AKTU Festival Offer

GATEWAY CLASSES

B.Tech II-Year EC & EC Allied

DSD : Digital System Design

Unit-1 Lec-2



Today's target

- Binary arithmetic
- PYQ
- DPP

Avinash Sir

Gateway Classes

AKTU : *DIGITAL SYSTEM DESIGN (BEC-302)* Syllabus

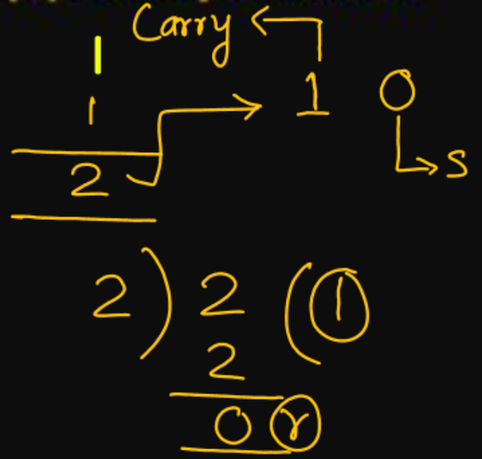
UNIT-1 : Logic simplification and combinational logic design

- Number Systems
- Binary arithmetic
- Signed magnitude representation
- Binary codes, code conversion
- Review of Boolean algebra and Demorgans theorem
- SOP & POS forms
- Canonical forms
- Karnaugh maps up to 5 variables
- Tabulation method.

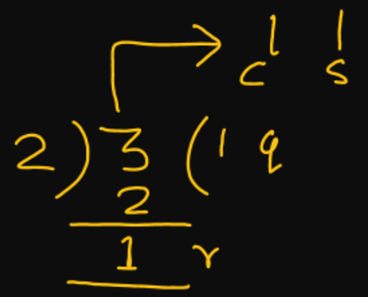
Gateway Classes

Binary Arithmetic

(1) Binary Addition



	SUM	CARRY
0 + 0 =	0	0
0 + 1 =	1	0
1 + 0 =	1	0
1 + 1 =	0	1
1 + 1 + 1 =	1	1



Note:

(i) 1 + 1 = 10

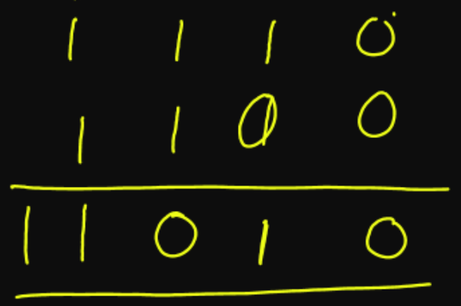
SUM = 0 Carry = 1

(ii) 1 + 1 + 1 = 11

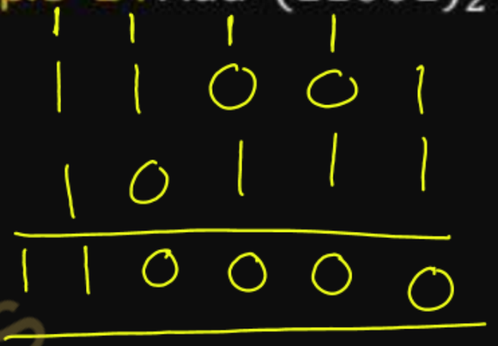
SUM = 1 Carry = 1

Gateway Classes

Example - 1 : Add $(1110)_2$ and $(1100)_2$



Example -2 : Add $(11001)_2$ and $(10111)_2$



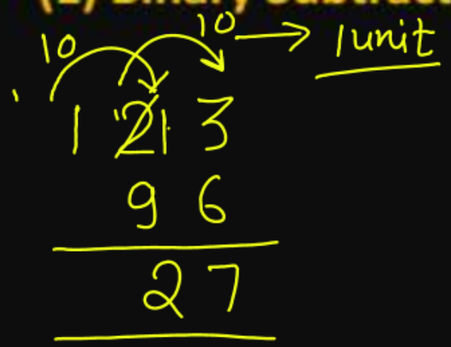
Example - 3 : Add binary number $(1110.110)_2$ to $(1100.011)_2$



Gateway Classes

Binary Arithmetic

(1) Binary Subtraction



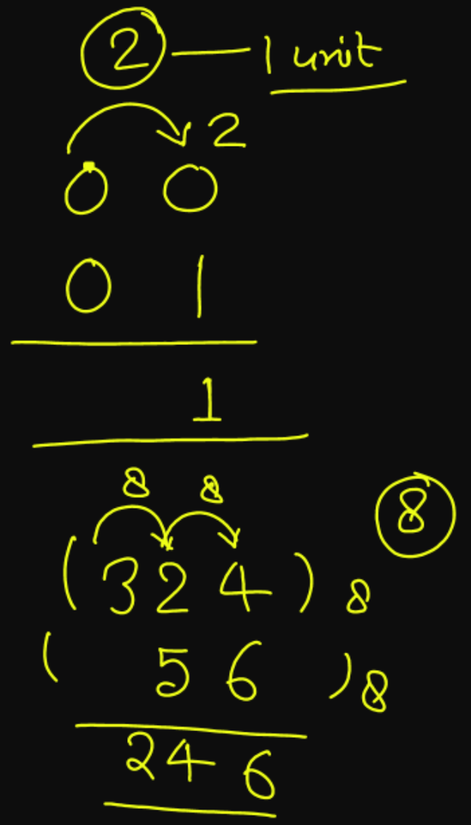
Subtraction	Borrow
0 - 0 = 0	0
1 - 0 = 1	0
1 - 1 = 0	0
0 - 1 = 1	1

Note:

$0 - 1 = 10 - 1$

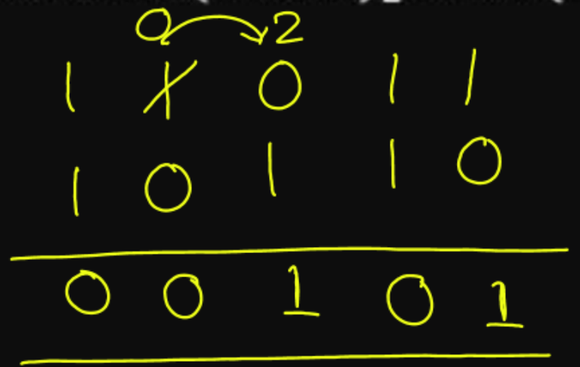
$= 2 - 1$

$= 1$

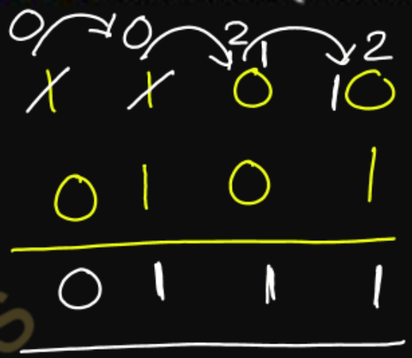


Gateway Classes

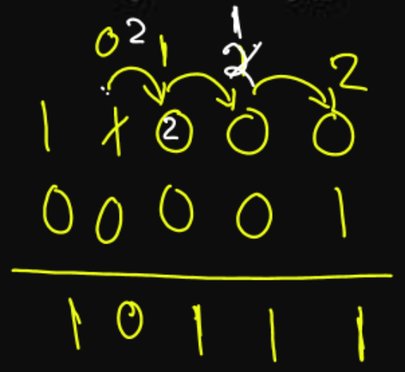
Example -1 : Subtract $(10110)_2$ from $(11011)_2$



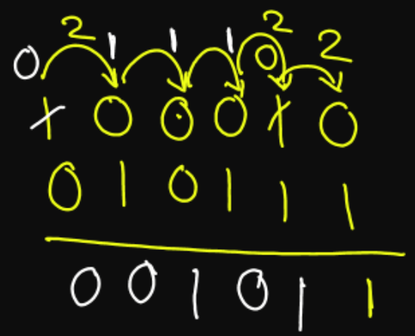
Example -3 : Subtract $(0101)_2$ from $(1100)_2$



Example - 2 : Subtract $(00001)_2$ from $(11000)_2$



Example - 4 : Subtract $(010111)_2$ from $(100010)_2$



Gateway Classes

Complements

Complements are used in the digital computers in order to simplify the subtraction operation and for the logical manipulation

For Binary System

(i) 1' S complement

(ii) 2 ' S complement

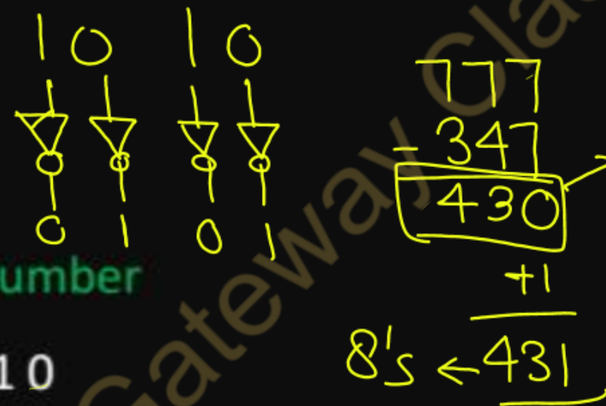
1' S complement

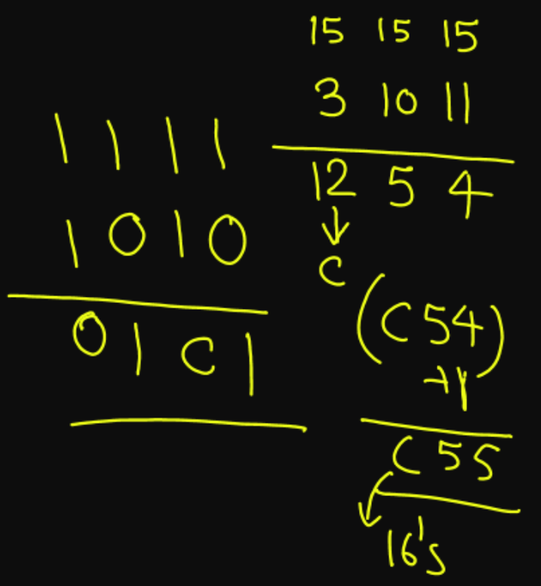
r - Complement → 2's 8's 10's 16's

(r-1) - Complement → 1's 7's 9's 15's

Binary Octal Decimal Hex decimal

3AB





Given Number	1' S complement
1010	0101 ✓
11010101	00101010
1001	0110

Gateway Classes

2' S complement

2' S complement = 1' S complement + 1

Given	1' S complement	2' S complement
1011	0100	0100
0100		1
		0101 → 2's Complement



10110010 → 01001101

01001101
+1
01001110 2's Complement

Gateway Classes

Binary Subtraction 1' S complement

$A - B = A + (-B)$ ⟷ (-) ⟶ Complement

STEP – 1 : Find the 1'S complement of the number to be subtracted

STEP – 2 : Perform addition

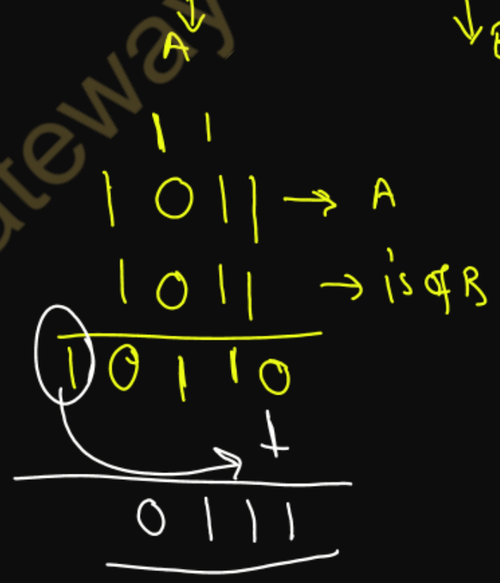
STEP – 3 : CASE – 1 : If the final carry is 1, then add it to the result obtained in step-2

CASE – 2 : If the final carry is zero, result obtain in step-2 is negative and in the 1'S complement form

Example – 1 : Subtract using 1' S complement $(1011)_2 - (0100)_2$

B = 0100

1's Complement of B = 1011



Gateway Classes

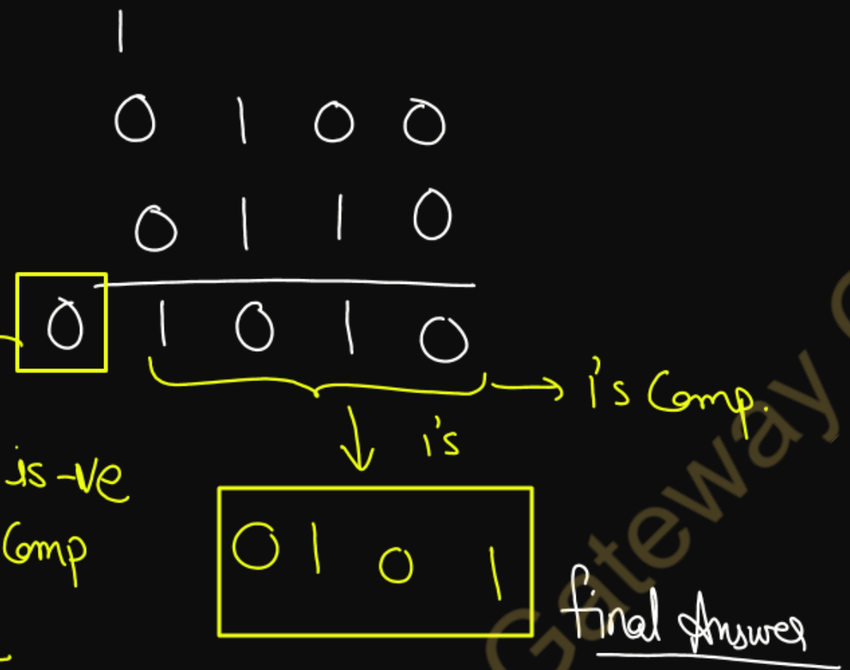
Example – 2 : Subtract using 1' S complement $(0100)_2 - (1001)_2 \rightarrow -(0101)_2$

↳A ↳B

B → 1001

1's Comp of B → 0110

Add.



Gateway Classes

Binary Subtraction 2' S complement

A - B = A + (-B)

STEP – 1 : Find the 2' S complement of number to be subtracted

STEP – 2 : Perform addition

STEP – 3 : CASE – 1 : If the final carry is [redacted] generated, then the result is positive and is in its true form

CASE – 2 : If the final carry is not generated, then the result is negative and is in its 2' S complement form.

↳ 0

Example – 1 : Subtract using 2' S complement $(1001)_2 - (0101)_2$ → $(0100)_2$ Ans

↳ B

B

1's of B

2's " "

0 1 0 1

1 0 1 0

+ 1

1 0 1 1 – 2's

A ←

1 1

1 0 0 1

1 0 1 1

1 0 1 0 0

discard

Gateway Classes

Example – 2 : Subtract using 2' S complement $(0100)_2 - (1001)_2 \rightarrow -(0101)_2$

A ↵ B ↵

B ⟶ 1 0 0 1

1's Comp of B → 0 1 1 0

+ 1

2's Comp → 0 1 1 1

2's Comp

0 1 0 0

0 1 1 1

0 1 0 1 1

↵ If Carry is 0

Answer is -ve and in 2's Comp form.

2's Comp of 1 0 1 1

0 1 0 0 ⟶ 1's

+ 1

0 1 0 1 final Answer

Gateway Classes

For Decimal system System

(i) 9' S complement

(ii) 10 ' S complement

9' S complement

Given Number	9' S complement
2467	9999 − 2467 = 7532 → 9's 7532 + 1 = 7533 → 10's
75468	99999 − 75468 = 24531 → 9's 24531 + 1 = 24532 → 10's

Gateway Classes

10' S complement

10' S complement = 9' S complement + 1

Given Number	9' S complement	10' S complement
4862	5137	5137 + 1 = 5138 (10's)
65432	34567	34567 + 1 = 34568 (10's)

Gateway Classes

Binary Subtraction 9' S complement

$$A - B = A + (-B)$$

STEP – 1 : Find the 9'S complement of B

STEP – 2 : Add A and 9'S complement of B

STEP – 3 : CASE – 1 : If the final carry is 1, then add it to the result obtained in step-2

CASE – 2 : If the final carry is zero, result obtain in step-2 is negative and in the 9'S complement form

Example – 1 : (437 – 235) using 9's

A ← 437 – 235 → B

B = 235

9's = 999 − 235 = 764

1	1
4	3 7
7	6 4
1	2 0 1
	1
	2 0 2

Ans.

Gateway Classes

Example – 2 :

$$235 - 437$$

B

9's of B = 999 − 437 = 562

$$\begin{array}{r} 235 \\ +\ 562 \\ \hline 0797 \end{array}$$

↵

−ve

9's Comp

Ans ⇒ 9's Comp of 797

$$\begin{array}{r} 999 \\ -\ 797 \\ \hline 202 \end{array}$$

Answer = $-(202)_{10}$

Gateway Classes

Binary Subtraction 10' S complement

A - B = A + (-B)

STEP – 1 : Find the 10' S complement B

STEP – 2 : Add A and 10' S complement B

STEP – 3 : CASE – 1 : If the final carry is generated, then the result is positive and is in its true form

CASE – 2 : If the final carry is not generated, then the result is negative and is in its 2' S complement form.

Example – 1 : (437 - 235) using 10's

↳ B

10's of B →

```
  9 9 9
  2 3 5
-------
  7 6 4
    +1
-------
  7 6 5   → 10's
```

```
  4 3 7
  7 6 5
-------
1 2 0 2   Answer
```

↳ discard

Gateway Classes

Example – 2 :

$235 - 437$

10's of 437 =

$$\begin{array}{r} 999 \\ 437 \\ \hline 562 \\ +1 \\ \hline 563 \end{array} \rightarrow 10's$$

$$\begin{array}{r} 235 \\ 563 \\ \hline 0798 \end{array}$$

↳ -ve

10's

$$\begin{array}{r} 999 \\ 798 \\ \hline 201 \\ +1 \\ \hline 202 \end{array} \begin{array}{l} \rightarrow 9's \\ \\ \\ \rightarrow 10's \end{array}$$

Final Answer = $-(202)$ Ans.

Gateway Classes

Digital System Design

UNIT -1 L 2 : DPP

Q. Perform following operation as indicated.

I. Subtract using 1's complement: $(10111)_2 - (110011)_2$

II. find the 1's and 2's compliment of $(010100)_2$

III. Determine 2's complement of $(1010.110)_2$.

IV. Convert $(25.125)_{10}$ into Hexadecimal number.

V. Add binary number $(1011)_2$ and $(1111)_2$.

VI. Subtract using 10's complement: $(9754)_{10} - (364)_{10}$

VII. Subtract using 1's complement: $(10111)_2 - (110011)_2$

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Empowering Learners, Transforming Futures

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Thank You

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