GOVERNMENT POLYTECHNIC, AMRAVATI

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Certificate

Name of Department: Computer Science and Engineering.

This is to certify that Mr. Ayush Shashikant Bulbule Identity Code 19CM007 has completed the practical work of the course FC3403 Digital Electronics during the Academic year 2020-2021.

Signature of the Teacher

Date: *who taught the examinee* *Head of Department*

Index

Practical No.1: Test & Verify the functionality of specified logic gates

Practical Significance

Logic gates are the basic building block of all type of digital systems. Digital gates are used in all digital circuits such as switches, memories, microprocessor, and embedded systems. Knowledge of functions of logic gates will help the students to build the digital circuits.

Relevant Program Outcomes (POs)

Practical Skills

This practical is expected to develop the following skills: '**Build/ test digital logic circuits using digital ICs.'**

1. Verify voltage level for logic 0 and 1.
2. Identify pin configuration of logic gate IC's.
3. Test the functionality of the logic gates.

Relevant Course Outcome(s)

 Use Boolean expressions to realize logic circuits.

Practical Outcome

- Test the functionality of specified logic gates using breadboard. (IC 7404, 7408,7432, 7486)

Relevant Affective domain related Outcome(s) Handle IC and equipment carefully.

- Follow safe practices.

Minimum Theoretical Background

A logic gate is an electronic circuit which makes logical decisions. It has only one output and one or many inputs. The output signal appears for certain combinations of input signals. Logic gates are the basic building blocks of all digital systems. These gates are AND, OR, NOT, NAND, NOR, EXOR and EXNOR gates. The basic operations are described below with the help of truth tables.

In digital logic design only two voltage levels or states are applied as input, and these states are generally referred to as Logic "1" and Logic "0", High and Low, or True and False. These two states are represented in truth tables as binary digits "1" and "0" respectively.

Classification of Logic Gates:

Logic Gates

- Basic Gates
  - Not
  - **And**
  - **Or**
- Derived Gates
  - Universal Gates
    - NAND
    - NOR
  - Special Purpose Gate
    - EX-OR
    - EX-NOR

Practical Circuit diagram

a) Sample

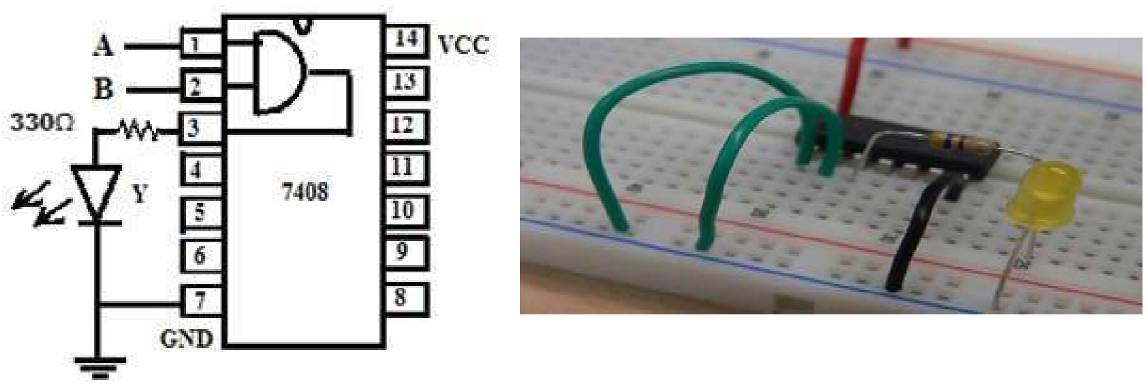


Figure 1.1:Sample Circuit

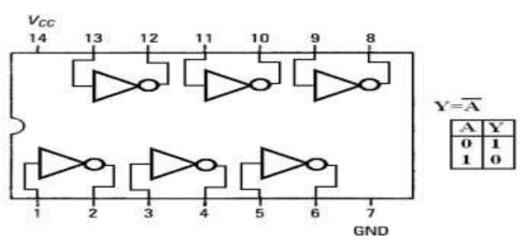
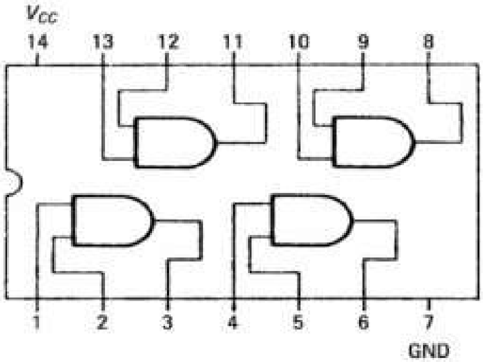


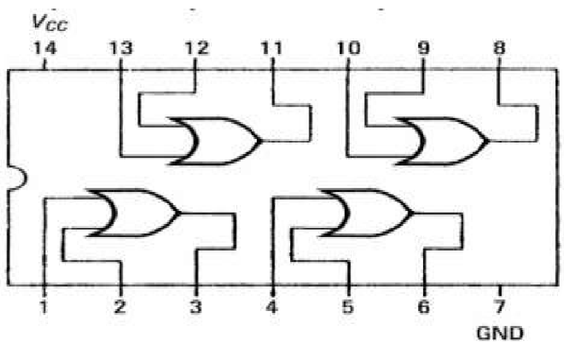
Figure 1.2 NOT Gate IC 7404 and truth table



Y=A.B

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

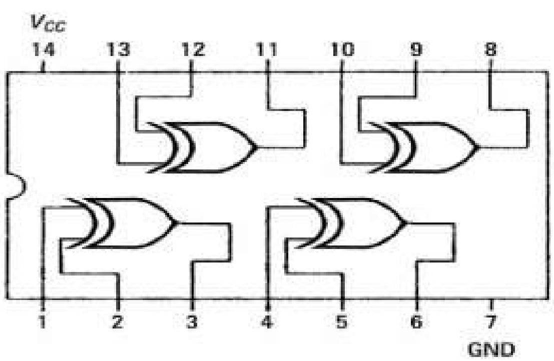
Figure 1.3 AND gate IC 7408and truth table



Y=A+B

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Figure 1.4 OR Gate IC 7432and truth table



Y=AΘB

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Figure 1.5 EX-OR Gate IC 7486and truth table

Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multi meter	Digital Multi meter: 3 1/2 digit display.	2	
2.	Digital IC Tester	Tests a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1	
3.	DC power supply	+5 V Fixed power supply	1	
4.	Breadboards	5.5cm X 17 cm	1	
5.	IC	7486, 7404, 7432, 7408	1 Each	
6.	LED	Red /Yellow colour 5 mm	1	
7.	Connecting wires	Single strand 0.6 mm Teflon coating	As required	
8.	Resistor	1.1 KΩ or 330Ω	As required	

Precautions to be followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram. **Procedure**

1. Identify pin configuration of logic gate IC (7408) and test with digital IC Tester.
2. Make the connections as per figure 1.1 on breadboard and give supply voltage to relevant pin as per logic level.
3. Observe the LED (on or off) for each combination of input as per truth table.
4. Verify the truth table.
5. Repeat the process for IC 7404, 7432, 7486.

Observations and Calculation

Table 1.1: Observation table

Inputs		7404 (NOT)		7408(AND)		7432(OR)		7486(EX-OR)	
A	B	LED Status (ON/OFF)	Output voltage(v)	LED Status (ON/OFF)	Output voltage	LED Status (ON/OFF)	Output voltage	LED Status (ON/OFF)	Output voltage
0(0V)	0(0V)	**ON**	**5V**	**OFF**	**0V**	**OFF**	**0V**	**Off**	**0V**
0(0V)	1(5V)	**__**	**__**	**OFF**	**0V**	**ON**	**5V**	**ON**	**5V**
1(5V)	0(0V)	**__**	**__**	**OFF**	**0V**	**ON**	**5V**	**ON**	**5V**
1(5V)	1(5V)	**OFF**	**ON**	**ON**	**5V**	**ON**	**5V**	**OFF**	**0V**

Results

We have successfully tested the IC's 7404,7408,7432 and 7486 which function as Logic gates NOT, AND, OR and EX-OR respectively.

Practical Related Questions

1. Write down voltage at logic level 0 and 1.
2. List the function of pin 7,14of IC 7432.
3. State the effect if pin number 14 is connected to ground and pin number 7 is connected to VCC?
4. List numbers of NOT gates are available in IC 7404.
5. List the name of manufacturers of Digital IC used in your lab.
6. State the need for the resister connected in series with LED. Write down the value of resister.
7. State the significance of LS of IC number74LS00.

Answers:---

1. In most circuits, **logic 1** is represented by approximately +5 V (positive 5 volts) relative to ground, while **logic 0** is represented by approximately the same **voltage** as ground (**0** V).
2. Pin 7 – Ground Pin which used to provide the power supply to the IC.
   Pin 14 – It is Vcc pin which used to provide the power supply to the IC.
3. In 14 pin DIP packages, pin 7 is usually connected to ground (Gnd), and pin 14 is usually1 connected to the 5V power supply (Vcc). These connections must be made or the chip will not work. ... Take care not to connect pin 7 to power and pin 14 to ground, or to connect the outputs of two or more gates together.
4. Each **7404 NOT gate IC** has 6 **NOT gates** arranged as shown in the following figure. 14th pin is the Vcc and the 7th pin is the Ground. The outputs directly interface to CMOS, NMOS and TTL. It supports wide operating conditions and has large operating voltage range.
5.

Sr No.	**Company**	**Headquartered**
1	Texas Instruments	United States
2	Analog Devices	United States
3	Skyworks Solutions	United States
4	Infineon	Germany

6. The slightest difference in **LED** or supply voltage may cause the **LED** to light very dim, very bright, or even destroy. **A series resistor** will ensure that slight differences in voltage **have** only **a** minor effect **on** the **LED's** current, provided that the voltage drop across the **resistor** is large enough.

7. **LS is a subfamily called low power Schottky which was lower in power and faster than the original 7400 family. The 00 indicates logic function, 00 was a quadruple (four per package) 2-input NAND gate.**

Signature of Teacher

<u>Practical No.2</u>: Test the Functionality of Universal logic gates

Practical Significance

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

Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems

- **Discipline knowledge:** Apply Electronics and Telecommunication knowledge to solve broad-based electronics and telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems**.**
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

Relevant Course Outcome(s)

- Use Boolean expressions to realize logic circuits.

Practical Outcome

Test the functionality of NAND and NOR gate using breadboard (IC 7400 and7402).

Relevant Affective domain

related Outcome(s) Handle IC and equipment carefully.

- Follow safe practices.

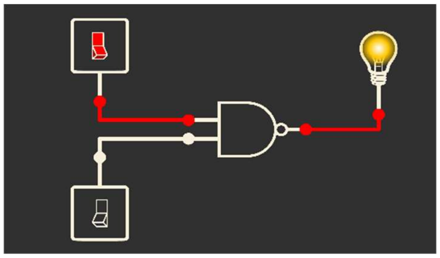
Minimum Theoretical Background

OR, AND and NOT gates are the three basic logic gates as they together can be used to construct the logic circuit for any given Boolean expression. NOR and NAND gates have the property that they individually can be used to implement logic circuit corresponding to any given Boolean expression.

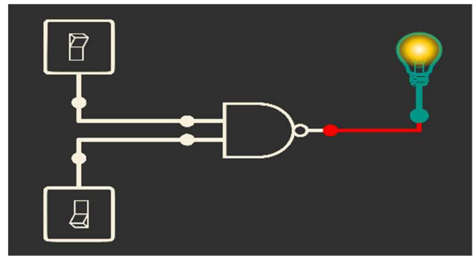
The NAND and NOR gates are known as universal gates.

Testing the functionality of Universal Gates on Circuit Simulator App

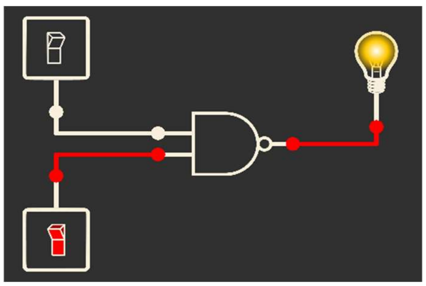
NAND Gate Testing



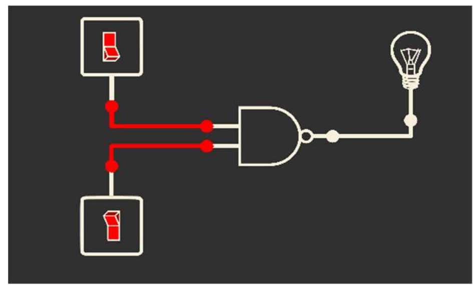
Input: 1, 0 Output: 1



Input: 0, 0 Output: 1

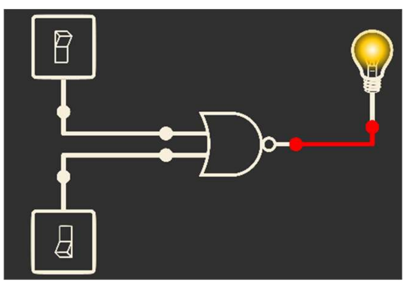


Input: 0, 1 Output: 1

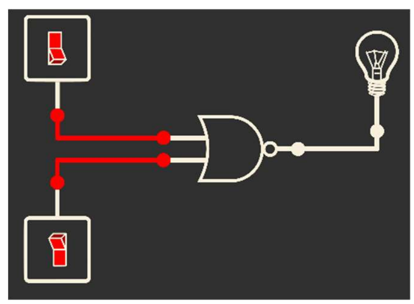


Input: 1, 1 Output: 0

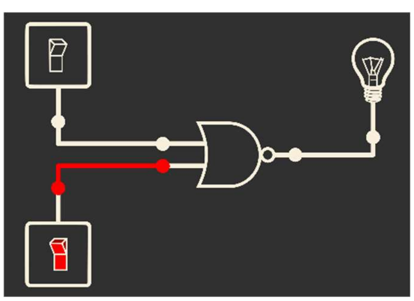
NOR Gate:



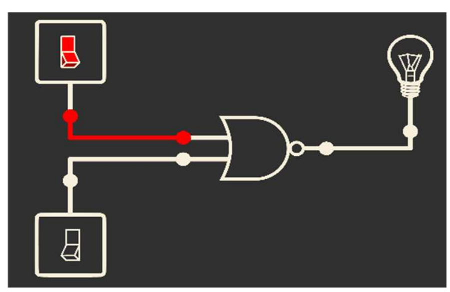
Input: 0, 0 Output: 1



Input: 1, 1 Output: 0

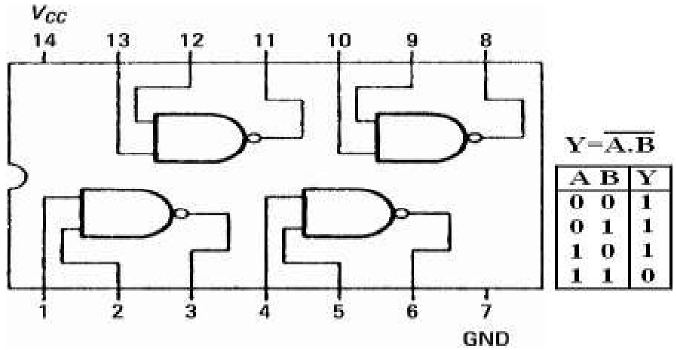


Input: 0, 1 Output: 0



Input: 1, 0 Output: 0

Practical Circuit Diagram



a) Sample

Figure 2.1.NAND Gate IC 7400 and Truth table

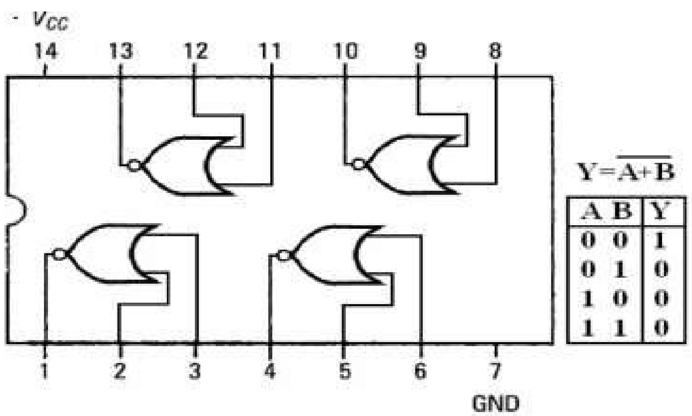


Figure 2.2.NOR Gate IC 7402 and Truth table

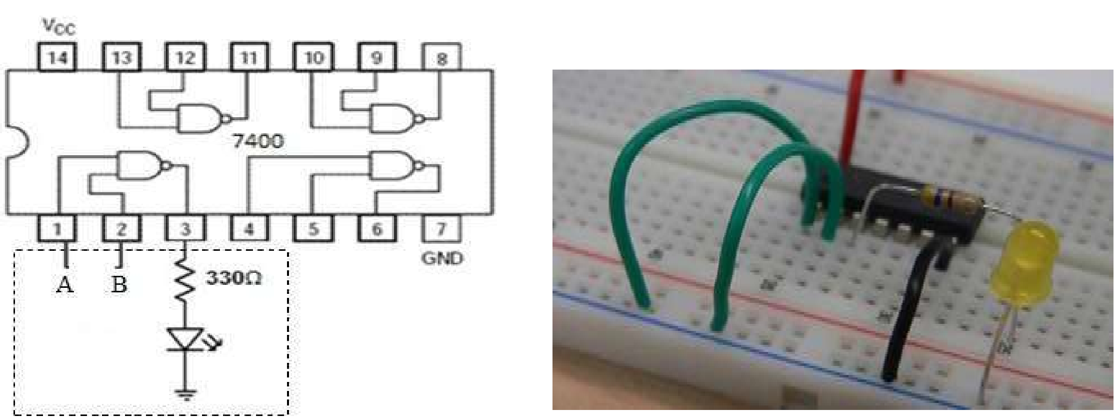


Figure 2.3:Sample Circuit

Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multi-meter	Digital Multi-meter: 3 1/2 digit display.	2	__
2.	Digital IC Tester	Tests a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1	__
3.	DC power supply	+5 V Fixed power supply	1	__
S. No.	Instrument /Components	Specification	Quantity	Remarks
4.	Breadboards	5.5cm X 17 cm	1	__
5.	IC	7400, 7402	1 Each	
6.	LED	Red /Yellow color 5 mm	1	__
7.	Connecting wires	Single strand 0.6 mm Teflon coating	As required	__
8	Resistor	1KΩ or 330Ω	As required	__

Precautions to be Followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

1. Identify pin configuration of logic gate IC (7400) and test with digital IC tester.
2. Make the connections as per figure 2.3 on breadboard and give supply voltage to relevant pin as per logic level.
3. Observe the LED (on or off) for each combination of input as per truth table.
4. Verify the truth table.
5. Repeat the process for IC 7402.

Observations and Calculations.

Table 2.1

Inputs		7400 (NAND)		7402(NOR)	
A	B	LED Status (ON/OFF)	Output voltage	LED Status (ON/OFF)	Output voltage
0(0V)	0(0V)	**ON**	**5V**	**ON**	**5V**
0(0V)	1(5V)	**ON**	**5V**	**OFF**	**0V**
1(5V)	0(0V)	**ON**	**5V**	**OFF**	**0V**
1(5V)	1(5V)	**OFF**	**0V**	**OFF**	**0V**

Results

1)NAND: If any input of NAND gate is low the output is high.

2)NOR gate: If any input of NOR gate I high then the output is ow

Conclusions & Recommendation

We have successfully tested NAND gate and NOR gate

Practical Related Questions:

1. List the function of pin 7 and 14 of IC 7400.
2. Write down name of manufacturer of Digital IC 7400, 7402 used in practical.
3. Suggest another IC used as NAND, AND, NOR Gate.
4. Write the IC no. which has three input NAND &NOR gate.

Answers:

1. Pin 7 : Ground pin which used to provide the power supply to the IC.
   Pin 14 : It is Vcc pin which used to provide the power supply to the IC.
2. IC 7400 : Texas Instruments . IC 7402 : Major Brands.
3. IC7402 is another IC used as NAND, AND, NOR Gate.
4. IC74LS10 has three input NAND and NOR gate.

Signature of Teacher

<u>Practical No.3:</u> Build & verify AND, OR, NOT gates using universal gates NAND & NOR

Practical Significance

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.

Relevant Course Outcome(s)

- Use Boolean expressions to realize logic circuits.

Practical Outcome

- Construct AND, OR, NOT gates using universal gates.

Relevant Affective domain related

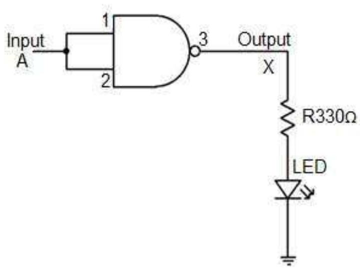
Outcome(s) ⍰ Handle IC and equipment carefully.

- Follow safe practices.

Minimum Theoretical Background

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. **Practical Circuit diagram**

a) Sample



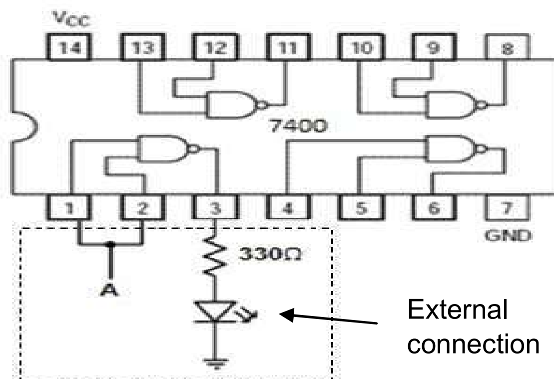
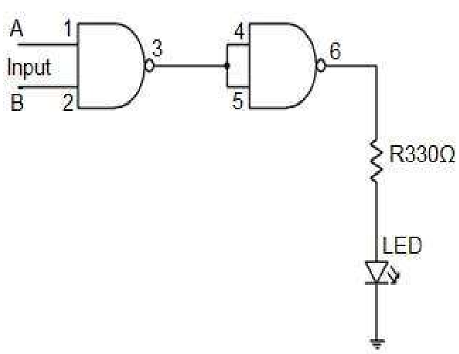
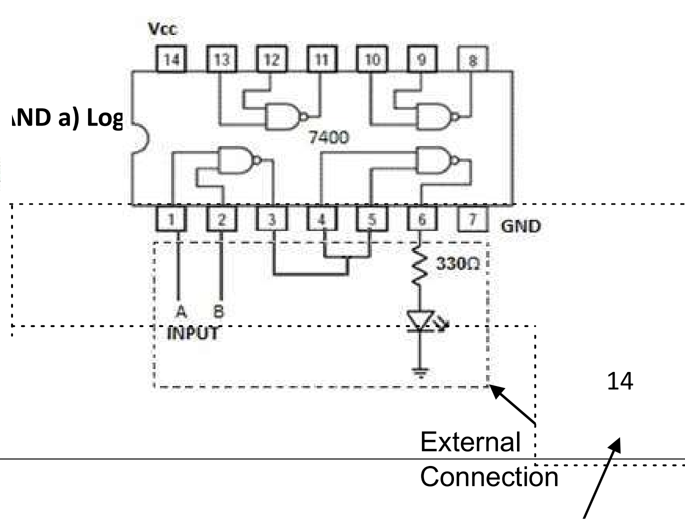


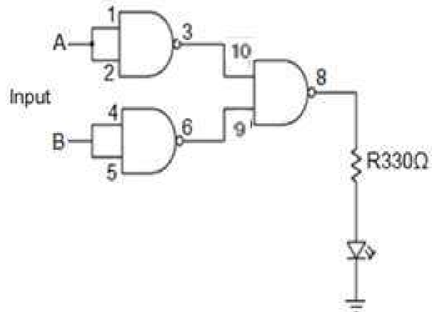
Figure (a) **Figure (b)**

Figure 3.1 NOT Gate using NAND a) Logic diagram b) IC Circuit diagram

(Use appropriate value of resistor . Diagram shows sample values)







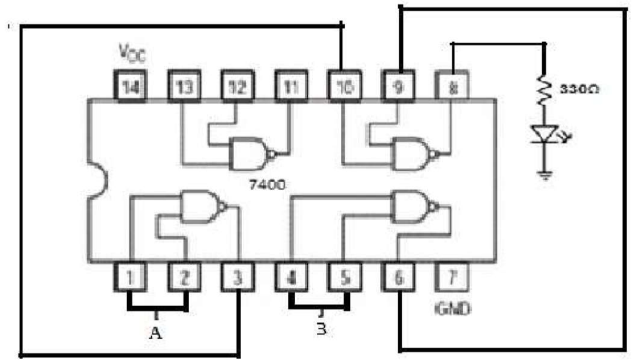
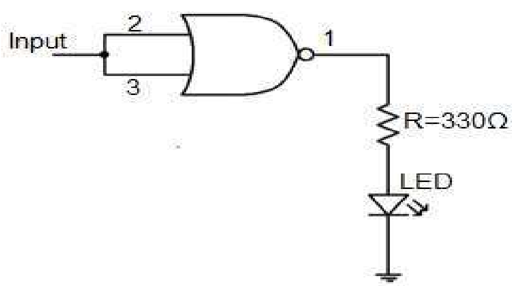
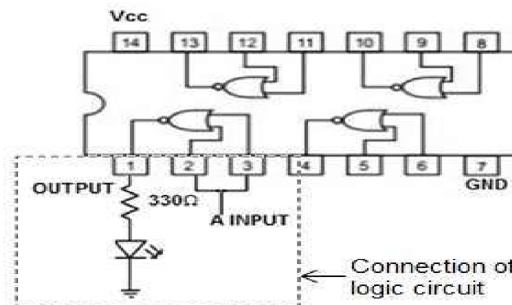


Figure (a) Figure (b)

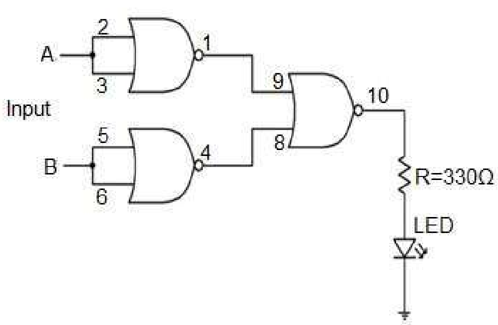
Figure 3.3OR Gate using NAND a) Logic diagram b) IC Circuit diagram





Figure(a) Figure (b)

Figure 3.4. NOT Gate using NOR a) Logic diagram b) IC Circuit diagram



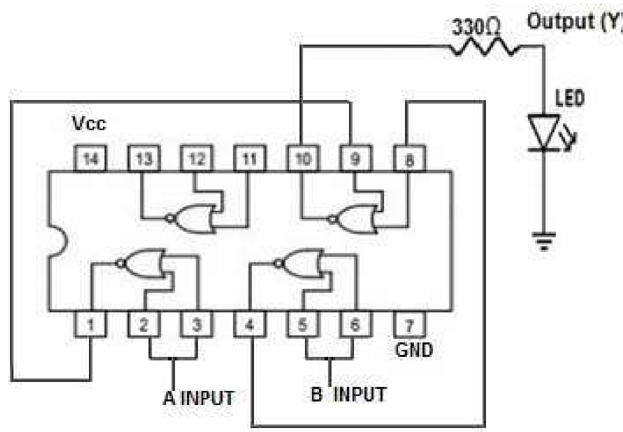
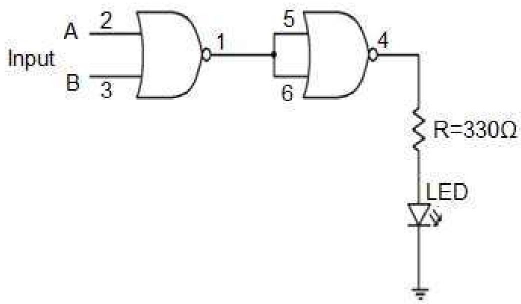
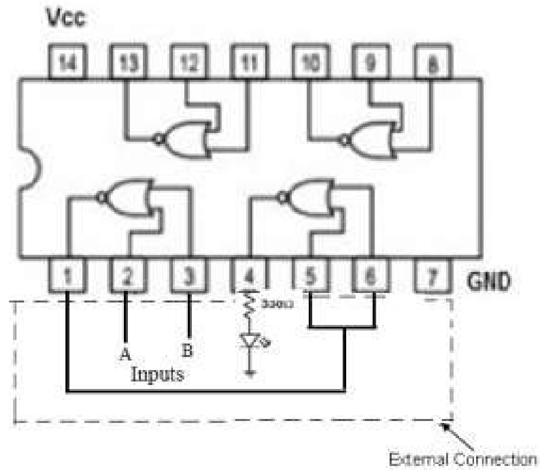


Figure (a) Figure (b)

Figure 3.5. AND Gate using NOR a) Logic diagram b) IC Circuit diagram





Figure(a) **Figure (b)**

Figure 3.6. OR Gate using a NOR a) Logic diagram b) IC Circuit diagram

Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	2	
2.	Digital IC Tester	Tests a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1	
3.	DC power supply	+5 V Fixed power supply	1	
4.	Breadboard	5.5cm X 17 cm	1	
5.	IC	7400, 7402	1 Each	
6.	LED	Red /Yellow color 5 mm	1	
7.	Connecting wires	Single strand 0.6 mm Teflon coating	As required	
8	Resistor	1KΩ/330Ω	As required	

Precautions to be Followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

1. Identify pin configuration of logic gate IC 7400 and test with digital IC Tester.
2. Make the connection as shown in figure 3.1-3.3 on breadboard and give supply voltage to relevant pins per logic level.
3. Observe the LED (on / off) for each combination of input as per truth table.
4. Verify the truth table.
5. Repeat the process for figure 3.4-3.6.

Observations and Calculations Table 3.1: Observations

Inputs		AND		OR		NOT	
A	B	LED Status (ON/OFF)	Output voltage	LED Status (ON/OFF)	Output voltage	LED Status (ON/OFF)	Output voltage
0(0V)	0(0V)	OFF	0	OFF	0	ON	1
0(0V)	1(5V)	OFF	0	ON	1	__	__
1(5V)	0(0V)	OFF	00	ON	1	__	__
1(5V)	1(5V)	ON	1	ON	1	OFF	0

Results

All universal gates can alone implement by all basic gates, any digital function can be implemented by any universal gate alone AND< OR, NOT are basic logic gates.

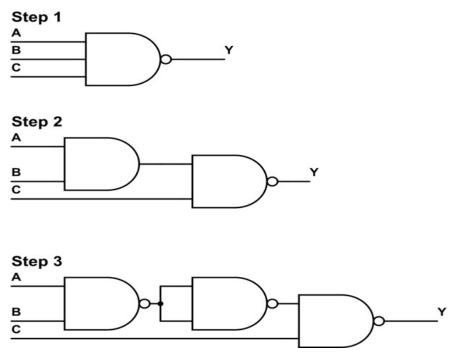
The NAND and nor gates are also known as universal gate can be implemented using NAND or NOT gate.

Practical Related Questions:

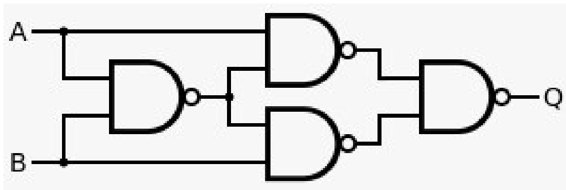
1. Design 3 input NAND gate using 2 input NAND gate IC 7400.
2. Draw EX-OR gate using NAND Gates.
3. What is the significance of L, LS and H in the following IC 74L00, 74LS00, and 74H00?

Answers :

1.



2.



3. L stands for low power. LS stands for low power Schottky. And H stands for high speed.

Signature of Teacher

Practical No.4: Verification of De-Morgan's theorem

Practical Significance

Logic gates are the basis units to implement complex logic functions. De Morgan's Theorems are used to simplifies the complex Boolean/Logic functions. This practical will enable the students to use De Morgan's theorem to simplify the complex function for the efficient hardware implementation.

Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication knowledge to solve broad-based electronics and telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

Relevant Course Outcome(s)

- Use Boolean expressions to realize logic circuits.

Practical Outcome

- Build the logic circuit on breadboard to check the De Morgan's theorems.

Relevant Affective domain related Outcome(s) Handle IC and equipment carefully.

- Follow safe practices.

Minimum Theoretical Background

De Morgan's theorem is used to simplify Boolean expressions and digital circuits.
De Morgan's first Theorem: It states that for any two elements A and B in a Boolean algebra, the complement of the sum is equal to product of complements.

The theorem can be expressed by logic circuit as

$$\overline{\mathbf{A}+\mathbf{B}} = \overline{\mathbf{A}}.\overline{\mathbf{B}}$$

NOR gate = Bubbled AND gate

De Morgan's theorem is used to simplify Boolean expressions and digital circuits.

De Morgan's second Theorem: It states that for any two elements A and B in a Boolean algebra, the complement of a product is equal to the sum of the complements. The theorem can be expressed by logic circuit as

$$\overline{\mathbf{A.B}} = \ \overline{\mathbf{A}} + \overline{\mathbf{B}}$$

NAND gate = Bubbled OR gate

Practical Circuit diagram

a) Sample

De Morgan's first theorem:

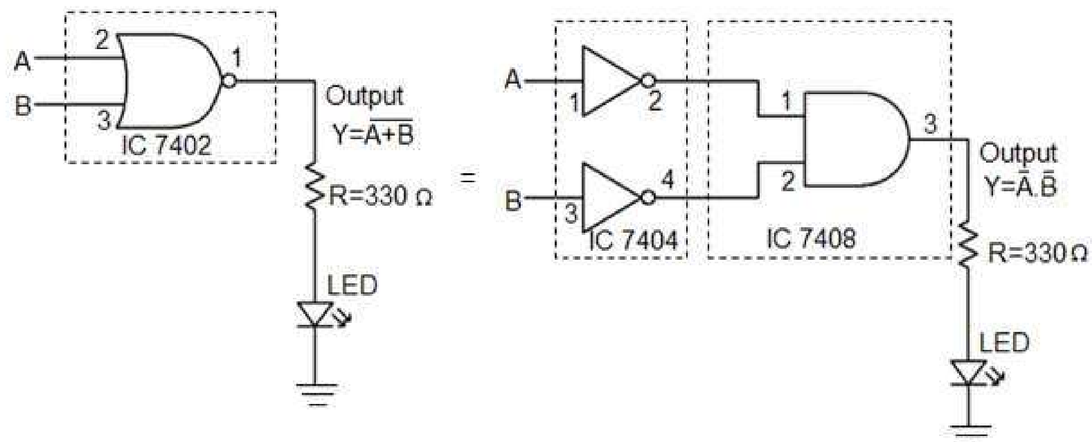


Figure 4.1 De Morgan's first theorem

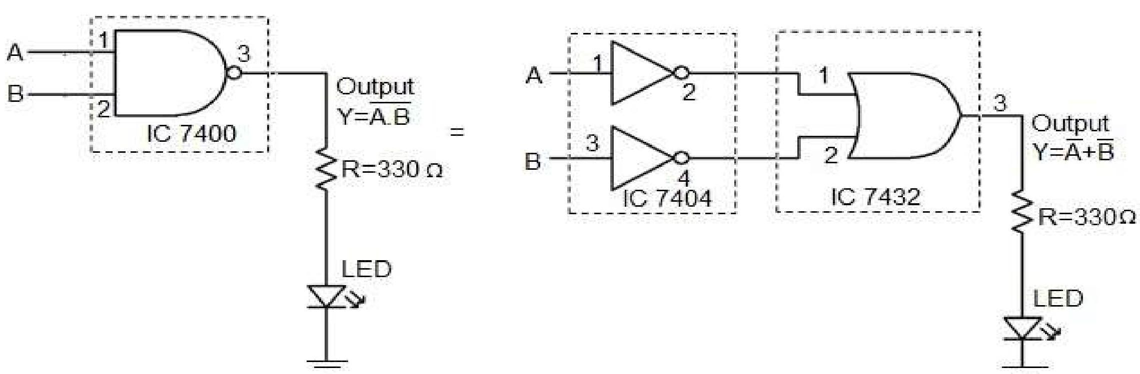
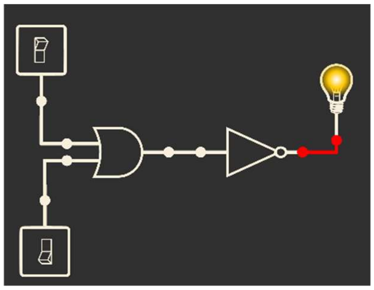


Figure 4.2 De Morgan's second theorem

Verification on Circuit Simulator:

a) **De Morgan's first theorem**:



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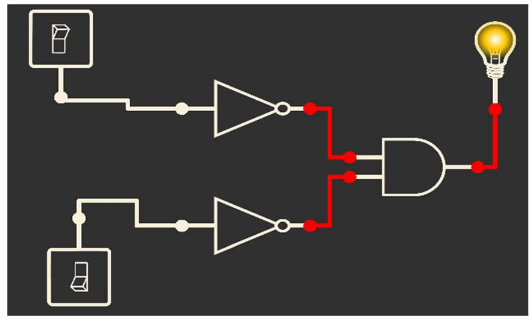

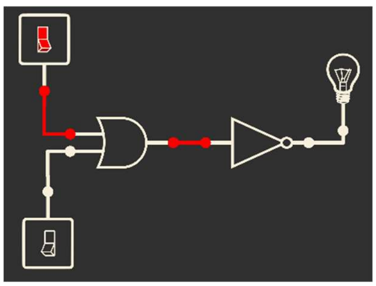

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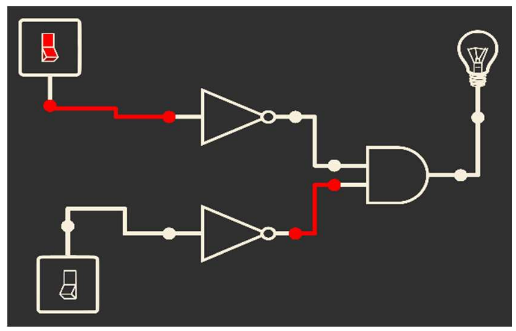
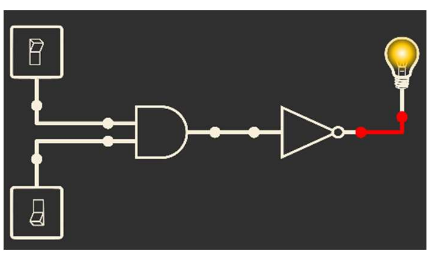


b) **De Morgan's Second Theorem**:



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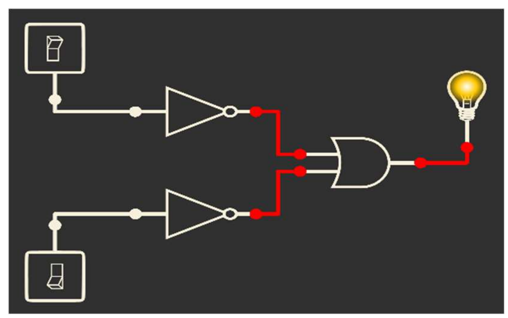

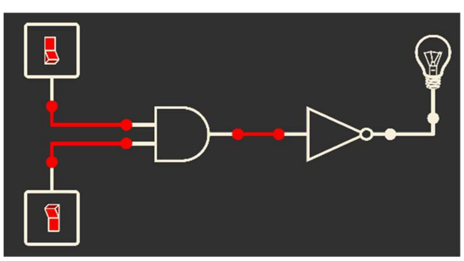

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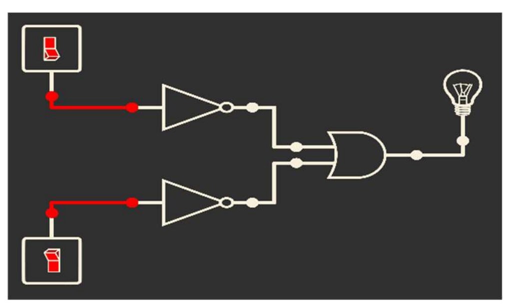


Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1.	Digital Multi-meter	Digital Multi-meter: 3 1/2 digit display.	2	
2.	Digital IC Tester	Tests a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1	
3.	DC power supply	+5 V Fixed power supply	1	
4.	Breadboard	5.5cm X 17 cm	1	
5.	IC	7400, 7404,7432,7402,7208,	1 Each	
6.	LED	Red /Yellow color 5 mm	1	
7.	Connecting wires	Single strand 0.6 mm Teflon coating	As required	

Precautions to be Followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

1. Identify pin configuration of logic gate IC and test with digital IC Tester.
2. Make the connections as per figure 4.1 on breadboard and give supply voltage to relevant pin as per logic level.
3. Observe the LED (on or off) for each combination of input as per truth table
4. Verify the truth table.
5. Repeat the process for figure 4.2.

Observations and Calculations

Table 4.1: De Morgan's first theorem observation:

Inputs		Outputs	
A	B	LHS=$\overline{A+B}$	RHS=$\overline{A}.\overline{B}$
0	0	**1**	**1**
0	1	**1**	**1**
1	0	**1**	**1**
1	1	**0**	**0**

Table 4.2: De Morgan's second theorem observation:

Inputs		Outputs	
A	B	LHS=$\overline{A.B}$	RHS= $\overline{A}+\overline{B}$
0	0	1	1
0	1	0	0
1	0	0	0
1	1	0	0

Results

1) **De Morgan’s Frist theorem states that complement of product is equal to sum of complement.**
   $\overline{A}.\overline{B}$ **=** $\overline{A+B}$

2) **De Morgan’s second theorem states that complement of sum is equal to product of complement.**
   $=\overline{A}+\overline{B}$ **=** $\overline{A.B}$
3) **It is verified that:**
   $\overline{A}.\overline{B}$ **=** $\overline{A+B}$
   $=\overline{A}+\overline{B}$ **=** $\overline{A.B}$

Practical Related Questions

1. List the IC numbers used in De Morgan’s first theorem.
2. List the IC numbers used in De Morgan’s second theorem.
3. Why do we reduce the expression with the help of Boolean algebra and DeMorgan’s theorem?

Answer:

1. In De Morgan’s first theorem IC’s used are : IC7402 , IC7404 , IC7408.
2. In De Morgan’s second theorem IC’s used are : IC7400 , IC7404 , IC7432
3. We reduce the expression with the help of Boolean algebra because they are used in circuits and gates. So the simpler the expression the better is the circuit. Simpler boolean expression reduces the number of gates which in turn reduces the cost, size and area of the integrated circuit or chip

Signature of Teacher

<u>Practical No.5</u>: Design of Half adder and Full adder

I Practical Significance:

Digital computers perform variety of information tasks. Among the functions encountered is the various arithmetic operations, the most basic arithmetic operation is the addition or subtraction of two binary digits. A binary adder-subtractor is a combinational circuit that performs the arithmetic operations of addition and subtraction with binary numbers.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electronics and Telecommunication knowledge to solve broad-based electronics and telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified

Competency through various teaching learning experiences: competency:
'Build Combinational logic circuits consist of digital ICs.'

i. Testing of IC's on IC tester.

ii. Identify pin configuration
for gates.

iii. Make connections as per circuit diagram.

IV Relevant Course Outcome(s)

 Build simple combinational circuits.

V Practical Outcome

Design half adder and half subtractor using Boolean expressions.

VI Relevant Affective domain related Outcome(s)

 Handle IC and equipment carefully. Follow safe practices.

VII Minimum Theoretical Background

<u>Half Adder:</u>

A half-adder is composed of one X-OR gate and one AND gate that produces two binary

outputs from two binary inputs. It adds two one-bit binary numbers (A, B). The output is the sum of the two bits (S) and the carry C . The C output is 1 only when both inputs are 1. The S output represents the least significant bit of the sum.

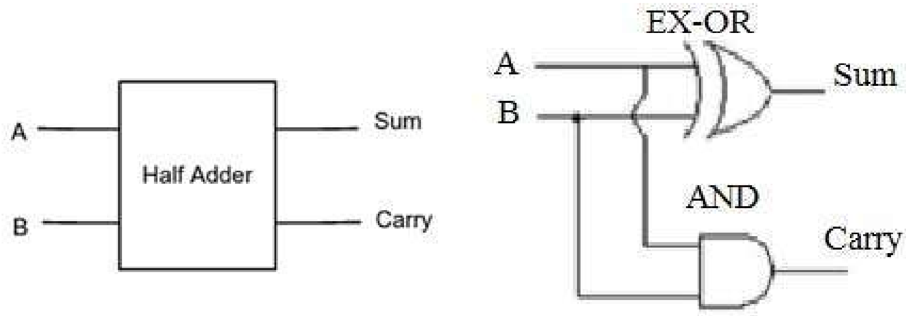
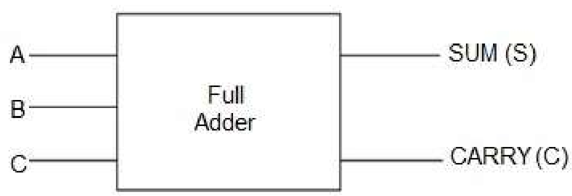


Fig 5.1 Half Adder

Full Adder:

The full adder is a combinational circuit which is used to perform addition of three input bits. Full adder is difficult to implement than a half-adder. The difference between a halfadder and a full-adder is that the full-adder has three inputs and two outputs. The first two inputs are A and B and the third input is an input carry as C-IN and outputs are sum(S) and carry(C).



Practical set-up / Circuit diagram

a) Sample

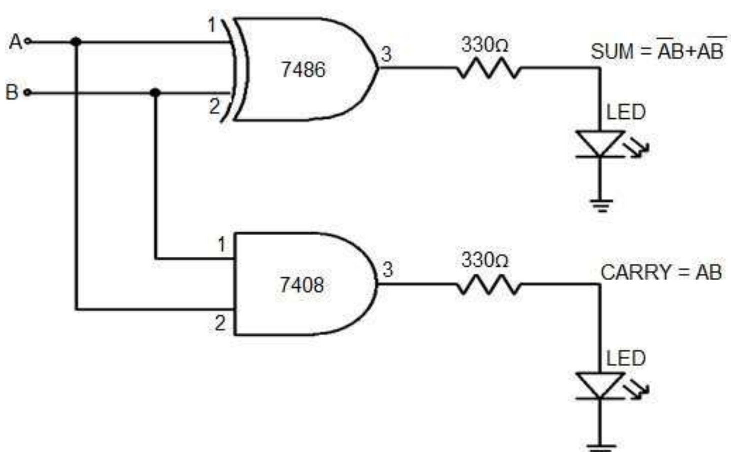
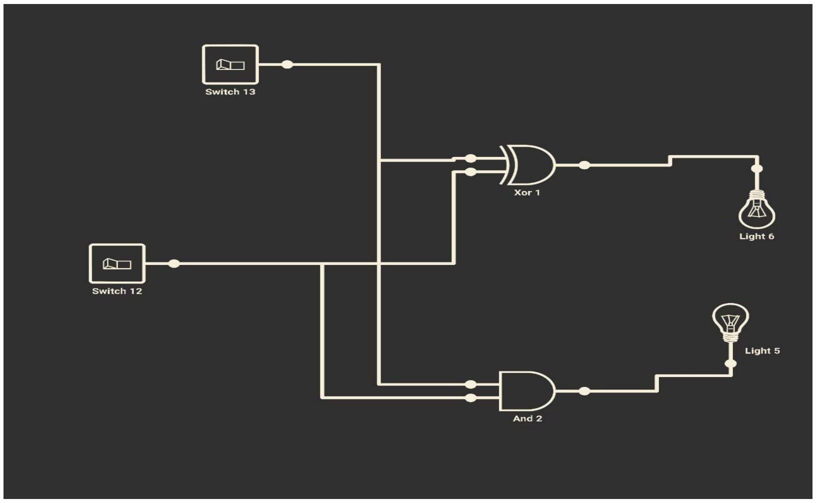


Fig : Half Adder Circuit

Half Adder on Circuit Simulator



b)

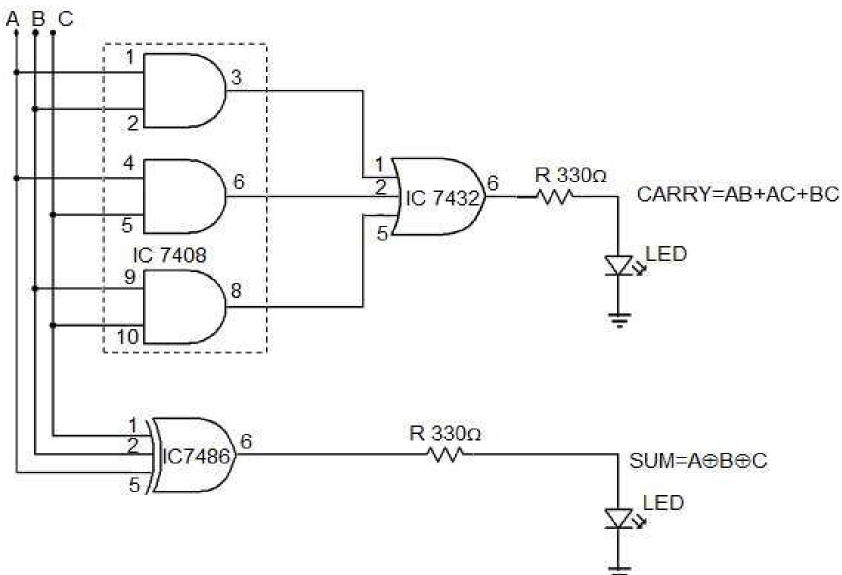
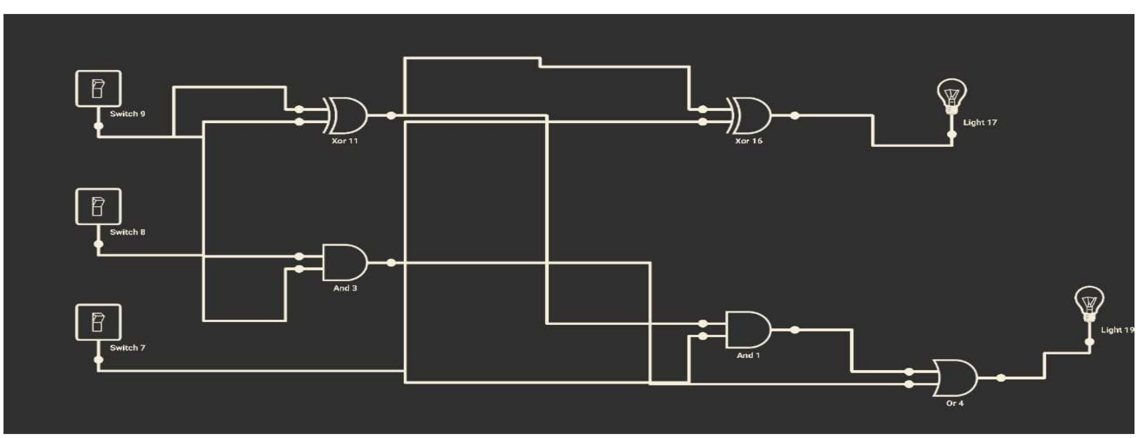
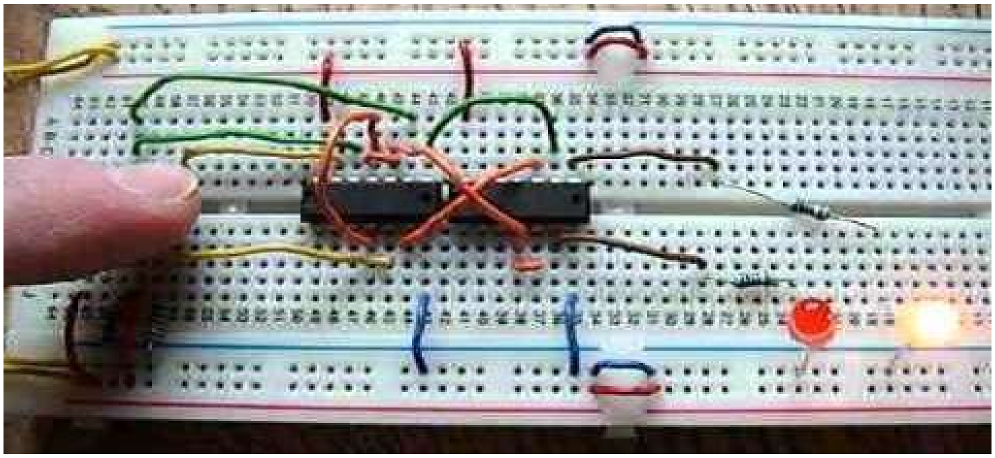


Figure : Full Adder Circuit

Full Adder on Circuit Simulator



Note : Pin no 3 and pin no 4 of IC 7432 and 7486 are shorted to make 3 input gate



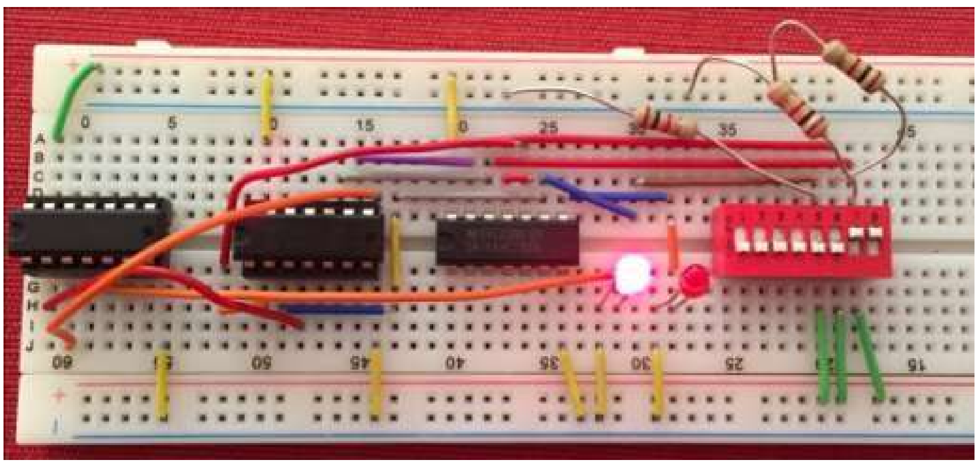


Fig 5.5 Practical Setup

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity	Remark
1.	Digital Multi-meter	Digital Multimeter:3 ½ digital display	1	
2.	IC Tester	Digital IC Tester	1	
3.	Breadboards	5.5cm X 17 cm	1	
4.	DC power supply	+5 V Fixed power supply	1	
5.	IC 1	7486	1	
6.	IC 2	7404	1	
7.	IC 3	7408	1	
8.	LED	Red /Yellow color 5 mm	2	
9.	Connecting wires	Single strand 0.6 mm Teflon coating	As required	
10.	Resistors	330 Ω/0.25 W	2	

Precautions to be followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

1. Test the IC's using IC tester.
2. Mount IC's on breadboard
3. Set up a half adder and full adder circuit and feed all the input combinations
4. Observe the outputs corresponding to input combinations on LEDs.
5. Fill up the observation table.
6. The supply voltage to the IC's should not exceed +5V.

Observations and Calculations:

Observation Table for Half Adder

Input		Output	
A	B	**Sum**	**Carry**
0	0	**0**	**0**
0	1	**1**	**0**
1	0	**1**	**0**
1	1	**0**	**1**

Observation Table for Full Adder

Input			Output	
A	B	C	**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**

Results

1. **Half Adder can add only one Bit number as it can't consider previous carry.**
2. **Full Adder can perform addition of more than 1 bit Numbers.**
3. **A combinational logic circuit used to add three binary digit is known as Full Adder.**

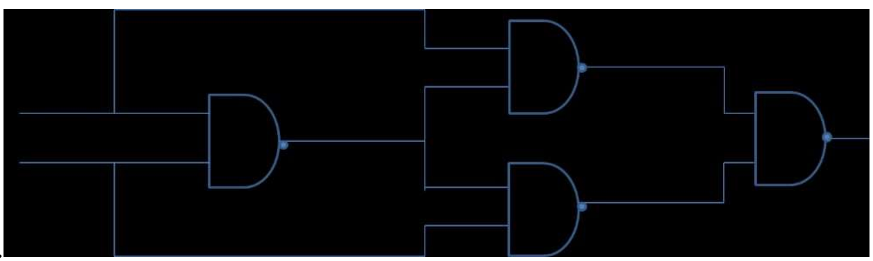
Practical Related Questions

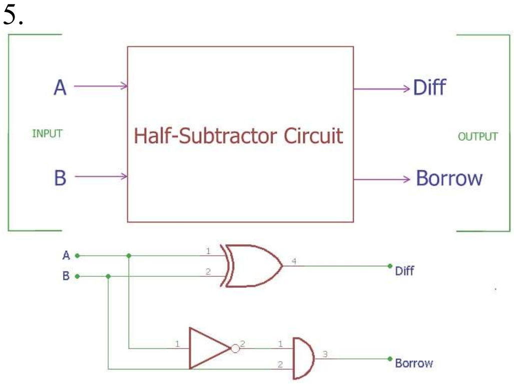
1. Find out the values of resistors to get proper outputs.
2. Write down drawback of Half Adder circuit.
   3.Draw half adder using NAND gates only.

4. Draw Half Subtractor circuit using Basic gates(AND,OR,NOT)
5. Design Half Adder/Half Subtractor using K-map.

Answers:

1. 330 Ω/0.25 W
2. A half adder circuit has one significant drawback:
3. since pair of bits can produce an output carry,in addition to the inputs A and B, we need to account for a possible carry over from a bit of the lower order of magnitude. Unfortunately, half adder has no support for such carry over input by design.

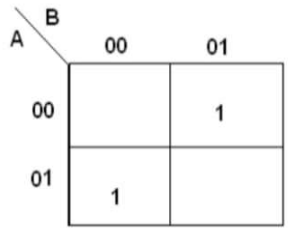
4.


5.


Half-Subtractor Circuit

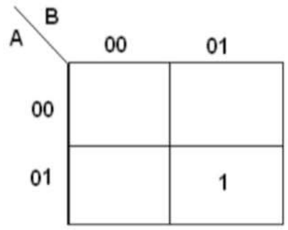
6.

K-Map for SUM:



SUM = A'B + AB'

K-Map for CARRY:



CARRY = AB

Signature of Teacher

Practical No.6: Design half subtractor and full subtractor.

I Practical Significance:

Digital computers perform variety of information tasks. Among the functions encountered are the various arithmetic operations. The most basic arithmetic operation is the addition or subtraction of binary digits. A binary adder-subtractor is a combinational circuit that performs the arithmetic operations of addition and subtraction with binary numbers. In this practical, students will build circuit and perform addition and subtraction of 3 bits.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified competency through various teaching learning experiences: competency: '**Build Combinational logic circuits consist of digital ICs.'**

i. Testing of IC's on IC tester. ii. Identify pin configuration for gates.

iii. Make connections as per circuit diagram. **IV Relevant Course Outcome(s)**

 Build simple combinational circuits.

V Practical Outcome

- Design Full adder and full subtractor.

VI Relevant Affective domain related Outcome(s) Handle IC and equipment carefully.
 Follow safe practices.

VII Minimum Theoretical Background

Half-Subtractor:

A half-subtractor is a combinational circuit which is used to perform subtraction of two bits.

It has two inputs, A (minuend) and B (subtrahend) and two outputs D (difference) and B(borrow). It is made of X-OR gate, NOT gate (Inverter), and AND gate. The B output is 1 only when the subtrahend (B) is greater than the minuend (A).

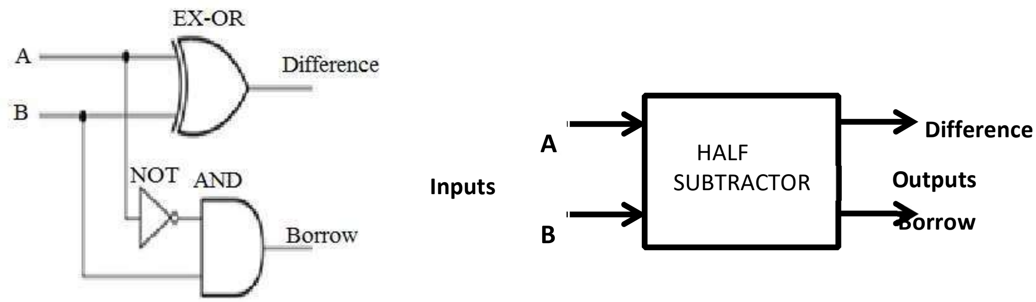
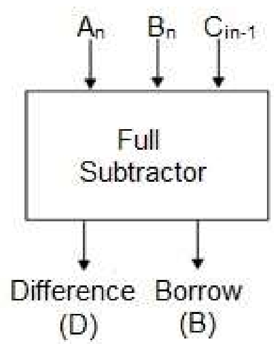


Fig5.2 Half Subtractor

Full subtractor is a combinational circuit that performs subtraction of two bits, one is minuend and other is subtrahend. In full subtractor '1' is borrowed by the previous adjacent lower minuend bit. Hence these three bits are considered at the input of a full subtractor. There are two outputs, that are DIFFERENCE output D and BORROW output Bo.



VIII Practical set-up / Circuit diagram

a)

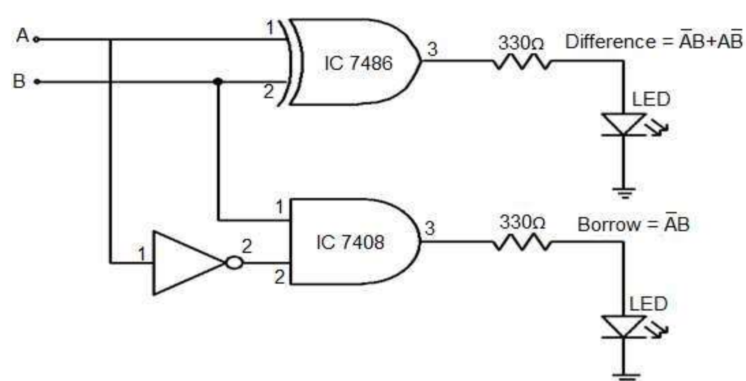


Fig 5.4 Half subtractor Circuit

b)

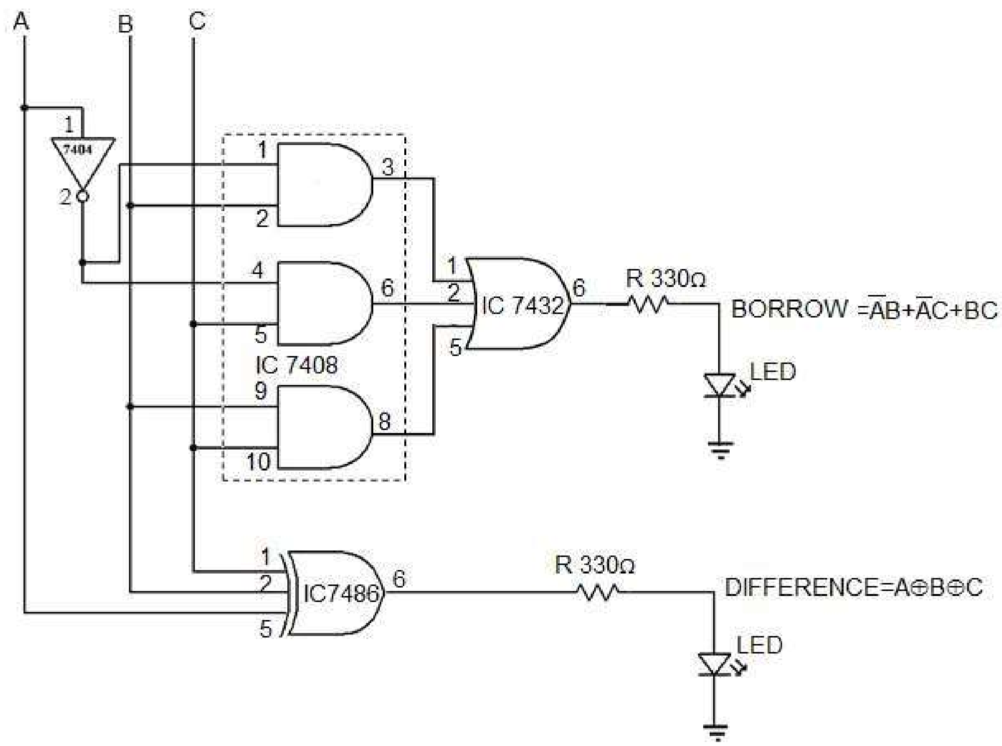
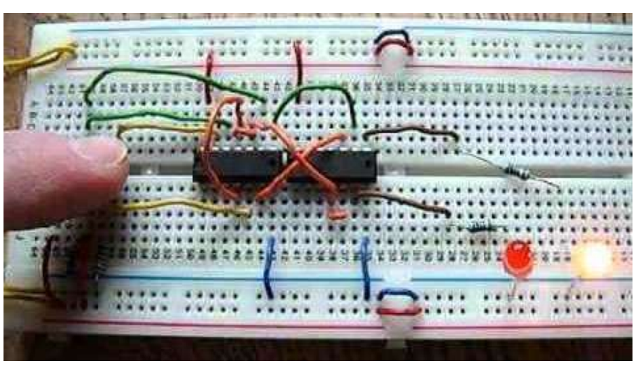


Figure 6.2 Full Subtractor circuit

Note:Pins 3 and 4 of IC 7432 and 7486 are shored to make 3 input gate



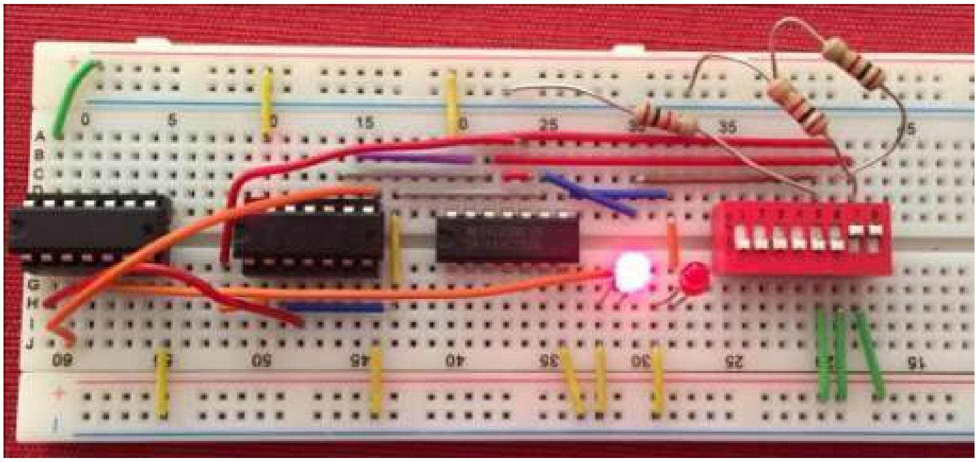


Fig 3 Practical Setup

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity	Remark
1	Multi-meter	Digital Multimeter:3 ½ digital display	1	
2	IC Tester	Digital IC Tester	1	
3	Breadboard	5.5cm X 17 cm	1	
4	DC power supply	+5 V Fixed power supply	1	
5	IC 1	7486	1	
6	IC 2	7404	1	
7	IC 3	7408	1	
8	IC 4	7432	1	
9	LED	Red /Yellow color 5 mm	2	
10	Connecting wires	Single strand 0.6 mm Teflon coating	As required	
11	Resistors	330 Ω,0.25 W	2	

X Precautions to be followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Test the IC's using IC tester.
2. Mount IC's on breadboard.
3. Understand working of all the circuit.
4. Set up half subtractor and full subtractor circuit and feed all the input combinations
5. Observe the outputs corresponding to input combinations on LEDs.
6. Fill up the observation table.
7. The supply voltage to the IC's should not exceed +5V.

XV Observations and Calculations:

Observation Table for Half Subtractor

Input		Output	
A	B	Difference	Borrow
0	0	**0**	**0**
0	1	**1**	**1**
1	0	**1**	**0**
1	1	**0**	**0**

Observation Table for Full Subtractor

Input			Output	
A	B	C	Difference	Borrow
0	0	0	**0**	**0**
0	0	1	**1**	**1**
0	1	0	**1**	**1**
0	1	1	**0**	**1**
1	0	0	**1**	**0**
1	0	1	**0**	**0**
1	1	0	**0**	**0**
1	1	1	**1**	**1**

XVI Results

1. **Half Subtractor: It is a combinational circuit that performs subtraction of two bits.**
2. **Full Subtractor: It is a combinational circuit that performs subtraction of three bits.**
3. **Also, Subtractor is a electronic circuit for calculating difference between two binary number which provides difference and borrow outputs.**

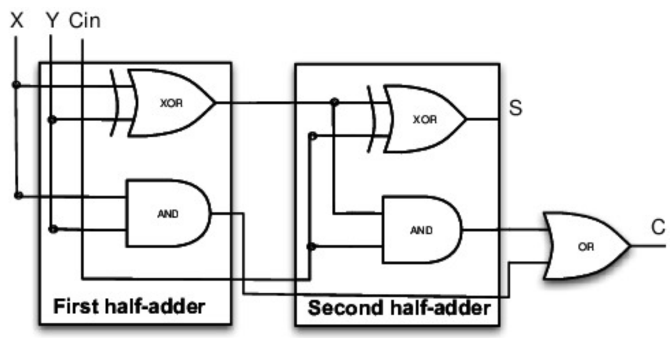
XIX Practical Related Questions

Note: Below given are few sample questions for reference. Teachers must design more such questions so as to ensure the achievement of identified CO.

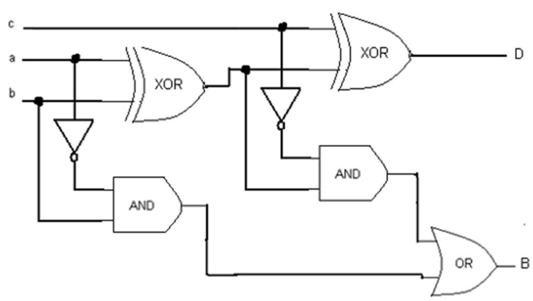
1. Draw Full adder circuit using two Half adder circuits.
2. Draw full subtractor using two half subtractor circuits
3. Write any four application of full adder circuit.
4. Design Full Adder using K-map.
5. If inputs to IC 7486 are 1, 0, 1 then what is the Output?

Answers:

1.



2.



3. Application of full adder circuit.

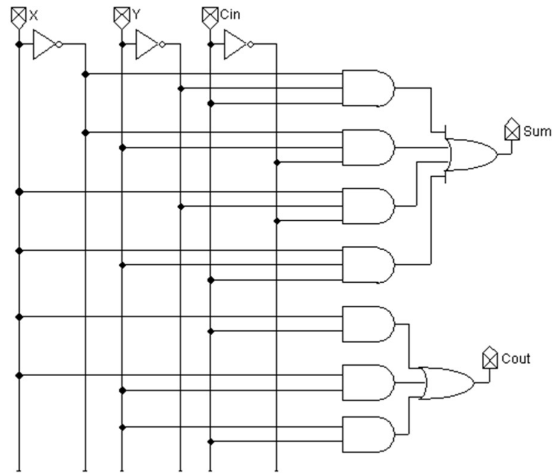
- Ripple carry adder, it adds n-bits at a time.
- carryout Multiplication -the dedicated multiplication circuit uses it.
- ALU- Arithmetic Logic Unit (one of the circuit is a full adder).
- to generate memory addresses inside a computer and to make the Program Counter point to next instruction, the ALU makes use of this adder.

For graphics related applications, where there is a very much need of complex computations, the GPU uses optimized ALU which is made up of full adders, other circuits as well….

4.

$Sum = x'y'Cin + x'yCin' + xy'Cin' + xyCin$

$Cout = xCin + xy + yCin$



5. If inputs to IC 7486 are 1, 0, 1 then Output is difference =0 and borrow=0.

Signature of Teacher

Practical No.7: Verification of operation of 7-segment decoder driver

Practical Significance: BCD is an abbreviation for binary-coded decimal. A Digital **Decoder IC**, is a device which converts one digital format into another and one of the most commonly used devices for doing this is called the **BCD to 7-Segment Display Decoder**. It is used to display decimal numbers.

Relevant Program Outcomes (POs)

1. **Discipline knowledge:** Apply Electronics and Telecommunication knowledge to solve broad-based electronics and telecommunication engineering related problems.
2. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
3. **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified competency through various teaching learning experiences: competency: '**Build Combinational logic circuits consist of digital ICs.'**

i. Clear concept of BCD codes.
ii. Test seven segment display.
iii. Assemble the circuit on
breadboard.
iv. Make connections as per circuit diagram.

Relevant Course Outcome(s):

 Build simple combinational circuits.

Practical Outcome

- Construct and test BCD to 7 segment decoder using IC 7447/ 7448

Relevant Affective domain related Outcome(s) Handle IC and equipment carefully.

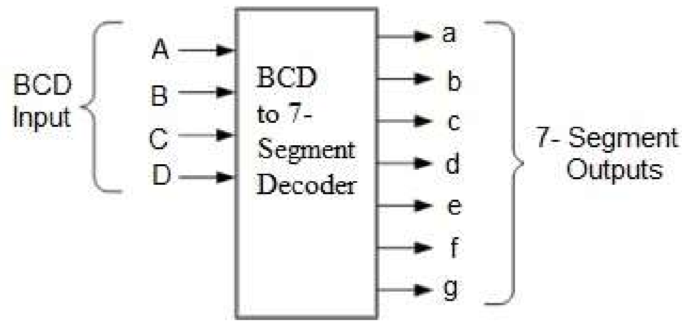
- Follow safe practice

Minimum Theoretical Background

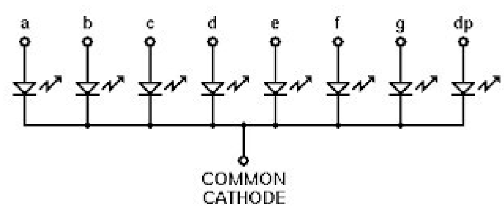
A decoder is a combinational circuit that connects the binary information from 'n' input lines to a maximum of 2^n unique output lines. The IC7447 is a BCD to 7-segment pattern converter. The IC7447 takes the Binary Coded Decimal (BCD) as the input and outputs the relevant 7 segment code. A seven segment decoder is an IC decoder that can be used to drive a seven segment indicator. There are two types of 7-segment LED digital display 1. Common anode display (CCD) and 2.common cathode display (CAD).

Each decoder driver has 4 BCD inputs and 7 output pins (a to g segment).

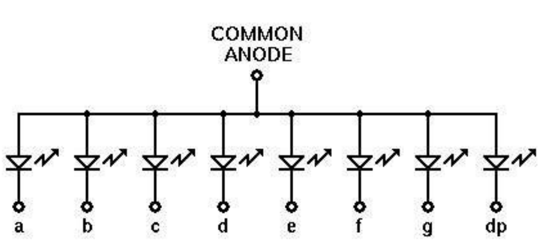
BCD to 7-Segment Decoder:



Common Cathode Display (CCD):
Common cathode has all the cathodes of the 7-segments connected directly together to ground (Logic 0).The individual segments are illuminated by application of high (Logic1)signal to the individual anode terminals. For common cathode LED display the ICs are IC 7448,IC 74248,IC 7449 etc. are used. They have active high, open collector outputs. Common Cathode Display(CCD):

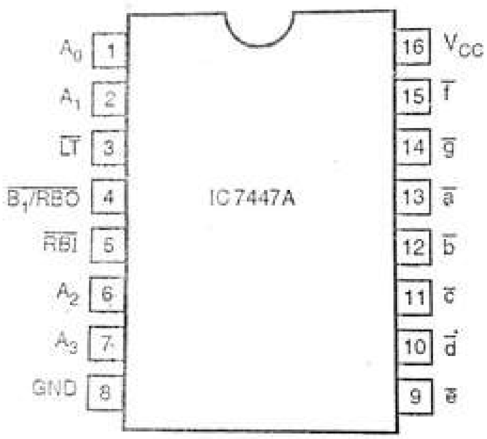


Common Anode Display(CAD):
Common anode has all the anodes of the 7-segments connected together to VCC (Logic 1).The individual segments are illuminated by connecting the individual cathode terminals to low (Logic0) signal to the individual anode terminals. For common anode LED display the ICs are IC 7446,IC 74246,IC 7447 etc. are used. They have active low, open collector outputs.



IC 7447(BCD to 7-Segment decoder IC)

IC 7447 is BCD to 7-Segment decoder IC whose output is active low depending on the corresponding BCD inputs so it is used to drive common anode 7- segment displays.

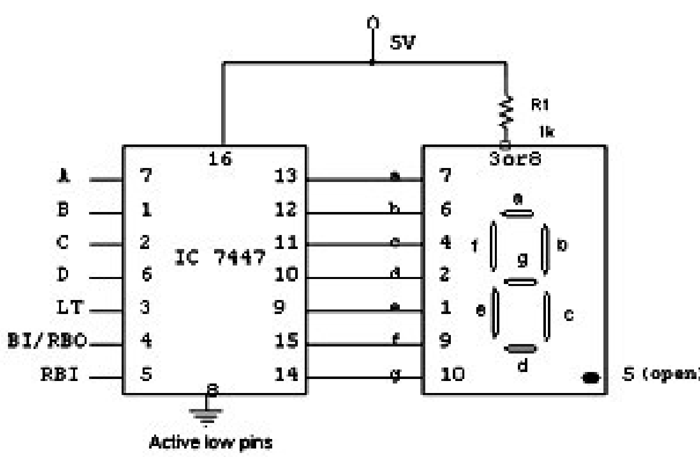


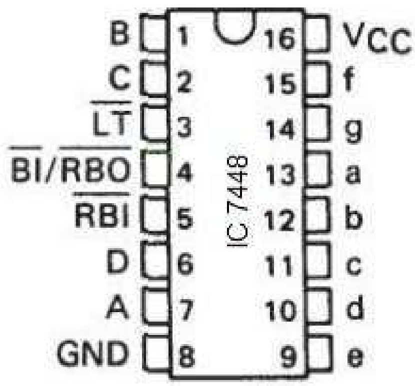
Pin Name	Description
A_0, A_1, A_2, A_3	BCD input
$\bar{a}$ to $\bar{g}$	Active low outputs
$\overline{LT}$	Lamp test
$\overline{RBI}$	Ripple blanking input
$\overline{BI}$	Blanking input
$\overline{RBO}$	Ripple blanking output

Figure 7.4

IC 7448(BCD to 7-Segment decoder IC)

IC 7448 is BCD to 7-Segment decoder IC whose output is active high depending on the corresponding BCD inputs so it is used to drive common cathode 7- segment displays



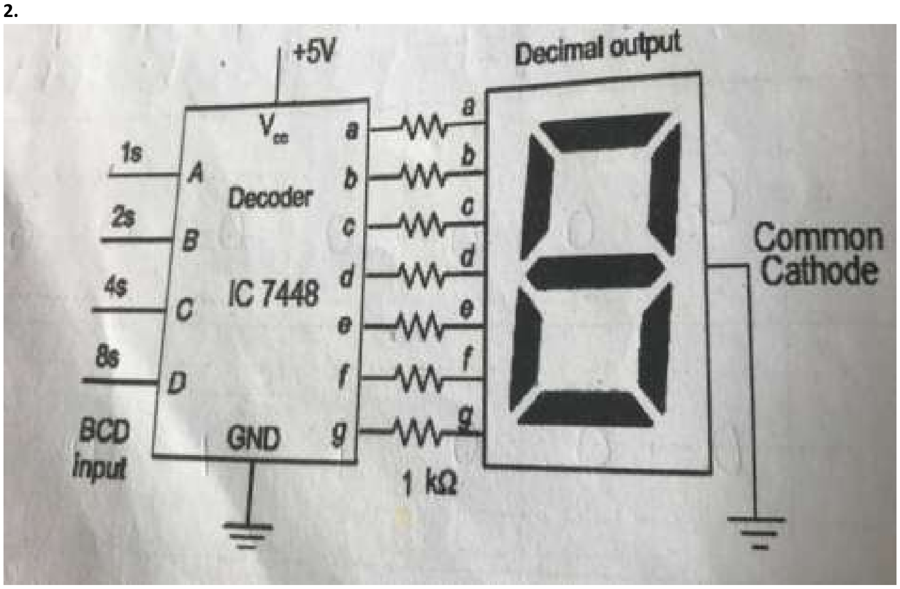


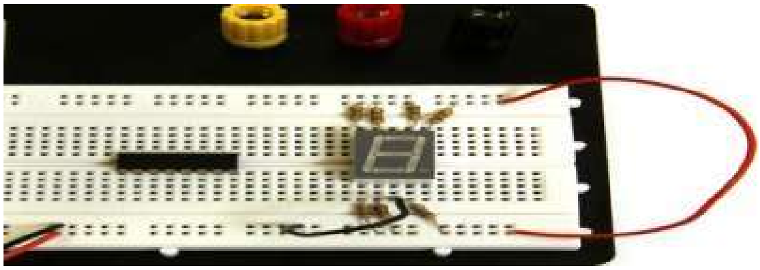
Practical set-up / Circuit diagram

1.

For normal functioning of IC 7447 Pin number 3, 4, 5 should be connected to logic 1⍰V_{cc}

2.





Practical Setup

Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity	Remark
1.	Digital Multimeter	Digital Multimeter:3 ½ digital display	1	
2.	IC Tester	Digital IC Tester	1	
3.	Breadboard	5.5cm X 17 cm	1	
4.	DC power supply	+5 V Fixed power supply	1	
5.	IC 1	7447	1	
6.	IC 2	7448	1	
7.	Common anode 7-seg Display	IC FND 507/LT 542	1	
8.	Common cathode 7seg Display	IC LT 543	1	
9.	Connecting wires	Single strand 0.6 mm Teflon coating	As required	
10.	Resistors	330 Ω/0.25 W	7	

Precautions to be Followed

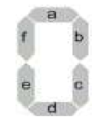
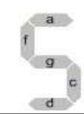
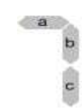
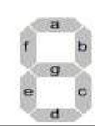
Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

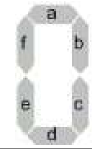
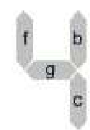
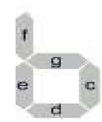
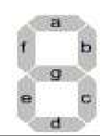
1. Test the IC's using IC tester.
2. Mount IC's on breadboard
3. Connect different BCD inputs from 0000 to 1001 and note down the corresponding output on the display.
4. Observe the outputs on 7- segment display.
5. Fill up the observation table.
6. The supply voltage to the IC's should not exceed +5V.

Observations

1.Observation Table for common anode Display

BCD inputs				7-SEGMENT CODED OUTPUTS							Display output
D	C	B	A	a	b	c	d	e	f	g	
0	0	0	0	0	0	0	0	0	0	1	
0	0	0	1	1	0	0	1	1	1	1	
0	0	1	0	0	0	1	0	0	1	0	
0	0	1	1	0	0	0	0	1	1	0	
0	1	0	0	1	0	0	1	1	0	0	
0	1	0	1	0	1	0	0	1	0	0	
0	1	1	0	1	1	0	0	0	0	0	
0	1	1	1	0	0	0	1	1	1	1	
1	0	0	0	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	1	1	0	0	

2.Observation Table for common cathode Display

BCD inputs				7-SEGMENT CODED OUTPUTS							Display output
D	C	B	A	a	b	c	d	e	f	g	
0	0	0	0	0	0	0	0	0	0	1	
0	0	0	1	1	0	0	1	1	1	1	
0	0	1	0	0	0	1	0	0	1	0	
0	0	1	1	0	0	0	0	1	1	0	
0	1	0	0	1	0	0	1	1	0	0	
0	1	0	1	0	1	0	0	1	0	0	
0	1	1	0	1	1	0	0	0	0	0	
0	1	1	1	0	0	0	1	1	1	1	
1	0	0	0	0	0	0	0	0	0	0	
1	0	0	1	0	0	0	1	1	0	0	

Conclusions /Result

BCD to seven segment display decoder convers BCD output to a pattern that can directly give seven segment display.

For displaying data using 7 segment display device, the data must be converted from BCD to 7-segment Code.

Practical Related Questions

1. Write down functions of decoder.
2. Write the functions of pin No. 3, 4, and 5 of IC 7447.
3. List different types of decoder.

Answers:

1. A decoder is a circuit that changes a code into a set of signals. It is called a decoder because it does the reverse of encoding, but we will begin our study of encoders and decodrs with decoders because they are simpler to designs.

2. Pin no. 3 is a display test. Pin no. 4 is a blanking output. And pin no. 5 is RBI input pin.

3. Types of decoders are :

   2 to 4 line decoder.

   3 to 8 decoders.

   4 to 16 decoder.

   Binary decoder.

Signature of teacher

Practical No.8: Verify operation of Multiplexer (MUX)

Practical Significance

In most of the electronic systems, the digital data is available on more than one line. It is necessary to route this data over a single line.Under such circumstances we require a circuit which selects one of the many inputs at a time.This circuit is a multiplexer, which has many inputs, one output and some select inputs.Multiplexer improves the reliability of the digital system because it reduces the number of external wired connections.

Relevant Program Outcomes (POs)

1. **Discipline knowledge:** Apply Electronics and Telecommunication knowledge to solve broad-based electronics and telecommunication engineering related problems.
2. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
3. **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.
4. **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.

Competency and Practical Skills

This practical is expected to develop the following skills for the industry-identified competency: '**Build/ test digital logic circuits using digital ICs.'**

i. Identify pin configuration of
Multiplexer IC's. ii. Test the
functionality of the Multiplexer.

IV Relevant Course Outcome(s)

 Build simple combinational circuits. .

V Practical Outcome

 Build / test function of MUX 74151/74150 or any other equivalent.
(IC 74151/74150)

VI Relevant Affective domainrelated
Outcome(s) Handle IC and
equipment carefully.
 Follow safe practices.

VII Minimum Theoretical Background

Multiplexer is a combinational circuit that is one of the most widely used in digital design. The multiplexer is a data selector which gets one out of several inputs to a single output. It has n data inputs and one output line and m select lines where

$2^m = n$ shown in figure 8.1. Depending upon the digital code applied at the select inputs one out of n data input is selected and transmitted to a single output channel. Normallystrobe (G) input is incorporated which is generally active low which enables the multiplexer when it is LOW. Strobe input helps in cascading. IC 74151A is an 8: 1 multiplexer which provides two complementary outputs Y and $\overline{Y}$ The output Y is same as the selected input and $\overline{Y}$ is its complement. The n: 1 multiplexer can be used to realize m variable function. ($2^m = n$, m is no. of select inputs)

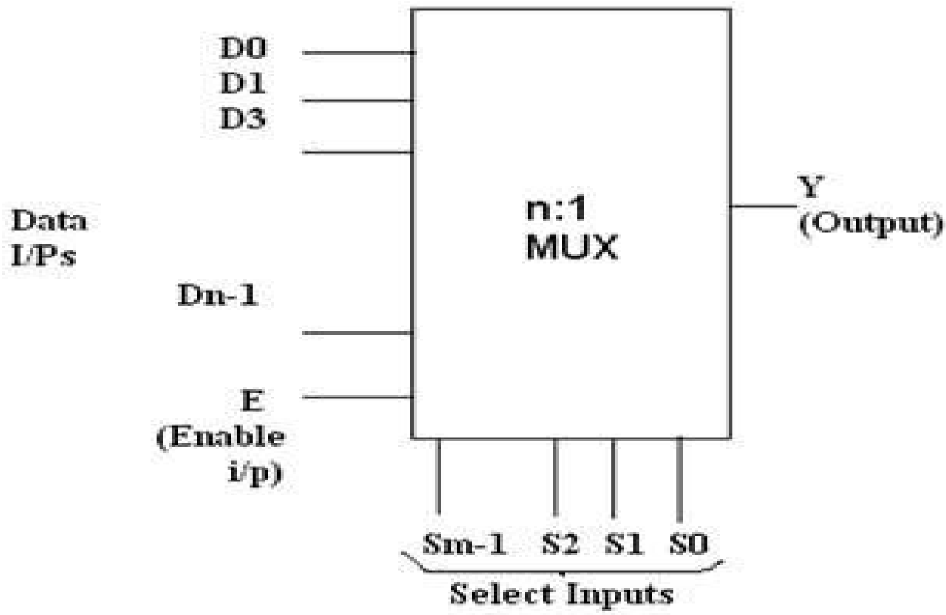


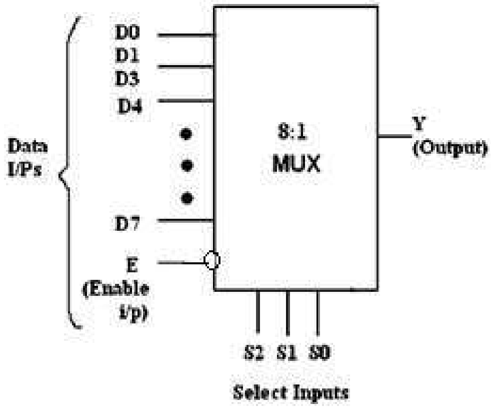
Figure 8.1 Block diagram of n: 1 Multiplexer

Types of Multiplexer(MUX):

1. 2:1 MUX (2 lines to 1 line)
2. 4:1 MUX (4 lines to 1 line)
3. 8:1 MUX (8 lines to 1 line)
4. 16:1 MUX (16 lines to 1 line)
5. 32:1 MUX (32 lines to 1 line)

List of ICs which provide multiplexing

IC No.	Function	Output State
74157	Quad 2:1 MUX.	Output same as input given
74158	Quad 2:1 MUX.	Output is inverted input
74153	Dual 4:1 MUX	Output same as input
74352	Dual 4:1 MUX	Output is inverted input
74151A	8:1 MUX	Both outputs available (i.e., complementary outputs)
74151	8:1 MUX	Output is inverted input
74150	16:1 MUX	Output is inverted input



Enable	Select Inputs			Output
E	S2	S1	S0	Y
1	X	X	X	0
0	0	0	0	D0
0	0	0	1	D1
0	0	1	0	D2
0	0	1	1	D3
0	0	0	0	D4
0	0	0	1	D5
0	0	1	0	D6
0	0	1	1	D7

(E=1 for active high E=0 for active low)

Figure 8.2 Block diagram of 8: 1 MUX, Truth Table of 8:1 MUX

VIII PracticalCircuit diagram

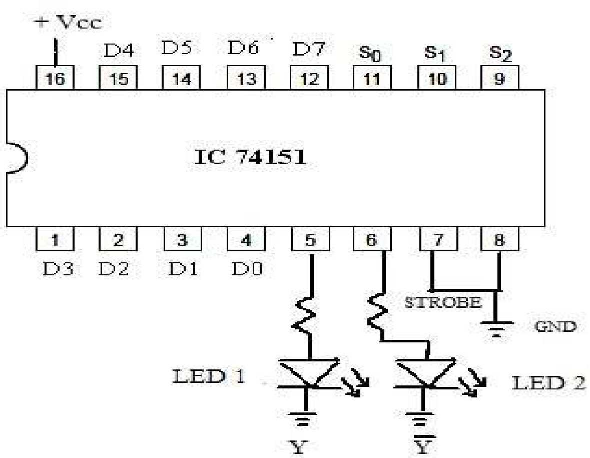


Figure 8.3: Circuit Diagram

IX Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	2	
2	Digital IC Tester	Tests a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC’s.	1	
3	DC power supply	+5 V Fixed power supply	1	
4	Breadboards	5.5cm X 17 cm	1	
5	IC	74151/74150	1	
6	LED	Red /Yellow color 5 mm	1	

7	Resistor	330 Ω	2	
8	Connecting wires	Single strand 0.6 mm Teflon coating	As required	

X Precautions to be Followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

XI Procedure

1. Test the IC using Digital IC Tester.
2. Mount the IC on the breadboard.
3. Make the connections as per figure 8.3
4. Give the supply voltage to IC +5V.
5. Observe the LED (on or off) for each combination of input as per truth table.
6. Verify the truth table.

XII Observations and Calculations

Table 8.1: Observation table

Inputs					**Outputs**	
Strobe	**Data input**	**Select Input**			**Y**	$\overline{\mathbf{Y}}$
G	**Dn**	**S2**	**S1**	**S0**		
0	D_0	**0**	**0**	**0**	D_0	D_0`
0	D_1	**0**	**0**	**1**	D_1	D_1`
0	D_2	**0**	**1**	**0**	D_2	D_2`
0	D_3	**0**	**1**	**1**	D_3	D_3`
0	D_4	**1**	**0**	**0**	D_4	D_4`
0	D_5	**1**	**0**	**1**	D_5	D_5`
0	D_6	**1**	**1**	**0**	D_6	D_6`
0	D_7	**1**	**1**	**1**	D_7	D_7`
1	**X**	X	X	X	**X**	**X**

(Write the observation with respective to number of inputs)

(Note: 'X'-indicates the don't care conditions. It means status of select input may be any combination.)

Results

1. **Multiplexer has many inputs and single output.**

2. **One of the input reflects the output of the multiplexer according to selected line input given to multiplexer.**

Practical Related Questions

1. List the function of Pin 5, 6 and 7 of IC 74151.
2. List the Name of manufacturers of digital IC used in your lab.
3. What is the output of IC 74151 if G=1, S2S1S0=XXX, Y=? Y=?

Answers

Answers :

1. **Function of pin no. 5 is multiplexer output. Pin no. 6 is complementary multiplexer output. Function of pin no. 7 is enable input.**
2. **Texas ltd.**
3. **Output is Y = 1 and Y = 0.**

Signature of Teacher

<u>Practical No.9</u>: Construct Demultiplexer circuit and verify its truth table.

Practical Significance

A demultiplexer (or demux) is a device taking a single input signal and selecting one of many data-output-lines, which is connected to the single input. An electronic demultiplexer can be considered as a single-input, multiple-output switch. Demultiplexers are mainly used in Boolean function generators and decoder circuits.

Relevant Program Outcomes (POs)

1. **Discipline knowledge:** Apply Electronics and Telecommunication knowledge to solve broad-based electronics and telecommunication engineering related problems.
2. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
3. **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

Competency and Practical Skills

This practical isexpected to develop the following skills for the industry-identified competency: '**Build/ test digital logic circuits using digital ICs.'**

i. Identify pin configuration of IC.
ii. Test the functionality of the Demultiplexer.

Relevant Course Outcome(s)

 Build simple combinational circuits. .

Practical Outcome

- Build / test function of DEMUX 74154/74155 or any other equivalent.

Relevant Affective

domainrelated Outcome(s)

 Handle IC and equipment carefully.

- Follow safe practices.

Minimum Theoretical Background

Demultiplexer has only one input and "n" number of outputs along with "m" number of select inputs. A demultiplexer performs the reverse operation of multiplexer i.e. it receives one input and distributes it over several outputs. At a time only one output line is selected by the select lines and the input is transmitted to the selected output line. Hence demultiplexer is equivalent to a single pole multiple way switch as shown in figure. The enable input will enable the demultiplexer. The relation between the n output lines and m select lines is as given below.

$$n = 2^m$$

The demultiplexer performs opposite process to a multiplexing process it performs “one to many” operation. It has only one input (D) and n number of outputs (Y0, Y1, Y2... Yn-1) as shown in the figure given below.Demultiplexer can also be used as a decoder e.g. Binary to

Decimal Decoder.Data input given is I, strobe/enable pin is used for enabling DEMUX

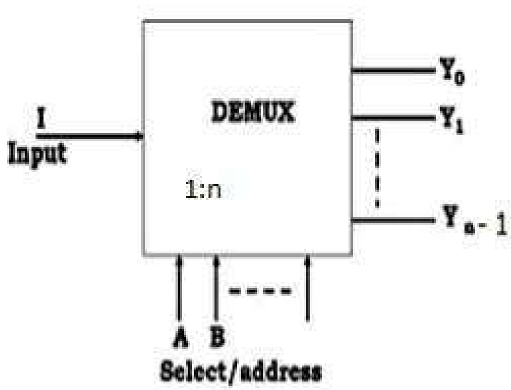
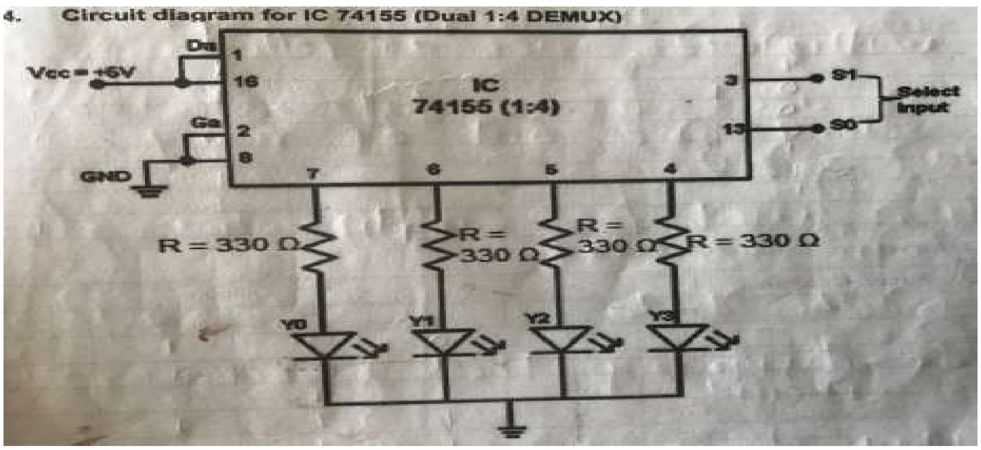


Figure 9. 1 Block diagram of 1:nDemultiplexer
Courtesy:https://www.electronicshub.org/demultiplexerdemux/13.3.2018

PracticalCircuit diagram



Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remark
1.	Digital Multi-meter	Digital Multi-meter: 3 1/2 digit display.	2	
2.	Breadboard	5.5cm X 17 cm	1	
3.	DC power supply	+5 V Fixed power supply	1	
4.	IC	74154/74155	Any one	
5.	LED	Red / Yellow color 5 mm	1	
6.	Resistor	330 Ω	4	
7.	Connecting wires	Single strand 0.6 mm Teflon coating	As required	

Precautions to be Followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

1. Test the IC using Digital IC Tester.
2. Mount the IC on the breadboard.
3. Make the connections as shown in figure 9.3 4. Give the supply voltage to IC +5V.
5. Apply input to select lines according to the observation table.
6. Observe the LED (on or off) for each combination of input as per truth table.
7. Verify the truth table.

Observations

INPUT				OUTPUT			
Din	**G**	**S1**	**S0**	**YO**	**Y1**	**Y2**	**Y3**
1	0	0	0	1	0	0	0
1	0	0	1	0	1	0	0
1	0	1	0	0	0	1	0
1	0	1	1	0	0	0	1
1	1	x	x	0	0	0	0

(Note: 'X'-indicates the don't care conditions. It means status of select input may be any combination.)

Conclusions

Demux has only one input and Multiplexer outputs with selected lines. Input reflects on one of the output pin according to selected line input.

Practical Related Questions

1. What is the role of select lines in a Demultiplexer?
2. What is the output of IC 74155 if D0=1, G=1, S3, S2, S1=XXX?

Answers:

1. **Select lines in a Demultiplexer are used to select which input line to send to the output.**
2. Output is not defined

Signature of Teacher

<u>Practical No.10</u>: Test functionality of RS flip flop using NAND Gates.

Practical Significance

A flip-flop is a circuit that has two stable states and can be used to store information. A flipflop is a bi-stable multi-vibrator. The circuit can be made to change state by signals applied to one or many control inputs and will have one or two outputs. The flip flop is a one bit memory cell it stores one bit of information. The data available in memory can be used for further operation. The flip flops are used in bounce elimination switch, shift registers, counters and in random access memory.

Relevant Program Outcomes (POs)

1. **Discipline knowledge:** Apply Electronics and Telecommunication knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
2. **Experiments and practice:** Plan to perform experiments and practices to solve broadbased Electronics and telecommunicationengineering problems.
3. **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

Relevant Course Outcome(s)

- Build simple sequential circuits.

Practical Outcome

Build / test function of RS flip flop using NAND Gates.

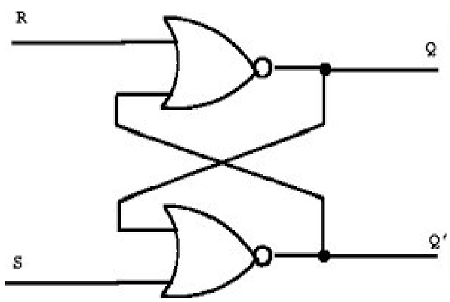
Minimum Theoretical Background

Digital circuits have many combinations of logic circuits. They are classified as either combinational or sequential. The output of combinational circuits depends only on the current inputs. In contrast, sequential circuit depends not only on the current value of the input but also upon the internal state of the circuit. Basic building blocks (memory elements) of a sequential circuit are the flip-flops (FFs). The FFs change their output state depending upon inputs at certain interval of time synchronized with some clock pulse applied to it.

Types of flip flops

1. SR-FF (Set Reset flipflop)
2. JK-FF (JK flip flop)
3. MSJK-FF(Master Slave JK flip flop)
4. D-FF (Delay flip flop)
5. TFF (Toggle flip flop)

Practical Circuit diagram



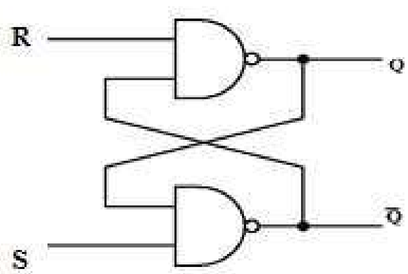


Figure 10.2a) RS Latch Using NOR **(b) RS Latch Using NAND**

S	R	Q	Q`	Comment
0	0	Prev.	Prev.	No Change
0	1	0	1	Reset
1	0	1	0	Set
1	1	X	X	Invalid

Figure 10.2Truth Table of logic diagram for figure 10.1a, b

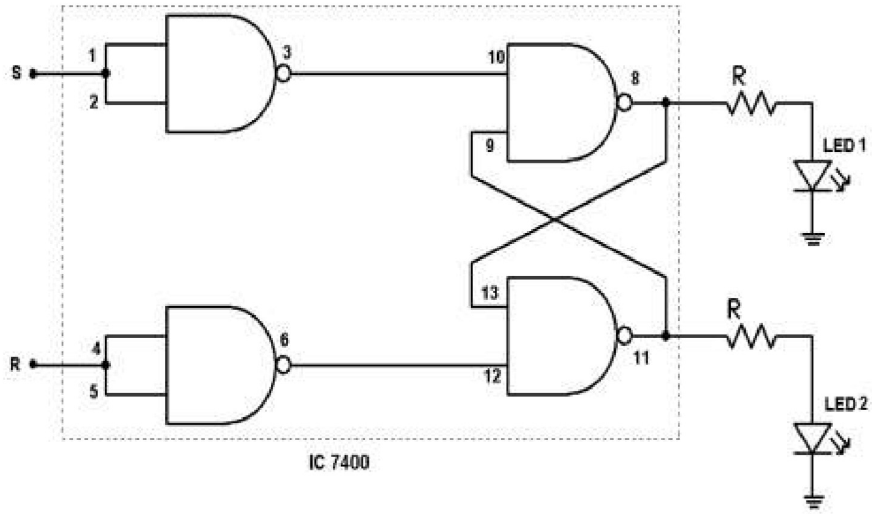


Figure RS-FF Using NAND Gate

Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1	Digital Multi-meter	Digital Multi-meter: 3 1/2 digit display.	2	
2	Digital IC Tester	Tests a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1	
3	DC power supply	+5 V Fixed power supply	1	
4	Breadboard	5.5cm X 17 cm	1	
5	IC	7400	1 Each	
6	LED	Red /Yellow colour 5 mm	2	
7	Connecting wires	Single strand 0.6 mm Teflon coating	As required	
8	Resistors	330Ω	2	

Precautions to be Followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

1. Mount the IC7400 on the breadboard.
2. Make the connections as shown in figure 10.3 3. Apply the supply voltage to IC +5V.
4. Apply inputs according to the observation table.
5. Observe the LED (on or off) for each combination of input as per truth table.
6. Verify the truth table.

Observations

Table 1: Truth Table SR flip-flop

S	R	Q	$\overline{Q}$	Comment
0	0	Q	Q`	No Change
0	1	0	1	Reset
1	0	1	0	Set
1	1	X	X	Invalid

Conclusions

The SR flip flop is also known as SR Latch, can be considered as one of the most basic logic circuit. The Simple flip-flop is basically a one bit memory bi- stable device that has two inputs "SET" and "RESET"(output).

Practical Related Questions

1. List the name of manufacturer of Digital IC used in practical.
2. Test the output when S=R=1.
3. Test the output when CLK =1, verify truth table. (for clocked input circuit)
4. Test the output when CLK =0, verify truth table (For clocked input circuit)

Answers :

1. When input of SR flip flop is both high. Then the output is not stable there is race around condition.
2. When the CLK is one flip flop is active.
3. When CLK is zero clock is inactive.

Signature of Teacher

Practical No. 11: Test functionality of D and T flip flop

Practical Significance

D Flip –Flop (Delay Flip –Flop) is used to provide time delay. They are basic building blocks of Shift Registers. T Flip-Flop (Toggle Flip-Flop) experiences a change in output in each clock edge. Hence it can be used as a frequency divider. T Flip-Flop can also be used to design Counters

Relevant Program Outcomes (POs)

1. **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunication engineering related problems.
2. **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
3. **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

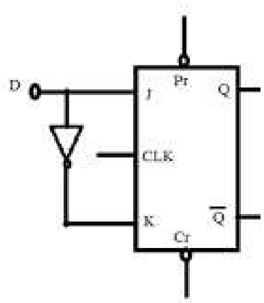
Relevant Course Outcome(s) Build simple sequential circuits. **Practical Outcome**

Use IC7476 to construct and test the functionality of D and T flip flop.

Minimum Theoretical Background

The D flip-flop is obtained from the JK/SR flip-flop by connecting a NOT gate between the J/S and K/R inputs of the JK/SR flip-flop and T flip-flop is obtained from JK flip-flop by shorting J and K inputs of the JK flip-flop.

Practical Circuit diagram



Input D	Output Q_{n+1}
0	0
1	1

Figure 52.1a) D FF using 7476 b) Symbol c) Truth Table

Input T	Output Q_{n+1}
0	Q_n
1	$\overline{Q_n}$

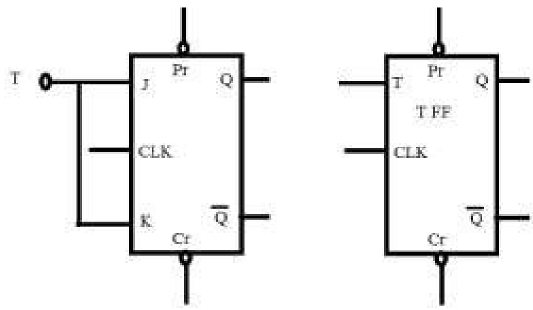


Figure 62.2a) T FF using 7476 b) Symbol c) Truth Table

Practical Circuit diagram

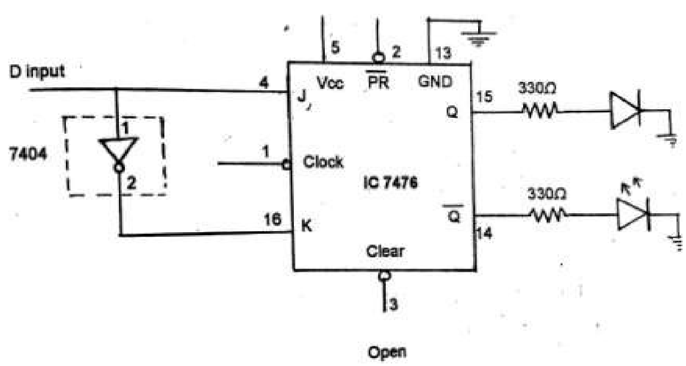


Figure 72.3 D FF using 7476

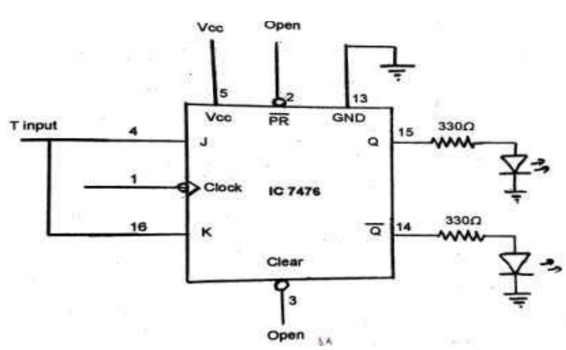


Figure 82.4 T FF using 7476

Resources Required

S. No.	Instrument /Components	Specification	Quantity	Remarks
1	Digital Multimeter	Digital Multimeter: 3 1/2 digit display.	2	
2	Digital IC Tester	Tests a wide range of Digital IC's such as 74 Series, 40/45 Series of CMOS IC's.	1	
3	DC power supply	+5 V Fixed power supply	1	
4	Breadboard	5.5cm X 17 cm	1	
5	IC	7476	1	
6	LED	Red /Yellow color 5 mm	2	
7	Connecting wires	Single strand 0.6 mm Teflon coating	As required	
8	Resistors	330Ω	2	

Precautions to be Followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

1. Mount the IC7476 on the breadboard.
2. Make the connections as shown in figure 12.3,12.4 3. Apply the supply voltage to IC +5V.
4. Apply inputs according to the observation table.
5. Observe the LED (on or off) for each combination of input as per truth table.
6. Verify the truth table.

Observations and Calculations

Table 3: Truth Table D, T flip-flop

Input D	Q_{n+1} Output
0	0
1	1

Input T	Q_{n+1} Output
0	1
1	0

Conclusions

In the D filp flop, output is same as the input with some delay while output of T flip flop isinverted input.

T filp flop is also known as Toggle Filp flop. To Avoid the occurrence of intermediate state in SR flip flop we should provide only one input to flip flop called as toggle or trigger.

Practical Related Questions

1. List the name of manufacturer of Digital IC used in practical.
2. What is the function of IC 7474 draw its pin diagram?

Answers :

1.Texas limited.

2.Basically IC7474 is a dual D-type positive edge triggered flipflops, with preset, clear and complementary outputs. The information on the D input is accepted by the flip flops on the positive going edge of the clock pulse. IC7474 functions as same as D- flip flop(Delay flip flop).

signature of Teacher

<u>Practical No. 12:</u> To design 4 Bit Ripple Counter

Practical Significance:

Counter is a sequential circuit used for counting the number of clock pulses. It is a group of Flip-Flops with a clock signal applied to it. A counter has natural count of 2^n where "n" is number of flip-flops in the counter. A 4-bit counter has 16 states.

Relevant Course Outcome(s)

- Build simple Sequential circuits.

Practical Outcome:

- Implement 4 bit ripple counter using 7476.

Relevant Affective domain related

Outcome(s) ▯ Handle IC and equipment carefully.

- Follow safe practices.

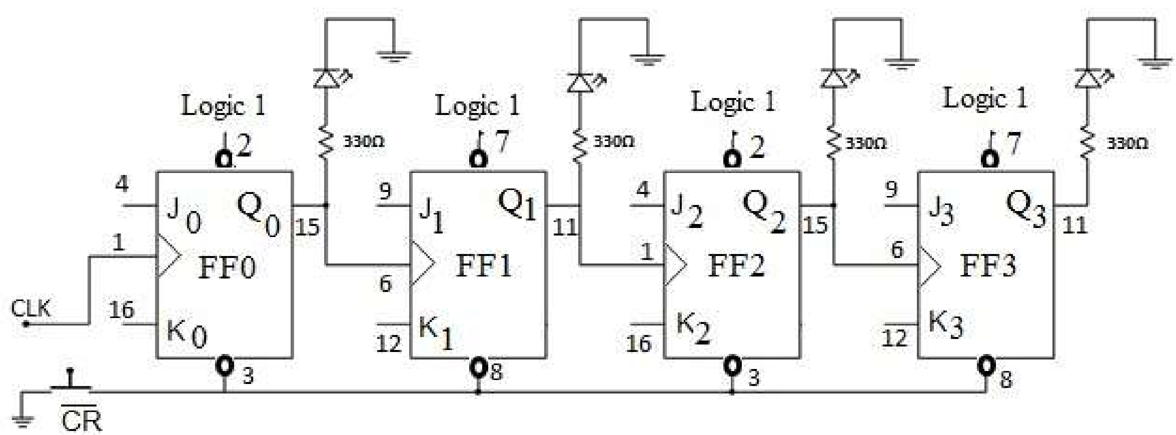
Minimum Theoretical Background:

A ripple **counter** is an **asynchronous counter** where only the first flip-flop is clocked by an external clock. All subsequent flip-flops are clocked by the output of the preceding flip-flop. **Asynchronous counters** are also called ripple-**counters** because of the way the clock pulse ripples away through the flip-flops.

When decimal equivalent of the counter output increases as it receives the clock pulses, then that counter is known as **Up Counter**

When decimal equivalent of the counter output decreases as it receives the clock pulses, then that counter is known as **Down Counter Practical set-up / Circuit diagram**

4-BIT Asynchronous counter



(J, K, PR terminals are kept open which act as high for TTL IC) Fig. 4 bit Ripple Counter using J-K flip flop

Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	Digital Multimeter	Digital Multimeter:3 ½ digital display	1
2	IC Tester	Digital IC Tester	1
3	Breadboard	5.5cm X 17 cm	1
4	DC power supply	+5 V Fixed power supply	1
5	Clock Pulse	Function/Pulse Generator	1
6	IC 1	7476	2
7	LED	Red /Yellow color 5 mm	4
8	Connecting wires	Single strand 0.6 mm Teflon coating	As required
9	Resistors	330 Ω/0.25 W	4

Precautions to be followed

Do not switch ON the power supply unless you have checked the circuit connections as per the circuit diagram.

Procedure

1. Connect +5V Power supply to proper pins of IC.
2. Connect appropriate resistor and LED to output Q.
3. Clear all the flip-flops by applying active low input to the clear pin so that the flip-flops have 0000 stored in them.
4. Apply clock pulse at clock input and after every clock pulse write down the counter output state from LED (ON LED =1 State, OFF LED =0 State)
5. Apply 16 clock pulses and write down the output of counter in truth table.

Observation Table for 4-BIT Asynchronous Up counter

Input	Output				
No. of clock pulses	Q_3	Q_2	Q_1	Q_0	Decimal Equivalent
0	0	0	0	0	0
1	0	0	0	1	1
2	0	0	1	0	2
3	0	0	1	1	3

4	0	1	0	0	4
5	0	1	0	1	5
6	0	1	1	0	6
7	0	1	1	1	7
8	1	0	0	0	8
9	1	0	0	1	9
10	1	0	1	0	10
11	1	0	1	1	11
12	1	1	0	0	12
13	1	1	0	1	13
14	1	1	1	0	14
15	1	1	1	1	15
16	0	0	0	0	16

Conclusions

A bit counter can count 2^4 i.e. 16 states of input. After 16^{th} State Clock pulse it again starts counting from zero. This counter is U Counter As Output increases By 1.

Practical Related Questions

1. How many flip-flops are required to count 8 clock pulses? Why?
2. Write down pin numbers for VCC, GND, Clear and Preset.
3. Test output for Clear and Preset for 1 and 0.
4. Write down observation table for down counter.

Answers:

1. A 3 flip flops are required to count 8 clock pulses. No of flip flops are counted by no. of bits and for 8 clock pulses 3 bits are required as no. of bits = $\log_2$no.of pulses.
2. Pin no. 5 is for VCC and pin no. 10 GND, pin no. 1 for clear and pin no.14 for preset.
3. When the preset is not activates=d, the flip flop will be set(Q = 1, NOT-Q = 0) regardless of any synchronous inputs or the clock. When the clear input is activated, the flip flop will be reset (Q =0, not-Q = 1), regardless of any of the synchronous inputs or the clock.

4.

BCD count sequence				
Count	Output			
	D	C	B	A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

Signature of Teacher

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