Name: Universal Gates

A. Objectives:

* Understand the concept of universal gates (NAND & NOR).
* Implement the basic logic gates using universal gates.
* Implement Boolean functions using universal gates.
* Understand the gate level optimization.

B. Apparatus :

* Trainer Board.
* IC 7400 Quadruple 2-input NAND gates.
* IC 7402 Quadruple 2-input NOR gates.

C. Theory:

A universal gate is a gate which can implement any Boolean function without need to use any other gate type. The NAND and NOR gates are universal gates. In practice, this is advantageous since NAND and NOR gates are economical and easier to fabricate and are the basic gates used in all IC digital logic families.

Figure 01 shows the implementation of NOT, AND & OR gates using only NAND gates.

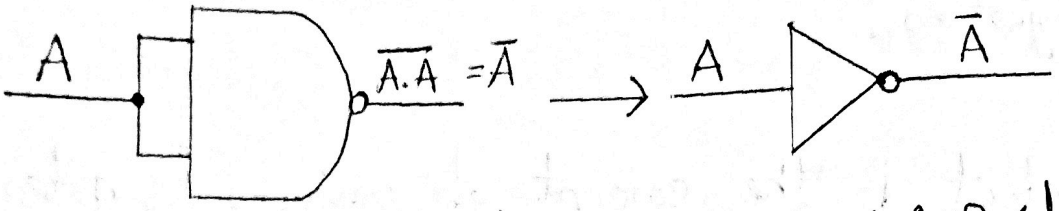


Figure : implementation of NOT gate using NAND gate

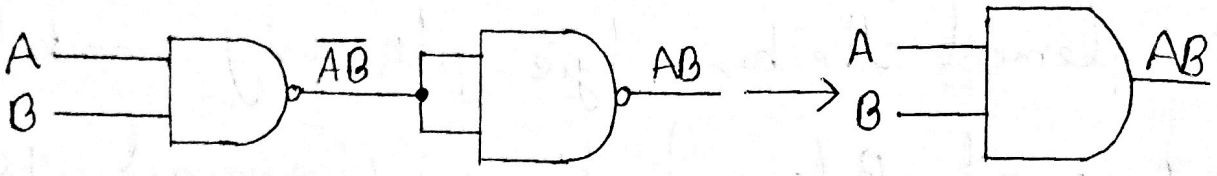


Figure : implementation of AND gate using NAND gate

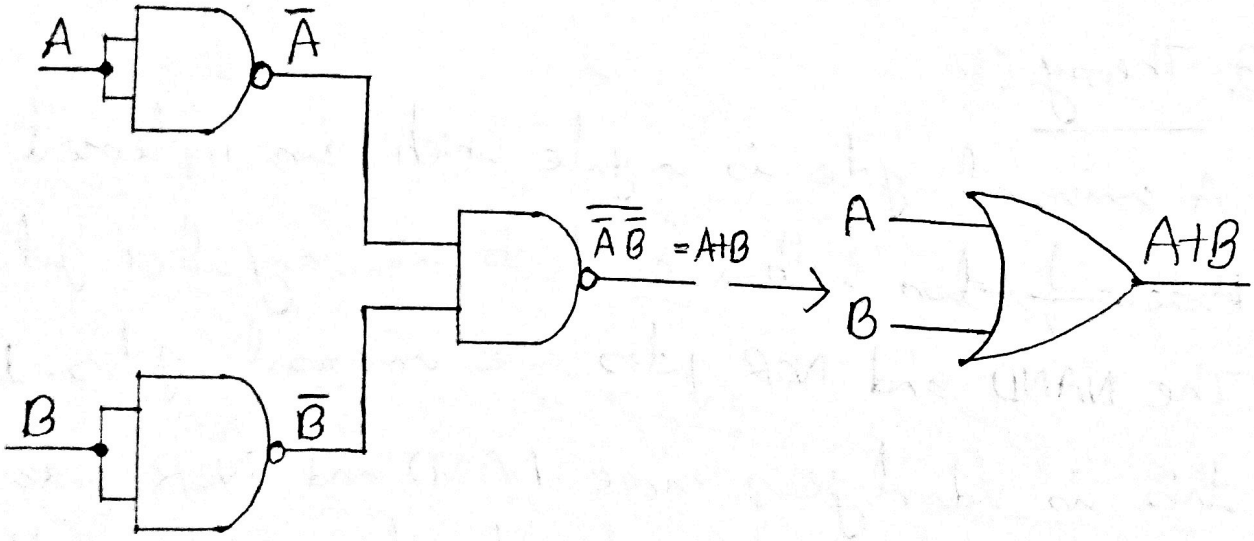


Figure : implementation of OR gate using NAND gate

Figure 01: NAND as a universal gate

F. Experimental Data :

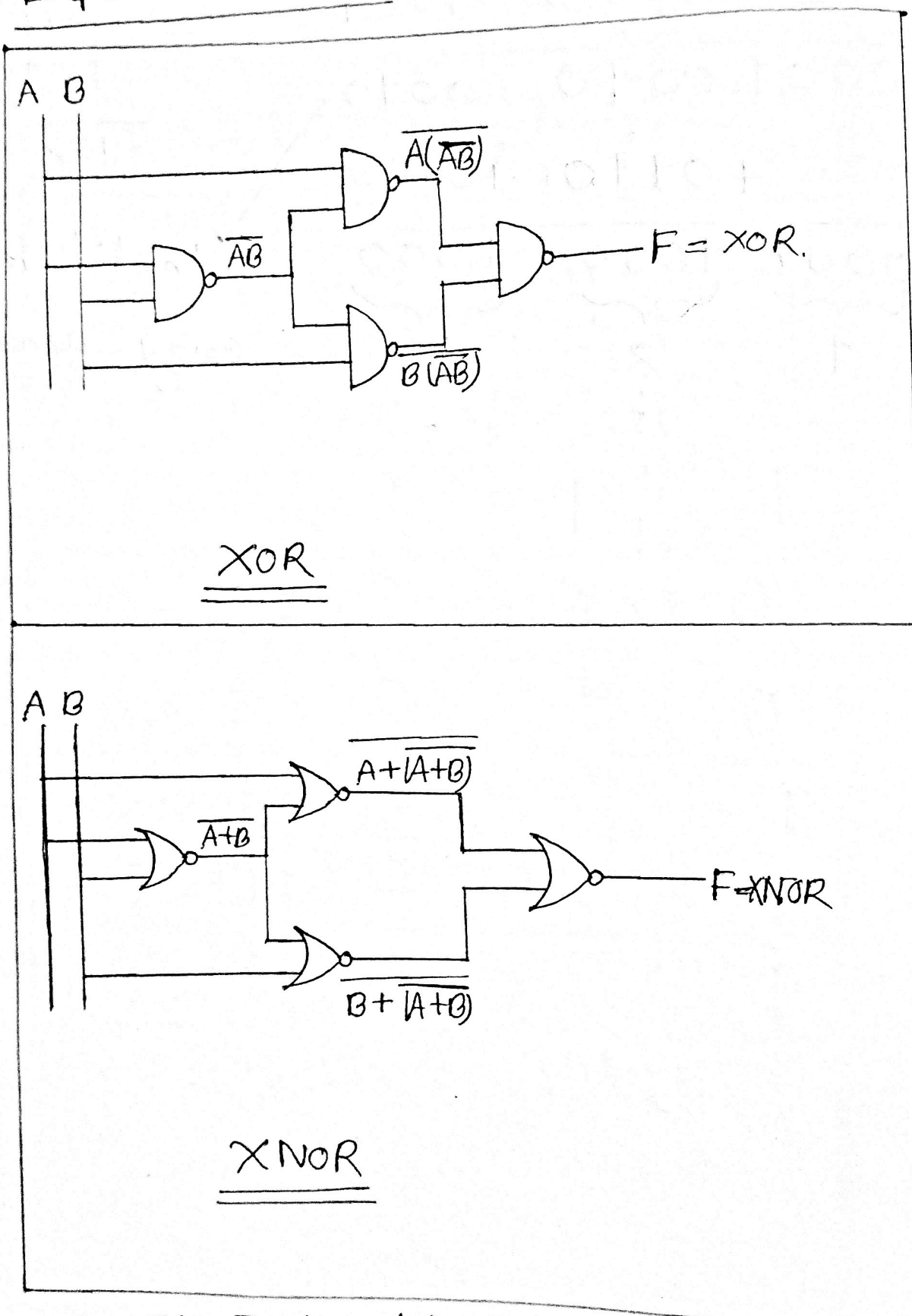


Figure F1 : Implementation of XOR and XNOR using NAND gates.

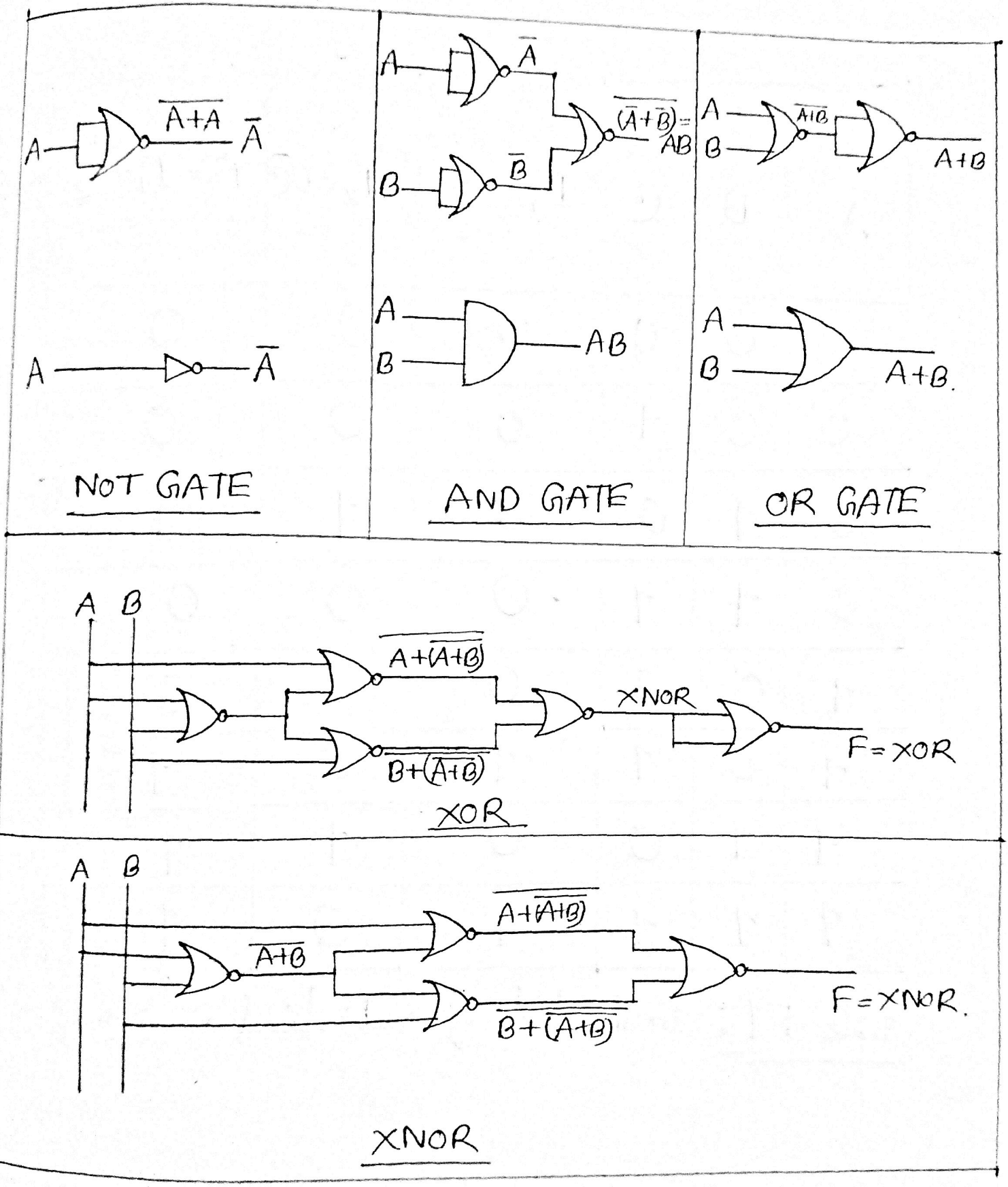
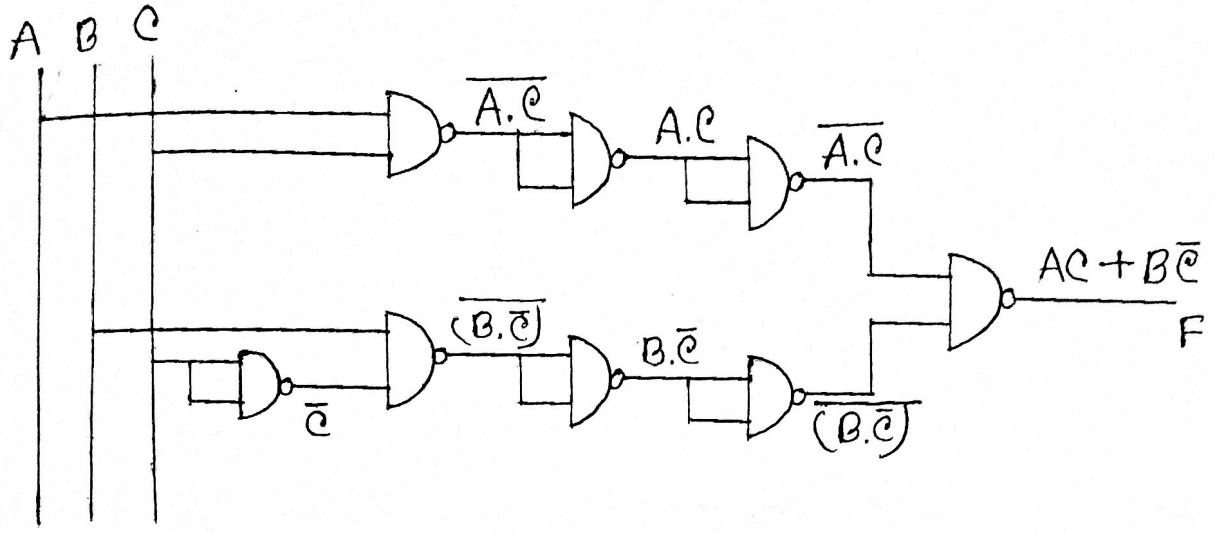


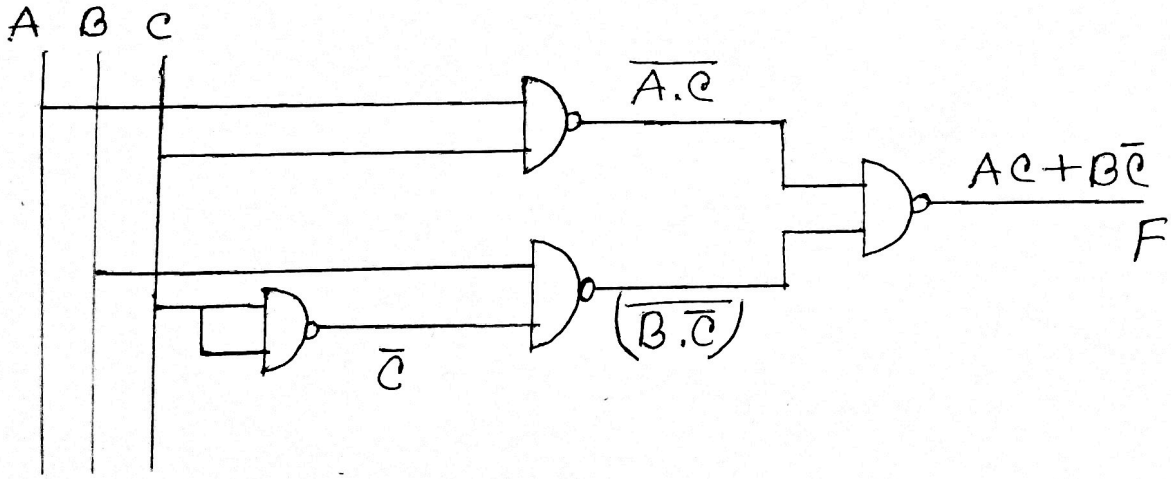
Figure F2: Implementation of NOT, AND, OR, XOR and XNOR using NOR gates

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 F1: Truth table of combinational circuit in figure B2



Part-01



Part-02

Figure F3: Universal (NAND) gate implementation of the circuit of Figure D_2