

Name : Combinational Logic Design

A. Objectives :

- Familiarize with the analysis of combinational logic network.
- Learn the implementation of network using the two canonical forms.
- Derive combinational circuits using universal logic.
- Acquaint with basic binary arithmetic circuits - the half and full adders.

B. Theory :

Concise theory pertinent to lab experiments to go there to aid students in performing experiments with minimal supervision.

For example, topics for this lab should include definition and steps to :

Analysis of combinational logic design
Min term and max term

Canonical Forms

Universal gates - bubble pushing, De Morgan's theorem.

C. Experiment 1: Analysis of a Combinational Logic Circuit

C.1 Apparatus:

- * Trainer Board.
- * 1 × IC 7411 Triple 3-input AND gates.
- * 1 × IC 7432 Quaduple 2-input OR gates.
- * 1 × IC 7404 Hex Inverters (NOT gates)

Input Reference	A	B	C	F	Minterm	Max term
0	0	0	0	0		$A + B + C$
1	0	0	1	1	$\bar{A} \bar{B} C$	
2	0	1	0	1	$\bar{A} B \bar{C}$	
3	0	1	1	0		$A + \bar{B} + \bar{C}$
4	1	0	0	0		$\bar{A} + B + C$
5	1	0	1	0		$\bar{A} + B + \bar{C}$
6	1	1	0	1	$A B \bar{C}$	
7	1	1	1	0		$\bar{A} + \bar{B} + \bar{C}$

Table 1: Truth table to a combinational circuit.

For minterm:

$$\begin{aligned}
 F &= \bar{A} \bar{B} C + \bar{A} B \bar{C} + A B \bar{C} \\
 &= \bar{A} \bar{B} C + B \bar{C} (\bar{A} + A) \\
 &= \bar{A} \bar{B} C + B \bar{C} \cdot 1 \quad [\bar{A} + A = 1] \\
 &= \bar{A} \bar{B} C + B \bar{C}
 \end{aligned}$$

For maxterm:

$$F = (A + B + C)(\bar{A} + \bar{B} + \bar{C})(\bar{A} + B + C)(\bar{A} + B + \bar{C})(\bar{A} + \bar{B} + \bar{C})$$

$$\begin{aligned}
 \bar{F} &= \overline{(A+B+C) \cdot (A+\bar{B}+\bar{C}) \cdot (\bar{A}+B+C) \cdot (\bar{A}+B+\bar{C}) \cdot (A+\bar{B}+\bar{C})} \\
 &= (\bar{A}\bar{B}\bar{C}) + (\bar{A}BC) + (A\bar{B}\bar{C}) + (A\bar{B}C) + (ABC) \\
 &= (\bar{A}\bar{B}\bar{C}) + (A\bar{B}\bar{C}) + (\bar{A}BC) + (ABC) + (A\bar{B}C) \\
 &= \bar{B}\bar{C}(\bar{A}+A) + BC(\bar{A}+A) + (A\bar{B}C) \\
 &= \bar{B}\bar{C} \cdot 1 + BC \cdot 1 + (A\bar{B}C) \quad [\because \bar{A}+A=1] \\
 &= A\bar{B}C + BC + \bar{B}\bar{C}.
 \end{aligned}$$

	Shorthand Notation	Function
1st Canonical Form	$F = \Sigma(1, 2, 6)$	$F = \bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C}$ $= \bar{A}\bar{B}\bar{C} + BC$
2nd Canonical Form	$F = \Pi(0, 3, 4, 5, 7)$	$F = A\bar{B}C + BC + \bar{B}\bar{C}$

Table C.2: 1st and 2nd Canonical forms of the combinational circuit of Table C.1

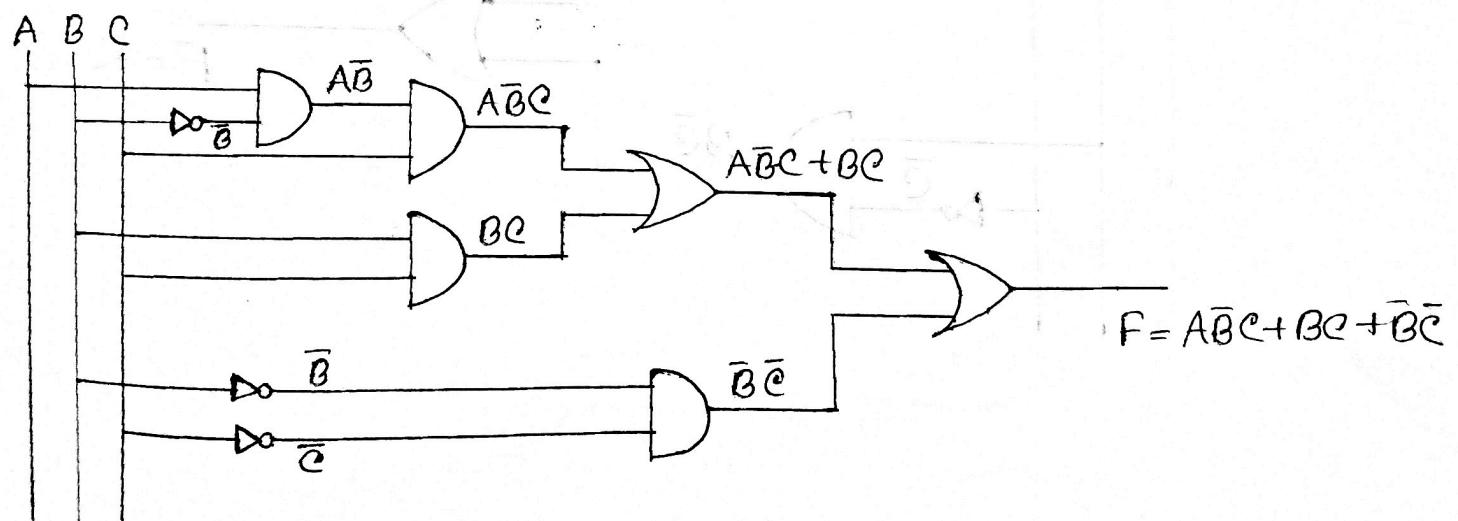
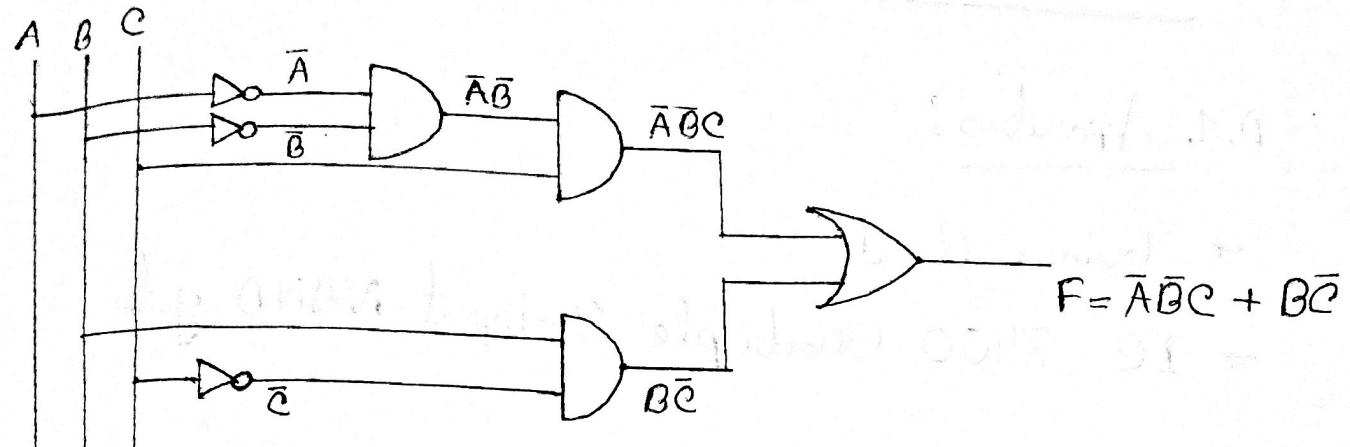


Figure C.1: 1st and 2nd canonical circuit diagram of the combinational circuit of Table C.1.

D. Experiment 2: Universal Gate

D. 1. Apparatus:

+ Trainer Board

+ IC 7400 Quaduple 2-input NAND gates.

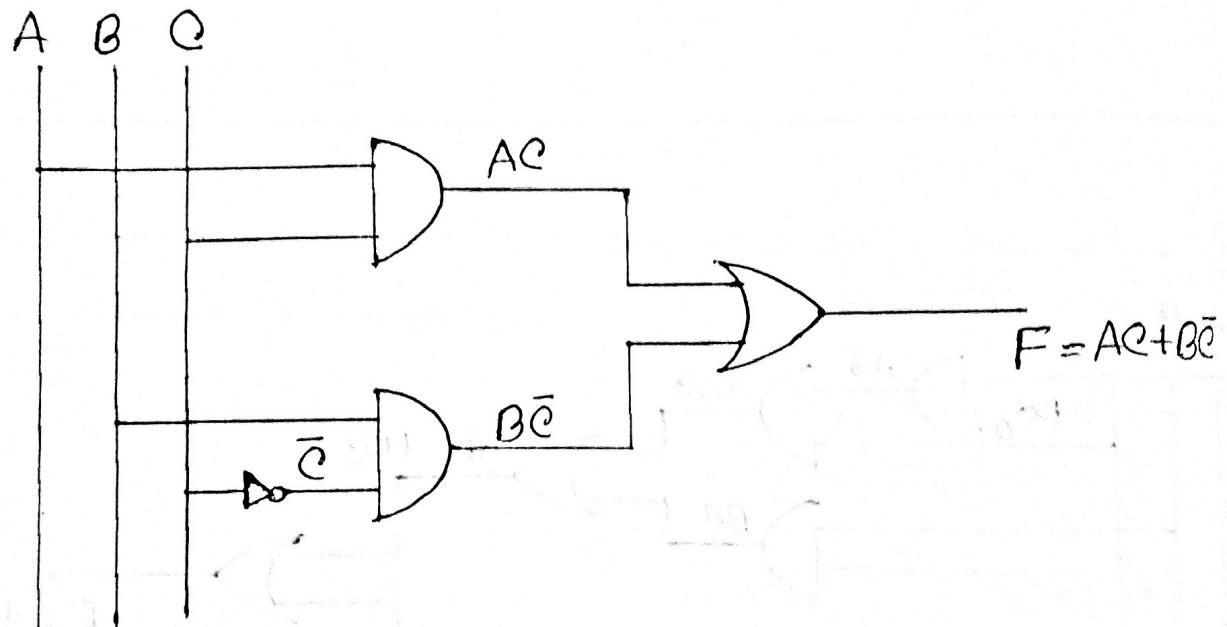
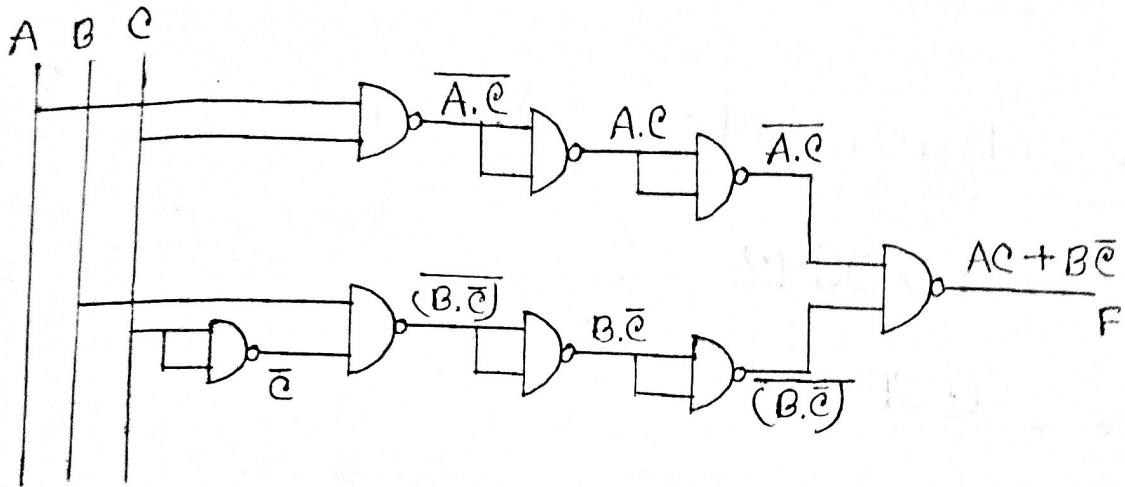


Figure 0.1: A combinational circuit.

A	B	C	$I_1 = AC$	$I_2 = B\bar{C}$	$F = I_1 + I_2$
0	0	0	0	0	0
0	0	1	0	0	0
0	1	0	0	1	1
0	1	1	0	0	0
1	0	0	0	0	0
1	0	1	1	0	1
1	1	0	0	1	1
1	1	1	1	0	1

Table 0.1: Truth table of combinational circuit in figure 0.1

Step-01



Step-02

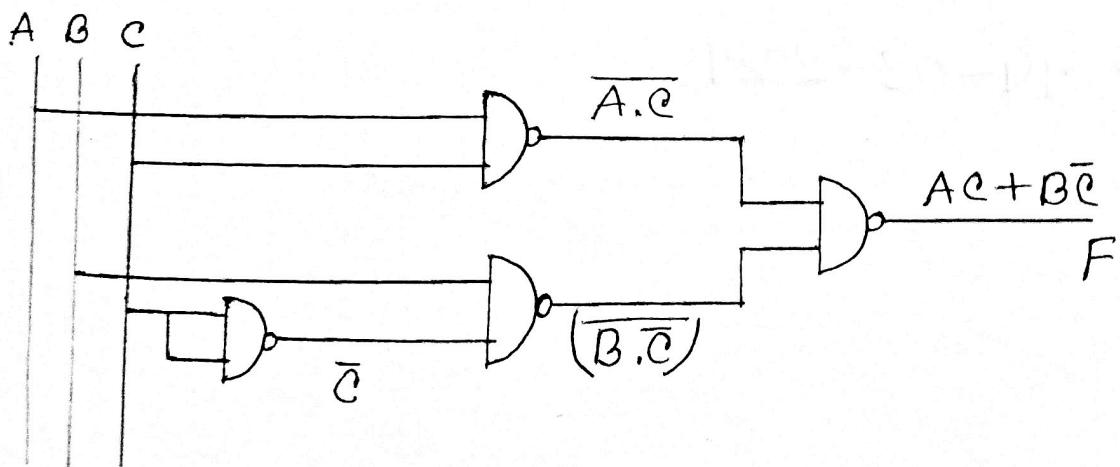


Figure 0.2 : Universal (NAND) gate implementation of the circuit of Figure 0.1