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Unit-II. Number System and Codes.

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1. Subtract using 2's complement method:

a. $(1111101)_2 - (100101)_2$.

Ans. Taking 2's complement of $(100101)_2 = (011010)+1$

$= 011011.$

Adding $(1111101)_2$ with 2's complent of $(100101)_2$.

$$
\begin{array}{cccccccc}
 & 1 & 1 & 1 & 1 & 1 & 0 & 1 \\
+ & 0 & 0 & 1 & 1 & 0 & 1 & 1 \\
\hline
1 & 0 & 0 & 1 & 1 & 0 & 0 & 0
\end{array}
$$

final carry discarded

$\therefore (1111101)_2 - (100101)_2 = 11000_2$

b. $(10011000)_2 - (1001100)_2$.

Ans. Taking 2's complement of $(1001100)_2 = 0110011 + 1$

$= 0110100$

Adding $(10011000)_2$ with 2's complement of $(1001100)_2$.

$$
\begin{array}{ccccccccc}
 & 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\
+ & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 0 \\
\hline
 & 1 & 1 & 0 & 0 & 1 & 1 & 0 & 0
\end{array}
$$

$\therefore (10011000)_2 - (1001100)_2 = 11001100$

2. Use 1's complement method to subtract the following.

a. $(100)_2 - (110000)_2$

Ans. Taking 2's complement of $(110000)_2 = 001111+1$
$= (010000)_2$

Adding $(100)_2$ with 2's complement of $(110000)_2$

$$
\begin{array}{r}
0\ 0\ 0\ 1\ 0\ 0 \\
+\ 0\ 1\ 0\ 0\ 0\ 0 \\
\hline
0\ 1\ 0\ 1\ 0\ 0
\end{array}
$$

Since, there is no carry so the result is -ve and the 2's complement of 010100 is $101011+1 = 101100$

$\therefore (100)_2 - (110000)_2 = -(101100)_2$

b. $(7850)_{10} - (7650)_{10}$

Ans. Here,

10's complement of 7650 is,

$$
\begin{array}{r}
9\,9\,9\,9 \\
-\ 7\,6\,5\,0 \\
\hline
2\,3\,4\,9 \\
+\ 1 \\
\hline
2\,3\,5\,0
\end{array}
$$

$\therefore$ 10's complement of 7650 is 2350.

Now adding 7850 with 10's complement of 7650.

$$
\begin{array}{r}
7\ 8\ 5\ 0 \\
+\ 2\ 3\ 5\ 0 \\
\hline
1\ 0\ 2\ 0\ 0
\end{array}
$$

Discarded.

$\therefore (7850)_{10} - (7650)_{10} = (200)_{10}$

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c. $(1010)_2 - (1000)_2$

Ans. Taking 2's complement of $(1000)_2 = 0111 + 1$
$= 1000$

Adding $(1010)_2$ with 2's complement of $(1000)_2$.

$$
\begin{array}{cccccc}
 & & 1 & 0 & 1 & 0 \\
 & + & 1 & 0 & 0 & 0 \\
\hline
\text{carry is discarded} \leftarrow & 1 & 0 & 0 & 1 & 0
\end{array}
$$

$\therefore (1010)_2 - (1000)_2 = 10_2$.

d. $(1000)_2 - (1010)_2$

Ans. Taking 2's complement of $(1010)_2 = 0101 + 1 = 0110$.

Adding $(1000)_2$ with 2's complement of $(1010)_2$.

$$
\begin{array}{ccccc}
 & 1 & 0 & 0 & 0 \\
+ & 0 & 1 & 1 & 0 \\
\hline
\text{carry is discarded} \leftarrow & 1 & 0 & 1 & 0
\end{array}
$$

Here carry is generated so the result is -ve.

$\therefore (1000)_2 - (1010)_2 = -10_2$.

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3. Perform the following operation:

a. $(211)_x = (125)_8$, find the value of x.

Ans. Here,

$$2\times x^2 + 1\times x^1 + 1\times x^0 = 1\times 8^2 + 2\times 8^1 + 5\times 8^0$$

or, $2x^2 + x + 1 = 64 + 16 + 5$

or, $2x^2 + x + 1 = 85$

or, $2x^2 + x - 84 = 0$

or, $x = \dfrac{-1 \pm \sqrt{1 - 4\cdot 2\cdot(-84)}}{2\cdot 2}$

$x = \dfrac{-1 \pm \sqrt{673}}{4}$

$\therefore x = 6.23$ or, -6.73.

b. $(10101)_{gray} = (?)_2$

Ans. Gray code: 1 0 1 0 1

Binary Number: 1 1 0 0 1

$\therefore (10101)_{gray} = (11001)_2$.

c. $(756)_8 = (?)_{16}$

Ans. Here,

$(756)_8 = 111\ 101\ 110$

$\therefore (756)_8 = (111101110)_2$.

Again, $\underline{0001}\ \underline{1110}\ \underline{1110}$

1 E E

$\therefore (756)_8 = (1EE)_{16}$

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d. $(256)_{10} = (?)_8$.

Ans.

$$\begin{array}{r|l l}
8 & 256 & \\
8 & 32 & 0 \\
8 & 4 & 0 \\
 & 0 & 4
\end{array}$$

$\therefore (256)_{10} = (400)_8$

e. $(11011.11)_2 = (?)_{10}$

Ans. Here,

$(11011.11)_2 = 1\times2^4 + 1\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0 .$
$1\times2^{-1} + 1\times2^{-2}$

$= 16 + 8 + 0 + 2 + 1 \, . \, 75$

$= 27.75$

$\therefore (11011.11)_2 = (27.75)_{10}$.

f. $(3ACD)_{16} = (?)_2$

Ans. Here,

$(3ACD)_{16} = 0011 \; 1010 \; 1100 \; 1101$

$= 11101011001101$

$\therefore (3ACD)_{16} = (11101011001101)_2$

g. $(777)_8 = (?)_{10} = (?)_{16}$

Ans. Here,

$$(777)_8 = 7\times8^2 + 7\times8^1 + 7\times8^0$$
$$= 448 + 56 + 7$$
$$= 511$$

$\therefore (777)_8 = (511)_{10}$

Also,

$$(777)_8 = 111 \quad 111 \quad 111$$
$$= \underbrace{1}_{1}\underbrace{1111}_{F}\underbrace{1111}_{F}$$

$\therefore (777)_8 = (1FF)_{10}$

$\therefore (777)_8 = (511)_{10} = (1FF)_{10}$

h. $(7845)_{10} - (3499)_{10}$ (using r-1 complement method)

Ans. Here,

9's complement of 3499 is,

$$\begin{array}{r} 9999 \\ -\,3499 \\ \hline 6500 \end{array}$$

Adding 7845 with 9's compliment of 3499

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$$\begin{array}{rcccc} & 7 & 8 & 4 & 5 \\ + & 6 & 5 & 0 & 0 \\ \hline 1 & 4 & 3 & 4 & 5 \\ & & & & +1 \\ \hline & 4 & 3 & 4 & 6 \end{array}$$

$\therefore (7845)_{10} - (3499)_{10} = (4346)_{10}$

i. $(101101)_2 - (11010000)_2$ (using r-1 complement method).

Ans Here,

1's complement of 11010000 is 00101111.

Adding 101101 with 1's complement of 11010000.

$$\begin{array}{rcccccccc} & 0 & 0 & 1 & 0 & 1 & 1 & 0 & 1 \\ + & 0 & 0 & 1 & 0 & 1 & 1 & 1 & 1 \\ \hline & 0 & 1 & 0 & 1 & 1 & 1 & 0 & 0 \end{array}$$

since there is no carry so the result is negative.

Converting 01011100 in 1's complement we get

10100011

$\therefore (101101)_2 - (11010000)_2 = -(10100011)_2.$

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j. $(100010)_2 - (10101)_2$. (Using user's complement)

Ans Here,

2's complement of 10101 is 01010 + 1
= 1011.

Adding 100010 with 2's complement of 10101.

$$\begin{array}{r} 1\ 0\ 0\ 0\ 1\ 0 \\ +\ 0\ 0\ 1\ 0\ 1\ 1 \\ \hline 1\ 0\ 1\ 1\ 0\ 1 \end{array}$$

Carry is Discarded

$\therefore (100010)_2 - (10101)_2 = (1101)_2$

K. $(3857)_{10} - (1250)_{10}$ (Using user's complement)

Ans Here,

10's complement of 1250 is

$$\begin{array}{r} 9\ 9\ 9\ 9 \\ -\ 1\ 2\ 5\ 0 \\ \hline 8\ 7\ 4\ 9 \end{array}$$

$\therefore$ 10's complement of 1250 is, 8794 + 1
= 8795.

Adding 3857 with 10's complement of 1250.

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$$\begin{array}{rrrrr} & 3 & 8 & 5 & 7 \\ + & 8 & 7 & 9 & 5 \\ \hline 1 & 2 & 6 & 5 & 2 \end{array}$$

Discarded.

$\therefore (3857)_{10} - (1250)_{10} = (2652)_{10}$

4. Explain gray code and its application.

Ans. Gray code:

- The gray code is non-weighted code.
- It is not suitable for arithimetic operations.
- It is a cyclic code because successive code words in this code differ in one bit position only i.e. unit distance code.

Binary	Gray code.
000	000
001	001
010	011
011	010
100	110
101	111
110	101
111	100

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Application of graycode is generally in the system that requires fast switching of the signals.

5. What do you mean by alphanumeric code. excess 3 code are called self complementing code. Explain it.

Ans. Alphanumeric code:

- Alphanumeric codes are also called character codes, are binary codes to represent alphanumeric data. The codes write alphanumeric data, including letters of the alphabet, numbers, mathematical symbols and punctuation marks, in a form that is understanable and processable by a computer.

- Using these code we can interface, input output devices such as keyboard, monitors, printers, etc. with computer.

⇒ Excess 3 code are called self complementing code because in Excess-3 code we get the 9's complement of a number by just complementing each bit that means by replacing '0' by '1' and '1' by '0'.

6. Describe 1's complement and 2's complement method of subtraction of binary numbers.

Ans.

Subtraction using 1's complement

- In 1's complement subtraction, add the 1's complement of subtrahend to the minuend.
- If there is carry out, bring the carry around and add it to LSB.
- If carry is present, the answer is positive and it is true binary form.
- If there is no carry, the answer is negative and it is in 1's complement.

Subtraction using 2's compliment.

- In 2's complement subtraction, add the 2's complement of subtrahend to the minuend
- If carry is generated then the result is positive and in its true binary form.
- If carry is not generated then the result is negative and in it's 2's complement form.

7. Explain parity method for error detection for four bit binary number with even and odd parity.

Ans. Parity bit: an extra bit included with message to make total number of 1's either odd or even.

Message	P(odd)	P(even)
0000	1	0
0001	0	1

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0010	0	1
0011	1	0
0100	0	1
0101	1	0
0110	1	0
0111	0	1
1000	0	1
1001	1	0
1010	1	0
1011	0	1
1100	1	0
1101	0	1
1110	0	1
1111	1	0