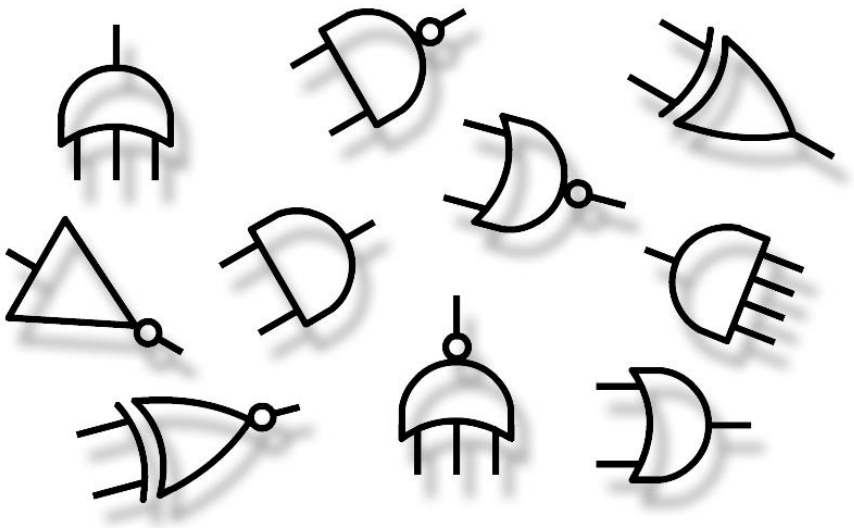
Logic Functions



Topics covered in this presentation:

- Static Logic Functions
- Dynamic Logic Functions

ClassAct SRS enabled.

Digital Electronics

The field of digital electronics deals with circuits that follow a specific set of logical rules.

These rules state what the output will be for a given set of inputs.

Whereas in analogue circuits a signal can have a range of values, in digital circuits a signal can only have one of two voltage levels.

These voltage levels are known as **logic high** and **logic low** and are generally represented by **+5V** and **0V** respectively.

Since the signals in a digital circuit can only have one of two states, it is often convenient to use **1** to indicate **logic high** and **0** to indicate **logic low**.

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Truth Table

A convenient way to show what the output will be for a given set of inputs is to record this information in a table called a **truth table**.

This table shows what the output will be for all possible input combinations.

Input A	Input B	Output Q
0	0	**0**
1	0	**0**
0	1	**0**
1	1	**1**

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Question 1

What is this called?

Input A	Input B	Output Q
0	0	**1**
1	0	**0**
0	1	**0**
1	1	**0**

A) Logic diagram

B) Logic chart

C) Truth table

D) Results table

Logic Functions

There are three basic logic functions:

- **AND**
- **OR**
- **NOT**

On the following screens the operation of these logic functions will be investigated.

Next >

AND Function

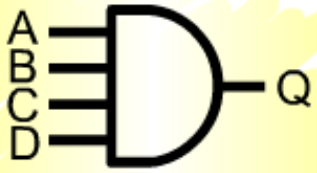
The AND function will output a logic ‘1’ when all of its inputs are at logic ‘1’.

The truth table for a 2-input AND function is shown opposite together with its circuit symbol.

The AND function can have more than two inputs, but it will still require all of the inputs to be at logic 1 for the output to be at logic 1.

Input A	Input B	Output Q
0	0	**0**
1	0	**0**
0	1	**0**
1	1	**1**

2 Input AND Gate



4 Input AND Gate

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Question 2

How many possible input combinations are there for a two input logic function?

Enter your answer and press **SEND**.

Question 3

How many possible input combinations are there for a three input logic function?

A) 2

B) 4

C) 8

D) 16

Question 4

How many input combinations give an output of logic 1 for a three input AND logic function?

Enter your answer and press **SEND**.

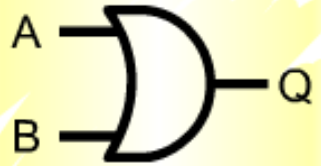
OR Function

The OR function will output a logic ‘1’ when one or more of its inputs are at logic ‘1’.

The truth table for a 2-input OR function is shown opposite together with its circuit symbol.

The OR function can have more than two inputs, but it will still only require one or more inputs to be at logic 1 for the output to be at logic 1.

Input A	Input B	Output Q
0	0	**0**
1	0	**1**
0	1	**1**
1	1	**1**



2 Input OR Gate

3 Input OR Gate

Next >

Question 5

The output of a two-input OR function is logic 1 if either or both of its inputs are at logic 1. Is this true or false?

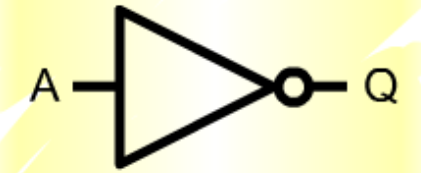
Answer **T**rue or **F**alse.

NOT Function

The NOT function is the only logic function to have a single input and output.

The output is always the opposite of the input as shown in the truth table opposite.

Since the output is always the opposite (inverse) of the input, it is also known as an **inverter**.



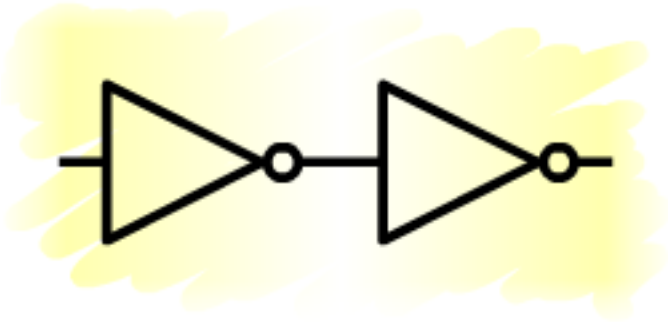
NOT Gate (inverter)

Input A	Output Q
0	**1**
1	**0**

Next >

Question 6

The diagram shows two NOT functions connected together. What will be the output of this arrangement if a logic 1 is applied to the input?

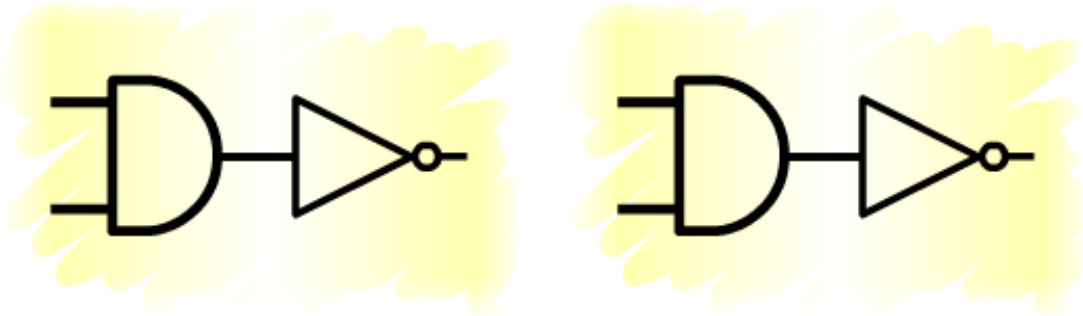


A) Logic 0

B) Logic 1

Combining Functions

The AND and OR functions can be combined with the NOT function to create two more functions called NAND (NOT AND) and NOR (NOT OR).



Next >

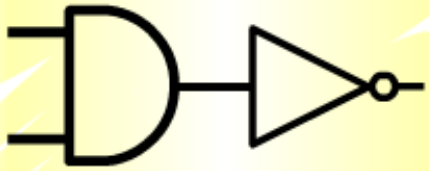
NAND Function

The **NAND** function is a combination of the **NOT** and **AND** functions.

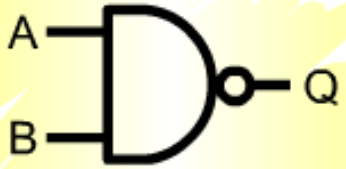
The NOT function has the effect of inverting the AND function.

The NAND function will output a logic ‘0’ when all of its inputs are at logic ‘1’.

The truth table for a 2-input NAND function is shown opposite together with its circuit symbol.



Input A	Input B	Output Q
0	0	**1**
1	0	**1**
0	1	**1**
1	1	**0**



2 Input NAND Gate

Next >

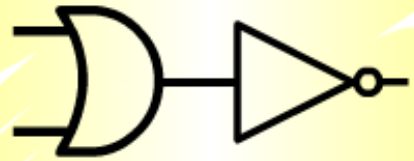
NOR Function

The **NOR** function is a combination of the **NOT** and **OR** functions.

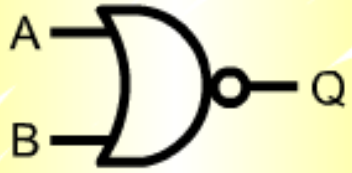
The NOT function has the effect of inverting the OR function.

The NOR function will output a logic 0 when one or more of its inputs are at logic 1.

The truth table for a 2-input NOR function is shown opposite together with its circuit symbol.



Input A	Input B	Output Q
0	0	**1**
1	0	**0**
0	1	**0**
1	1	**0**



2 Input NOR Gate

Next >

Question 7

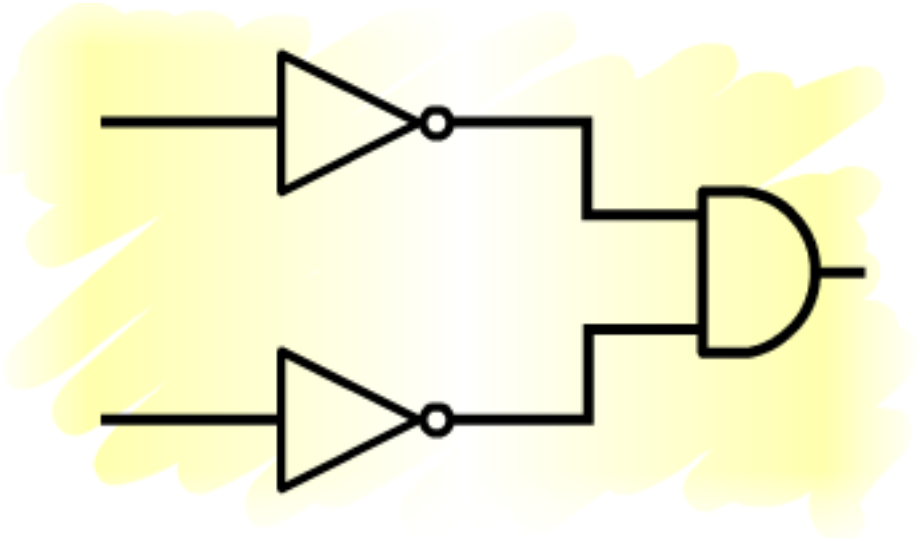
The diagram shows an AND function with a NOT function on each input. Work out the truth table of this arrangement and then select which function it is equivalent to.

A) AND

B) OR

C) NAND

D) NOR



Question 8

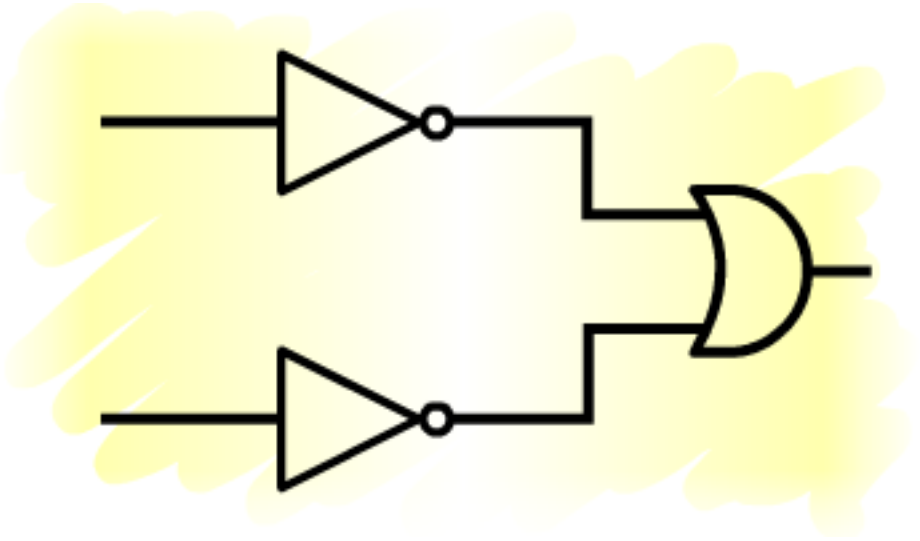
The diagram shows an OR function with a NOT function on each input. What function is this equivalent to?

A) AND

B) OR

C) NAND

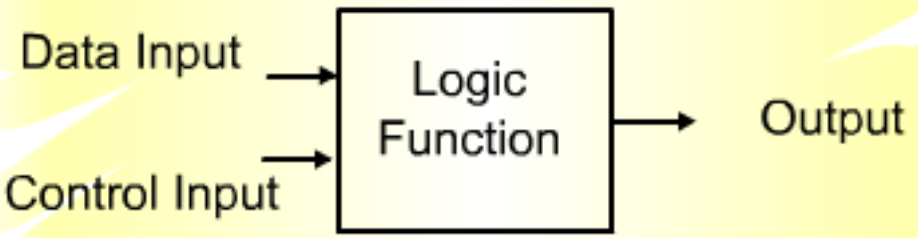
D) NOR



Dynamic Logic

The 2-input AND and OR functions can also be used as gates to control whether a digital data signal is passed or not.

The dynamic digital signal is applied to one input and the other input is used to control whether the dynamic digital signal appears at the output.



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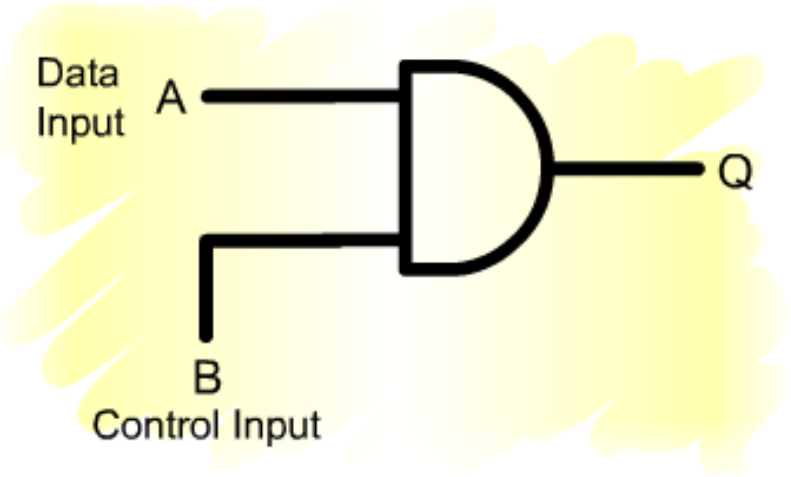
Dynamic AND Gate

The circuit below shows how a 2-input AND function is connected as a gate.

The digital data signal is connected to Input A.

Input B is the control input and can be connected to either logic 1 or logic 0 depending upon whether the digital data signal is to be allowed through the gate.



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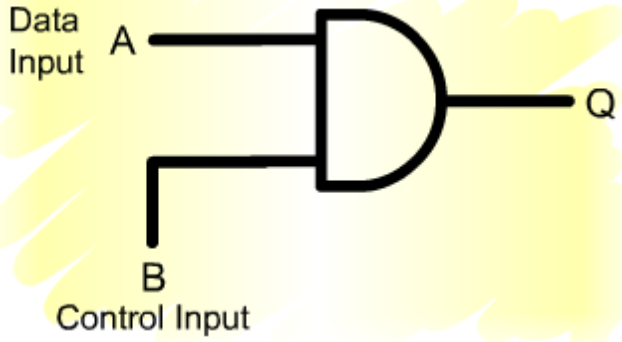
Dynamic AND Gate

From the truth table for the 2-input AND function it can be seen that when input B is at logic 0, the output will always be logic 0 no matter what the input is at input A.

When input B is at logic 1, the truth table shows that the output will always be the same as the input at input A.

The digital signal is therefore only allowed through the gate when the control input is at logic 1.



Input A	Input B	Output Q
0	0	**0**
1	0	**0**
0	1	**0**
1	1	**1**

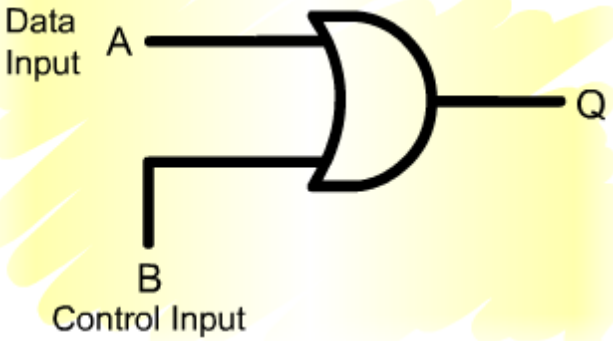
Next >

Dynamic OR Gate

The OR function can also be used in the same way.

From the truth table for the 2-input OR function it can be seen that when input B is at logic 1, the output will always be logic 1 no matter what the input is at input A.

When input B is at logic 0, the truth table shows that the output will always be the same as the input at input A.



Input A	Input B	Output Q
0	0	**0**
1	0	**1**
0	1	**1**
1	1	**1**

Next >

Question 9

Here is the truth table for a NOR function used as a gate. Input A is the data signal and input B is the control signal. Which of the following correctly describes the output of the gate when the control signal is at logic 1?

Input A	Input B	Output Q
0	0	**1**
1	0	**0**
0	1	**0**
1	1	**0**

A) The gate is closed - no signal passes through

B) The gate is open but stuck at logic 1

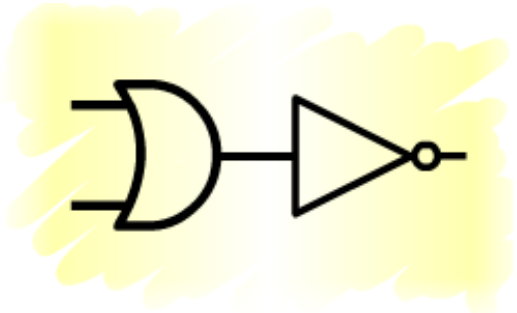
C) The gate is open but the data signal is inverted

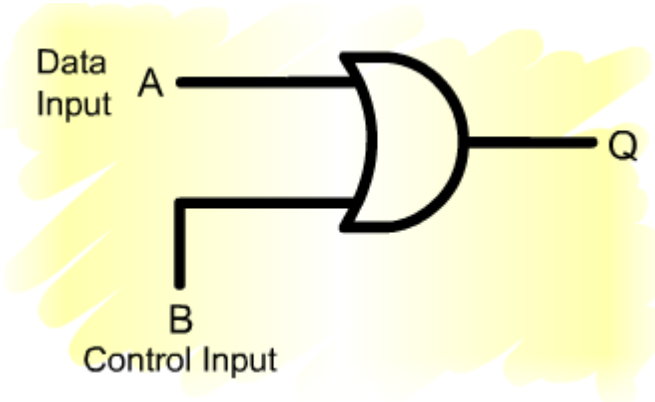
D) The gate is open and the data signal passes through unaltered

Summary

You should now be aware of:

- Static Logic Functions
- Dynamic Logic Functions





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