POSTAL Book Package 2023

Electrical Engineering

Conventional Practice Sets

Digital Electronics

Contents

MADE EASY Publications

1 CHAPTER Number Systems and Codes

Practice Questions : Level-I

Q.1 (i) Convert octal 756 to decimal.
(ii) Convert hexadecimal 3B2 to decimal.
(iii) Convert the long binary number 1001001101010001 to octal and to hexadecimal.

Solution:

(i) $(756)_8$

$$= 7 \times 8^2 + 5 \times 8^1 + 6 \times 8^0$$
$$= 448 + 40 + 6 = (494)_{10}$$

(ii) $(3B2)_{16}$

$$= 3 \times 16^2 + 11 \times 16^1 + 2 \times 16^0 \quad \text{(put B = 11)}$$
$$= 768 + 176 + 2 = (946)_{10}$$

(iii)
$$\underbrace{0\ 0\ 1}_{1}\ \underbrace{0\ 0\ 1}_{1}\ \underbrace{0\ 0\ 1}_{1}\ \underbrace{1\ 0\ 1}_{5}\ \underbrace{0\ 1\ 0}_{2}\ \underbrace{0\ 0\ 1}_{1}$$
$$= (111521)_8$$

and
$$\underbrace{1\ 0\ 0\ 1}_{9}\ \underbrace{0\ 0\ 1\ 1}_{3}\ \underbrace{0\ 1\ 0\ 1}_{5}\ \underbrace{0\ 0\ 0\ 1}_{1}$$
$$= (9351)_{16}$$

Q.2 Show the value of all bits of a 12-bit register that holds the number equivalent to decimal 215 in
(a) binary (b) binary coded octal (c) binary coded hexadecimal and (d) binary coded decimal.

Solution:

(a) Binary

$$(215)_{10} = (11010111)_2$$

2	215	
2	107	1
2	53	1
2	26	1
2	13	0
2	6	1
2	3	0
	1	1

In a 12-bit register, it will be stored as: "0 0 0 0 1 1 0 1 0 1 1 1"

(b) Binary Coded Octal

$$(215)_{10} = (0327)_8 = 000\ \ 011\ \ 010\ \ 111$$

(c) Binary Coded Hexadecimal

$$(215)_{10} = (0D7)_{16} = 0000\ \ 1101\ \ 0111$$

(d) Binary Coded Decimal

In binary coded decimal, each decimal (0 to 9) digit is represented by 4-bit binary code.

$$(215)_{10} = 0010\ \ 0001\ \ 0101$$

Q.3 Consider the addition of numbers with different bases
$(x)_7 + (y)_8 + (w)_{10} + (z)_5 = (k)_9$
If $x = 36$, $y = 67$, $w = 98$ and $k = 241$, then z is

Solution:

$$(36)_7 = (27)_{10}$$
$$(67)_8 = (55)_{10}$$
$$(98)_{10} = (98)_{10}$$
$$(z)_5 = (z)_5$$
$$(241)_9 = (199)_{10}$$
$$(z)_5 = (199)_{10} - (27)_{10} - (55)_{10} - (98)_{10}$$

5	19	4
	3	

$$(z)_5 = (19)_{10}$$
$$(z)_5 = (34)_5$$
$$\therefore \quad z = 34$$

Q.4 (a) Convert the below binary code into Gray code.

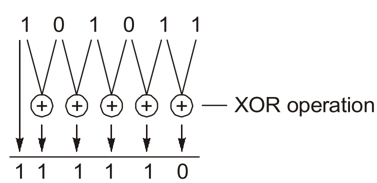
(i) 101011 (ii) 110110

(b) Convert below gray code into binary

110011

Solution:

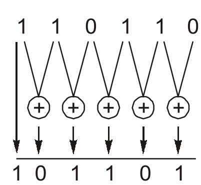
(a) (i) Binary code:



Write the most significant as it is then obtain the remaining bits by doing XOR operation between adjacent bits.

Hence Gray code will be 111110.

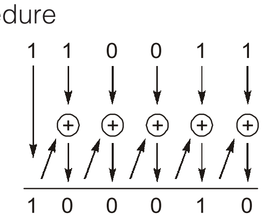
(ii) 110110



Hence Gray code will be 101101

(b) Given Gray code is 110011.

Now to convert it into binary, write most significant bit as it is and then XOR this bit to the next most significant bit and repeat the procedure



Hence result binary code will be $(100010)_2$.

Q.5 (a) Represent the 8620 into following codes:

(i) BCD (ii) Excess-3 (iii) 2421

(b) Find 7's complement of the given number $(2365)_7$

Solution:

(a) (i) Write binary equivalent of each decimal

8620 ⇒ 1000 0110 0010 0000

(ii) **Excess-3:** For excess 3, add 3 (binary 0011) to each BCD part.

Hence,

1000	0110	0010	0000
+0011	+0011	+0011	+0011
1011	1001	0101	0011

(iii) 2421: It is a weighted binary code

Decimal digit	2	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	1	0	1	1
6	1	1	0	0
7	1	1	0	1
8	1	1	1	0
9	1	1	1	1

There codes are minor image from the given dotted line.

As $(4)_{10}$ and $(5)_{10}$ make complementary pair.

Similarly, $(3)_{10}$ and $(6)_{10}$ .... make the complementary pair.

Hence, 1110 1100 0010 0000.

(b) For a value/number having a base of r, then r's complement = $(r-1)$'s complement + 1

Hence, 7's complement of $(2365)_7$ = 6's complement + 1

$$\begin{array}{r l} 6\,6\,6\,6 & \\ -\,2\,3\,6\,5 & \\ \hline 4\,3\,0\,1 & \text{6's complement} \\ +\,1 & \\ \hline 4\,3\,0\,2 & \text{7's complement} \end{array}$$

Q.6 Perform the following conversions:

(i) $(3287.5100098)_{10}$ into octal (ii) $(675.625)_{10}$ into hexadecimal (iii) $(A72E)_{16}$ into octal

Solution:

(i) To convert $(3287.5100098)_{10}$ into octal:

- Integer part conversion,

$$\begin{array}{r|l} 8 & 3287 \\ \hline 8 & 410-7 \\ \hline 8 & 51-2 \\ \hline 8 & 6-3 \\ \hline & 0-6 \end{array} \uparrow \qquad (3287)_{10} = (6327)_8$$

- Fractional part conversion,

$$0.5100098 \times 8 = 4.0800784 \rightarrow 4$$
$$0.0800784 \times 8 = 0.6406272 \rightarrow 0$$
$$0.6406272 \times 8 = 5.1250176 \rightarrow 5$$
$$0.1250176 \times 8 = 1.0001408 \rightarrow 1$$
$$(0.5100098)_{10} = (0.4051...)_8$$

So, $(3287.5100098)_{10} = (6327.4051...)_8$

(ii) To convert $(675.625)_{10}$ into hexadecimal:

- Integer part conversion,

$$\begin{array}{r|l} 16 & 675 \\ \hline 16 & 42-3 \\ \hline 16 & 2-A \\ \hline & 0-2 \end{array} \uparrow \qquad (675)_{10} = (2A3)_{16}$$

- Fractional part conversion,

$$0.625 \times 16 = 10.000 \rightarrow A$$

$$(0.625)_{10} = (0.A)_{16}$$

So, $(675.625)_{10} = (2A3.A)_{16}$

(iii) To convert $(A72E)_{16}$ into octal:

- Hexadecimal to binary conversion,

$$(A72E)_{16} = (1010\ 0111\ 0010\ 1110)_2$$

- Binary to octal conversion,

$$(1010\ 0111\ 0010\ 1110)_2 = (001\ 010\ 011\ 100\ 101\ 110)_2$$

$$= (123456)_8$$

So, $(A72E)_{16} = (123456)_8$

Practice Questions : Level-II

Q.7 If $X = 111.101$ and $Y = 101.110$ calculate $X + Y$ and $\left.\begin{matrix} X-Y \\ Y-X \end{matrix}\right\}$ by 2's complement method.

Solution:

Given $X = 111.101$

$Y = 101.110$

Now
$$\begin{array}{r} X+Y = \quad 111.101 \\ 101.110 \\ \hline 1101.001 \\ \hline \end{array}$$

For $X - Y = X +$ 2's complement of Y

$= 111.101 + 010.010$

Discard the carry $=$ ① 001.111 as number will be positive

$= 001.111 = 1.111$

For $Y - X = Y +$ 2's complement of X

$= 101.110 + 000.011 = 110.001$

$\because$ There is no carry generated its a negative number.

$\therefore$ Difference = – (2's complement of 110.001) = – 1.111

Q.8 Perform the following addition and subtraction of excess-3 numbers:

(i) 0100 1000 + 0101 1000 (ii) 1100 1011 – 0100 1001

Check the results obtained, by performing the above operations in decimal format.

Solution:

(i) 0100 1000 + 0101 1000 in excess-3 format:

$$\begin{array}{rrl} & 0100 \quad 1000 & \\ (+) & 0101 \quad 1000 & \\ \hline & 1001 \; \textcircled{1} \; 0000 & \text{There is a carry from lower} \\ & 1 \hookleftarrow \quad & \text{nibble, which is to be propagated} \\ \hline & 1010 \quad 0000 & \text{Add "0011" to lower nibble} \\ (-) & 0011 \; (+) \; 0011 & \text{Subtract "0011" from higher nibble} \\ \hline & 0111 \quad 0011 & \leftarrow \text{Final result in excess-3 format} \\ \hline \end{array}$$

Checking the above result in decimal format:

$$0100\,1000 \xrightarrow{\text{To 8421 BCD}} 00010101 \xrightarrow{\text{To decimal}} (15)_{10}$$

$$01011000 \xrightarrow{\text{To 8421 BCD}} 0010\,0101 \xrightarrow{\text{To decimal}} (25)_{10}$$

$$(15)_{10} + (25)_{10} = (40)_{10}$$

$$(40)_{10} \xrightarrow{\text{To 8421 BCD}} 0100\,0000 \xrightarrow{\text{To excess-3}} 01110011$$

(ii) 1100 1011 – 0100 1001 in excess-3 format:

$$\begin{array}{rrl} & 1100 \quad 1011 & \\ (-) & 0100 \quad 1001 & \\ \hline & 1000 \quad 0010 & \text{Add "0011" to both the nibbles} \\ (+) & 0011 \; (+) \; 0011 & \\ \hline & 1011 \quad 0101 & \leftarrow \text{Final result in excess-3 format} \\ \hline \end{array}$$

Checking the above result in decimal format:

$$1100\,1011 \xrightarrow{\text{To 8421 BCD}} 10011000 \xrightarrow{\text{To decimal}} (98)_{10}$$

$$0100\,1001 \xrightarrow{\text{To 8421 BCD}} 00010110 \xrightarrow{\text{To decimal}} (16)_{10}$$

$$(98)_{10} - (16)_{10} = (82)_{10}$$

$$(82)_{10} \xrightarrow{\text{To 8421 BCD}} 1000\,0010 \xrightarrow{\text{To excess-3}} 10110101$$

Q.9 (i) Each of the following arithmetic operations is correct in atleast one number system. Calculate the minimum non-zero base for which the following operations are true.

1. $\dfrac{54}{4} = 13$ 2. $\sqrt{41} = 5$ 3. $\dfrac{302}{20} = 12.1$ 4. $3 \times 11 = 33$

(ii) Calculate the minimum non-zero base of *x* which satisfies the quadratic equation $x^2 - 11x + 22 = 0$, whose roots are $x = 3$ and $x = 6$.

Solution:

(i) 1. Let the base of the expression be 'x'.

thus,
$$\frac{(54)_x}{(4)_x} = (13)_x$$

$$\Rightarrow \quad \frac{5x+4}{4} = x + 3$$

$$\Rightarrow \quad 5x + 4 = 4x + 12$$

$$x = 8$$

Hence, the minimum non-zero base is equal to '8'.

2. Let the base of the expression be equal to 'x'.

$$\sqrt{(41)_x} = (5)_x$$

$$\sqrt{4x+1} = 5$$