# Digital Logic Design (ESC-151)

**Abdul Rehman** **email id:- abdul@northern.edu.pk** **Whatsapp#03087792217**

## Objectives:

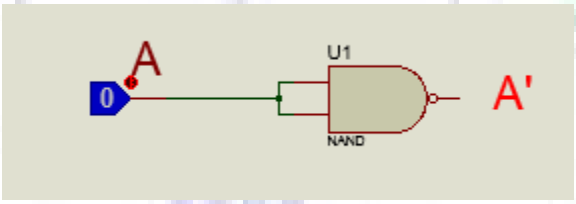
The objective for this week will be to do detailed discussion on universal gates, their possible uses along with practice examples. Basically, in these lectures, I will teach you to design all the gates with the help of universal gates (nand, nor). So, in case, you are left with only universal gates, you can design all other gates with the help of these gates without buying new gates.

- NAND Implementation
- NOR Implementation
- PLD
- Function Implementation on PROM

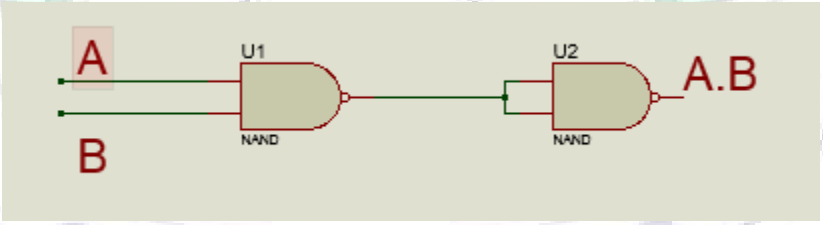
# LECTURE-21

## NAND IMPLEMENTATION

### NOT GATE




### AND GATE




### OR GATE

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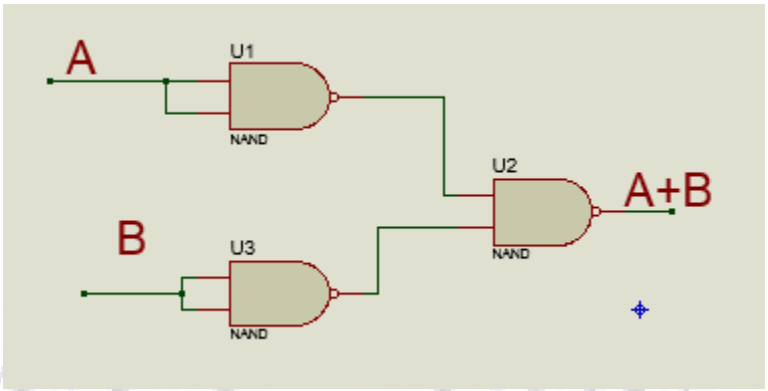
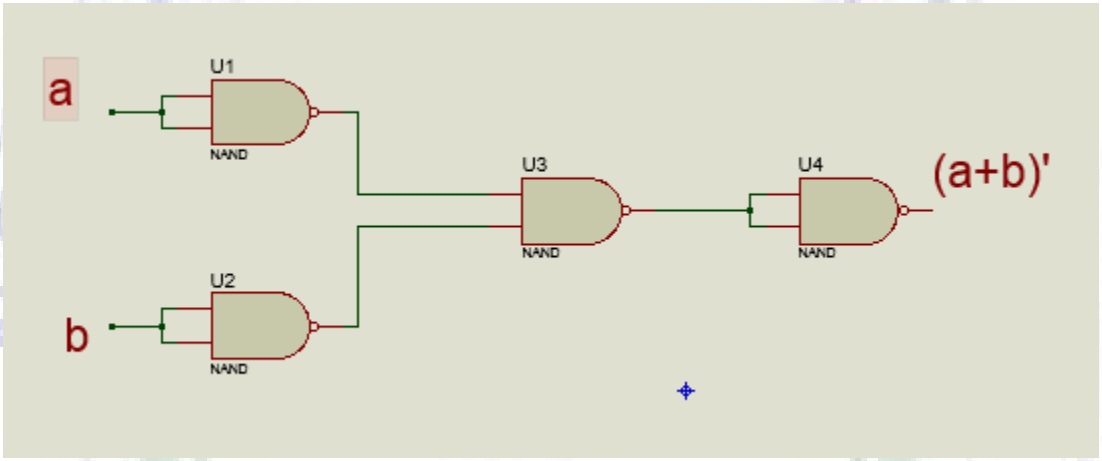
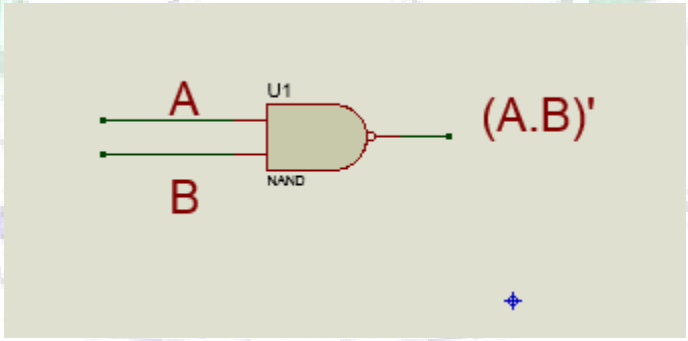



## NOR GATE




## NAND GATE




## XOR GATE
## (A'B+AB')

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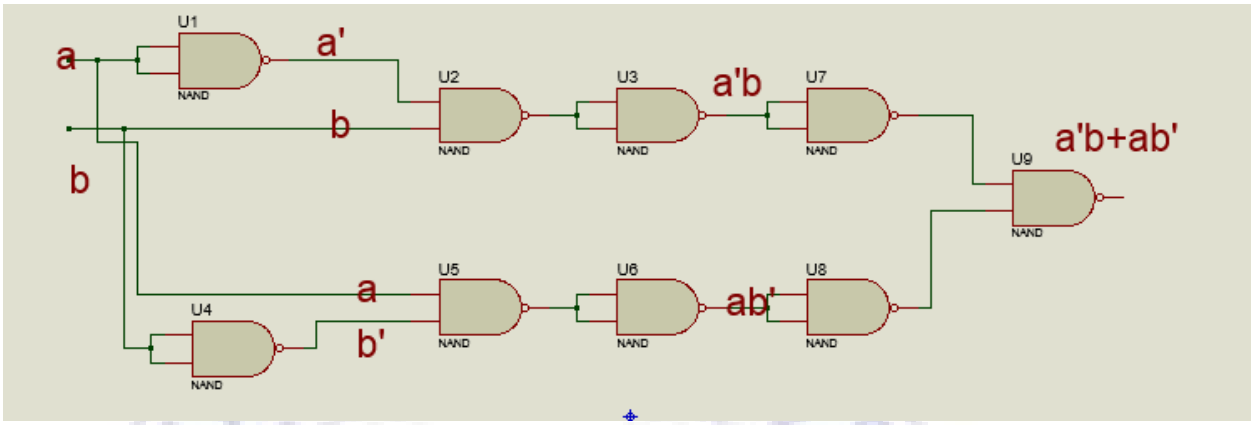
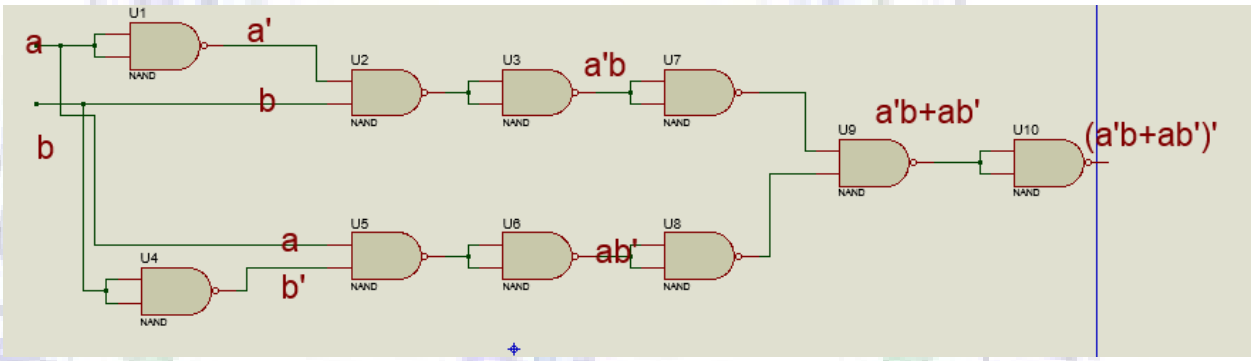



## XNOR GATE




## :PRACTICE EXAMPLES:

## Scenario#1

**Equation To Circuit:**

**{(A+B')C}'+(BC')**

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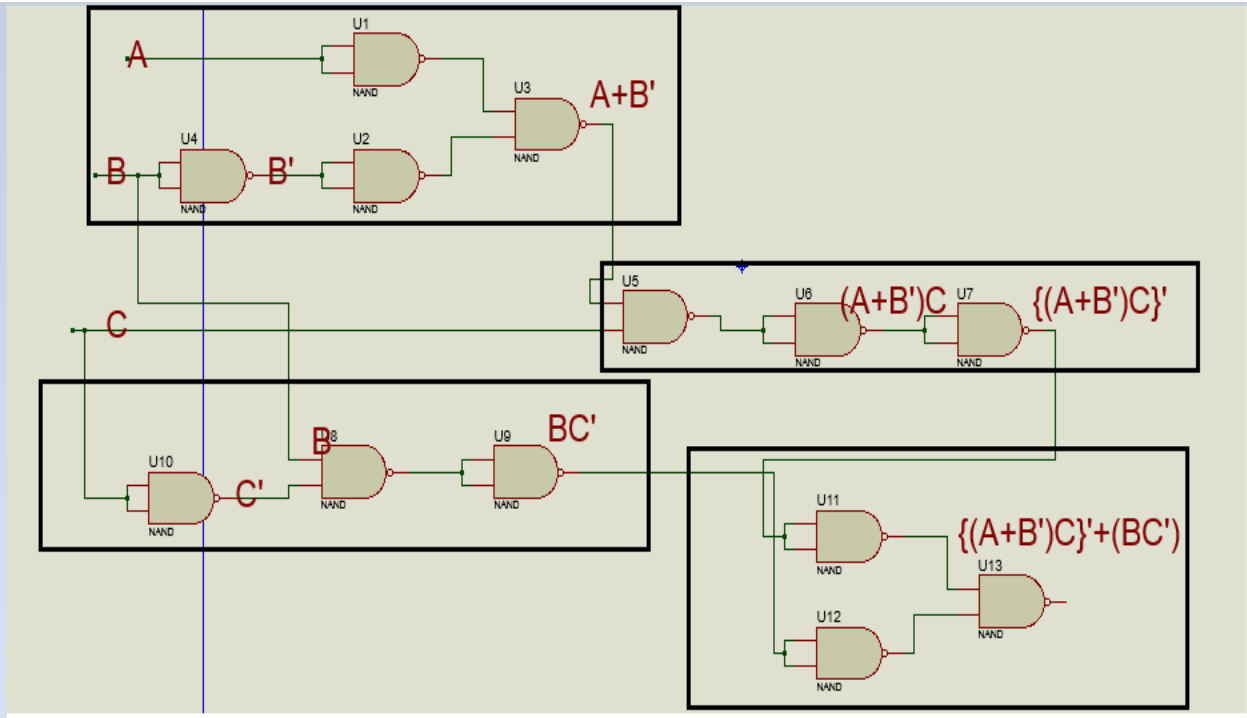
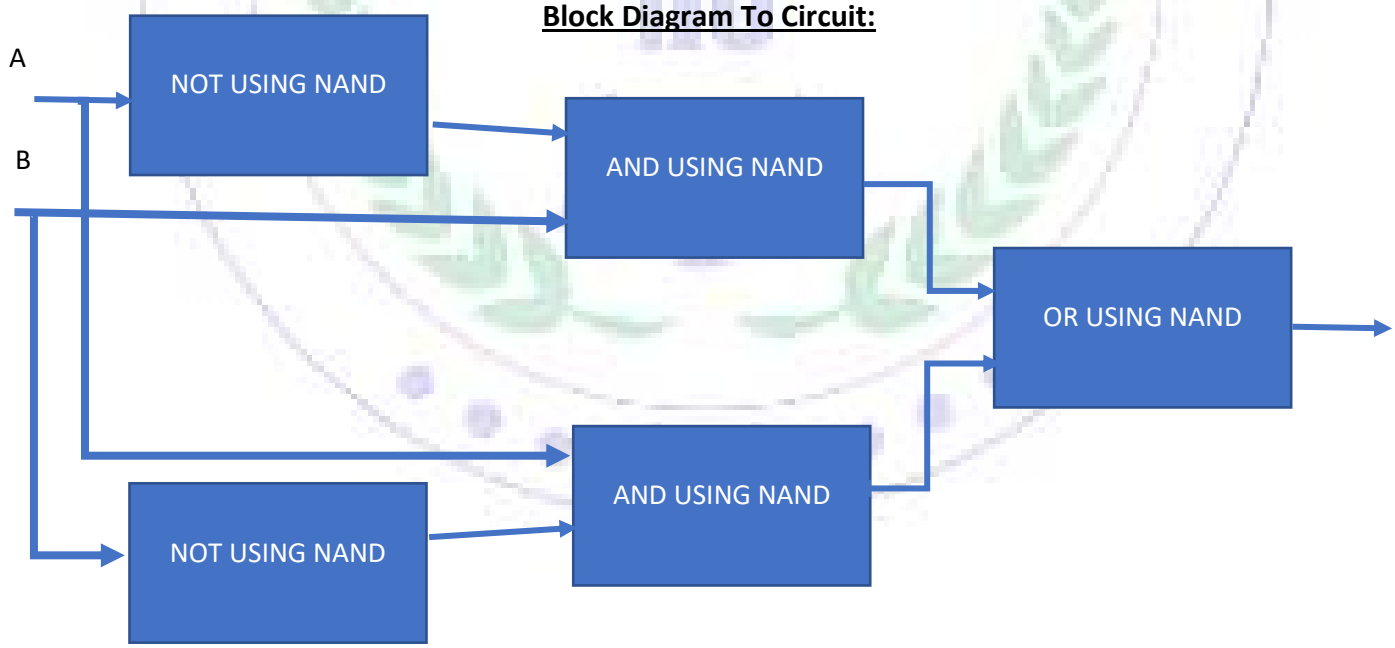



## Scenario#2

**Block Diagram To Circuit:**



# Digital Logic Design (ESC-151)

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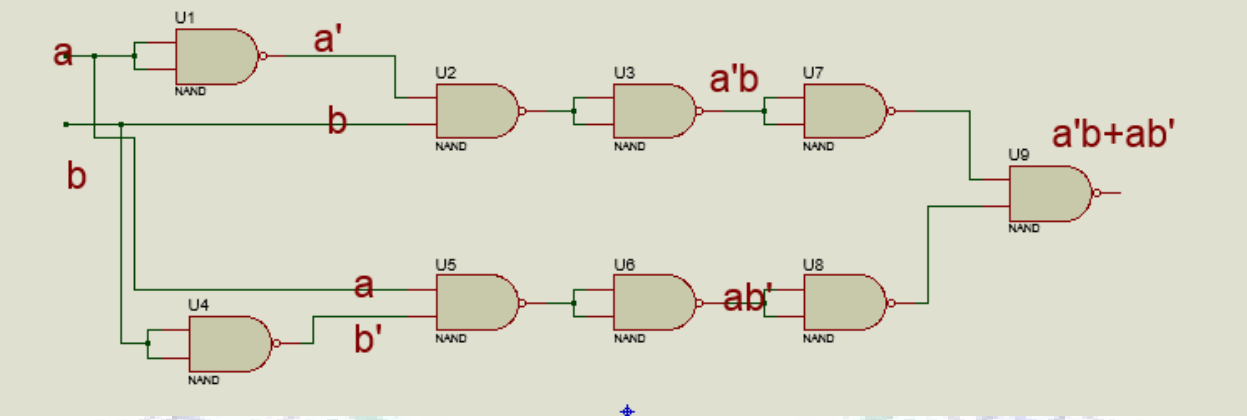
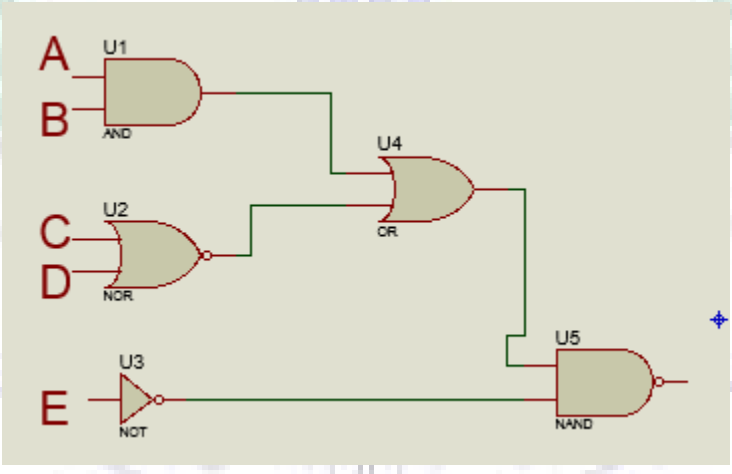



## Scenario#3

### Circuit To Circuit Conversion:




## Solution:

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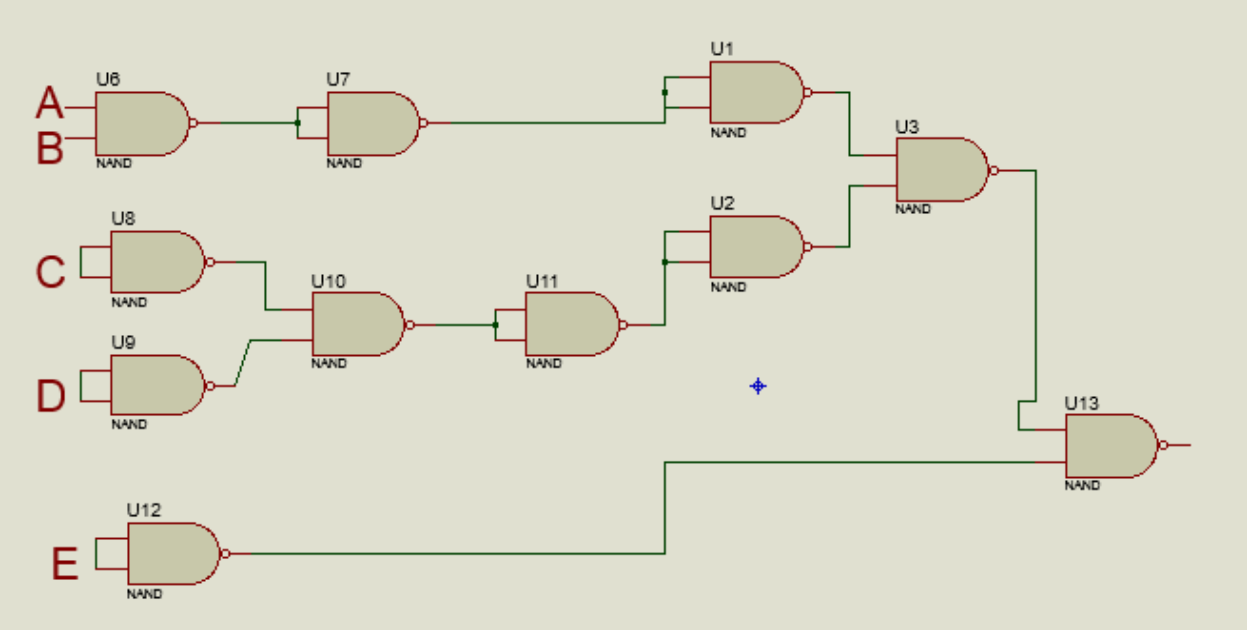
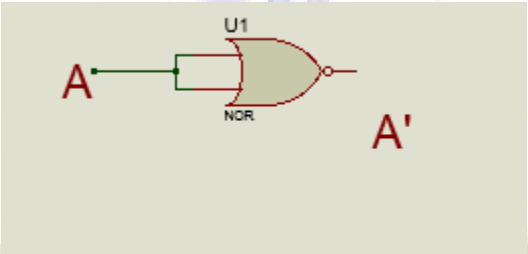
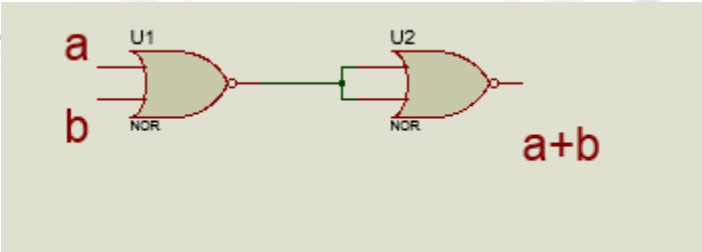



## NOR Implementation

### NOT GATE




### OR GATE




### AND GATE

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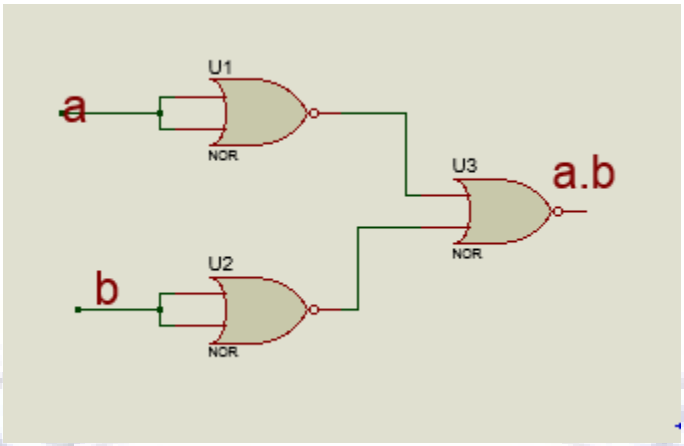
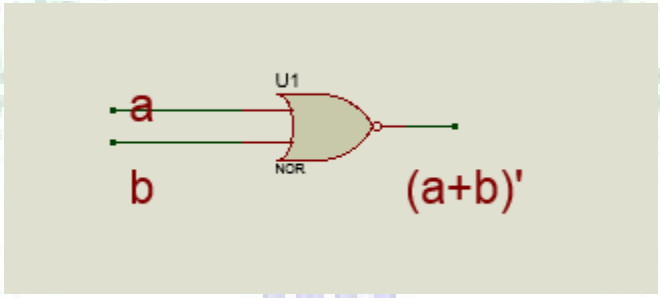
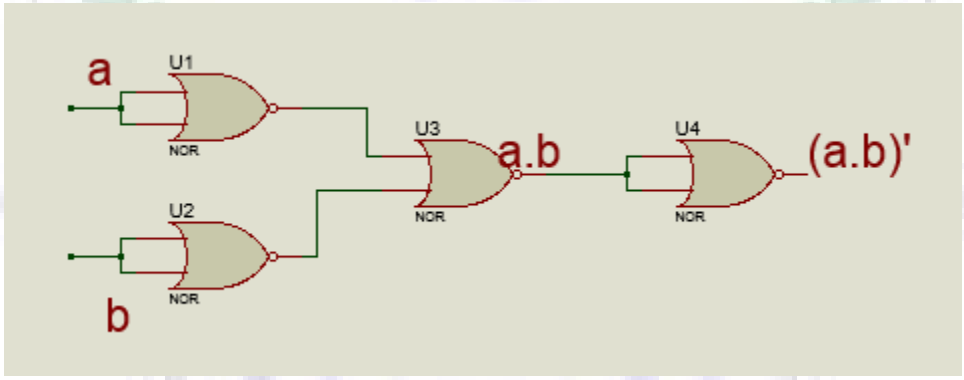



## NOR GATE




## NAND GATE




## XOR GATE

# Digital Logic Design (ESC-151)

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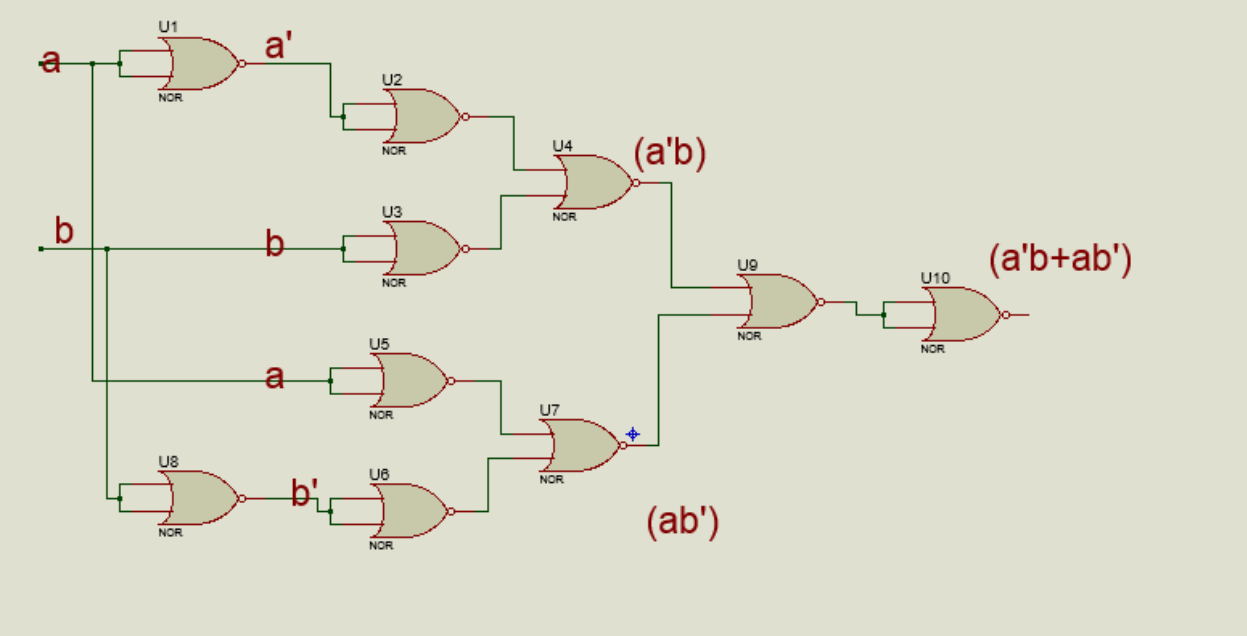
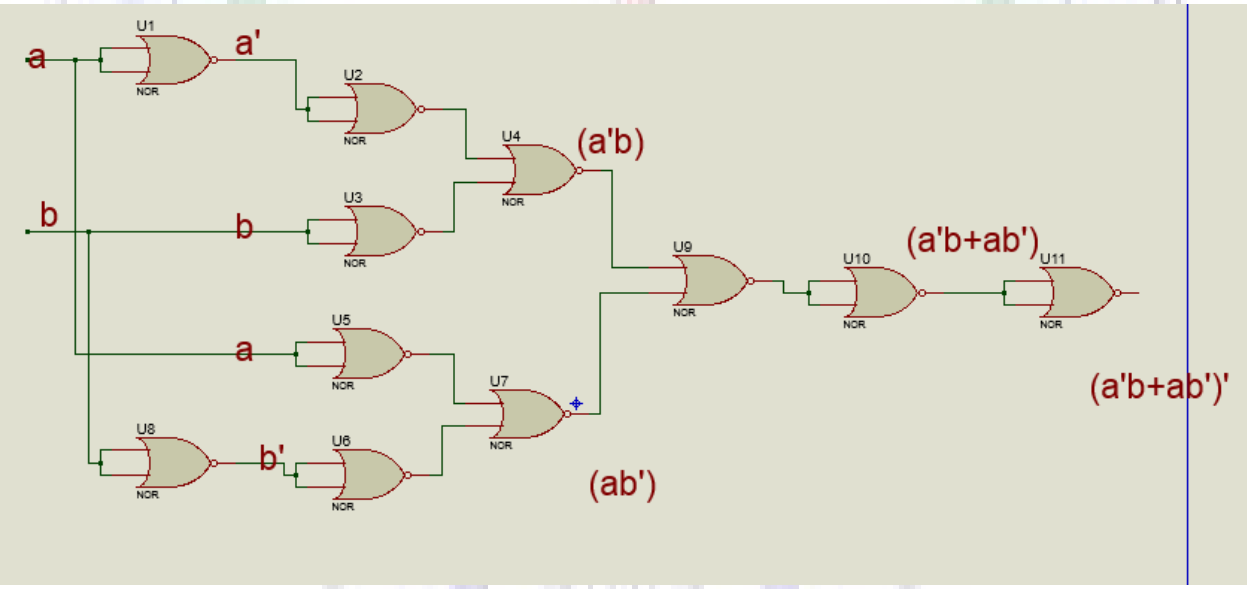



## XNOR GATE




## :Practice Examples:

## Scenario#1:

# Digital Logic Design (ESC-151)

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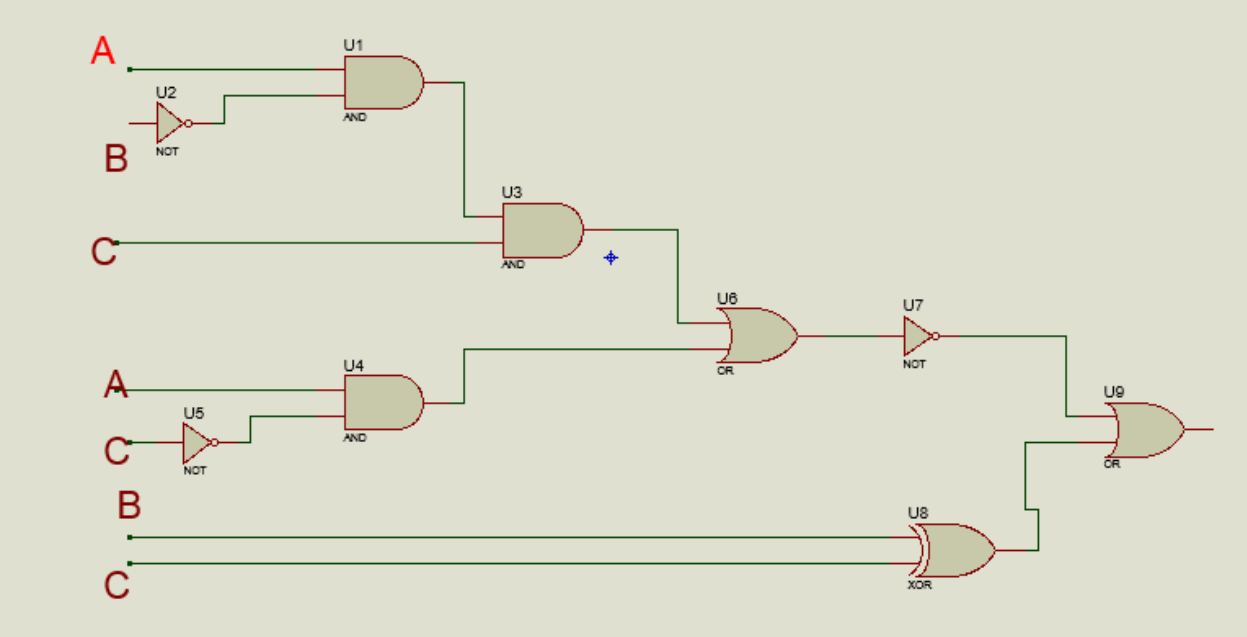
## Equations To Circuit:

**(AB'C+AC')'+(BXORC)**

### General Circuit Before Conversion:




### After Conversion, Final Circuit Diagram:

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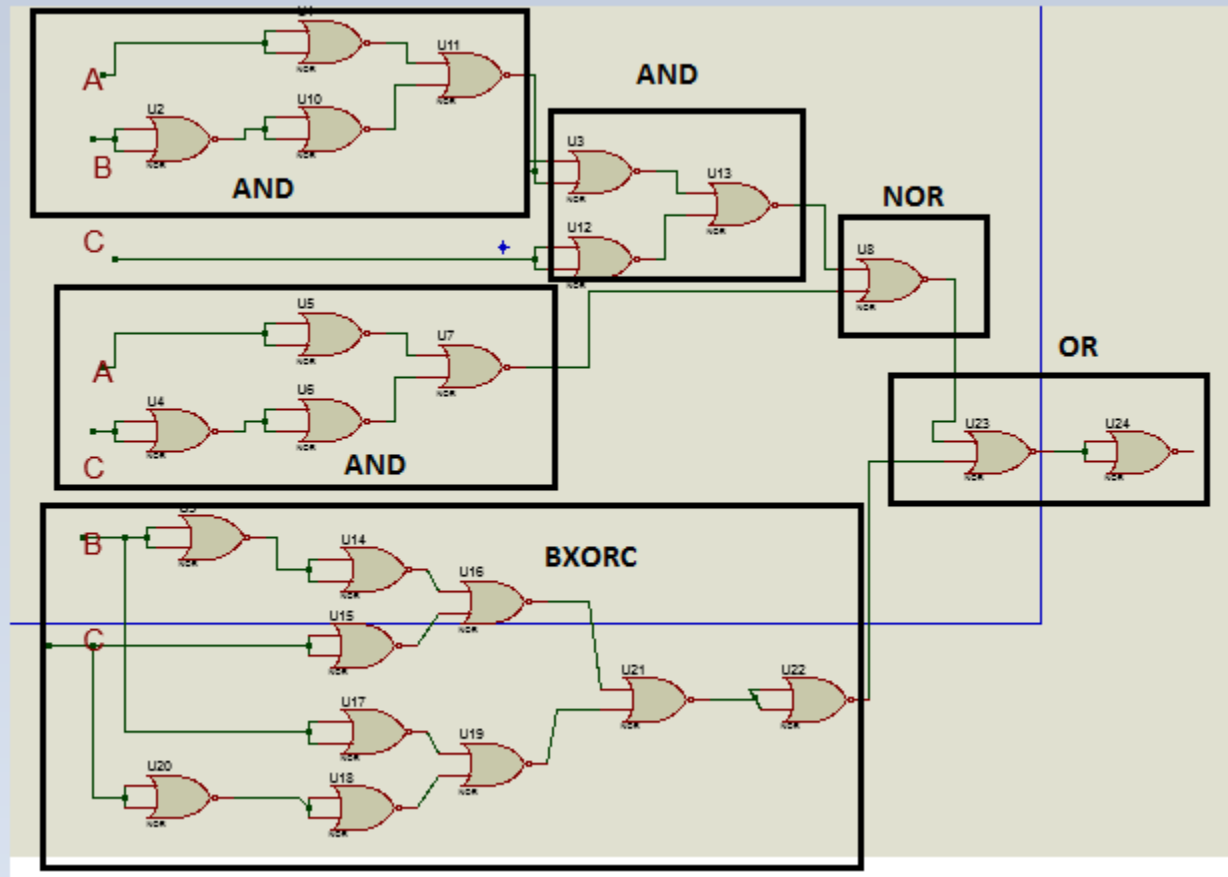
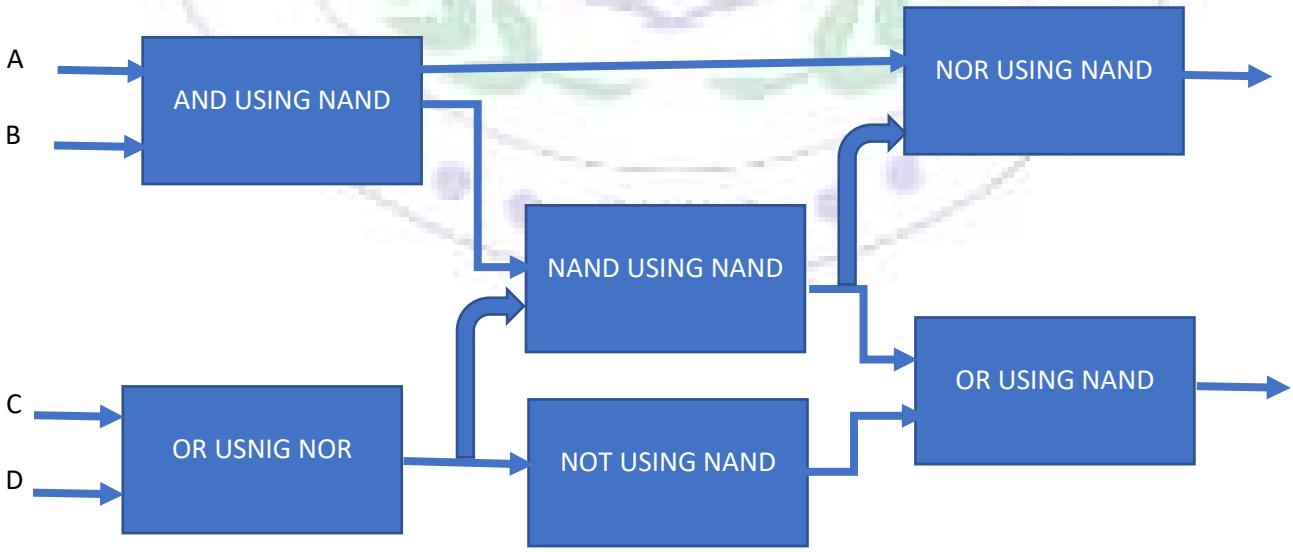



## Scenario#2

### Block Diagram To Circuit:



# Digital Logic Design (ESC-151)

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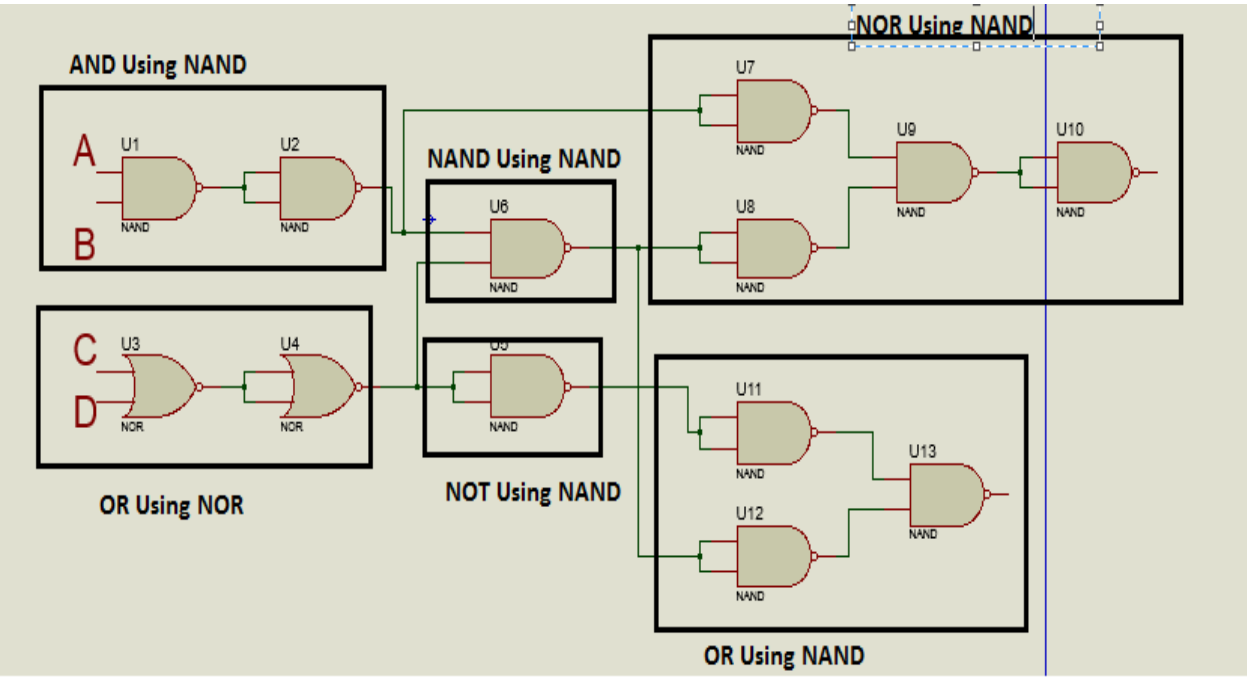
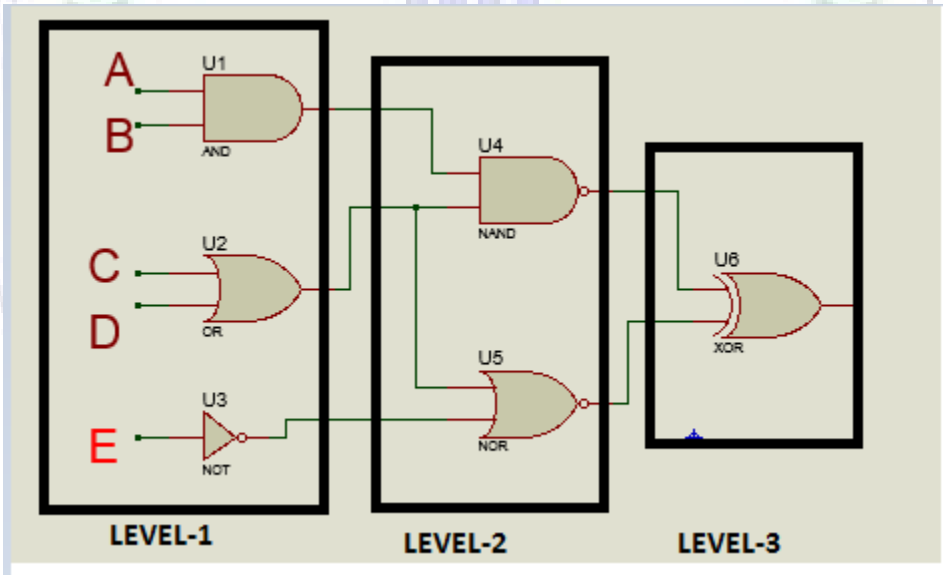



## Scenario#3

### Circuit To Circuit Conversion:




- Solve Level-1 Using Equivalent NAND Implementation
- Solve Level-2 Using Equavenlt NOR Implementation
- Solve Level-3 Using Equivalent NAND Implementation

## Solution:

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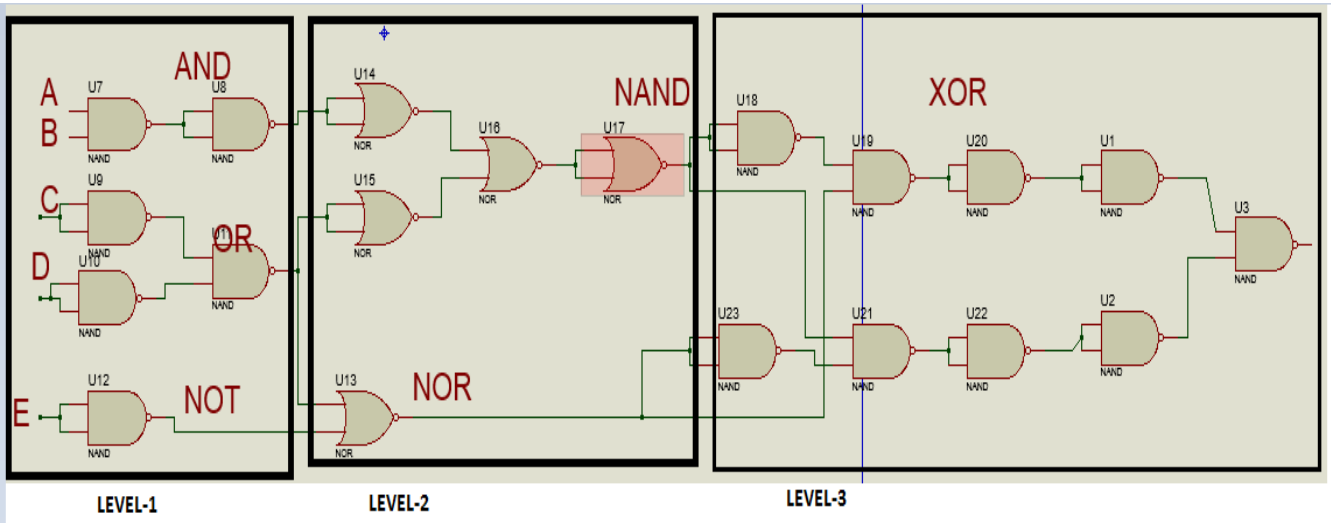
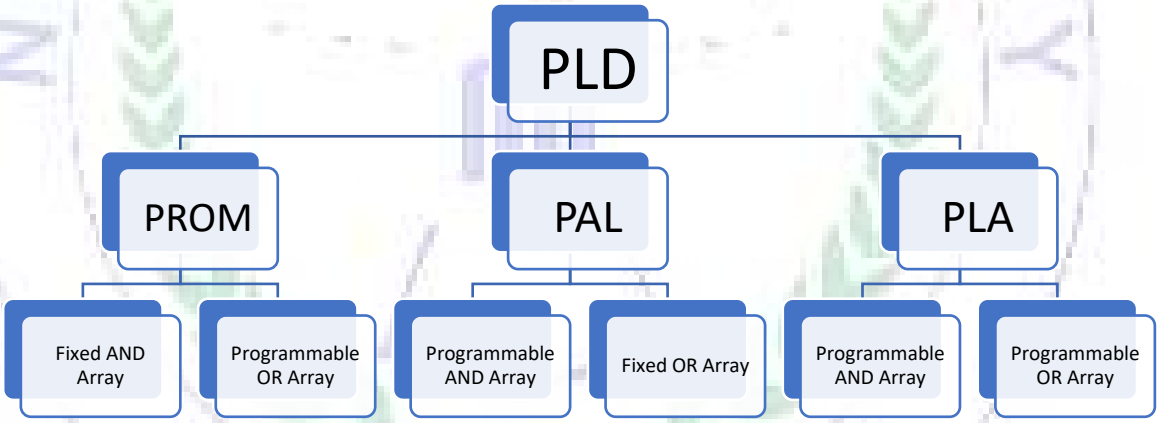



## LECTURE-22

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### Important Points:

- Combination of AND-OR Array
- Hardware level Programming
- Fuses are used
- NOT gate can be used
- Symbols:

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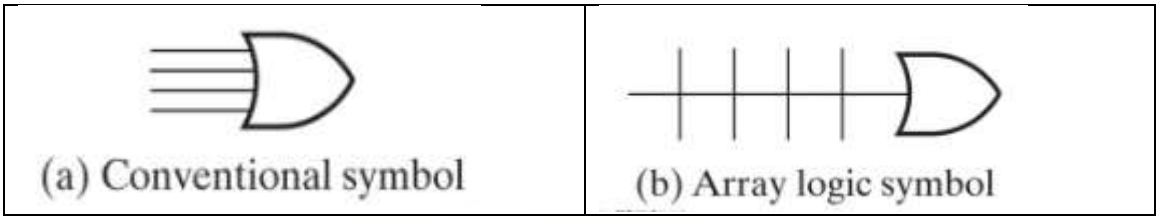


## ROM Types:

1. ROM (Masking)
2. PROM (Programmable ROM)
3. EPROM (Erasable PROM)
4. EEPROM/ $E^2$PROM (Electrically Erasable PROM)

## PROM Programming:

- Fixed AND Array
- Programmable OR Array

**Note:**

✓ For AND Array, decoder will be used. (to decide the order of the decoder, see the input variables of given function to be embedded on the ROM)

✓ For OR Array, OR gates will be used. (to decide number of OR gates to be used, see the number of functions given)

**Lets get started:**

### Example#1:

**Design following output functions on an 8x2 PROM:**

| A | B | C | $F_1$ | $F_2$ |
|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 1 |
| 0 | 1 | 0 | 1 | 0 |
| 0 | 1 | 1 | 0 | 0 |
| 1 | 0 | 0 | 0 | 1 |
| 1 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 0 |

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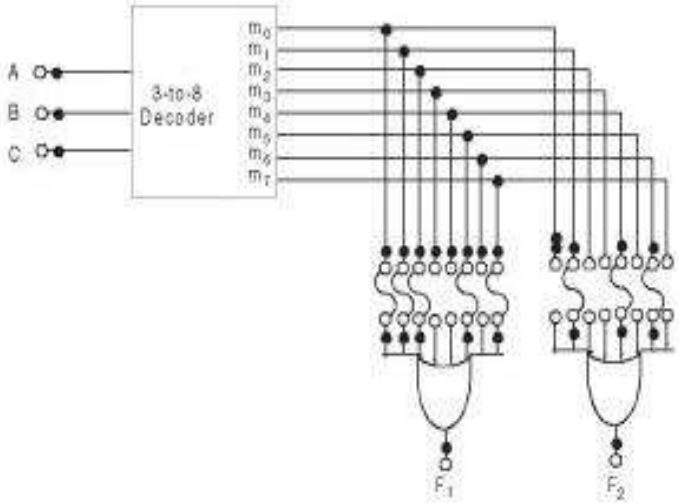
**$F_1$=** A'B'C'+A'B'C+A'BC'+AB'C+ABC

**$F_2$=**A'B'C+AB'C'+ABC'

OR

$F_1 = \sum(m0, m1, m2, m5, m7)$

$F_2 = \sum(m1, m4, m6)$




## Example#2:

**Design following equations on an 8x4 PROM**

**$F_0$**=(m1+m5+m7)

**$F_1$**=(m1+m4)

**$F_2$**=(m0+m7)

**$F_3$**=(m2+m5+m7)

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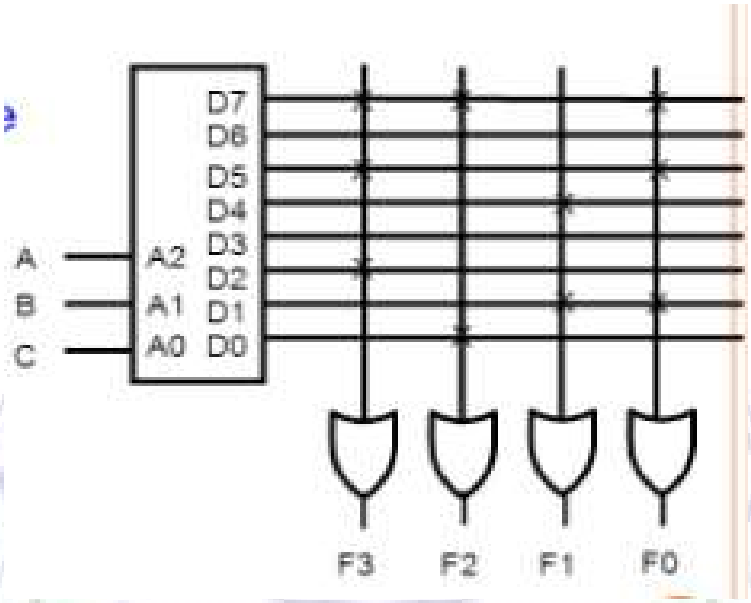


## Example#3:

**Implement following functions on an 8x3 PROM:**

**F1=**AB'+AC+B'

**F2=**ABC+B'C+AC'

**F3=** A'B'C'+A'B'

As, we are doing programming in PROM, where we use decoder for AND Array, and as you know that, in case of decoder, all the equations must be standard. So first convert these non-standard equations into standard equations and then we will be able to program these functions on a PROM.

**F1=**AB'+AC+B'

| AB'? | A?C | ?B'? |
|---|---|---|
| ~~100~~ | ~~101~~ | 000 |
| ~~101~~ | 111 | 001 |
| | | 100 |
| | | 101 |

**F1=**ABC+A'B'C'+A'B'C+AB'C'+AB'C

**F2=**ABC+B'C+AC'

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| ABC | ?B'C | A?C' |
|---|---|---|
| 111 | 001 | 100 |
| | 101 | 110 |

**F2=**ABC+A'B'C+AB'C+AB'C'+ABC'

**F3=** A'B'C'+A'B'

| A'B'C' | A'B'? |
|---|---|
| ~~000~~ | 000 |
| | 001 |

**F3=**A'B'C'+A'B'C

## Resultant Standard Equations:

**F1=**ABC+A'B'C'+A'B'C+AB'C'+AB'C

**F2=**ABC+A'B'C+AB'C+AB'C'+ABC'

**F3=**A'B'C'+A'B'C

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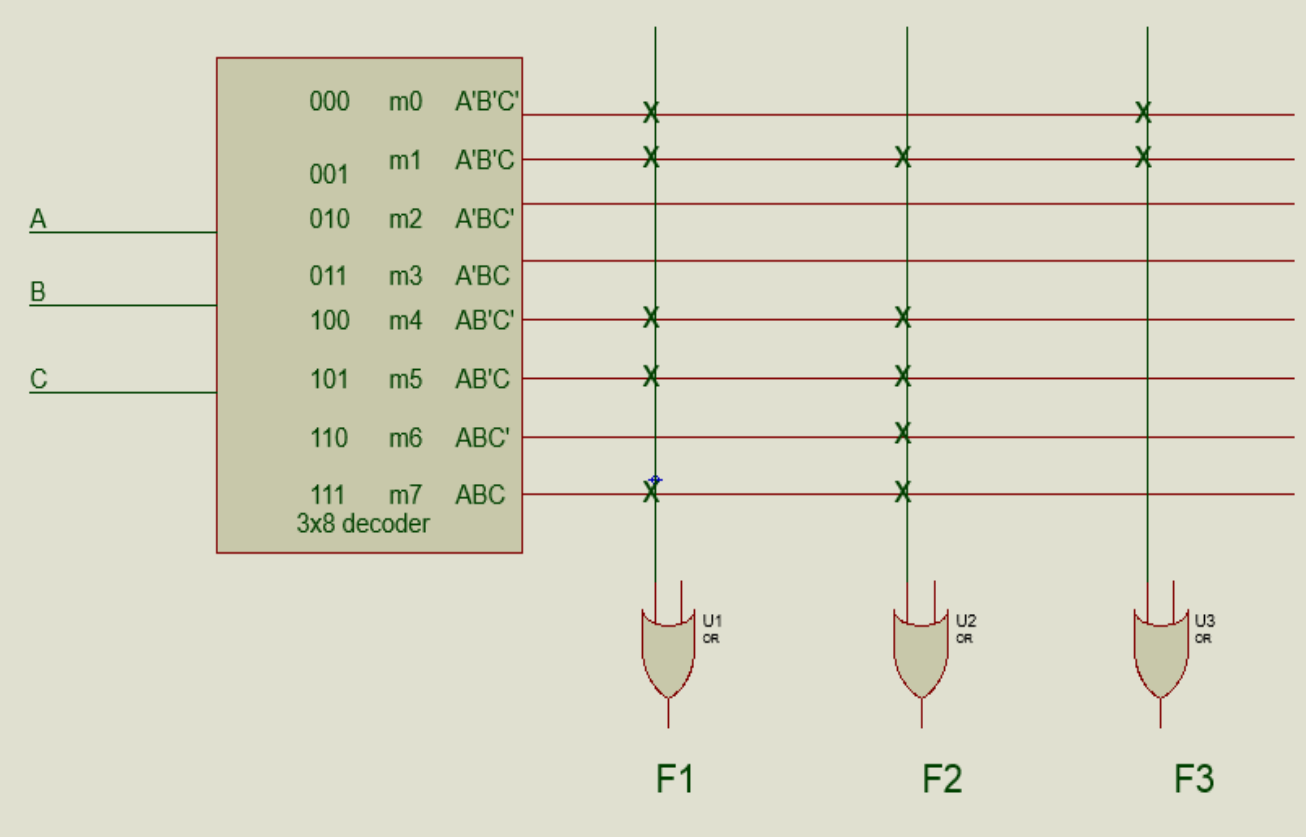
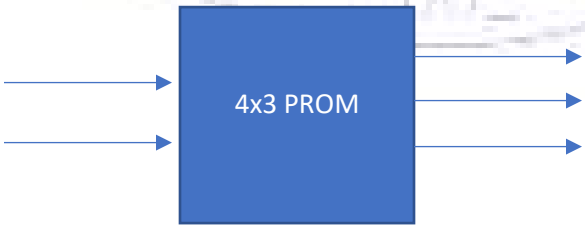



## Practice Examples for Students:

### Example#1:

Implement following functions on a 4x3 PROM:

1. **F1**=AB'+AB
2. **F2**=AB+AB'
3. **F3**=AB+A'B'



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## Example#2:

**Get equations from the given truth table and implement the output functions on a PROM. (Decide the order of PROM by your self)**

| A | B | C | O1 | O2 | O3 |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 1 |
| 1 | 0 | 1 | 0 | 0 | 1 |
| 1 | 1 | 0 | 1 | 0 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 |

## Example#3:

**Design following equations on a PROM. (Decide the order of PROM first)**

**F1=** (A+B+C)(A'+B+C')(A'+B+C)

**F2=**(A+B'+C')(A+B+C)(A'+B'+C')(A+B+C')

**HINT:** PROM makes use of decoder, and decoder's outputs are in SOP Form, so first convert the given POS Into SOP And then start designing

## Assignment:11

**Dear students read the given lectures carefully as per the course objectives mentioned on the top and carryout the assignment as per following instructions**

# Digital Logic Design (ESC-151)

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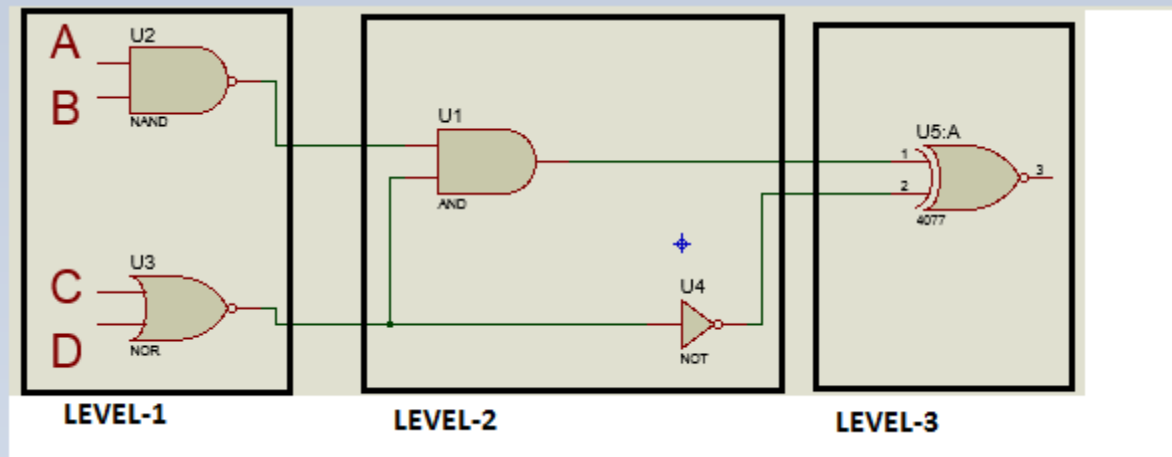
## Task to do:

1) Convert following equation into its equivalent NOR implementation:

   (a+b+c')xor(b.d)'

2) Convert following circuit into equivalent NAND- NOR Implementation as per said in the given question:




- Level-1 into equivalent NAND implementation
- Level-2 into equivalent NOR implementation
- Level-3 into equivalent NAND implementation

## Reference Material:

Lesson plans

Text book: Digital design by Moris Mano 4th edition

Also see digital fundamentals 8th ed by Floyd

## Lecture Video Links:

part-1: https://youtu.be/v-8ltNjOclM

part-2: https://youtu.be/H70LLK5SfDQ

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part-3: https://youtu.be/nKK2X-akJuo

part-4: https://youtu.be/vBXRlAKrl9Q

part-5: https://youtu.be/asPZxhw7i8Q

Lab Work: https://youtu.be/4NIU6nSXCg8

## LAB Work:

Design the circuits given in this week assignment on proteus and send screenshots to Mr Hamza Sakhi via email at **hamzasakhic97@gmail.com**

**Lab manuals have been uploaded on watsapp and Edmodo library section.**