this decimal number into base 5 by 5 progressively

| Divisor | Number | Generated Integer |
|---|---|---|
| 5 | 268 | 3 |
| 5 | 53 | 3 |
| 5 | 10 | 0 |
| 5 | 2 | 2 |

$= (2033)_5$

Hence X = 2033

**Note :** Any number with any base r can be converted to decimal number and vice-versa.

**(i) Decimal to Base r :** For integer part divide the decimal number by r progressively. For fractional part multiply by r progressively.

**(ii) Base r to Decimal :** Multiply each digit by its corresponding weight and add all.

**21.** ***Ans. (b)***

The Excess-3 code is a self complementing code.

**Note :**

- 2421 code is also a self complementing code.
- A code is called a self complementing code if 1's complement of the coded number yield 9's complement of the number itself.

**22.** ***Ans. (c)***

During the process of binary data transmission errors may occur. In order to detect errors, error-detecting codes are used. The simplest error detecting method is the parity check, in which an extra parity bit is included with the binary message to make the total number of 1's either odd or even, resulting in two methods.

1. **Even-parity method :** The total number of 1's in the code group (including the parity bit) must be an even number.
2. **Odd parity method :** The total number 1's (including parity bit) must be an odd number.

**Note :** The parity bit can be placed at either end of the code word, such that the receiver should be able to understand the parity bit and the actual data

**23.** ***Ans. (b)***

**24.** ***Ans. (d)***

**(a)** ICs are classified into two general categories

**Linear ICs :** Linear ICs operate with continuous signals and are used to construct electronic circuits such as amplifiers, voltage comparators etc.

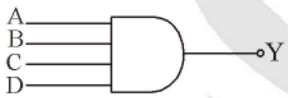
**Digital ICs :** Digital ICs operate with binary signals. Hence alternative (a) is incorrect.

**(b)** The devices used in digital circuits generally operate in one of the two states, known as ON and OFF. The two discrete signal levels HIGH and LOW or ON and OFF can also be represented by the binary digits 1 and 0 respectively So digital circuits are not linear circuits.

**(c)** AND gate


Although highest input is 1 but output is 0. Hence in AND gate output is not always equal to highest input. (c) is incorrected.

**(d)**

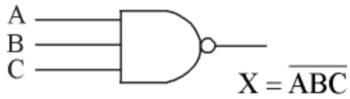



Truth Table

| A | B | C | D | Y |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 0 |
| 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 |
| 1 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 | 1 |

Output is HIGH only when all the inputs are HIGH. So, (d) is correct.

**25.** ***Ans. (c)***



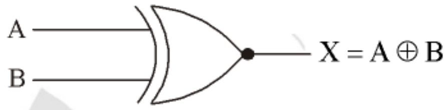

Suppose using three input NAND gate we want to invert the input A then it is possible if

$$ABC = A11 = A$$

then $X = \bar{A}$ for B = C = logic 1

**26.** ***Ans. (c)***

Inverter using the Ex-OR gate




$$X = \bar{A}B + A\bar{B} = A \oplus B$$

Suppose we have to invert the input A

i.e. output must be

$$X = \bar{A}1 + 0A = \bar{A}$$

and it is possible if and only if other inputs are Logic 1. or High


**27.** ***Ans. (d)***

**28.** ***Ans. (b)***

**29.** ***Ans. (d)***

**30.** ***Ans. (d)***

**31.** ***Ans. (d)***

**32.** ***Ans. (a)***

**33.** ***Ans. (a)***

**34.** ***Ans. (c)***

**35.** ***Ans. (b)***

**36.** ***Ans. (c)***

| | |
|---|---|
| 42 in a byte | 00101010 |
| 42 in a word | 0000000000101010 |
| – 42 in a byte | 11010110 |
| – 42 in a word | 1111111111010110 |

**37.** ***Ans. (c)***

2C H + 4F H = 7B H

5E H + 1A H = 78 H

3B H + 6D H = A8 H

5A H + 2C H = 86 H

**38.** ***Ans. (a)***

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