CHAPTER – 3

NUMBER SYSTEMS

The numbers that are commonly used are the decimal numbers which involve ten symbols, namely 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. If we consider the number 526 in the decimal system, it means $5 \times 10^2 + 2 \times 10^1 + 6 \times 10^0$. Likewise, 85.67 means $8 \times 10^1 + 5 \times 10^0 + 6 \times 10^{-1} + 7 \times 10^{-2}$. The role played by "10" in the decimal system is termed as the "base" of the system. In this chapter we see the numbers expressed in various other bases.

Base: It is a number which decides the place value of a symbol or a digit in a number. Alternatively, it is the number of distinct symbols that are used in that number system.

Note:

(A) The base of a number system can be any integer greater than 1.
(B) Base is also termed as radix or scale of notation.

The following table lists some number systems along with their respective base and symbols.

Number System	Base	Symbols
Binary	2	0,1
Septenuary	7	0,1,2,3,4,5,6
Octal	8	0,1,2,3,4,5,6,7
Decimal	10	0,1,2,3,4,5,6,7,8,9
Duo-decimal	12	0,1,2,3,4,5,6,7,8,9,A,B
Hexa decimal	16	0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

A = 10, B = 11, C = 12, D = 13, E = 14, F = 15. Some books denote ten as "E" and eleven as "e".

Representation:

Let N be any integer, r be the base of the system and let a_0, a_1, a_2, ……., a_n be the required digits by which N is expressed. Then

$N = a_n r^n + a_{n-1} r^{n-1} + a_{n-2} r^{n-2} + \ldots\ldots\ldots\ldots + a_1 r + a_0$, where $0 \le a_i < r$.

We now look into some representations and their meaning in decimal system.

Examples:

(i) $(10011)_2$
$= 1 \times 2^4 + 0 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$
$= 16 + 0 + 0 + 2 + 1 = 19_{10}$

(ii) $(1740)_8$
$= 1 \times 8^3 + 7 \times 8^2 + 4 \times 8^1 + 0 \times 8^0$
$= 512 + 448 + 32$
$= 992_{10}$

(iii) $(A3D)_{16}$
$= A \times 16^2 + 3 \times 16^1 + D \times 16^0$
$= 10 \times 256 + 48 + 13 = 2621_{10}$

Conversions

1. Decimal to binary:

(a) $(252)_{10} = (11111100)_2$
Working:

$$\begin{array}{r|l} 2 & 252 \\ \hline 2 & 126 - 0 \\ \hline 2 & 63 \;\; - 0 \\ \hline 2 & 31 \;\; - 1 \\ \hline 2 & 15 \;\; - 1 \\ \hline 2 & 7 \;\;\; - 1 \\ \hline 2 & 3 \;\;\; - 1 \\ \hline & 1 \;\;\; - 1 \end{array}$$

Note: The remainders are written from bottom to top.

(b) $(36.3125)_{10} = (100100.0101)_2$
Working:
The given decimal number has 2 parts:
(i) Integral part 36,
(ii) Fractional part 0.3125.

(i) Conversion of integral part:

$$\begin{array}{r|l} 2 & 36 \\ \hline 2 & 18 \;\; - 0 \\ \hline 2 & 9 \;\;\; - 0 \\ \hline 2 & 4 \;\;\; - 1 \\ \hline 2 & 2 \;\;\; - 0 \\ \hline 1 & \;\;\; - 0 \end{array} \qquad \therefore (36)_{10} = (100100)_2$$

(ii) Conversion of the fractional part:
Multiply the decimal part with 2 successively and take the integral part of all the products starting from the first.

	Binary digits
$0.3125 \times 2 = 0.6250$	0
$0.6250 \times 2 = 1.2500$	1
$0.2500 \times 2 = 0.500$	0
$0.5000 \times 2 = 1.0$	1

$\therefore (0.3125)_{10} = (0.0101)_2$

Note: We should stop multiplying the fractional part by 2, once we get 0 as a fraction or the fractional part is non-terminating. It can be decided depending on the number of digits in the fractional part required.

2. Binary to decimal:

(i) $(101011001)_2 = (345)_{10}$

Working : $(101011001)_2$
$= 1 \times 2^8 + 0 \times 2^7 + 1 \times 2^6 + 0 \times 2^5 + 1 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$
$= 256 + 0 + 64 + 0 + 16 + 8 + 0 + 0 + 1 = (345)_{10}$

(ii) $(0.11001)_2 = (0.78125)_{10}$

Working : $(0.11001)_2$
$= 1 \times 2^{-1} + 1 \times 2^{-2} + 0 \times 2^{-3} + 0 \times 2^{-4} + 1 \times 2^{-5}$
$= 1/2 + 1/4 + 1/32 = 25/32 = (0.78125)_{10}$

3. **Decimal to octal:**

(i) $(2593)_{10} = (5041)_8$

Working :

$$\begin{array}{r|l} 8 & 2593 \\ \hline 8 & 324 - 1 \\ \hline 8 & 40 \ \ - 4 \\ \hline & \ 5 \ \ - 0 \end{array}$$

$\therefore$ $(2593)_{10} = (5041)_8$

(ii) $(420.235)_{10} = (644.170)_8$

Working:

(a) Integral part:

$$\begin{array}{r|l} 8 & 420 \\ \hline 8 & 52 - 4 \\ \hline & \ 6 \ - 4 \end{array}$$

$\therefore$ $(420)_{10} = (644)_8$

(b) Fractional part:

$0.235 \times 8 = 1.88 \quad \rightarrow \quad 1$

$0.88 \times 8 = 7.04 \quad \rightarrow \quad 7$

$0.04 \times 8 = 0.32 \quad \rightarrow \quad 0$

We can stop here as the fraction is non-terminating.

$\therefore (420.235)_{10} = (644.170)_8$ (approx.)

This is done to find a 3-digit accuracy.

4. **Octal to decimal:**

(i) $(3721)_8 = (2001)_{10}$

Working:

$(3721)_8 = 3 \times 8^3 + 7 \times 8^2 + 2 \times 8^1 + 1 \times 8^0$

$= 1536 + 448 + 16 + 1 = (2001)_{10}$

(ii) $(362.74)_8 = (242.9375)_{10}$

Working:

(a) Integral part:

$(362)_8 = 3 \times 8^2 + 6 \times 8^1 + 2 \times 8^0$

$= 192 + 48 + 2 = 242$

$\therefore$ $(362)_8 = (242)_{10}$

(b) Fractional part:

$(0.74)_8 = 7 \times 8^{-1} + 4 \times 8^{-2}$

$= \dfrac{56+4}{64} = \dfrac{60}{64} = 0.9375$

$\therefore$ $(362.74)_8 = (242.9375)_{10}$

5. **Decimal to hexa-decimal:**

(i) $(47236)_{10} = (B884)_{16}$

Working:

$$\begin{array}{r|l} 16 & 47236 \\ \hline 16 & 2952 \ - 4 \\ \hline 16 & 184 \ \ \ - 8 \\ \hline & 11 \ \ \ \ - 8 \end{array}$$

Recall: 11 is B, in hexa-decimal system.

$\therefore (47236)_{10} = (B884)_{16}$

(ii) $(30004)_{10} = (7534)_{16}$

Working:

$$\begin{array}{r|l} 16 & 30004 \\ \hline 16 & 1875 - 4 \\ \hline 16 & 117 \ \ - 3 \\ \hline & \ 7 \ \ \ \ - 5 \end{array}$$

$\therefore$ $(30004)_{10} = (7534)_{16}$

6. **Hexa-decimal to decimal:**

$(51B)_{16} = (1307)_{10}$

Working:

$(51B)_{16} = 5 \times 16^2 + 1 \times 16^1 + B \times 16^0$

$= 1280 + 16 + 11$

$= (1307)_{10}$

$\therefore (51B)_{16} = (1307)_{10}$

7. **Decimal to duo-decimal or duodenary (base 12):**

$(946)_{10} = (66A)_{12}$

Working:

$$\begin{array}{r|l} 12 & 946 \\ \hline 12 & 78 \ - 10 \text{ or A} \\ \hline & \ 6 \ \ \ - 6 \end{array}$$

$\therefore (946)_{10} = (66A)_{12}$

8. **Duo-decimal to decimal:**

$(5BA)_{12} = (862)_{10}$

Working:

$(5BA)_{12} = 5 \times 12^2 + B \times 12^1 + A \times 12^0$

$= 720 + 132 + 10 = (862)_{10}$

9. **Binary to octal:**

8 being the base of octal system and 2 being the base of binary system, there is a close relationship between both the systems. One can just club three digits of a binary number into a single block and write the decimal equivalent of each group (left to right).

Example:

(i) $(100101011)_2 = (100)_2\ (101)_2\ (011)_2 = (453)_8$

$\therefore$ $(100101011)_2 = (453)_8$

(ii) $(10111110)_2 = (010)_2\ (111)_2\ (110)_2 = (276)_8$

$\therefore$ $(10111110)_2 = (276)_8$

Note: Introduce leading zeros to form a block of 3 without changing the magnitude of the number.

10. **Binary to hexa-decimal:**

This is similar to the method discussed for octal; instead of clubbing 3, we club 4 digits.

Example:

$(10101110)_2 = (1010)_2\ (1110)_2 = (10)\ (14) = (AE)_{16}$

$\therefore$ $(10101110)_2 = (AE)_{16}$

Note: If the number of digits is not a multiple of 4, introduce leading zeros as done earlier for octal conversion.

Binary Arithmetic:

Addition:

Elementary Rules

$0 + 0 = 0$

$0 + 1 = 1$

$1 + 0 = 1$

$1 + 1 = 10$ (1 will be regarded as carry1 + 1 + 1 = 11 as we do in decimal system)

Examples of binary addition:

1. $(100101)_2 + (110)_2$

```
      1        →  carry
  1 0 0 1 0 1
  0 0 0 1 1 0   (Introduce leading zeros)
  -----------
  1 0 1 0 1 1
```

2. $(101110)_2 + (111011)_2$

```
   1 1  1 1    → carry
   1 0 1 1 1 0
   1 1 1 0 1 1
  -------------
  1 1 0 1 0 0 1
```

3. $(110)_2 + (100)_2 + (010)_2$

```
   1      → carry
   1 1 0
   1 0 0
   0 1 0
  ------
  11 0 0
```

Subtraction: Subtract 1101 from 11010.

1.

```
             2
           0 0 2 0 2
           1 1 0 1 0
          – 1 1 0 1
result →    1 1 0 1
```

Explanation: Say N = 11010,
As 1 cannot be subtracted from 0, we borrow 2 from the next place. This gives 2 – 1 = 1, as the right most digit of the result. The penultimate digit of N would become 0. A similar calculation gives the 3rd digit of the result from the right as 1 and the 4th digit of N from the right becomes 0.
We now borrow a 2 from the 5th digit of N, this makes the 4th digit of N as 2, thereby resulting in 2 – 1 = 1 as the 4th digit of the result.

2. Subtract 11011 from 111001

```
   2 2 1
   0 0 2 2 →  Borrow
 1 1 1 0 0 1
 –1 1 0 1 1
   1 1 1 1 0
```

Examples:

3.01. Show that the binary number $(11101010010001)_2$ is equal to $(35221)_8$ and $(3A91)_{16}$.

Sol: (a) We keep forming blocks of 3 from left to right. Also, if the number of digits is not a multiple of 3, then we introduce leading zeros (since the inclusion of zero to the left will not affect the value).
$(\underline{011}\ \underline{101}\ \underline{010}\ \underline{010}\ \underline{001})_2$
$= ((011)_2\,(101)_2\,(010)_2\,(010)_2\,(001)_2)_8$
$= (35221)_8.$

(b) We keep forming blocks of 4 from left to right (introduce lead zeros)
$(\underline{0011}\ \underline{1010}\ \underline{1001}\ \underline{0001})_2$
$= ((0011)_2\,(1010)_2\,(1001)_2\,(0001)_2)_{16}$
$= (3A91)_{16}.$

3.02. Show that 121 is a perfect square in any base greater than 2.

Sol: Let n be the base of a number system ($n \ge 3$).
$(121)_n = n^2 + 2n + 1 = (n + 1)^2$.
Now $(n + 1)^2$ being a perfect square, for any value of n
$\therefore$ 121 is a perfect square in any base greater than 2.

3.03. If f(x, y, z) = (x + y) (y + z) (x + z) where x, y and z are decimal numbers, then find $f((13)_4, (11)_8, (17)_{10})$.

Sol: $(13)_4 = 4^1 \times 1 + 4^0 \times 3 = 4 + 3 = (7)_{10}$
$(11)_8 = 8^1 \times 1 + 8^0 \times 1 = 8 + 1 = (9)_{10}$
$(17)_{10} = (17)_{10}$
Now the numbers are in common base of 10.
f(x, y, z) = (x + y) (y + z) (z + x)
$f(7, 9, 17) = 16 \times 26 \times 24 = (9984)_{10}$

3.04. Find the base k of the number system, if $(543)_6 = (317)_k$.

Sol: $(543)_6 = 5 \times 6^2 + 4 \times 6 + 3 \times 6^0 = (207)_{10}$
i.e., $(207)_{10} = (317)_k$
$207 = 3k^2 + k + 7 \Rightarrow 3k^2 + k - 200 = 0$
$\Rightarrow 3k^2 - 24k + 25k - 200 = 0$
$\Rightarrow (3k + 25)(k - 3) = 0$
$\Rightarrow k = 8$ or $-25/3$ (not possible)
$\Rightarrow k = 8$
$\therefore$ The base is 8.

3.05. Find the hexa-decimal equivalent of the number $(174356)_8$

Sol: We initially convert the number $(174356)_8$ into binary system, by converting each digit into a triplet in terms of binary digits.

1	7	4	3	5	6
↓	↓	↓	↓	↓	↓
$(001)_2$	$(111)_2$	$(100)_2$	$(011)_2$	$(101)_2$	$(110)_2$

$(1111100011101110)_2$
Now, we group 4 digits into a single block (left to right) to get the hexa-decimal equivalent.
$(1111)_2\,(1000)_2\,(1110)_2\,(1110)_2 = (F8EE)_{16}$

3.06. Multiply $(134)_5$ and $(220)_5$.

Sol: We convert each number into base 10. After computing the product in base 10, we convert it back to base 5.
$(134)_5 = 1 \times 5^2 + 3 \times 5 + 4 \times 1$
$= 25 + 15 + 4 = (44)_{10}$
$(220)_5 = 2 \times 5^2 + 2 \times 5 + 0 \times 1$
$= 50 + 10 + 0 = (60)_{10}$
$44 \times 60 = (2640)_{10}$

```
5 | 2640
5 | 528 – 0
5 | 105 – 3
5 | 21  – 0
    4   – 1
```

so $(2640)_{10} = (41030)_5$
$\therefore (134)_5 \times (220)_5 = (41030)_5$

3.07. Which of these weights among 1, 2, 4, 8, 16 etc kgs are used in weighing 250 kgs, if, not more than one weight of each denomination is used for weighing?

Sol: The denominations are powers of 2, so we express 250 as sum of some powers of 2
Accordingly, 250 = 128 + 64+ 32 + 16 + 8 + 2. Thus on expressing 250 in binary scale, we get 11111010, the place value of 1's are the weights required for weighing.

3.08. Subtract $(23644)_7$ from $(41066)_7$.

Sol:

$$\begin{array}{r} 41066 \\ 23644 \\ \hline 14122 \\ \hline \end{array}$$

Explanation: 6 – 4 = 2 for the two right most digits.
As we cannot deduct 6 from 0, we now borrow 1 (= 7) from the next place and add it to 0. As (0 + 7) = 7, we deduct 6 from 7 which is 1. As one is borrowed from 1, so it becomes 0. Again since 3 cannot be deducted from 0, we borrow 1 from 4. Similarly, we can proceed.

3.09. Find the binary equivalent of the fraction 0.325.

Sol: Multiply the fractional part by 2. If we get any integer part, we take1, otherwise, 0 as the binary digit. Each time we multiply by 2 and take the fraction part for the next time. Once the fractional part becomes 0, we stop, and the binary equivalent of the fraction in 1's or 0's is taken in order from top to bottom as it is obtained in each step.

Also if the fraction does not terminate, we can stop the process after a certain number of times. The binary equivalent obtained will be the approximate value of the fraction.
So, $(0.325)_{10}$

Steps:	binary
(1) $0.325 \times 2 = 0.65$	0
(2) $0.65 \times 2 = 1.3$	1
(3) $0.3 \times 2 = 0.6$	0
(4) $0.6 \times 2 = 1.2$	1
(5) $0.2 \times 2 = 0.4$	0
(6) $0.4 \times 2 = 0.8$	0

As the fractional part is small, we can stop.
$\therefore (0.325)_{10} = (0.010100)_2$

3.10. A non-zero number in base 5 is such that twice the number equals the number formed by reversing the digits. Find the number.

Sol: Let the number be $(xy)_5$, where $0 \le x, y < 5$
The number formed by reversing the digits is $(yx)_5$

Now $(xy)_5 = (5x + y)_{10}$
and $(yx)_5 = (5y + x)_{10}$
Given $2(xy)_5 = (yx)_5$
so $2(5x + y) = 5y + x$
$\Rightarrow 9x = 3y$
$\Rightarrow 3x = y$
As the number is non - zero, x = 1 and y = 3.
Then the number is 13.

Concept Review Questions

Directions for questions 1 to 15: For the Multiple Choice Questions, select the correct alternative from the given choices. For the Non-Multiple Choice Questions, write your answer in the box provided.

1. The binary equivalent of the decimal number 502 is _____.
(A) $(111010011)_2$ (B) $(101111001)_2$
(C) $(100111111)_2$ (D) $(111110110)_2$

2. The decimal equivalent of the binary number 1000001 is $\boxed{}$.

3. The septenary equivalent of the decimal number 532 is $\boxed{}$.

4. The duo-decimal equivalent of the decimal number 1463 is _____.
(A) $(A19)_{12}$ (B) $(AB1)_{12}$
(C) $(A1B)_{12}$ (D) $(BA1)_{12}$

5. The largest 3-digit septenary number is $\boxed{}$.

6. The octal equivalent of the decimal number 239 is _____.
(A) $(753)_8$ (B) $(75)_8$
(C) $(57)_8$ (D) $(357)_8$

7. The decimal equivalent of the hexadecimal number AEB is _____.
(A) $(2595)_{10}$ (B) $(2795)_{10}$
(C) $(2790)_{10}$ (D) $(2790)_{10}$

8. A decimal number when represented in the binary system has its last three digits as zeros. The number (in decimal system) can be ______.
(A) 100 (B) 5 (C) 18 (D) 8

9. The hexa-decimal equivalent of the decimal number 1734 is ______.
(A) $(CC6)_{16}$ (B) $(BC6)_{16}$
(C) $(C6C)_{16}$ (D) $(6C6)_{16}$

10. Which of the following is equivalent to $(99)_{10}$?
(A) $(243)_6$ (B) $(201)_7$
(C) $(143)_8$ (D) All the above

11. To express a number in the binary system, the digits we use are ______.
(A) 0, 1, 2, 3 (B) 0, 1, 2
(C) 0, 1 (D) 0, 1, 2, 3, 4

12. In the duodecimal system, the numerical value of A is $\boxed{}$.

13. The last 4 bits in the binary representation of a multiple of 16 could be ______.
(A) 0100 (B) 1000
(C) 1100 (D) 0000

14. The decimal equivalent of the binary number 1. 011 is ______.
(A) 1.0375 (B) 0.0375
(C) 1.3075 (D) 1.375

15. The cube root of $(224)_5$ in base 3 is $\boxed{}$.

Exercise – 3(a)

Directions for questions 1 to 25: For the Multiple Choice Questions, select the correct alternative from the given choices. For the Non-Multiple Choice Questions, write your answer in the box provided.

1. The binary equivalent of the octal number 374 is ______.

(A) $(1111100)_2$ (B) $(1111110)_2$
(C) $(11111100)_2$ (D) $(1111110)_2$

2. $(386)_{12} – (177)_{12}$ = ______.

(A) $(206)_{12}$ (B) $(20B)_{12}$
(C) $(209)_{12}$ (D) $(2BB)_{12}$

3. The minimum number of bits required to represent the decimal number 418 in the binary system is ☐ .

4. The remainder obtained when $(110101111)_2$ is divided by $(A)_{16}$ is _____.
(A) $(5)_{10}$ (B) $(1)_{10}$ (C) $(3)_{10}$ (D) $(4)_{10}$

5. The binary equivalent of $(57{\cdot}140625)_{10}$ is _____.
(A) $(110101.001001)_2$ (B) $(111001.001001)_2$
(C) $(111001.1000100)_2$ (D) $(110101.001101)_2$

6. The decimal equivalent of the number $(13{\cdot}24)_5$ is ☐ .

7. If '0' is concatenated to the rightmost digit of a positive integer 'n' which is represented in the hexadecimal system, then the resultant number is ______.
(A) 16n (B) n (C) 16 + n (D) 16n + 16

8. All 7, 8 or 9-digit numbers in base m can be represented as 5 or 6-digit numbers in base n. Which of the following is a possible value of (m, n)?
(A) (2, 3) (B) (3, 6) (C) (3, 7) (D) (4, 8)

Directions for questions 9 and 10: Read the following data and attempt the questions based on the given data.

A milk vending machine gives milk in the quantities of 1litre, 2litres, 4litres, 8 litres, 16 litres, 32 litres, 64 litres, 128 litres or 256 litres. A person wants to buy 400 litres.

9. What is the minimum number of times he has to use the machine to obtain the milk?

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10. The machine develops a snag and cannot give 256 litres in one go. What is the minimum number of times he has to use the machine to obtain the milk?

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11. If $(11.5)_n = (1001.101)_2$, then n = ☐ .

12. If $(a)_{10}$ \$ $(b)_{10} = (5a + 2b + 2)_{10}$, then $(25)_{12}$ \$ $(17)_{10}$ = _____.
(A) $(186)_{10}$ (B) $(181)_{10}$
(C) $(191)_{10}$ (D) $(196)_{10}$

13. If the LCM of $(51)_k$ and $(50)_{k+2}$ is $(180)_{10}$,and their GCD is $(9)_{10}$, then k = ☐ .

14. In which of the following scales is the number 305 a perfect cube?
(A) 13 (B) 7 (C) 10 (D) 12

15. If the arithmetic mean of $(33)_7$ and $(28)_9$ is $(1C)_b$, then the value of b is ☐ .

16. If five and eight are the roots of the quadratic equation $x^2 – ax + 44 = 0$ in a certain number system, then find the base of the system.

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17. The product of $(34)_7$ and $(31)_8$ is _____.
(A) $(441)_{12}$ (B) $(443)_{12}$
(C) $(421)_{12}$ (D) $(431)_{12}$

18. A decimal number, which is represented by the scales of 3, 4, 5, and 7 has 1, 2, 3, and 5 respectively, as the digits on its extreme right. The smallest such positive number is ☐ .

19. If $(a)_{10}@(b)_{10} = (5a – 2b + 60)_{10}$, $(314)_5@(412)_6$ = _____.
(A) $(111100)_2$ (B) $(351)_7$
(C) $(6A)_{17}$ (D) $(341)_7$

20. The hexadecimal equivalent of the octal number 23516 is _____.
(A) $(247E)_{16}$ (B) $(27E4)_{16}$
(C) $(274E)_{16}$ (D) $(427E)_{16}$

21. If f(a, b, c) = 3a + 2b - c, then $f[(23)_{10}, (21)_8, (23)_5]$ = _____.
(A) $(231)_8$ (B) $(1011010)_2$
(C) $(315)_6$ (D) $(7B)_{14}$

22. The five numbers a, b, c, d and e are $(26)_7$, $(104)_6$, $(88)_9$, $(120)_{10}$ and $(114)_{12}$ respectively. Choose the correct statement.
(A) a, b, c are in AP (B) b, c, d are in GP
(C) c, d, e are in GP (D) a, c, e are in AP

23. The square root of the octal number 2000 in decimal system is ☐ .

24. The square of the number $(325)_8$ is _____.
(A) $(130471)_8$ (B) $(120473)_8$
(C) $(111476)_8$ (D) $(170473)_8$

25. If $(1002)_n = (345)_{10}$, then find the value of n.

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Exercise – 3(b)

Directions for questions 1 to 25: For the Multiple Choice Questions, select the correct alternative from the given choices. For the Non-Multiple Choice Questions, write your answer in the box provided.

Very Easy / Easy

1. The decimal equivalent of $(3AC)_{13}$ is $\boxed{}$.

2. The octal equivalent of the number $(100101011)_2$ is $\boxed{}$.

3. The number $(1110011101)_2$ in hexadecimal system is _____.
(A) $(E74)_{16}$ (B) $(47E)_{16}$ (C) $(39D)_{16}$ (D) $(3D9)_{16}$

4. If '0' is concatenated to the right most digit of a number whose radix is n, then the number thus formed is _____.
(A) the same as the original number
(B) half the original number
(C) n times the original number
(D) $\frac{1}{n}$ times the original number

Moderate

5. The duo-decimal equivalent of the decimal number 123456 is ______.
(A) $(45B5)_{12}$ (B) $(5B540)_{12}$
(C) $(511540)_{12}$ (D) $(5B54)_{12}$

6. $(101101)_2 + (201)_8 + (453)_{10}$ = _____.
(A) $(528)_{11}$ (B) $(766)_9$
(C) $(344)_{12}$ (D) $(3611)_8$

7. $(231)_{16} – (231)_8$ = _____.
(A) $(305)_9$ (B) $(525)_{13}$
(C) $(143)_{11}$ (D) $(341)_{11}$

8. Compute $(110110)_2 – (10001)_2$.
(A) $(112)_4$ (B) $(25)_7$ (C) $(104)_5$ (D) $(211)_4$

9. The decimal fraction (0.7265625) in binary system is ______.
(A) $(0.1011111)_2$ (B) $(0.1111101)_2$
(C) $(0.1011101)_2$ (D) $(0.1110101)_2$

10. The decimal equivalent of the binary number $(110101.11011)_2$ is $\boxed{}$.

11. The minimum number of bits required to represent the decimal number 281 in binary system is $\boxed{}$.

12. If a + b + c + d + e leaves a remainder of 3 when divided by n, (n > 6) then the remainder of $(abcde)_{n+1}$ when divided by n is ______.
(A) 1 (B) 2 (C) 3 (D) n – 3

13. The square root of the octal number 1331 is _____.
(A) $(36)_4$ (B) $(63)_7$
(C) $(21)_{13}$ (D) $(43)_8$

14. The square of $(132)_4$ is _____.
(A) $(4242)_7$ (B) $(10230)_4$
(C) $(2424)_7$ (D) $(32012)_4$

15. The remainder obtained when $(10111001)_2$ is divided by $(11110)_2$ is _____.
(A) $(4)_5$ (B) $(21)_3$ (C) $(5)_{10}$ (D) $(2B)_{12}$

16. $(215)_8 + (476)_8$ = _____.
(A) $(713)_{10}$ (B) $(713)_8$
(C) $(691)_{10}$ (D) $(731)_8$

17. The product of $(112)_3$ and $(111)_5$ expressed in duodenary system is $\boxed{}$.

18. In which of the following scales is the number 1654 a perfect square?
(A) 8 (B) 7 (C) 11 (D) 12

19. If the arithmetic mean of $(39)_{11}$ and $(62)_9$ is $(144)_n$, then the sum of $(32)_4$ and $(21)_5$ in a system with radix n is $\boxed{}$.

20. If $(125)_k = (68)_{10}$, then k = $\boxed{}$.

21. The numbers $(62)_8$, $(144)_8$ and $(226)_8$ are in _____.
(A) AP (B) GP
(C) HP (D) Both (AP) and (GP)

22. The LCM of $(310)_4$ and $(110)_4$ is ______.
(A) $(2021)_5$ (B) $(1112)_6$
(C) $(10011)_4$ (D) $(265)_{10}$

Difficult / Very Difficult

23. If f (x, y, z) = (x + 2y) (2y + z) (z + x), then find the value of f($(A)_{16}$, $(11)_2$, $(13)_8$).
$\boxed{}$

24. If $(346)_n = (1211)_5$, then $(235)_{10}$ in a system with radix n is $\boxed{}$.

25. In a certain system, if 2 and 9 are the roots of the quadratic equation $x^2 – px + (15)_n = 0$, then express $(543)_6$ in base n.
(A) 32A (B) 12C (C) C21 (D) 207

Key

Concept Review Questions

1. D	5. 666	9. D	13. D
2. 65	6. D	10. D	14. D
3. 1360	7. B	11. C	15. 11
4. C	8. D	12. 10	

Exercise – 3(a)

1. C	8. D	15. 13	22. B
2. B	9. 3	16. 9	23. 32
3. 9	10. 4	17. A	24. A
4. B	11. 8	18. 418	25. 7
5. B	12. B	19. D	
6. 8.56	13. 7	20. C	
7. A	14. A	21. B	

Exercise – 3(b)

1. 649	8. D	15. C	22. B
2. 453	9. C	16. B	23. 5712
3. C	10. 53.84375	17. 302	24. 454
4. C	11. 9	18. B	25. B
5. B	12. C	19. 100	
6. B	13. C	20. 7	
7. D	14. C	21. A	