OR Gate:-

⇒ Apparatus:

- Bread board
- Cutter
- Single core wire
- Pair of Strippers
- IC of OR gate

⇒ Objective:

→ Use IC of OR gate to perform the operation.

→ Write the truth table of OR gate

⇒ Procedure:

→ Connect the trainer board with power supply

→ Place the corresponding IC 74LS32 on the board

→ Connect pin 14 to +5V and 7 to GND

→ Connect pin 1 and 2 to two switches for input 3 to LED for output.

→ Give the input through switches according to the truth table and check the output.

⇒ Conclusion:

→ OR gate, generates high output when at least one input is high and even generates high output when both inputs are high

Truth Table:

Table 2-1

Input A	Input B	Output C
0	0	0
0	0	0
1	1	0
1	0	1
1	1	1

Pin Configuration:

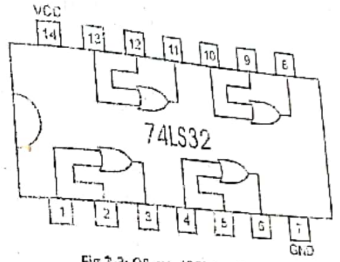


Fig 2-3: OR gate IC Pin Out Diagram

To check the operation of AND gate according to the AND's truth table, using the IC 74LS08

Theory

A Logic AND Gate is a type of digital logic gate that has an output which is normally at logic level "0" and only goes "HIGH" to a logic level "1" when ALL its inputs are at logic level "1". The output of a Logic AND Gate only returns "LOW" again when ANY of its inputs are at a logic level "0". The logic or Boolean expression given for a logic AND gate is that for Logical Multiplication which is denoted by a single dot or full stop symbol, (.) giving us the Boolean expression of:

$$A.B = Q$$

Equipment Required:

- 74LS08

AND Gate:-

⇒ Apparatus:

- Bread board
- Cutter
- Single core wire
- Pair of strippers
- IC of AND gate

⇒ Objective:

→ Use IC of AND gate and perform the operation.

→ Write the truth table of AND gate

⇒ Procedure:-

→ Connect your trainer board with power supply using single core wire

→ Place the corresponding IC 74LS08 on the board

→ Connect pin 14 to +5V and pin 7 to GND.

→ Connect pin 1 and 2 with 1st two switches for input and 3rd one with LED for output.

→ Give the input through switches according to the truth table and check the output.

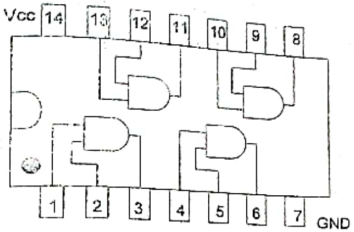
⇒ Conclusion:-

→ AND gate, generates high output when both inputs are high otherwise the output value is low

Symbolic diagram:

Fig 2-4: And Gate Diagram

Pin Configuration:



Quad 2-input AND gate 7408

Fig 2-5: And Gate IC pinout

Truth Table:

Table 2-2

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

To check the operation of NOT gate according to the NOT's truth table, using the IC 74LS04.

Theory:

The output of NOT gate is opposite to its inputs. It is also called an inverter because it inverts the input signal. It has one input and one output. All it does to invert (or complement) the inputs.

NOT Gate:-

⇒ Apparatus:

- Bread board
- Cutter
- Pair of strippers
- Single core wire
- IC of NOT gate

⇒ Objective:-

→ Use IC of NOT gate and perform the operation

→ Write the truth table of NOT gate

⇒ Procedure:-

→ Connect the trainer board with power supply.

→ Place the corresponding IC 74LS04 on the board.

→ Connect pin 14 with +5V and 7 with GND

→ Connect pin 9 with switch and 8 with LED.

→ Give the input values according to the truth table and check the output.

⇒ Conclusion:-

→ NOT gate, we have only one input and one output. The value of output is negation of input, if value of input is one, the value of output must be zero and vice versa

Equipment Required:

- 74LS04

Symbolic diagram:

Fig 2-6: Not Gate Diagram

Pin Configuration:

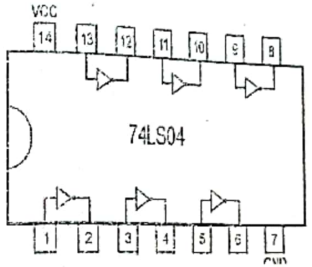


Fig 2-7: Not Gate IC Pinout

Truth Table:

Table 2-3

Input	Output
A	Y
0	1
1	0

To check the operation of NOR gate according to the NOR's truth table, using the IC 74LS02

Theory:

It is a NOT-OR gate. It can be obtained by connecting a NOT gate in the output of an OR gate as shown in fig. Its output is given by the Boolean equation.

$$C' = (A+B)'$$

It gives an output when it is both inputs are 0.

NOR Gate:-

⇒ Apparatus:

- Bread board
- Cutter
- Single core wire
- IC of NOR gate

⇒ Objective:

→ Use IC of NOR gate and perform the operation

→ Write the truth table of NOR gate

⇒ Procedure:

→ Connect the trainer board with power supply

→ Place the corresponding IC 74LS02 on the board

→ Connect pin 14 with +5V and 7 with GND

→ Connect pin 11 and 12 with two switches for input and 13 with LED for output

→ Apply the combination of input and check the output

⇒ Conclusion:

→ NOR gate, we have two inputs and one output The value of output is high, if both values of input are low otherwise, in remaining cases, the values of output must be low.

NOR gate is negation of OR

Equipment Required:

- 74LS02

Symbolic diagram:

Fig 2-8: NOR Gate Diagram

Pin Configuration:

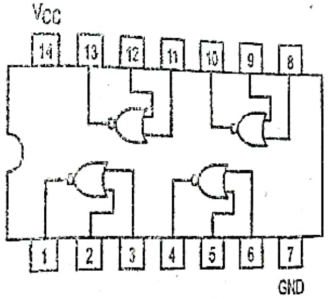


Fig 2-9: Nor Gate Diagram

Truth Table:

Table 2-4

Input		Output
A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

To check the operation of NAND gate according to the NAND's truth table, using the IC 74LS00

Theory:

It is in fact a NOT-AND gate. It can be obtained by connecting a NOT gate in the output of an AND gate as shown in fig. Its output is given by the Boolean equation.

NAND Gate :-

Apparatus:

- Bread board
- Cutter
- Single Core wire
- IC of NAND gate

Objective:

→ Use the IC of NAND gate and perform the operation

→ Write the truth table of NAND gate

Procedure:

→ Connect the trainer board with power supply.

→ Place the corresponding IC 74LS00 on the board.

→ Connect pin 14 to +5V and 7 to GND.

→ Connect pin 1 and 2 to two switches for input and 3 to LED for output.

→ Give the input through switches according to the truth table and check the output.

Conclusion:

NAND gates we have two inputs and one output. The value of output is low when both inputs are high otherwise, in remaining cases, The value of output is high.

NAND gate is negation of AND

$Q' = (A.B)'$

This gate gives an output high if either A or B or both are 0.

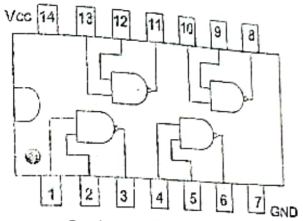
Equipment Required:

- 74LS00

Symbolic diagram:

Fig 2-10: NAND Gate Diagram

Pin Configuration:



Quad 2-input NAND gate 7400

Fig 2-11: NAND Gate IC Pinout

Truth Table:

Table 2-5

Input A	Input B	Output Q'
0	0	1
0	1	1
1	0	1
1	1	0

To check the operation of XOR gate according to the XOR's truth table, using the IC 74LS86

Theory:

It is the gate which gives an output 1when its inputs are not same (or exclusive) and anoutput0 when its inputs are same. Its symbol is shown in fig.

XOR Gate :-

⇒ **Apparatus:**

- Bread board
- Cutter
- Single core wire
- IC of XOR gate

⇒ **Objective:**

→ Use IC of XOR gate and perform the operation.

→ Write the truth table of XOR gate

Procedure:

→ Connect the trainer board with power supply

→ Place the corresponding IC 74LS86 on the board

→ Connect pin 14 to +5V and 7 to GND

→ Connect pin 1 and 2 to two switches for input and 3 to LED for output.

→ Give the input through switches according to the truth table and check the output.

⇒ **Conclusion:**

→ XOR gate, gives an output only if it's two inputs are dissimilar, means if one of them is high and other is low

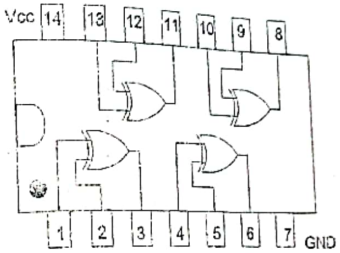
Equipment Required:

- 74LS86

Symbolic diagram:

Fig 2-12: XOR Gate Diagram

Pin Configuration:



Quad 2-input XOR gate 7486

Fig 2-13: XOR Gate IC Pinout

Truth Table: Table 2-6

Input		Output
A	B	X
0	0	0
0	1	1
1	0	1
1	1	0

Experiment No 3

⇒ Apparatus:

- Bread board
- Single core wire
- AND IC (74LS08)
- OR IC (74LS32)

⇒ Procedure:

→ Place the AND and OR ICs on breadboard.

→ Connect 7 and 14 pin of each IC to GND and +5V respectively through power supply.

→ Give input C,D to AND gate and pass its output to input of OR gate.

→ Take another input B. Apply OR operation on B and the output of AND operation.

→ Take the output of OR operation along with another input A and perform AND operation.

→ Connect the output to LED

⇒ Conclusion:

→ Conclusion in given in the table

CD term in function is product term that is represented by an AND gate. Similarly, OR gate is used for B+CD term. A detail logic diagram shown below with signal naming.

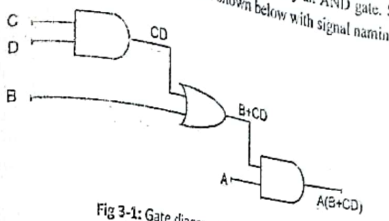


Fig 3-1: Gate diagram of function F1

Procedure

- Connect the trainer board with the power supply.
- Mount the corresponding 74LSXX IC on the board.
- Wire the circuit according to the diagram by consulting the corresponding gate ICs data sheet.
- Apply all the combinations of inputs and observe the output on the LED.
- Fill the truth table according to your observation.
- Draw Circuit 1 in Logic works and obtain is Truth table for all possible combination.
- Draw second reduced circuit in logic works and obtain its truth table.
- Compare truth table to verify both circuits.

Table 3-1

A	B	C	D	A(B+CD)
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

Experiment No 4

⇒ Apparatus:

- Bread board
- Single core wire
- ICs

⇒ Procedure:

→ Connect the trainer board with power supply.

→ Place the ICs and single core wires according to expression

$$F = \bar{X}\bar{Y}\bar{Z} + \bar{X}Y\bar{Z} + XY\bar{Z} + XYZ$$

→ Take a note of outputs for different inputs

→ Now place ICs and single core wires for simplified expression

$$XY + \bar{X}\bar{Z}$$

→ Cross check the outputs with previous outputs

⇒ Conclusion:

→ Conclusion is shown in truth table

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Experiment#04

GATE LEVEL MINIMIZATION OF BOOLEAN FUNCTION USING POSTULATES

Objectives:

- The need of gate level minimization
- Understand the K-Map method

Background Theory

Gate-level minimization refers to the design task of finding an optimal gate-level implementation of the Boolean functions describing a digital circuit. The K-map method provides a simple, straight forward procedure for minimizing Boolean functions. A K-map is a diagram made up of squares, with each square representing one min-term of the function. By recognizing various pattern, the user can derive alternative simple algebraic expression for the same function.

Equipment required.

- 74LS32 OR
- 74LS08 AND
- EPAL 27
- Cutter
- Single Core Wire
- Pair of Strippers

Lab Task

Simplify the following Boolean Expression using K-Map.

$$F = X'Y'Z' + X'YZ' + XYZ' + XYZ$$

The gate implementation of the above expression is given below.

TRUTH TABLE

X	Y	Z	$\bar{X}$	$\bar{Y}$	$\bar{Z}$	$\bar{X}\bar{Y}\bar{Z}$	$\bar{X}YZ$	$XY\bar{Z}$	XYZ	O_1
0	0	0	1	1	1	1	0	0	0	1
0	0	1	1	1	0	0	0	0	0	0
0	1	0	1	0	1	0	1	0	0	1
0	1	1	1	0	0	0	0	0	0	0
1	0	0	0	1	1	0	0	0	0	0
1	0	1	0	1	0	0	0	0	0	0
1	1	0	0	0	1	0	0	1	0	1
1	1	1	0	0	0	0	0	0	1	1

XY	$\bar{X}\bar{Z}$	$XY+\bar{X}\bar{Z}$
0	1	1
0	0	0
0	1	1
0	0	0
0	0	0
0	0	0
1	0	1
1	0	1

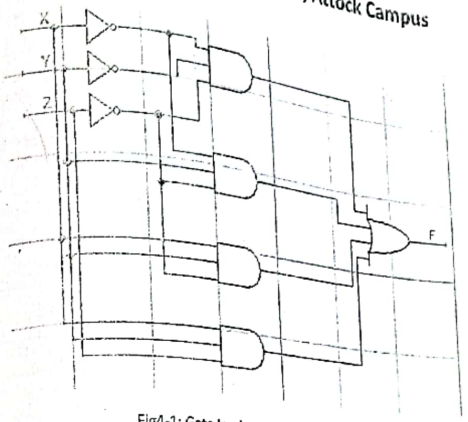

Fig4-1: Gate Implementation of In-lab task

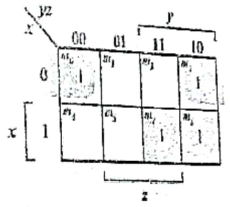

Fig 4-2: K-map for In-lab task

The simplified expression from the above K-Map is

$$F = XY + X'Z'$$

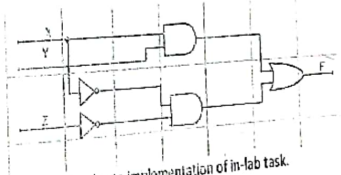

Fig 4-3: Minimized gate implementation of in-lab task.

The minimized gate implementation of the expression is.

Experiment NO-6

⇒ **Objective:**

→ The main objective of this experiment is to verify the operation of XOR gate using NAND gate.

⇒ **Apparatus:-**

- Bread board
- Single core wires
- IC (74LS00)

⇒ **Procedure:**

→ First take the IC of NAND gate and place it on bread board.

→ Draw datasheet diagram of the given IC and connections according to it.

→ Take two wires for input and one for output

→ Connect pin 14 to +5V and 7 to GND

→ Check all possible connections by changing inputs and verify the truth table of XOR gate.

⇒ **Conclusion:**

→ Conclusion is shown in the truth table.

A	B	C	D	E	F
0	0	1	1	1	0
0	1	1	1	0	1
1	0	1	0	1	1
1	1	0	1	1	0

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To check the operation of XOR gate, using NAND gate IC
With the help of 4 NAND gate, we can construct XOR gate.

Truth table
Truth table of XOR gate is given bellow.

Table 6-2

Input A	Input B	Output A⊕B
0	0	0
0	1	1
1	0	1
1	1	0

TRUTH TABLE

A	B	C	D	E	F
0	0	1	1	1	0
0	1	1	1	0	1
1	0	1	0	1	1
1	1	0	1	1	0

Boolean Expression
$F = AB' + A'B$

Circuit Diagram

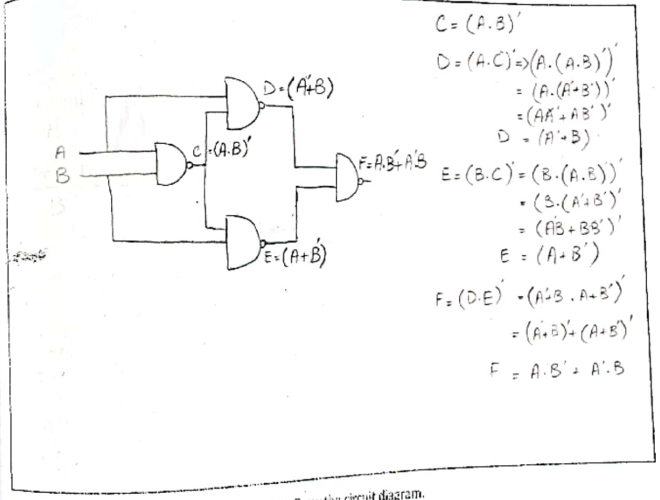

Fig 5-1: Draw the circuit diagram.

Experiment No 7

⇒ **Objective:**

→ The main objective of this experiment is to verify the operation of half adder

⇒ **Apparatus:**

- Bread board
- Single core wires
- Cutter
- IC 74LS86 (XOR)
- IC 74LS08 (AND)

⇒ **Procedure:**

→ Take the ICs of AND and XOR gate

→ Install them on breadboard

→ Take two wires for input and one for output for each IC

→ Make the connections of input wires of both ICs

→ Connect pin 14 to +5V and 7 to GND of both ICs

→ Check all possible connections and verify the truth table.

⇒ **Conclusion:**

→ Conclusion is shown in the truth table.

Truth table

In the light of the specifications of Half-adder give above, fill in a truth table containing all possible combinations of two 1-bit inputs and the resultant values of sum and carry.

Table 7-1

Inputs		Outputs	
B	A	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$Sum, S = A \oplus B$

$Carry, C = A.B$

Circuit Diagram

Fig 7-1: Half Adder circuit diagram

FULL ADDER:

A full adder is a combinational circuit that forms the arithmetic sum of three input bits. It consists of three inputs and two outputs. Two of the input variables, denoted by x and y represent the two significant bits to be added. The third input, z, represents the carry from the previous lower significant position. Two outputs are necessary because the arithmetic sum of three binary digits' ranges in value from 0 to 3, and binary 2 or 3 needs two digits. The two outputs are designated by the symbols S for sum and C for carry. The binary variable S gives the value of the least significant bit of the sum.

Equipment Required:

- 74LS08 (AND)
- 74LS86 (XOR)
- 74LS32 (OR)

Experiment No 8

⇒ Objective:

→ The main objective of this experiment is to verify the operation of full adder

⇒ Apparatus:

- Bread board
- Single core wires
- Cutter
- IC 74LS86 (XOR)
- IC 74LS08 (AND)
- IC 74LS32 (OR)

⇒ Procedure:

→ Take three ICs of XOR, AND and OR gates

→ Install them on bread board

→ Take two wires for input and one for output for each IC

→ Make the connections of input wires of all ICs

→ Connect pin 14 to +5V and 7 to GND of all ICs

→ Check all possible connections and verify the truth table.

⇒ Conclusion:

→ Conclusion is shown in the truth table

Truth table

In the light of the specifications of Full-adder give above, fill in a truth table containing all the possible combinations of two 1-bit inputs, a carry in (or a third input) and the resultant values of sum and carry.

Table 8-1

Inputs			Outputs	
Cin	B	A	Sum	Carry
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$S = A \oplus B \oplus C$

$C = A B + B Cin + A Cin$

Circuit Diagram

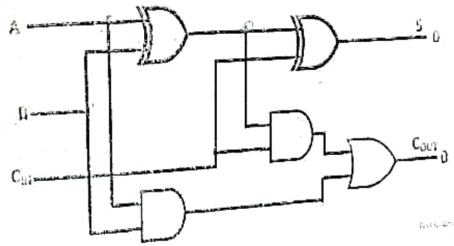

Fig 8-1: Full adder circuit diagram.