# BBM233: Logic Design Lab
# 2021 Fall
# Lab Experiment #2 Report

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## Question 1

- What does a universal gate mean?

  A universal gate is a gate which can implement any Boolean function without need to use any other gate type.

- Which logic gates are universal gates?

  NAND and NOR gates are universal gates.

## Question 2

Implementing other logic gates by using only the universal gates: 1 2

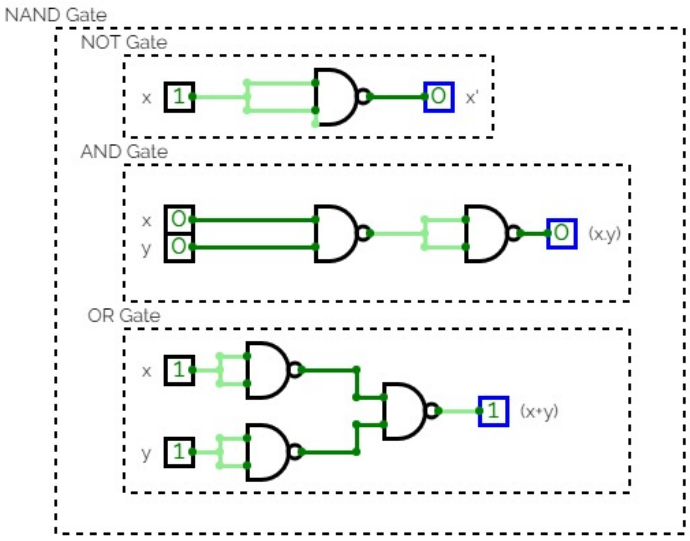


Figure 1: Implementing other gates using only NAND gate

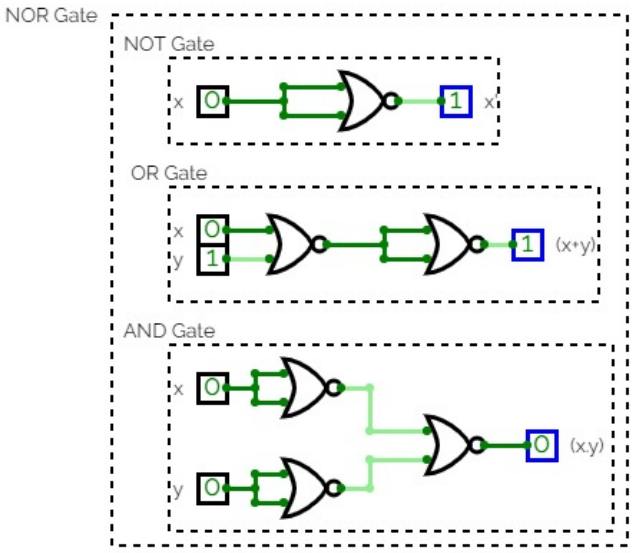


Figure 2: Implementing other gates using only NOR gate

## Question 3

A Boolean function is given: $F(A, B, C, D) = \sum(0, 2, 8, 10, 11)$

- Simplify F using a Karnaugh Map to obtain a Boolean function in sum-of-products form, 1

| **AB\CD** | **00** | **01** | **11** | **10** |
|---|---|---|---|---|
| **00** | 1 | 0 | 0 | 1 |
| **01** | 0 | 0 | 0 | 0 |
| **11** | 0 | 0 | 0 | 0 |
| **10** | 1 | 0 | 1 | 1 |

Table 1: Simplifying the the F(A,B,C,D)

$F(A, B, C, D) = B'D' + AB'C$

Since the question asks us to show the equation F(A,B,C,D) in "**sum-of-products**" form, we should multiply our terms accordingly:

$F(A, B, C, D) = B'D'(A + A')(C + C') + AB'C(D + D')$

Resulting;

$F(A, B, C, D) = A'B'C'D' + A'B'CD' + AB'C'D' + AB'CD' + AB'CD$

- Use the formula you obtained from the K-Map and express it using only NAND gates. You may find using De Morgan's Laws useful,

$F(A, B, C, D) = B'D' + AB'C = ((B'D')'.(AB'C)')'$

- Do the same but this time using only NOR gates.

$F(A, B, C, D) = B'D' + AB'C = (((B + D)' + (A' + B + C')')')'$

## References


- BBM231 Lecture Notes
- http://www.uop.edu.pk/ocontents/Lec-10-universal%20gates.pdf