Assignment 1

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Question 1

Obtain the 1's and 2's complements of the following binary numbers:

(a) 11100010

(b) 00011000

(c) 10111101

(d) 10100101

(e) 11000011

(f) 01011000

Solution

The 1's complement of a binary number can be found by flipping all bits (changing 0s to 1s and 1s to 0s). The 2's complement is obtained by adding 1 to the 1's complement.

(a) For 11100010

- 1's Complement: 00011101
- 2's Complement:

$$\begin{array}{r r} & 00011101 \\ + & 00000001 \\ \hline & 00011110 \end{array}$$

2's Complement is 00011110

(b) 00011000

- 1's Complement: 11100111
- 2's Complement:

$$\begin{array}{r r} & 11100111 \\ + & 00000001 \\ \hline & 11101000 \end{array}$$

2's Complement is 11101000

(c) 10111101

- 1's Complement: 01000010
- 2's Complement:

$$\begin{array}{r} 01000010 \\ +\ \ 00000001 \\ \hline 01000011 \end{array}$$

2's Complement is 01000011

(d) 10100101

- 1's Complement: 01011010
- 2's Complement:

$$\begin{array}{r} 01011010 \\ +\ \ 00000001 \\ \hline 01011011 \end{array}$$

2's complement is 01011011

(e) 11000011

- 1's Complement: 00111100
- 2's Complement:

$$\begin{array}{r} 00111100 \\ +\ \ 00000001 \\ \hline 00111101 \end{array}$$

2's Complement is 00111101

(f) 01011000

- 1's Complement: 10100111
- 2's Complement:

$$\begin{array}{r} 10100111 \\ +\ \ 00000001 \\ \hline 10101000 \end{array}$$

2's Complement is: 10101000

Question 2

Determine the base of the numbers in each case for the following operations to be correct:

1. $\frac{67}{5} = 11$

2. $15 \times 3 = 51$

3. $123 + 120 = 303$

Solution:

1. Let the base of the numbers be k. The value of the number in decimal system will be

$$\begin{aligned} 67 &= 6 \times k^1 + 7 \times k^0 \\ 11 &= 1 \times k^1 + 1 \times k^0 \\ 5 &= 5 \times k^0 \end{aligned}$$

The equation in decimal system will be

$$\begin{aligned} \frac{6k+7}{5} &= k+1 \\ 6k+7 &= 5k+5 \\ 6k-5k &= 5-7 \\ k &= -2 \end{aligned}$$

The base comes out to be -2 which is not possible. Hence there is not number system in which the equation is true.

2. Let the base of the numbers be k

$$\begin{aligned} 15 &= 1 \times k^1 + 5 \times k^0 \\ 51 &= 5 \times k^1 + 1 \times k^0 \\ 3 &= 3 \times k^0 \end{aligned}$$

The equation in decimal system will be

$$\begin{aligned} (k+5)3 &= 5k+1 \\ 3k+15 &= 5k+1 \\ 2k &= 14 \\ k &= 7 \end{aligned}$$

We get the base of the number system to be 7

3. Let the base of the numbers be k. The value of the number in decimal system will be

$$\begin{aligned} 123 &= 1 \times k^2 + 2 \times k^1 + 3 \times k^0 \\ 120 &= 1 \times k^2 + 2 \times k^1 + 0 \times k^0 \\ 303 &= 3 \times k^2 + 0 \times k^1 + 3 \times k^0 \end{aligned}$$

Above equation becomes,

$$\begin{aligned} (k^2+2k+3) + (k^2+2k) &= 3k^2+3 \\ 2k^2+4k+3 &= 3k^2+3 \\ k^2-4k &= 0 \\ k = 0 \quad k &= 4 \end{aligned}$$

As the base of the system cannot be 0, the base is 4

Question 3

The solutions to the quadratic equation $x^2 - 13x + 22 = 0$ are $x = 7$ and $x = 2$. What is the base of the numbers?

Solution

Let the numbers be in base k then, in decimal system the equation becomes

$$\begin{aligned} 13 &= 1 \times k^1 + 3 \times k^0 \\ 22 &= 2 \times k^1 + 2 \times k^0 \\ x^2 - (k+3)x + (2k+2) &= 0 \end{aligned}$$

As 7 and 2 are the solutions

$$\begin{aligned} 7^2 - 7(k+3) + (2k+2) &= 0 \\ 2^2 - 2(k+3) + (2k+2) &= 0 \\ 49 - 7k - 21 + 2k + 2 &= 0 \\ k &= 6 \\ 4 - 2k - 6 + 2k + 2 &= 0 \end{aligned}$$

The value of k can be anything for $x = 2$ to be a solution and $k = 6$ for $x = 7$ to be the solution. Hence the value of k is 6.

Question 4

How many printing characters are there in ASCII? How many of them are special characters (not letters or numerals)?

Solution

There are 95 printing characters in ASCII out of which 33 are special characters

Question 5

What bit must be complemented to change an ASCII letter from capital to lowercase and vice versa?

Solution

The 6th bit must be complemented to change an ASCII letter from capital to lowercase and vice versa.