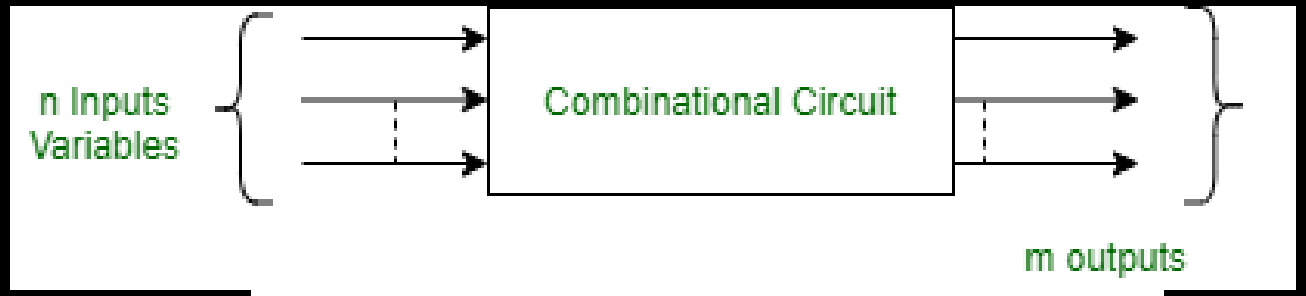
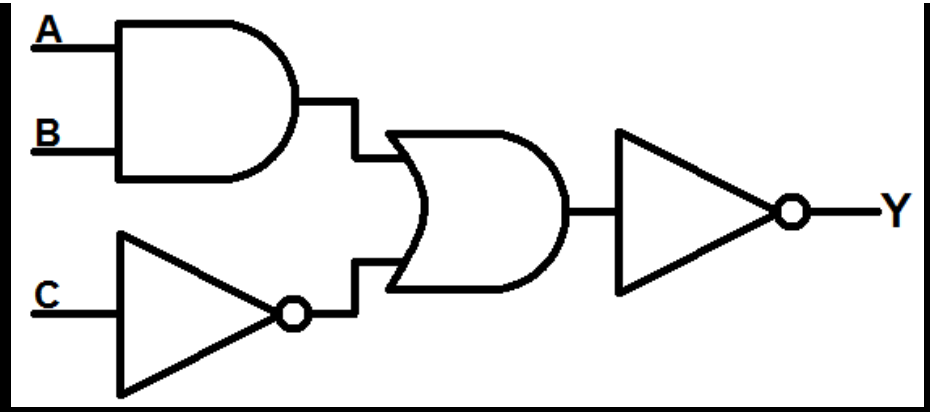
Dr. Kundan Kumar

Combinational Circuit





What is Combinational Circuit?

Combinational Circuit

- A **combinational circuit** is a logic circuit whose output at any given time depends solely on the combination of its current input values, not on previous input states (i.e., no memory element involved).
- To construct combinational circuit, we uses logic gates

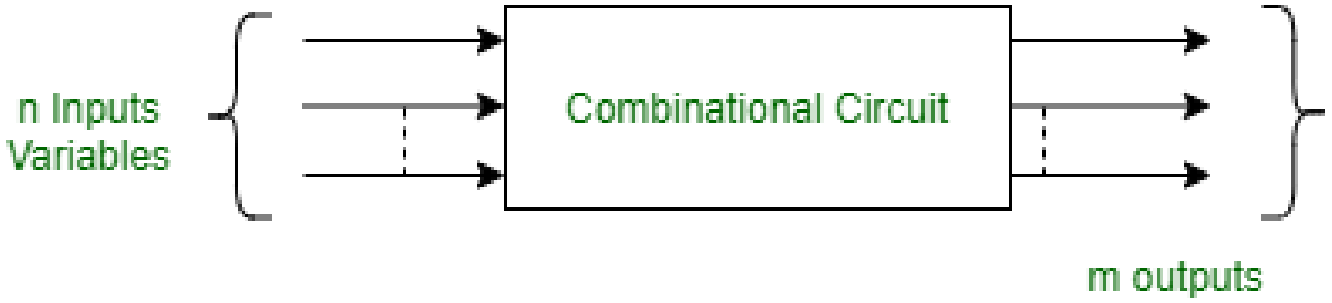


Figure - Block diagram of Combinational circuit

Types of Combinational Circuits

Rules for Finding Adjacent Cells

1) Arithmetic Circuits:

   - ✓ Half Adder
   - ✓ Full Adder
   - ✓ Subtractors and etc

2) Data Handling Circuits:

   - ✓ Multiplexers (MUX)
   - ✓ Demultiplexers (DEMUX)
   - ✓ Encoders
   - ✓ Decoders etc

Basic Design Steps

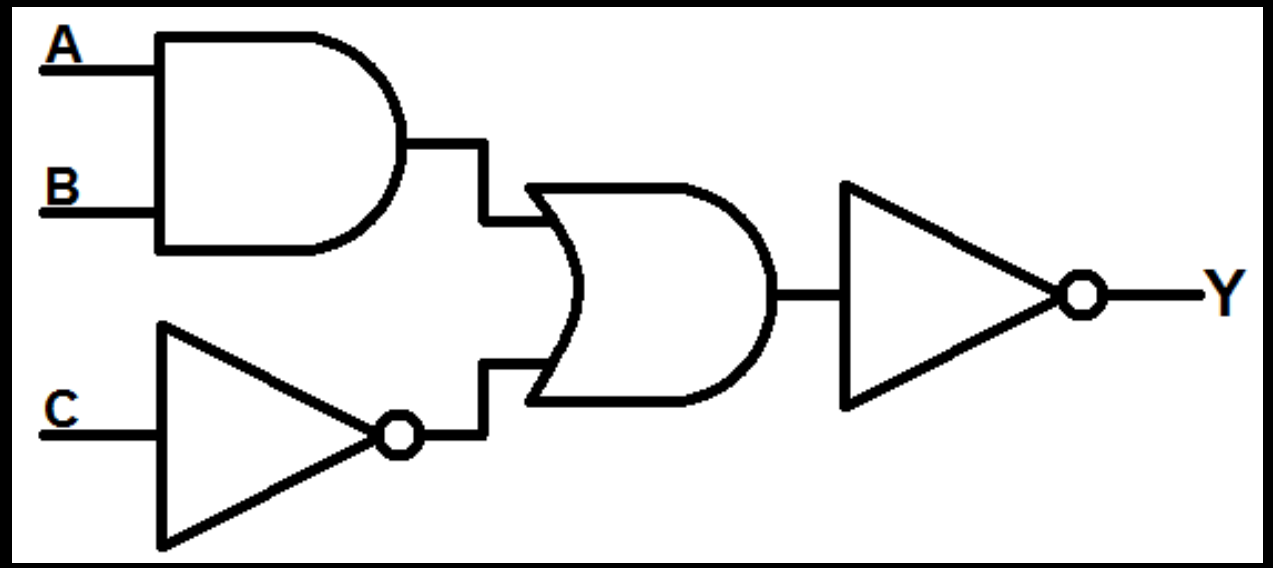
Basic Design Steps

1)Define input and output variables

2)Draw truth table

3)Simplify using K-map or Boolean algebra

4)Implement logic diagram



Exercises

Half Adder

Half Adder Design Steps

Step 1: State the Device to be Implemented

Device: Half Adder

Step 2: Define input and output variables

A half adder takes two single-bit binary inputs:

- Input A
- Input B

And it outputs:

- **Sum (S)**: Result of A + B
- **Carry (C)**: Carry generated from the addition

Half Adder Design Steps

Step 3 : Draw truth table

A	B	Sum (S)	Carry (C)
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Half Adder Design Steps

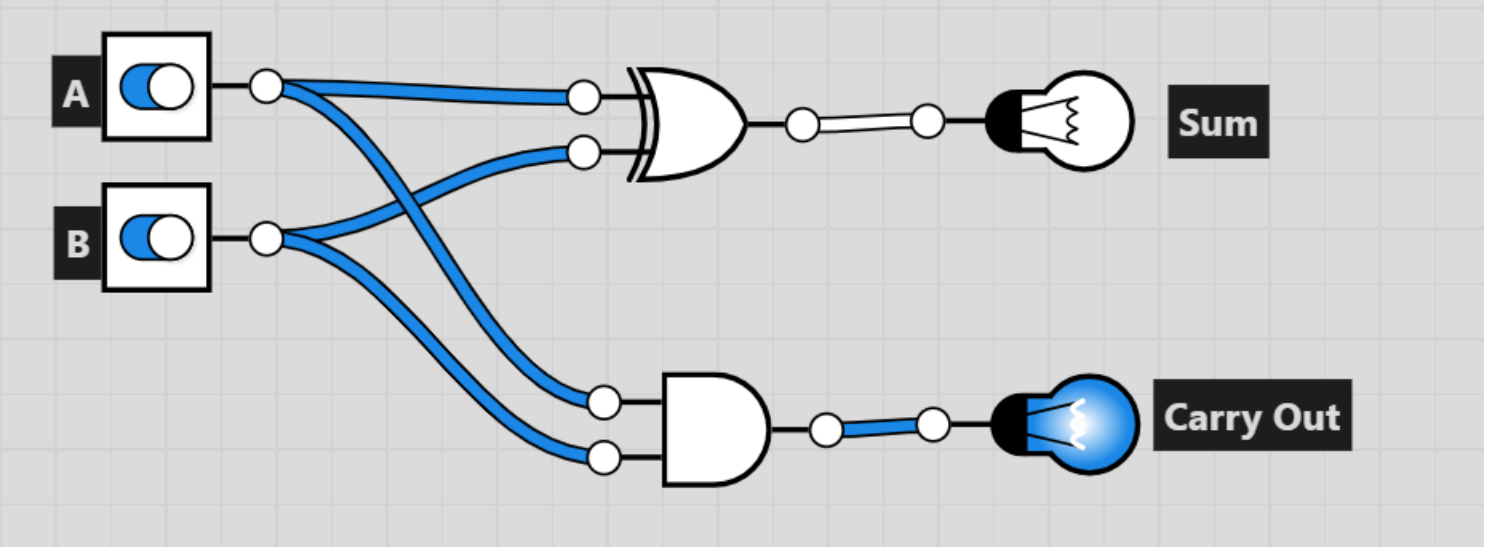
Step4: Derive Boolean Expressions

From the truth table:

Sum (S) = A ⊕ B (XOR operation)

Carry (C) = A · B (AND operation)

Step 5: Implement logic diagram



[SELF ASSESMENT]

Full Half Adder

[CASE STUDY]

Case Study: Problem Statement 1

- Design a combinational digital logic circuit that acts as a password-protected gate opener.
- The gate will only open when the correct 4-bit binary password is entered on the input keypad.
- Where correct password is only one. **for example,** Passowrd: 1011

Problem Statamenet-1

Solution:

Step 1: Define Input and Output Variables

- Inputs: A3,A2,A1, A0 (4-bit binary input from keypad)
- Output: G (Gate open signal; 1 = open, 0 = closed)

Step 2: Choose a 4-bit password

Example: Password = 1011

A3 = 1

A2 = 0

A1 = 1

A0 = 1

Cont...

Step 3: Construct Truth Table

A	B	C	D	G (Gate Open)
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

Step 4: Derive Boolean Expression (SOP form)

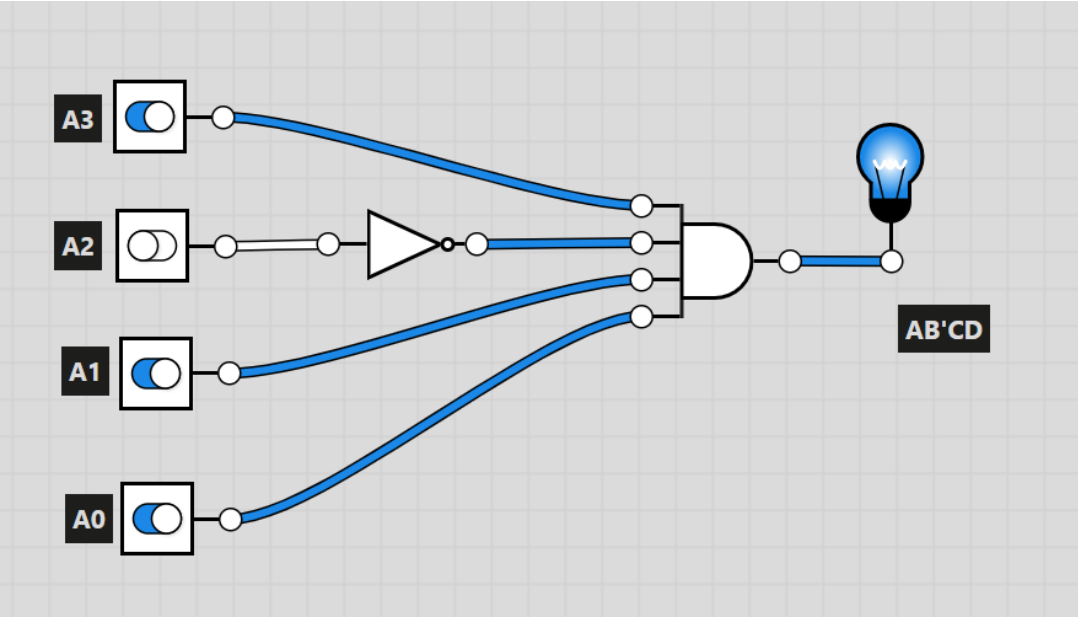
$$F = A \cdot \overline{B} \cdot C \cdot D$$

Cont...

Step 5: Draw Logic Circuit Diagram

Required Components

- NOT Gate: 1 Nos
- AND Gate: 1 Nos of 4 Input signals



[Self Assessment]

Extension of Problem Statamenet1

Problem Statement 2: Self Assessment

- Design a combinational digital logic circuit that acts as a password-protected gate opener.
- The gate will only open when the correct 4-bit binary password is entered on the input keypad.
- Where correct passwords are two. **for example,** Passowrd1: 1011 and Password2: 1100

Thank You