

# Complements

- Complements are used in digital computers for simplifying the subtraction process and for logical manipulation.
- There are two types of complements for each base  $r$  system.  $r$ 's complement and the  $(r-1)$ 's complement.
- When the value of  $r$  is 10, it is termed as 10's and 9's complement.
- When the value of  $r$  is 2, it is termed as 2's and 1's complement.

# 9's Complement

- In general, the 9's complement of the **unsigned** numbers 546700 & 12389 are

$$\begin{array}{r} 999999 \\ - 546700 \\ \hline 453299 \end{array}$$

$$\begin{array}{r} 99999 \\ - 12389 \\ \hline 87610 \end{array}$$

# 10's Complement

- In general, the 10's complement of the **unsigned** numbers 546700 & 12389 are

$$\begin{array}{r} 999999 \\ - 546700 \\ \hline 453299 \\ + 1 \\ \hline 453300 \end{array}$$

$$\begin{array}{r} 99999 \\ - 12389 \\ \hline 87610 \\ + 1 \\ \hline 87611 \end{array}$$

# Subtraction of Unsigned number - 9's Complement

**Example 1** : Using 9's complement, subtract  $7\ 2\ 5\ 3\ 2 - 3\ 2\ 5\ 0$  ( $M > N$ )

9's Complement of  $3\ 2\ 5\ 0$  is  $9\ 9\ 9\ 9\ 9 - 0\ 3\ 2\ 5\ 0 = 9\ 6\ 7\ 4\ 9$

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

$$\begin{array}{r} 1\ 6\ 9\ 2\ 8\ 1 \\ +\ 1 \\ \hline \end{array}$$



There is end carry

$$6\ 9\ 2\ 8\ 2$$



Final Result

**End carry** indicates that result is **Positive**. Carry need to be added to the obtained value to get final result.

# Subtraction of Unsigned number - 9's Complement

**Example 2 :** Using 9's complement, subtract  $3250 - 72532$  ( $M < N$ )

9's Complement of  $72532$  is  $99999 - 72532 = 27467$

$$\begin{array}{r} 03250 \\ + 27467 \\ \hline \end{array}$$

30717



There is no end carry.

$$\begin{array}{r} 99999 \\ - 30717 \\ \hline \end{array}$$

69282



Final Result

No end carry indicates that result is **Negative**. Do 9's complement of the obtained value to get final result.

# Subtraction of Unsigned number - 10's Complement

**Example 1 :** Using 10's complement, subtract  $7\ 2\ 5\ 3\ 2 - 3\ 2\ 5\ 0$  ( $M > N$ )

10's Complement of  $3\ 2\ 5\ 0$  is  $9\ 9\ 9\ 9\ 9 - 0\ 3\ 2\ 5\ 0 = 9\ 6\ 7\ 4\ 9 + 1 = 9\ 6\ 7\ 5\ 0$

	$M =$	$72532$
10's complement of	$N =$	$\underline{+96750}$
	Sum =	$169282$
	Discard end carry $10^5 =$	$\underline{-100000}$
	Answer =	$69282$



There is end carry



Final Result

End carry indicates that final result is **Positive**. Ignore end carry.

# Subtraction of Unsigned number - 10's Complement

**Example 2 :** Using 10's complement, subtract  $3\ 2\ 5\ 0 - 7\ 2\ 5\ 3\ 2$  ( $M < N$ )

10's Complement of  $7\ 2\ 5\ 3\ 2$  is  $9\ 9\ 9\ 9\ 9 - 7\ 2\ 5\ 3\ 2 = 2\ 7\ 4\ 6\ 7 + 1 = 2\ 7\ 4\ 6\ 8$

	M =	03250
10's complement of	N =	+ 27468
	Sum =	30718



There is no end carry.

$$\begin{array}{r}
 9\ 9\ 9\ 9\ 9 \\
 -\ 3\ 0\ 7\ 1\ 8 \\
 \hline
 6\ 9\ 2\ 8\ 1 \\
 +\ 1 \\
 \hline
 6\ 9\ 2\ 8\ 2
 \end{array}$$

10's complement of 30718



Final Result

No end carry indicates the end result is **Negative**. Do 10's complement of the obtained value to get final result.

# Questions

**Q 1 :** Using 9's complement, subtract  $6\ 4\ 3\ 2 - 1\ 9\ 1\ 0$

**Q 2 :** Using 9's complement, subtract  $1\ 9\ 1\ 0 - 6\ 4\ 3\ 2$

Ans: 9's Complement of  $1\ 9\ 1\ 0$  is  $8\ 0\ 8\ 9$

9's Complement of  $6\ 4\ 3\ 2$  is  $3\ 5\ 6\ 7$

$$\begin{array}{r} 6\ 4\ 3\ 2 \\ +\ 8\ 0\ 8\ 9 \\ \hline \end{array}$$

$$\begin{array}{r} 1\ 4\ 5\ 2\ 1 \text{ (End Carry – Re +ve)} \\ +\ 1 \text{ (Add Carry)} \\ \hline \end{array}$$

$$4\ 5\ 2\ 2$$

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

$$\begin{array}{r} 5\ 4\ 7\ 7 \text{ (No End carry – Re –ve)} \\ \text{(9's Complement of result)} \\ \hline \end{array}$$

$$4\ 5\ 2\ 2$$

9's complement of  $5\ 4\ 7\ 7$  is  $4\ 5\ 2\ 2$



# Questions

**Q 1 :** Using 10's complement, subtract  $6\ 4\ 3\ 2 - 1\ 9\ 1\ 0$

**Q 2 :** Using 10's complement, subtract  $1\ 9\ 1\ 0 - 6\ 4\ 3\ 2$

Ans: 10's Complement of  $1\ 9\ 1\ 0$  is  $8\ 0\ 8\ 9 + 1 = 8\ 0\ 9\ 0$

10's Complement of  $6\ 4\ 3\ 2$  is  $3\ 5\ 6\ 7 + 1 = 3\ 5\ 6\ 8$

$$\begin{array}{r} 6\ 4\ 3\ 2 \\ +\ 8\ 0\ 9\ 0 \\ \hline \end{array}$$

$$\begin{array}{r} 1\ 4\ 5\ 2\ 2 \text{ (End Carry – Re +ve)} \\ \text{(Ignore carry)} \\ \hline \end{array}$$

$$4\ 5\ 2\ 2$$

$$\begin{array}{r} 1\ 9\ 1\ 0 \\ +\ 3\ 5\ 6\ 8 \\ \hline \end{array}$$

$$\begin{array}{r} 5\ 4\ 7\ 8 \text{ (No End carry Re –ve)} \\ \text{(10's Complement of result)} \\ \hline \end{array}$$

$$4\ 5\ 2\ 2$$

10's complement of  $5\ 4\ 7\ 8$  is  $4\ 5\ 2\ 1 + 1 = 4\ 5\ 2\ 2$