Experiment: 01

Objective: To study and implement internal configuration of logic gates (NOT, NAND, NOR) by varying truth tables.

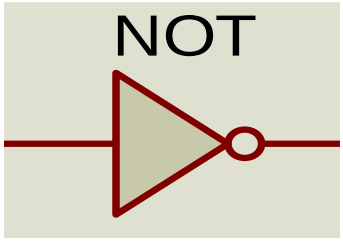
Apparatus:-

- NPN transistor MPS2222
- LED
- DC power supply
- Resistances 1k, 10k
- Jumper wires

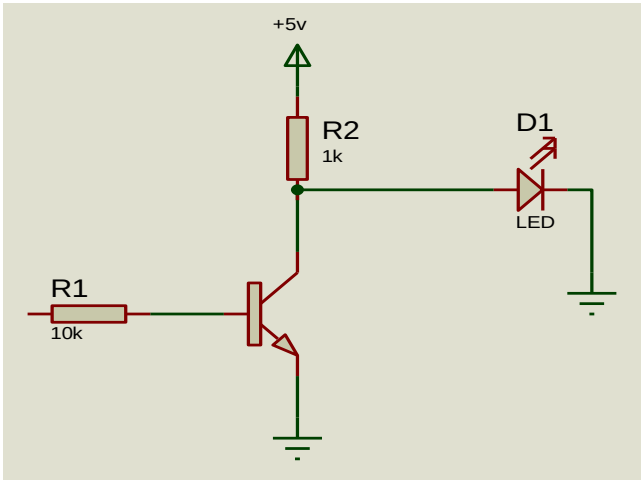
NOT Gate

Theory: A logic gate which gives the negation of any given number is known as NOT gate. When input is 1, circuit will be close and all the current flows to the emitter, which is grounded and LED will not glow, showing output 0. When input is 0, circuit will be open and LED will glow, showing output 1.

Symbol:



Circuit diagram:



Circuit diagram of NOT Gate

Procedure:

a) First of all take the components and make the connections according to circuit diagram.
b) Emitter of the NPN transistor should be grounded.
c) LED is connected with the collector along with 5V power supply in series with a resistance of 1k.
d) Base was given 5V to give input 1 at base and as a result the LED didn't glow showing output 0, along with a resistance of 10k.
e) When we grounded the base terminal, input was 0 and NPN transistor work as open switch and all the current flow towards the LED and as a result, LED glows showing output 1.
f) It means when we give input 1, it gives output 0 and when we give 0 at input, it gave us 1 at output.
g) Fill the table with the experimental values.

Truth table of NOT Gate:

Y=X

Input (X)	Output (Y)

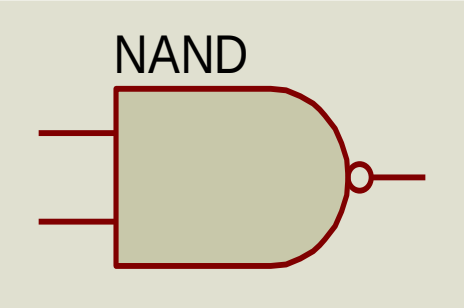
Result:

This circuit gives the negation of a number. When we give 0 at input, output is 1. When we give input 1, it gives 0 at output. This property exists for NOT gate.

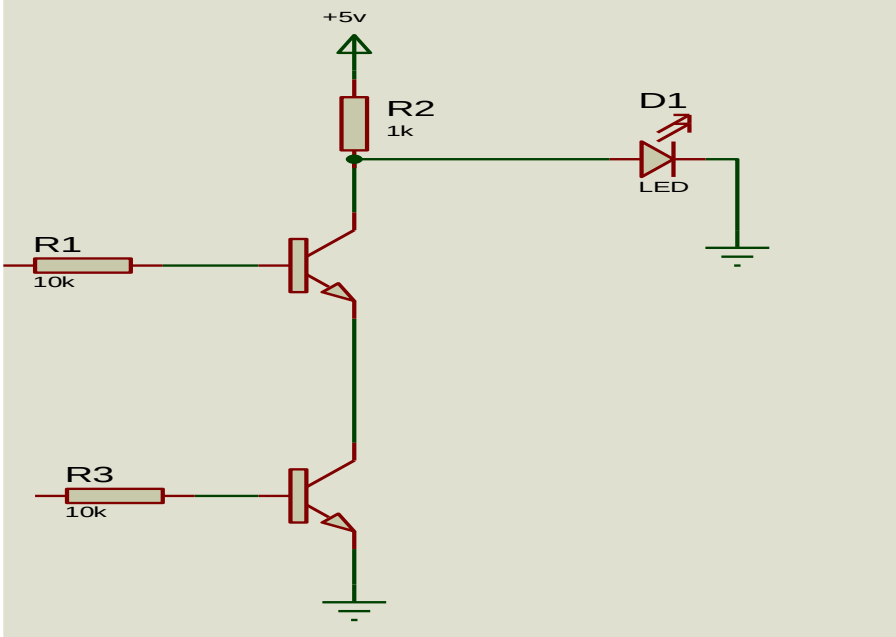
NAND Gate

Theory: It consists of 2 NPN transistors. It gives the negation of outputs given by AND gate. It takes 2 inputs and give one output. It gives output 1 when either one of its inputs are 1 or also when both are 0. When both inputs are 1, output will be 0.

Symbol:



Circuit diagram:



Circuit diagram of NAND Gate

Procedure:

a) First of all take all the components and connect them according to circuit diagram.
b) Connect the emitter of first transistor with the collector of other.
c) Ground the emitter of second transistor.
d) Base of both transistors are connected to 10k resistances.
e) Collector of first transistor is connected with LED and also with a resistance of 1k which is in series with LED and further connected with 5V power-source.
f) First, we grounded both inputs X, Y in order to give inputs 0, LED glows showing output 1.
g) Then apply 5V to Y only for giving input 1 at Y but X will remains at 0 input, giving output 1.
h) When we give 5V to X and grounded the Y terminal, results will be same.

i) But when both X and Y were given 5V for input 1, LED didn't glow, showing output 0.
j) Fill the experimental table after doing all these combinations.

Truth table of NAND Gate:

Z=X.Y

Input (X)	Input (Y)	Output (Z)

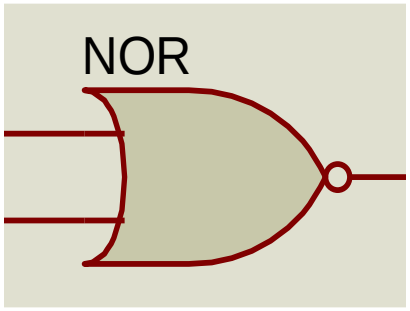
Results:

This circuit gives the negation of AND gate. When input at both terminals is 0 or when either one of input is 1, output is 1. When both inputs are 1, output is 0. This property exists for NAND gate.

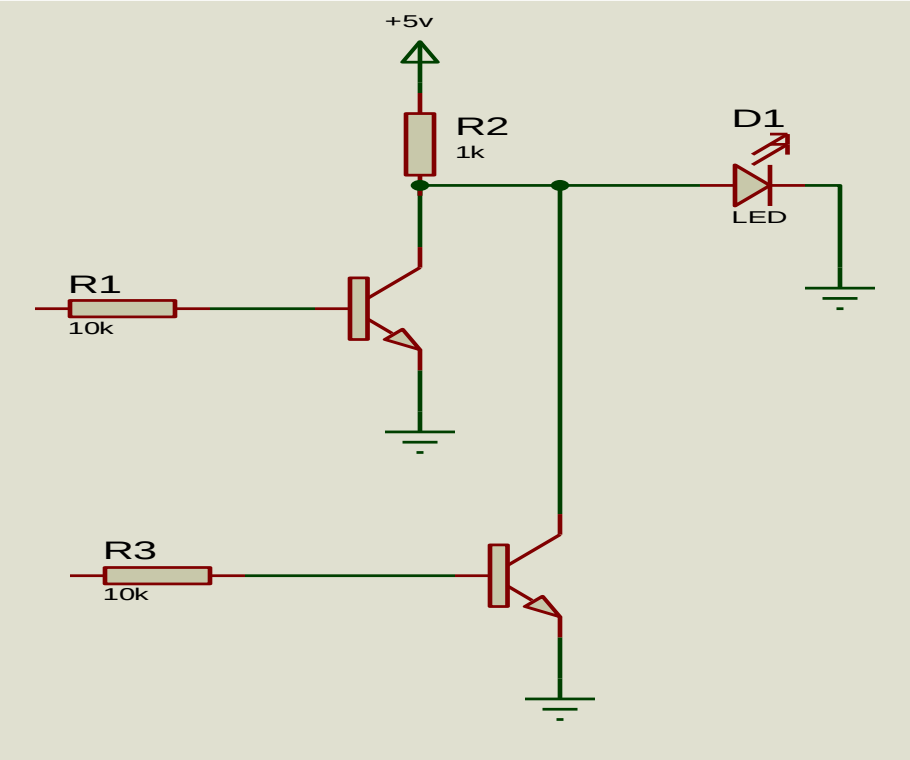
NOR Gate

Theory: It also takes 2 inputs and gives the negation of OR gate. It takes two inputs and give one output. When inputs are 0, output is 1. When either one of its inputs are 1 or both are 1, then output is 0.

Symbol:



Circuit diagram:



Circuit diagram of NOR Gate

Procedure:

a) First of all take all components and arrange them according to circuit diagram.
b) Ground the emitters of both transistors.
c) Connect the collector of first transistor with the collector of second transistor.
d) Also connect LED with the collector of first transistor and also connect one resistance of 1k in series with collector which is further connected to 5V power-source.
e) Base of both transistors are connected to 10k resistances.
f) First, we grounded both inputs X, Y in order to give inputs 0, LED glows showing output 1.
g) Then apply 5V to Y only for giving input 1 at Y but X will remains at 0 input, giving output 0.
h) When we give 5V to X and grounded the Y terminal, results will be same.
i) But when both X and Y were given 5V for input 1, LED didn't glow, showing output 0.
j) Fill the experimental table after doing all these combinations.

Truth table of NOR Gate:

Z=X+Y

Input (X)	Input (Y)	Output (Z)

Result:

This circuit gives negation of OR gate. When both inputs are 0, output is 1. When both are 0 or either one of its inputs are 1, then output is 0. This property exists for NOR gate only.

Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Fill all the truth tables carefully.

Experiment: 02

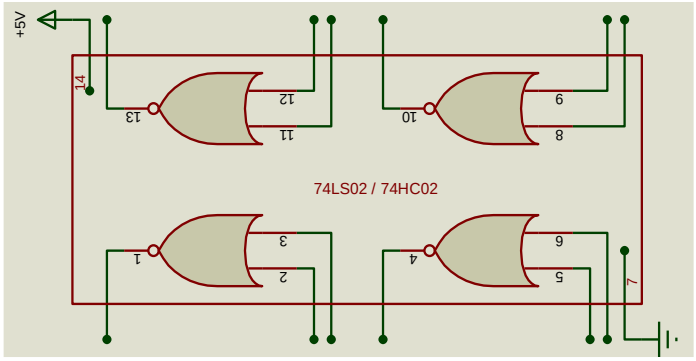
Objective: To implement basic and universal gates.

Apparatus:-

- LED
- Jumper wires
- DC power supply
- IC 74LS02/ IC 74HC02
- IC 74LS32/ IC 74HC32
- IC 74LS86/ IC 74HC86
- IC 74LS04/ IC 74HC04
- IC 74LS08/ IC 74HC08
- IC 74LS00/ IC 74HC00
- LM7805

Theory:

1) **IC 74LS02/ IC 74HC02:-** This IC is of NOR gate. It is a 14 pin IC which consists of 4 NOR gates inside it. Fourteenth pin is for input and seventh pin is grounded. 1st, 4th, 10th and 13th pins are used for taking output while remaining pins give input to specific gates inside it.



2) **IC 74LS32/ IC 74HC32:-** This IC is of OR gate. This IC also has 14 pins. The main difference between above mentioned IC and this is that of input/output pins because, 3rd, 6th, 8th and 11th pin gives output and remaining pins are used for taking inputs. 7th pin is grounded and 14th is used for taking input from the source.

3) **IC 74LS86/ IC 74HC86:-** This IC is of XOR gate. This IC also has 14 pins. Similar to the above mentioned IC, 3rd, 6th, 8th and 11th pin give output and remaining pins are used for taking inputs. 7th pin is grounded and 14th is used for taking input from the source.

4) **IC 74LS08/ IC 74HC08:-**This IC is of AND gate. This IC also has 14 pins. Similar to the above mentioned IC, 3rd, 6th, 8th and 11th pin give output and remaining pins are used for taking inputs. 7th pin is grounded and 14th is used for taking input from the source.

5) **IC 74LS00/ IC 74HC00:-** This IC is of NAND gate. This IC also has 14 pins. Similar to the above mentioned IC, 3rd, 6th, 8th and 11th pin give output and remaining pins are used for taking inputs. 7th pin is grounded and 14th is used for taking input from the source.

6) **IC 74LS04/ IC 74HC04:-** This IC is of NOT gate. Internal configuration of this IC is a bit different from the others. This IC contains 6 gates inside it while the others have 4 gates. 2nd, 4th, 6th, 8th, 10th and 12th pins are used for output while other are used for input.

Procedure:

a) Take all the required components and arrange them according to circuit diagram.
b) Place all seven ICs in line at the horizontal center line of breadboard with some distances.
c) Make sure that the notch is on the left. It makes connections easy.
d) Connect the positive input with pin 1 of voltage regulator and negative with pin 2.
e) Take output of +5V from pin 3 of regulator and -5V from other backside of pin 2. If we take negative voltage from front side, it would give -9V which burns the components.
f) Select any of the gate from each IC and connect one terminal of LED with the output pin of the selected gates.
g) Connect the other terminal of LED with the -5V which is taken from regulator to ground it.
h) Connect 7th pin of all ICs with -5V to ground them and 14th pin with +5V.
i) When input is +5V, it represents 1. When input is -5V, it represents 0
j) Apply all the four combinations of inputs (00, 01, 10 and 11) to the selected gates and observe the outputs.
k) If the LED of a specific gate glows, it means output is 1, otherwise its 0.
l) Note all the experimental values from each IC and note them in the table.

Truth Tables

1) **IC 74LS02/ IC 74HC02:**

2) **IC 74LS32/ IC 74HC32:**

3) **IC 74LS86/ IC 74HC86:**

4) **IC 74LS08/ IC 74HC08:**

5) **IC 74LS00/ IC 74HC00:**

6) **IC 74LS04/ IC 74HC04:**

Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Don’t apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.

Experiment: 03

Objective: To implement logic gates using NAND gate.

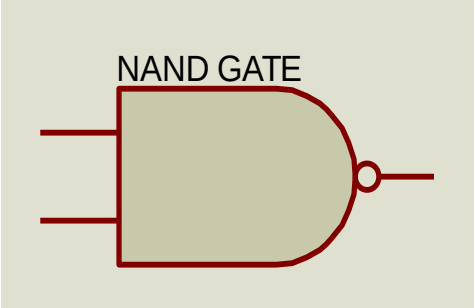
Apparatus:-

- IC 74LS00/74HC00
- LED
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Theory:

The NAND gate is universal gate. The NAND gate represents the complement of the AND operation. Its name is an abbreviation of NOT AND. NAND gates are economical and easier to fabricate and are the basic gates used in all IC digital logic families. To prove that any Boolean function can be implemented using only NAND gates, we will show that the NOT, AND, OR, NOR and XOR operations can be performed using only NAND gate.

Symbol:



Truth table:

$$Z = \overline{X.Y}$$

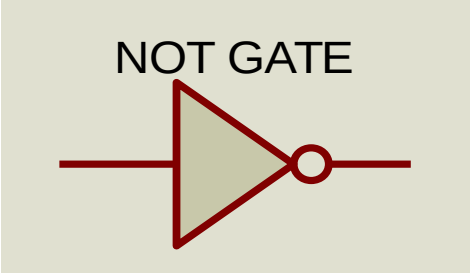
Input (X)	Input (Y)	Output (Z)

NOT gate from NAND gate

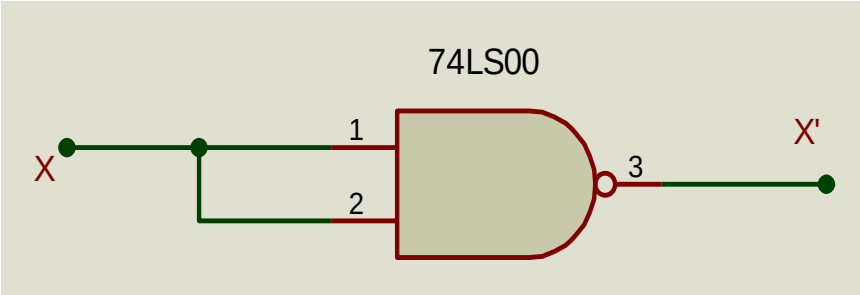
Theory:

NOT gate gives the negation of given binary number. When input is 1, LED didn't glow, showing output 0. When input is 0, NOT gate negate this value and LED will glow, showing output 1.

Symbol:

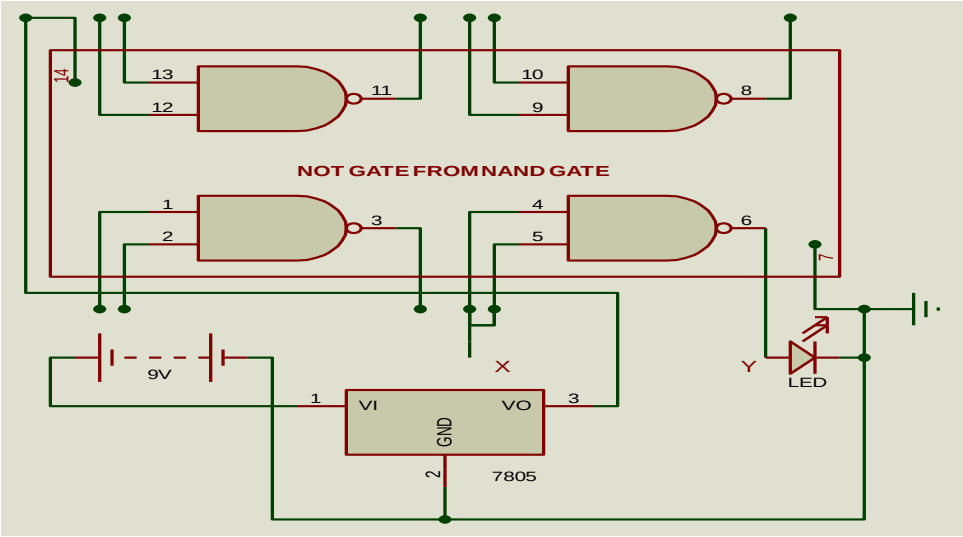


Internal configuration:



Internal configuration of NOT gate using NAND gate

Circuit diagram:



Circuit diagram of NOT gate using NAND gate

Procedure:

a) Place IC in the middle of breadboard and make all the connections according to circuit diagram.
b) Take the input and make its connection with voltage regulator to give IC constant 5V.
c) Give connection of positive input to pin 1 of voltage regulator, give negative input to 2nd pin.

d) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator. In case of taking from front side, it will give -9|V which is not compatible with our circuit.
e) Give this +5V to 14th pin of IC and give -5V to 7th pin because it must be grounded to activate IC.
f) Take any one gate of IC and short its both two inputs.
g) Connect LED with its output and ground it by connecting with -5V.
h) When gave input 0, LED will glow. It means output is 1.
i) When gave input 1, LED will not glow, showing output 0.
j) Fill the experimental values in the given table below.

Truth table:

$$Y = \overline{X}$$

Input (X)	Output (Y)

Conclusion:

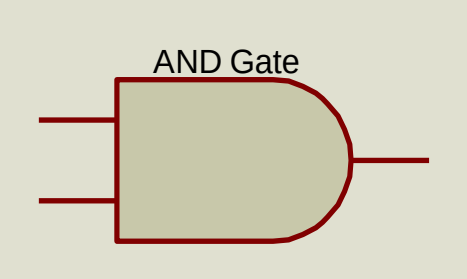
This gate gives the negation of given binary input. It means this gate is NOT gate.

And gate from NAND gate

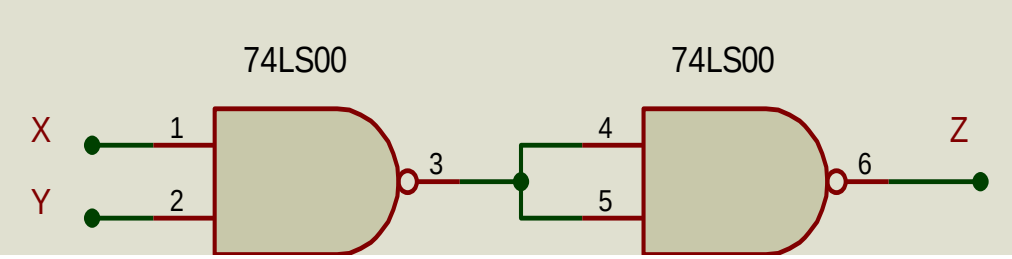
Theory:

It is a gate which gives product of its input and gives result in terms of binary numbers. It gives output 1 only when both inputs are 1. If both or either one of its input is 0, it gives output 0.

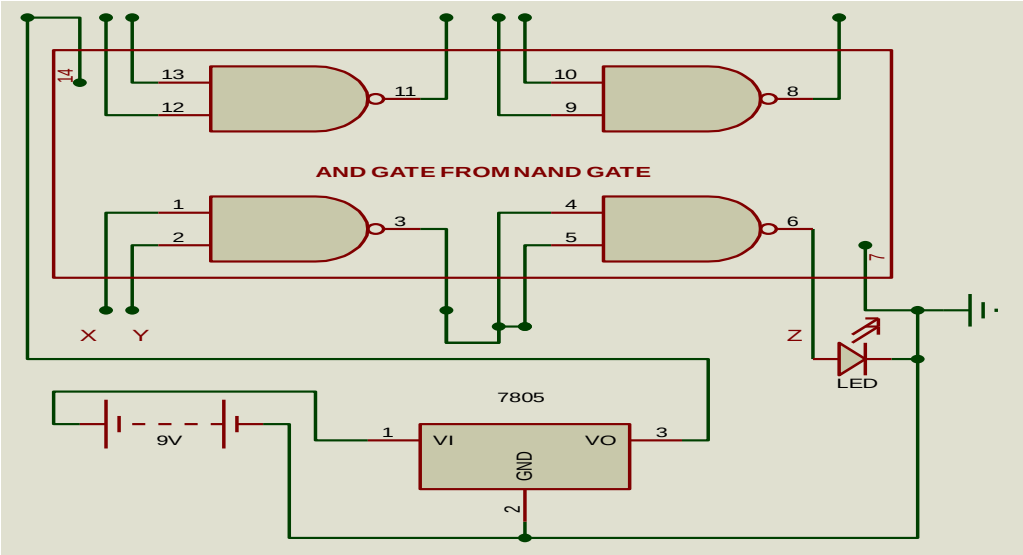
Symbol:



Internal configuration:



Circuit diagram:



Circuit diagram of AND gate using NAND gate

Procedure:

a) Take +5V and connect it with 14th pin and -5V to 7th pin to ground it.
b) Now consider one gate and give its output to another gate whose inputs are short with each other.
c) Give inputs in all four combinations (00, 01, 10, and 11) to first gate.
d) Connect LED with 2nd gate in such a way that its one terminal is connected with output of 2nd gate and ground its other terminal.
e) When input at both terminals is +5V (11), LED will glow giving output 1.
f) For all other combinations of inputs (00, 01 and 10), LED will not glow, showing output 0.
g) Note the experimental values in the given table below.

Truth table:

Z = X.Y

Input (X)	Input (Y)	Output (Z)

Conclusion:

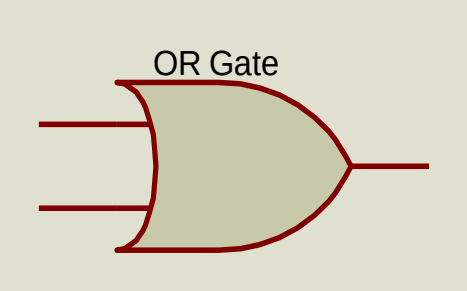
This gate gives the product of given binary inputs. This means that it is AND gate.

OR gate from NAND gate

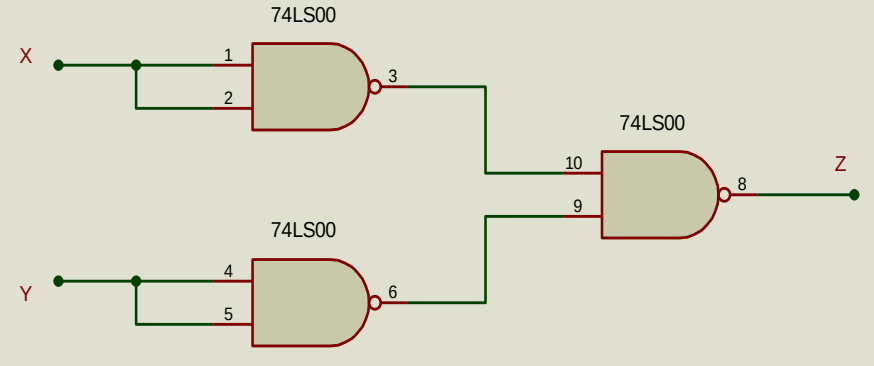
Theory:

It is a gate which gives sum of its input and gives result in terms of binary numbers. It gives output 0 only when both inputs are 0. If both or either one of its input is 1, it gives output 1.

Symbol:

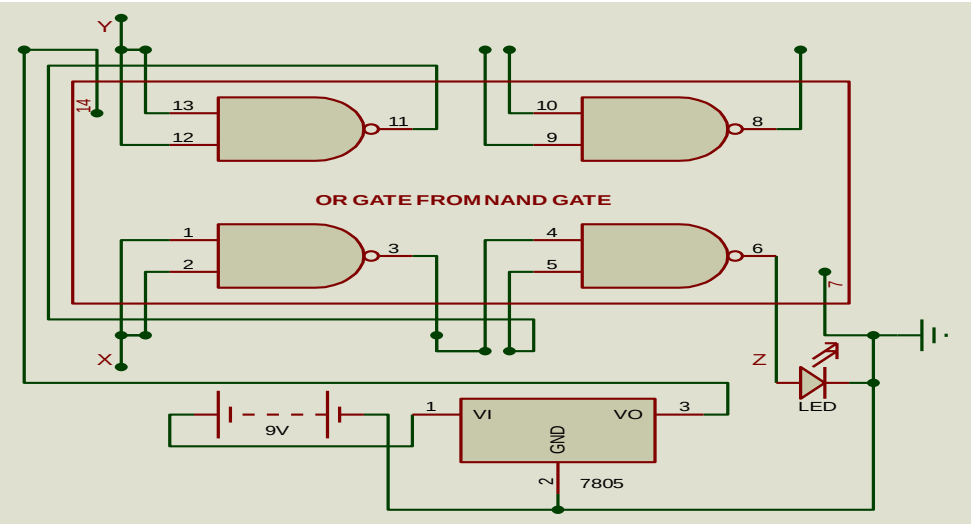


Internal configuration:



Internal configuration of OR gate using NAND gate

Circuit diagram:



Circuit diagram of OR gate using NAND gate

Procedure:

a) Take +5V and connect it with 14th pin and -5V to 7th pin to ground it.
b) Now consider two gate and short the inputs of 1st gate and then of 2nd gate and give their outputs to another gate which gives the resulting output..
c) Give inputs in all four combinations (00, 01, 10, and 11) to first gate.
d) Connect LED with 3rd gate in such a way that its one terminal is connected with output of 3rd gate and ground its other terminal.
e) When input at 1st and 2nd or either one of gate terminals is +5V (01,10 and 11), LED will glow, giving output 1.
f) For input -5V (00), LED will not glow, showing output 0.
g) Note the experimental values in the given table below.

Truth table:

Z = X+Y

Input (X)	Input (Y)	Output (Z)

Conclusion:

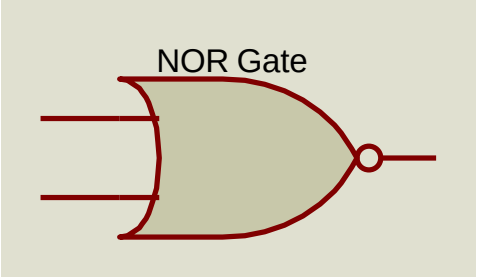
This gate gives the sum of given binary inputs. This means, it is OR gate.

NOR gate using NAND gate

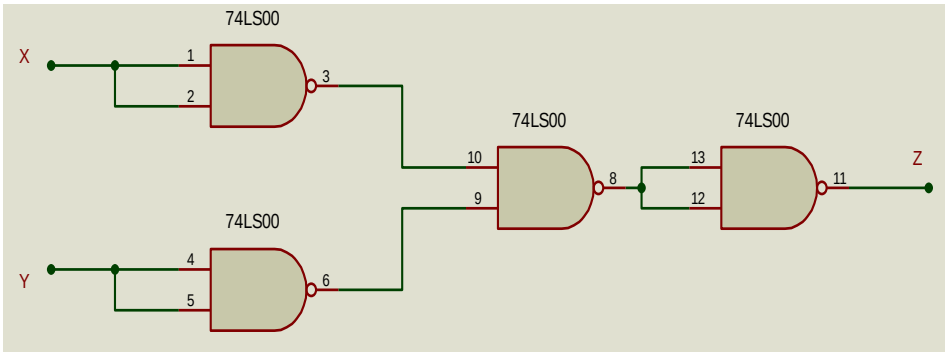
Theory:

It is a gate which gives negation of sum of its input and gives result in terms of binary numbers. It gives output 1 only when both inputs are 0. If both or either one of its input is 1, it gives output 0.

Symbol:

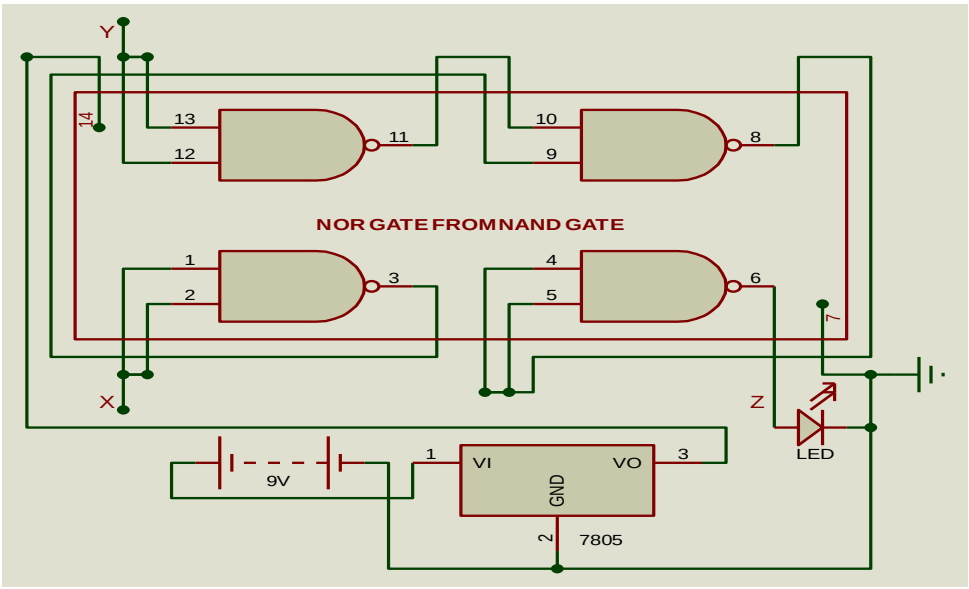


Internal configuration:



Internal configuration of NOR gate using NAND gate

Circuit diagram:



Circuit diagram of NOR gate using NAND gate

Procedure:

a) Take +5V and connect it with 14th pin and -5V to 7th pin to ground it.
b) Now consider two gate and short the inputs of 1st gate and then of 2nd gate and give their outputs to another gate which gives the resulting output.
c) This resulting output is then connected further to another gate whose inputs are short with each other.
d) Give inputs in all four combinations (00, 01, 10, and 11) to first gate.
e) Connect LED with 4rth gate in such a way that its one terminal is connected with output of 4th gate and ground its other terminal.
f) When input at 1st and 2nd or either one of gate terminals is +5V (01, 10 and 11), LED will not glow, giving output 0.
g) For input -5V (00), LED will glow, showing output 1.

Truth table:

$$Z = \overline{X+Y}$$

Input (X)	Input (Y)	Output (Z)

Conclusion:

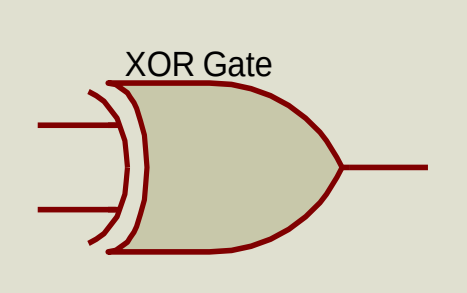
This gate gives the negation of the sum of given binary inputs. This means, it is NOR gate.

XOR gate using NAND gate

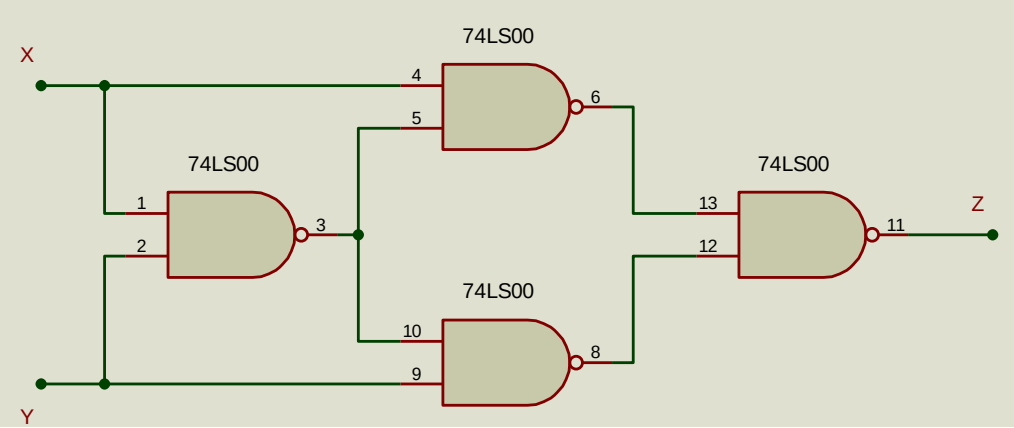
Theory:

An XOR gate (sometimes referred to by its extended name, Exclusive OR gate) is a digital logic gate, with two or more inputs in binary numbers and one output that performs exclusive disjunction. It gives output 1 when inputs are different. When inputs are same, output is 0.

Symbol:

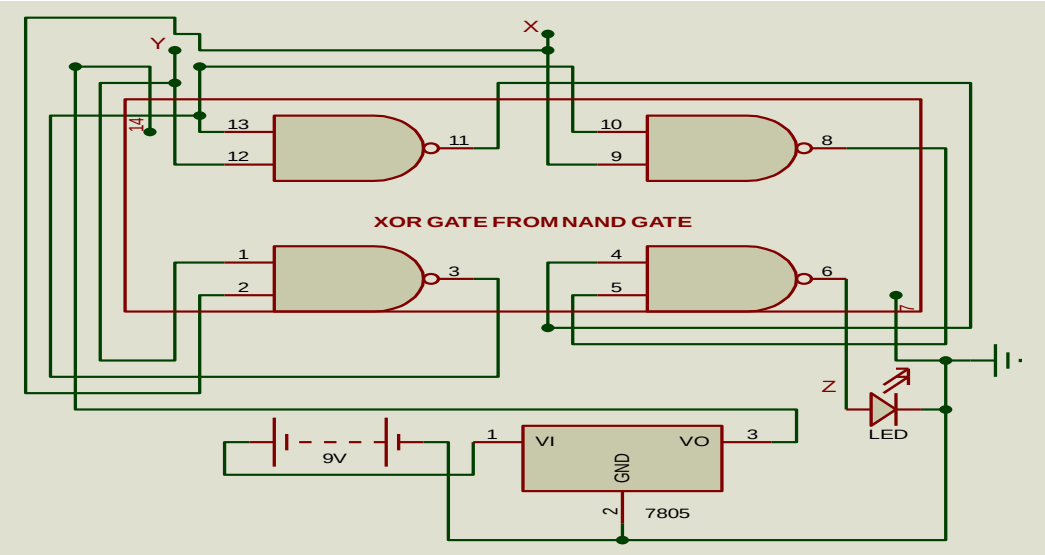


Internal configuration:



Internal configuration of XOR gate using NAND gate

Circuit diagram:



Circuit diagram of XOR gate using NAND gate

Procedure:

a) Take +5V and connect it with 14th pin and -5V to 7th pin to ground it.
b) Consider two gates. Give inputs at one terminal of both gates.
c) Connect the inputs of third gate with input of gate 1 and 2.
d) Connect output of 3rd gate with the second input of 1st and 2nd gate.
e) Then connect the output of 1st and 2nd gate with the inputs of 4th gate which gives the corresponding output.
f) Fill the experimental values in the table.

Truth table:

Z = A+B

Input (X)	Input (Y)	Output (Z)

Conclusion:

This gate perform exclusive disjunction on given binary inputs. This means, it is XOR gate.

Experiment: 04

Objective: To verify De-Morgan's law.

Apparatus:-

- IC 74LS08/74HC08
- IC 74LS04/74HC04
- IC 74LS32/74HC32
- LED
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Theory:

De-Morgan's Laws tell us how to negate a Boolean expression and what it means to do so. It tell us how to transform logical expressions (with multiple AND and/or OR statements) using the NOT operator. De-Morgan's Laws tell us how to translate from a "positive" version of a statement into a negative version.

De-Morgan's law states that:

1) **(X+Y)'=X'.Y'**
2) **(X.Y)'=X'+Y'**

1) (X+Y)'=X'.Y'

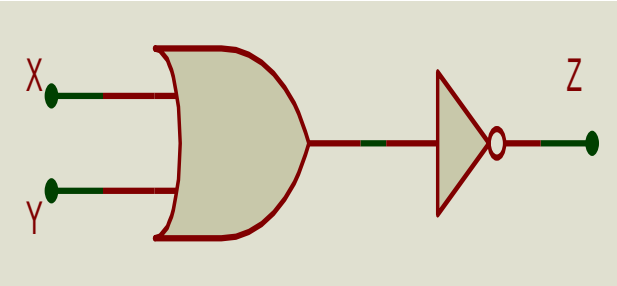
Theory:

NOT of sum of XY must be equal to the product of NOT of X and NOT of Y.

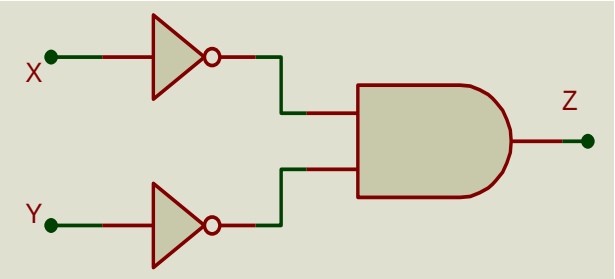
NOT (X OR Y) = (NOT X) AND (NOT Y)

Circuit:

L.H.S: ($Z=\overline{X+Y}$)



R.H.S: ($Z=\overline{X}.\overline{Y}$)



Procedure:

a) Place all required ICs at the middle separation line of breadboard.
b) Take the input and make its connection with voltage regulator to give ICs constant 5V.
c) Give connection of positive input to pin 1 of voltage regulator, give negative input to 2nd pin.
d) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator. In case of taking from front side, it will give -9V which is not compatible with our circuit.
e) Give this +5V to 14th pin of ICs and give -5V to 7th pin because it must be grounded to activate ICs.
f) First consider the L.H.S of the equation and make connections according to the given circuit diagram and then move towards R.H.S.
g) Short the inputs of both sides in such a way that 1st input of L.H.S is short with 1st input of R.H.S and similarly for other input, to make circuit easy.
h) Give all the possible combinations of binary inputs (00, 01, 10 and 11) and note the results.
i) Fill the experimental truth tables according to given inputs and outputs.

Truth table:

L.H.S: ($Z=\overline{X+Y}$)

Input(x)	Input(y)	Output(z)

R.H.S: ($Z=\overline{X}.\overline{Y}$)

Input(x)	Input(y)	Output(z)

Conclusion:

As L.H.S of equation is equal to R.H.S. it means De-Morgan 1st equation is true.

2) $\underline{(X.Y)'=X'+Y'}$

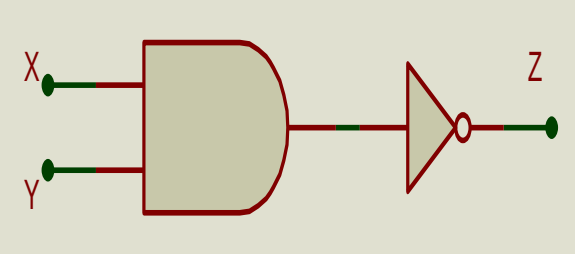
Theory:

NOT of product of X and Y must be equal to the sum of NOT X and NOT Y.

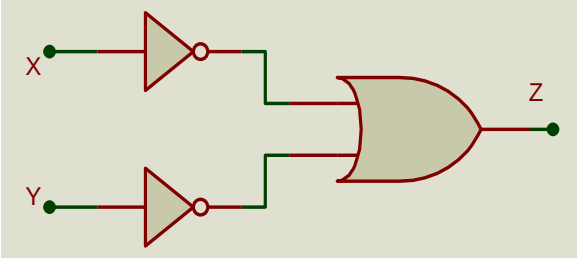
NOT (X AND Y) = (NOT X) OR (NOT Y)

Circuit:

L.H.S: ($Z=\overline{X.Y}$)



R.H.S: ($Z=\overline{X}+\overline{Y}$)



Procedure:

a) Take the input and make its connection with voltage regulator to give ICs constant 5V.
b) Give connection of positive input to pin 1 of voltage regulator, give negative input to 2nd pin.
c) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator. In case of taking from front side, it will give -9V which is not compatible with our circuit.
d) Give this +5V to 14th pin of ICs and give -5V to 7th pin because it must be grounded to activate ICs.
e) First consider the L.H.S of the equation and make connections according to the given circuit diagram and then move towards R.H.S or simply replace the IC of OR gate with AND gate and vice a versa, of 1st equation circuit will give you the circuit of 2nd equation.
f) Short the inputs of both sides in such a way that 1st input of L.H.S is short with 1st input of R.H.S and similarly for other input, to make circuit easy.
g) Give all the possible combinations of binary inputs (00, 01, 10 and 11) and note the results.
h) Fill the experimental truth tables according to given inputs and outputs.

Truth table:

L.H.S: ($Z=\overline{X.Y}$)

Input(x)	Input(y)	Output(z)

R.H.S: ($Z=\overline{X}+\overline{Y}$)

Input(x)	Input(y)	Output(z)

Conclusion:

As L.H.S is equal to R.H.S. it means De-Morgan 2nd equation is also true.

Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Don’t apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.

Experiment: 05

Objective: Implementation of single output function using basic gates.

Apparatus:-

- IC 74LS08/74HC08
- IC 74LS32/74HC32
- LED
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Theory:

Simplify the given democracy function using Karnaugh map and design the circuit of the simplified expression.

Function:

F=X'YZ+XY'Z+XYZ'+XYZ

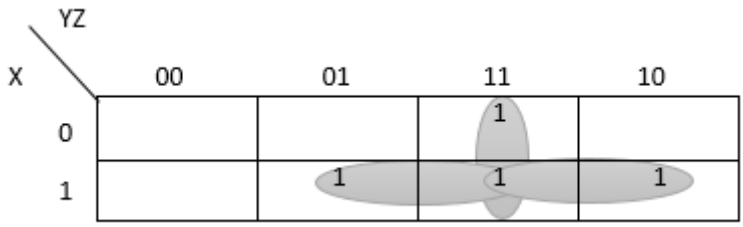
Procedure:

a) Make the truth table of given function.
b) Then simplify the given function using 3-variable K-Map.
c) Make the groups of '1' until no single '1' is left in the map.
d) Write the simplified expression of the given function.
e) Then make its circuit diagram and fill the experimental values in the truth table.
f) Verify the results by comparing the outputs of simplified expression with the outputs of given table.

K-Map simplification:

Given function is:

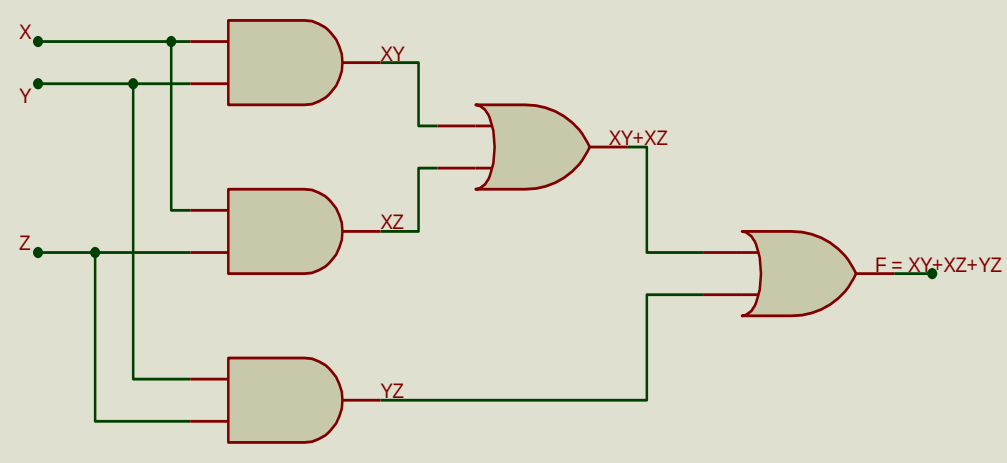
F=X'YZ+XY'Z+XYZ'+XYZ



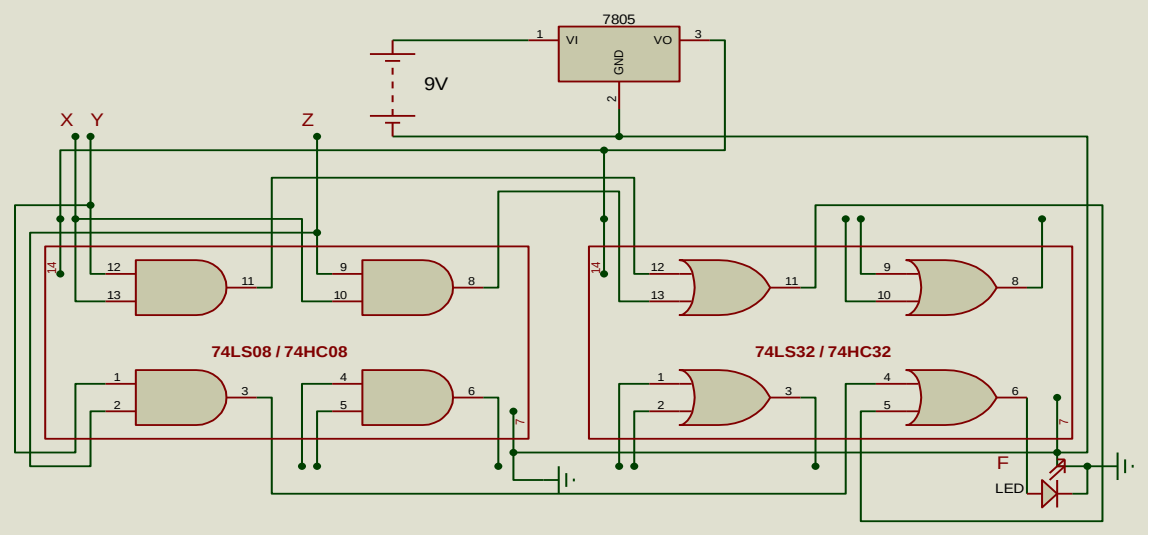
Simplified expression is:

F=XY+YZ+XZ

Circuit:



Circuit diagram:



Truth table:

DF=X'YZ+XY'Z+XYZ'+XYZ

(Given Function)

X	Y	Z	DF

F=XY+YZ+XZ

(Simplified expression)

X	Y	Z	F

Conclusion:

Results of given and simplified expression are same. Therefore, simplified expression is correct and the designed circuit represents both expressions.

Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Don’t apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.

Experiment: 06

Objective: Implementation of multi-output function using logic gates.

Apparatus:-

- IC 74LS08/74HC08
- IC 74LS32/74HC32
- IC 74LS04/74HC04
- LEDs
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Theory:

This function gives the square of given input. Input is given in three bits and maximum number represented in three bits is 7, whose square is 49 and it requires 6 bits at output. This is the reason that why we need 6 LEDs at ouput.

Procedure:

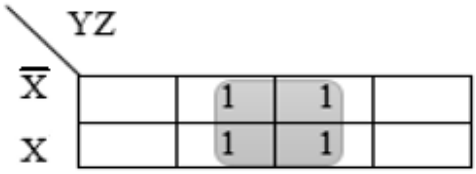
a) Make the truth table of given function.
b) Then simplify the given function using 3-variable K-Map.
c) Make the groups of '1' until no single '1' is left in the map.
d) Write the simplified expression of the given function.
e) Then make its circuit diagram and fill the experimental values in the truth table.
f) Verify the results by comparing the outputs of simplified expression with the outputs of given table.

Truth table:

	Inputs			Outputs						
	X	**Y**	**Z**	A_5	A_4	A_3	A_2	A_1	A_0	
0										0
1										1
2										4
3										9
4										16
5										25
6										36
7										49

K-Map simplification:

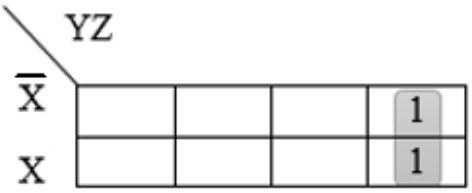
1) $A_o = \Sigma(1,3,5,7)$



$(A_o)_{simp} = Z$

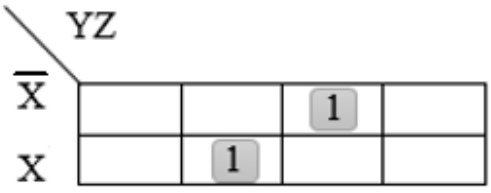
2) $A_1 = 0$

3) $A_2 = \Sigma(3,6)$



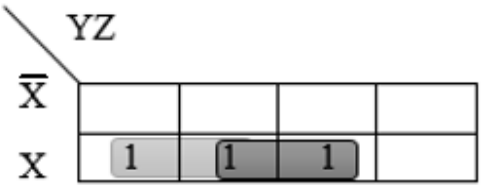
$(A_2)_{simp} = Y\overline{Z}$

4) $A_3 = \Sigma(3,5)$



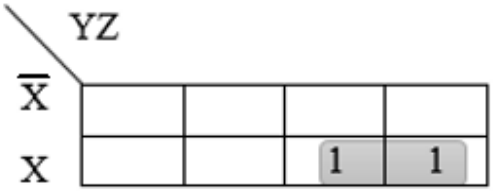
$(A_3)_{simp} = \overline{X}YZ+X\overline{Y}Z$

5) $A_4 = \Sigma(4,5,7)$



$(A_4)_{simp} = \overline{X}Y+XZ$

6) $A_5 = \Sigma(6,7)$



$(A_5)_{simp} = XY$

Simplified expressions:

$(A_0)_{simpl} = Z$

$(A_1)_{simpl} = 0$

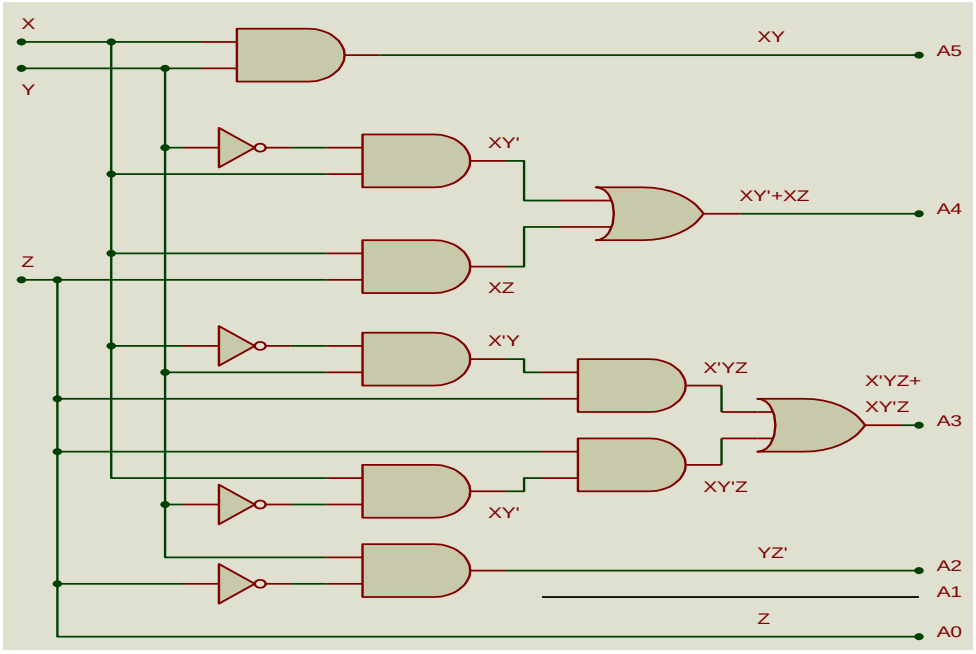
$(A_2)_{simpl} = Y\overline{Z}$

$(A_3)_{simpl} = \overline{X}YZ+X\overline{Y}Z$

$(A_4)_{simpl} = \overline{X}Y+XZ$

$(\mathbf{A_5})_{simpl}$ = **XY**

Circuit:



Conclusion:

Results of simplified expression are same as required. It gives square of given input in form of 6 bits.

Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Don't apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.

Experiment: 07

Objective: Implementation of binary half adder and full adder using logic gates.

Apparatus:-

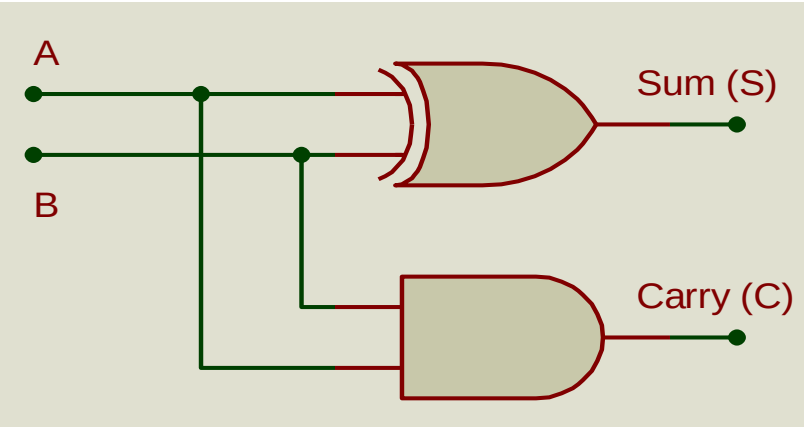
- IC 74LS08/74HC08
- IC 74LS32/74HC32
- IC 74LS86/74HC86
- LEDs
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Half adder

Theory: There are two inputs and two outputs in a Half Adder. Inputs are named as A and B, and the outputs are named as Sum (S) and Carry (C). The Sum is XOR of the input A, and B. Carry is AND of the input A and B. With the help of half adder, one can design a circuit that is capable of performing simple addition with the help of logic gates.

The main disadvantage of this circuit is that it can only add two inputs and if there is any carry, it is neglected. Thus, the process is incomplete. To overcome this difficulty Full, Adder is designed.

Circuit diagram:



Procedure:

a) Place all required ICs at the middle separation line of breadboard.
b) Take the input and make its connection with voltage regulator to give ICs constant 5V.
c) Give connection of positive input to pin 1 of voltage regulator, give negative input to 2nd pin.

d) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator. In case of taking from front side, it will give -9V which is not compatible with our circuit.
e) Give this +5V to 14th pin of ICs and give -5V to 7th pin because it must be grounded to activate ICs.
f) Then make all the connections according to circuit diagram.
g) Sum will be obtain through XOR gate as S and carry output will be receive at AND gate as C.
h) Note the experimental values.

Truth table:

Sum (S) = A'B+AB' = A⊕B

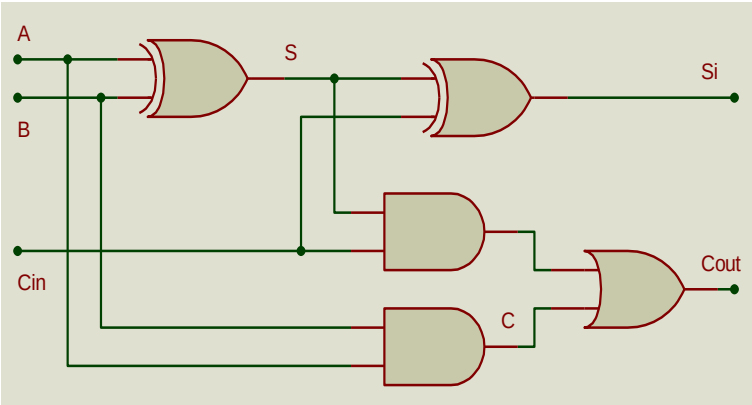
Carry (C) = AB

A	B	S	C

Full adder

Theory: The main difference between a half adder and a full adder is that the full adder has three inputs and two outputs. The two inputs are A B, and the third input is a carry input C_{in} . The output carry is designated as C_{out} and the normal output is designated as S. This is in short, combinational circuit of two half adders.

Circuit diagram:

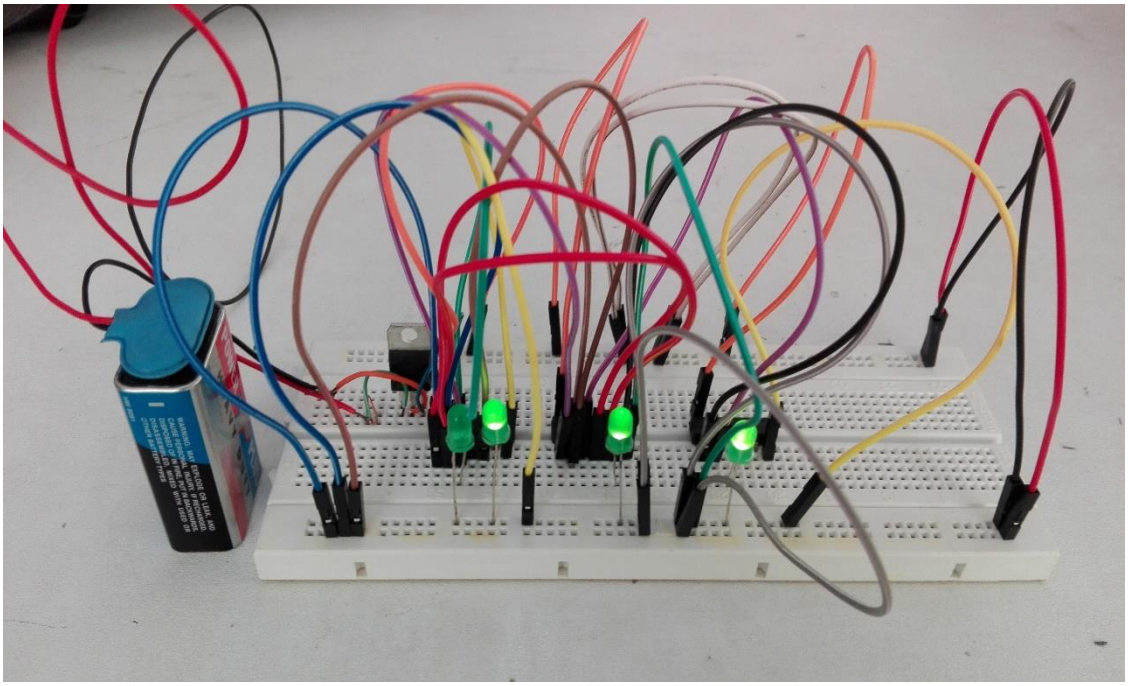


Procedure:

a) Make all the connections according to circuit diagram.
b) Sum will be obtain through XOR gate as the $S_i$and carry output will be receive at AND gate as C_{out}.

c) S_i is the XOR of previous sum S, which is sum of first two bits and the input carry C_{in}.
d) Note the experimental values.

Combinational circuit:



Truth table:

Sum (S) = $A \oplus (B \oplus C_{in})$

Carry (C) = $AB'C_{in}$ + A'BC_{in}+AB

A	B	C_{in}	S_i	C_{out}

Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.

e) Don’t apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.

Experiment: 08

Objective: Design a decoder which perform your requirement and covert binary code to 7-segment display

Apparatus:-

- Decoder IC 74LS47
- 7-segment display (Common anode)
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

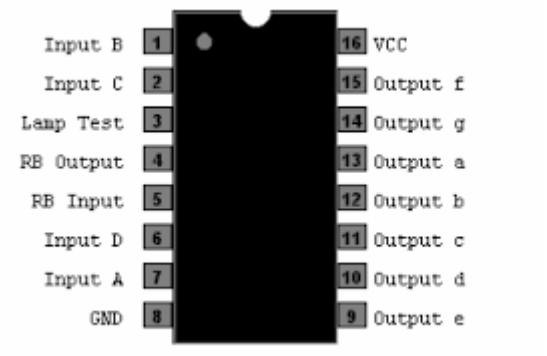
Theory:

1) Binary coded decimal (BCD):

BCD is a system of writing numerals that assigns a four-digit binary code to each digit 0 through 9 in a decimal (base-10) numeral. The four-bit BCD code for any particular single base-10 digit is its representation in binary notation.

2) Decoder IC 74LS47:

74LS47 is a BCD to 7-segment decoder/driver IC. It accepts a binary coded decimal as input and converts it into a pattern to drive a seven-segment for displaying digits 0 to 9. Binary coded decimal (BCD) is an encoding in which each digit of a number is represented by its own binary sequence (usually of four bits).

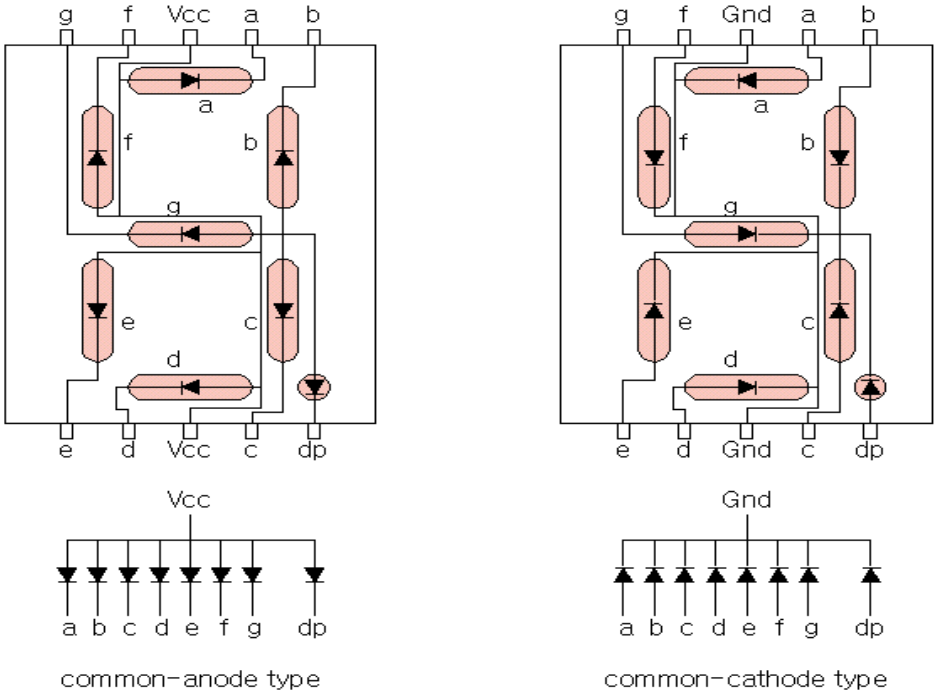


3) 7-segment display:

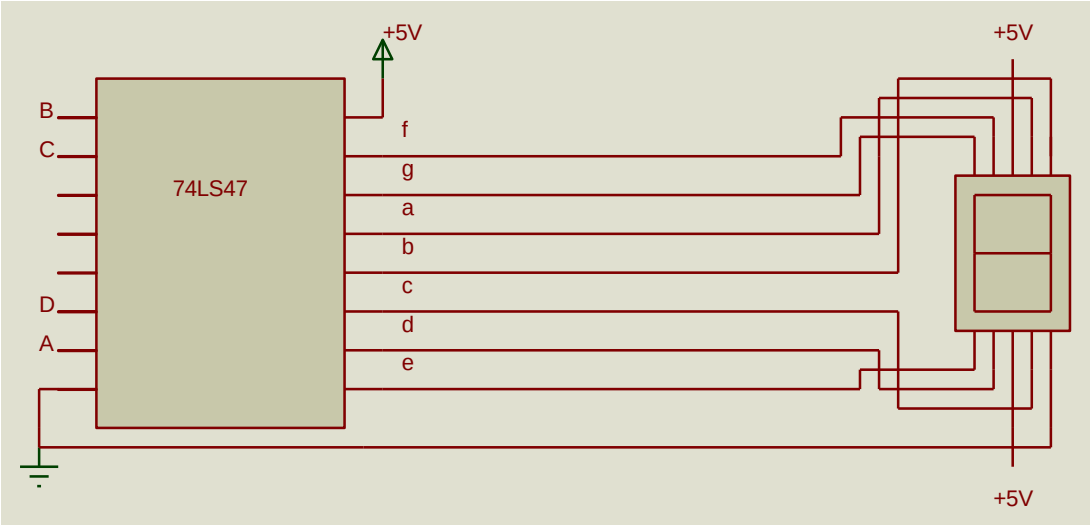
A **seven-segment display** (**SSD**), or **seven-segment indicator**, is a form of electronic display device for displaying decimal numerals. It can display digits from 0 to 9 only. It is of two types:

a) The Common Cathode (CC) – In the common cathode display, all the cathode connections of the LED segments are joined together to logic "0" or ground. The individual segments are illuminated by application of a "HIGH", or logic "1" signal via a current limiting resistor to forward bias the individual Anode terminals (a-g).

b) The Common Anode (CA) – In the common anode display, all the anode connections of the LED segments are joined together to logic "1". The individual segments are illuminated by applying a ground, logic "0" or "LOW" signal via a suitable current limiting resistor to the Cathode of the particular segment (a-g).



Circuit diagram:

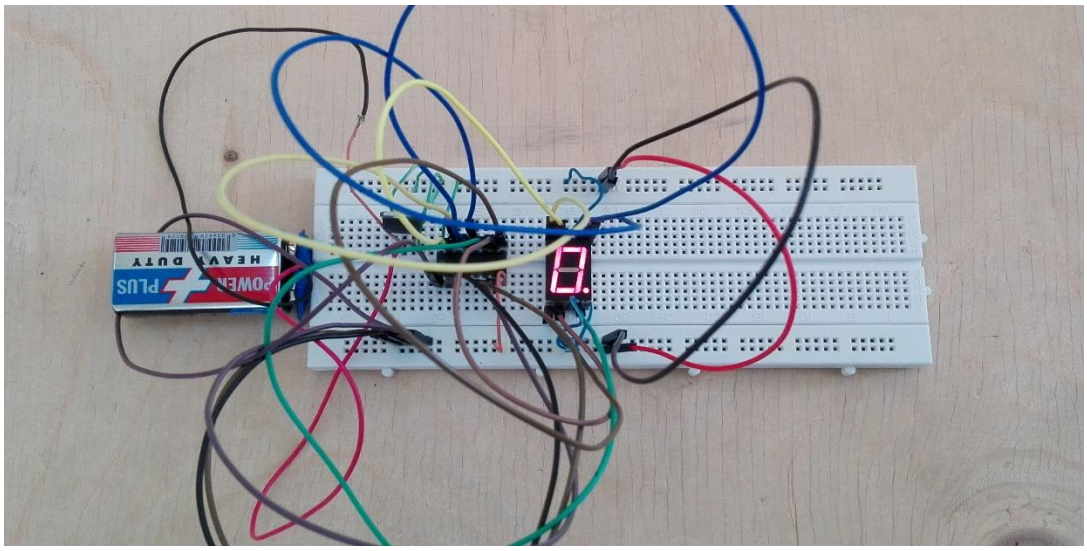


Procedure:

a) Place the IC and 7-segment display at the middle separation line of breadboard.
b) Take the input and make its connection with voltage regulator to give IC and 7-segment display constant 5V.
c) Give connection of positive input to pin 1 of voltage regulator and give negative input to 2nd pin.

d) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator. In case of taking from front side, it will give -9V which is not compatible with our circuit.
e) Give this +5V to 16th pin of IC and both middle pins of 7-segment display and give -5V to 8th pin because it must be grounded to activate IC.
f) Then make all the connections according to circuit diagram.
g) Note and verify the experimental values.

Circuit:



Truth table:

D	C	B	A	7-segment

Conclusion:

Results of simplified expression are same as required. It gives 7-segment display from 0 to 9.

Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Note down all the readings carefully.

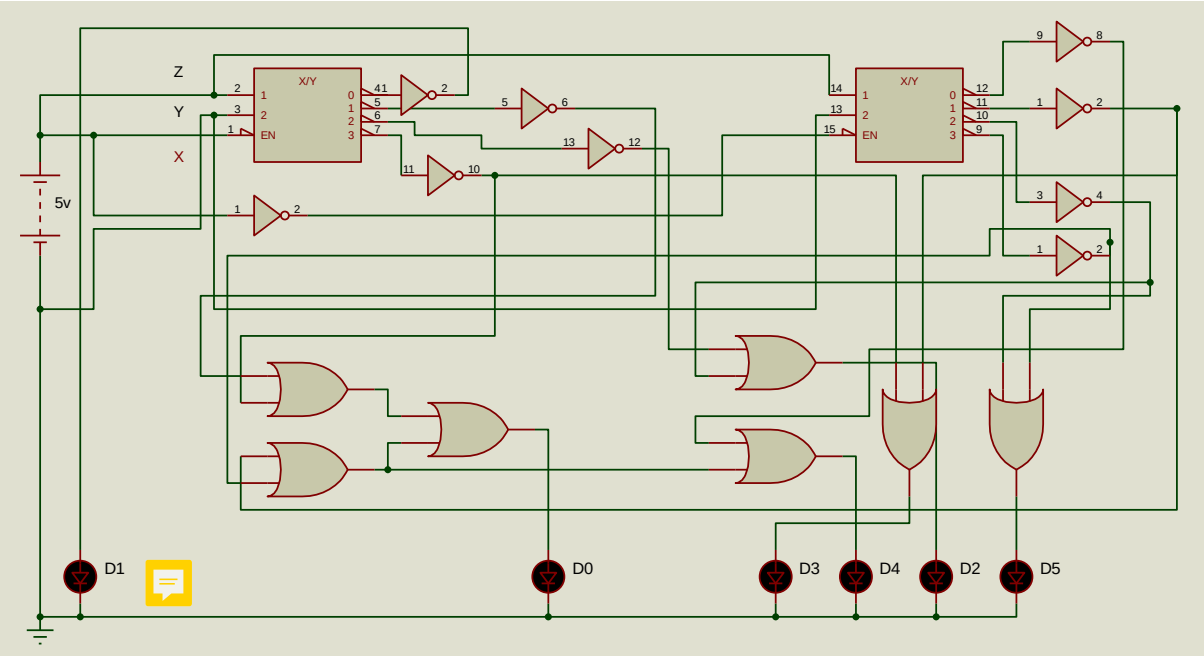
Experiment: 09

Objective: Design a circuit for implementation of a square function using decoder.

Apparatus:-

- Decoder IC 74HCT139
- IC 74LS04
- IC 74LS32
- LED's
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Circuit diagram:



Procedure:

a) Place all required ICs at the middle separation line of breadboard.
b) Take the input and make its connection with voltage regulator to give ICs constant 5V.
c) Give connection of positive input to pin 1 of voltage regulator, give negative input to 2nd pin.
d) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator. In case of taking from front side, it will give -9V which is not compatible with our circuit.
e) Give this +5V to 14th pin of ICs and give -5V to 7th pin because it must be grounded to activate ICs.
f) Then make table according to given information.
g) Make their respective equations and then make circuit according to given equations.

Equations:

$F_0 = D_1+D_3+D_5+D_7$ $F_1 = 0$

$F_2 = D_2+D_6$ $F_3 = D_3+D_5$

$F_4 = D_4+D_5+D_7$ $F_5 = D_6+D_7$

Truth table:

INPUTS			OUTPUTS						
X	Y	Z	F_5	F_4	F_3	F_2	F_1	F_0	
									D_0
									D_1
									D_2
									D_3
									D_4
									D_5
									D_6
									D_7

Circuit preview:

Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Don't apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.

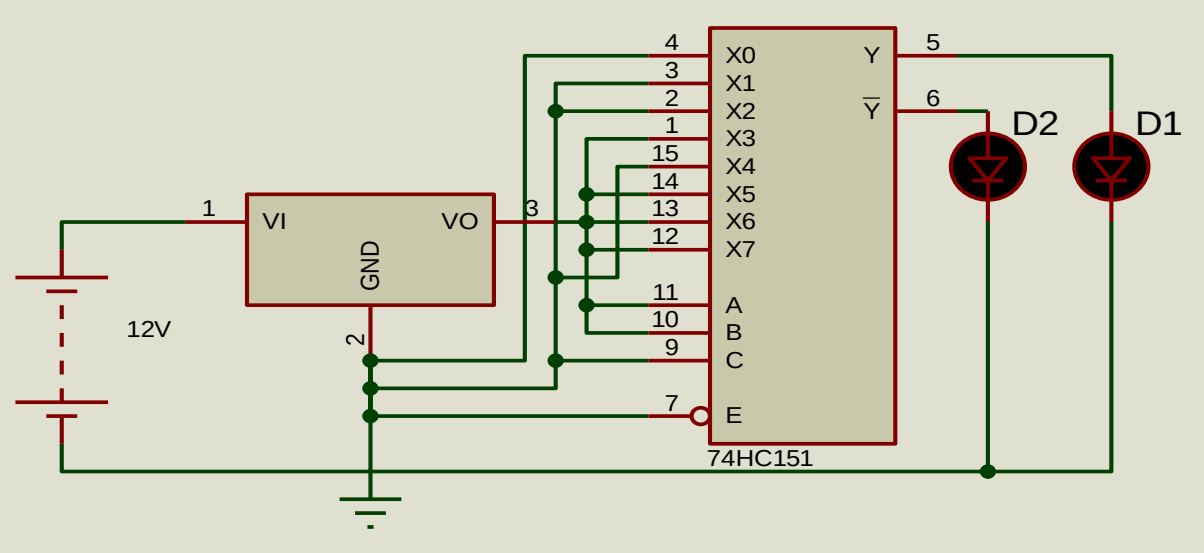
Experiment: 10

Objective: Implementation of democracy function using MUX.

Apparatus:-

- IC 74HC151 (MUX)
- LED's
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Circuit diagram:



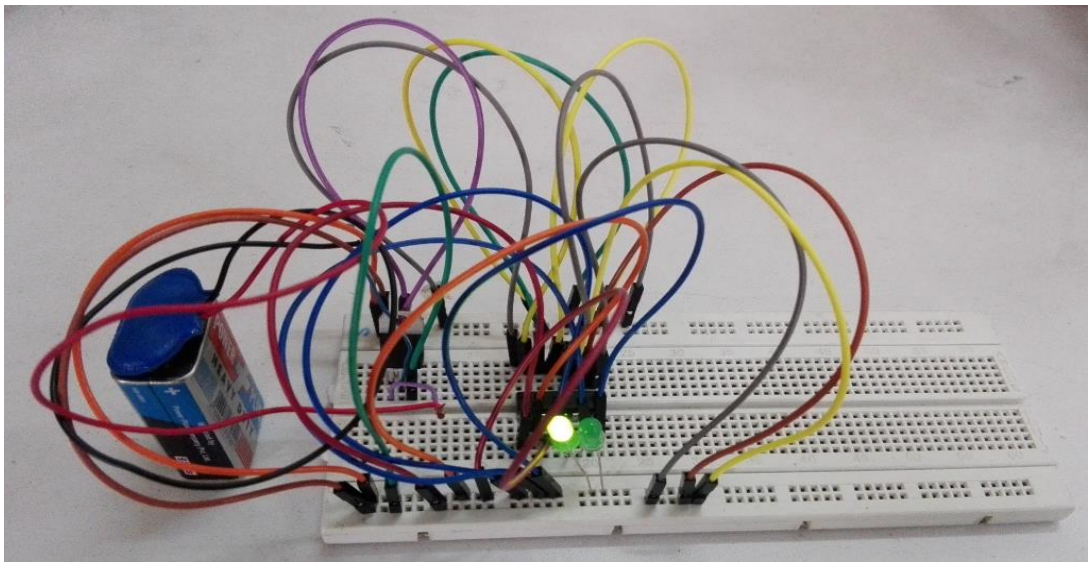
Procedure:

1) Place all required ICs at the middle separation line of breadboard.
2) Take the input and make its connection with voltage regulator to give ICs constant 5V.
3) Give connection of positive input to pin 1 of voltage regulator, give negative input to 2nd pin.
4) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator. In case of taking from front side, it will give -9V which is not compatible with our circuit.
5) Give this +5V to 14th pin of ICs and give -5V to 7th pin because it must be grounded to activate ICs.
6) Then make table and write outputs of the democracy function.
7) Give input +5V to the terminal of IC where output is 1 and -5V where output is 0.
8) Verify the table for each combination of X, Y and Z.

Truth table:

Inputs			Output	
X	**Y**	**Z**	**DF**	
				I_0
				I_1
				I_2
				I_3
				I_4
				I_5
				I_6
				I_7

Circuit preview:



Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Don't apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.

Experiment: 10

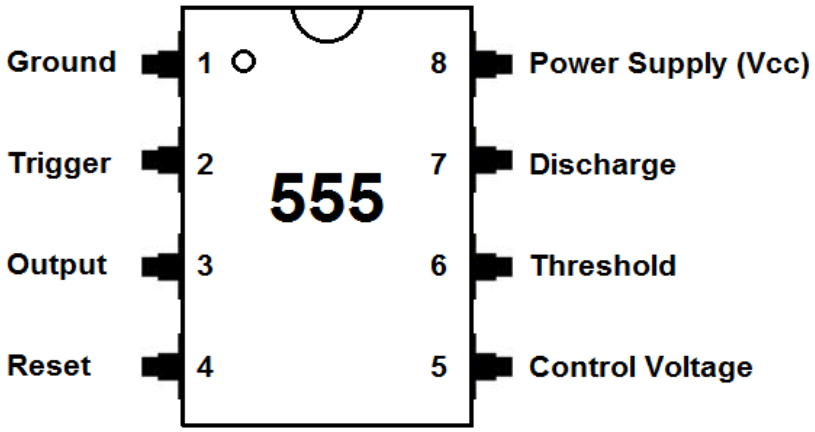
Objective: Design a circuit to study the clock pulse generator using 555 Timer IC.

Apparatus:-

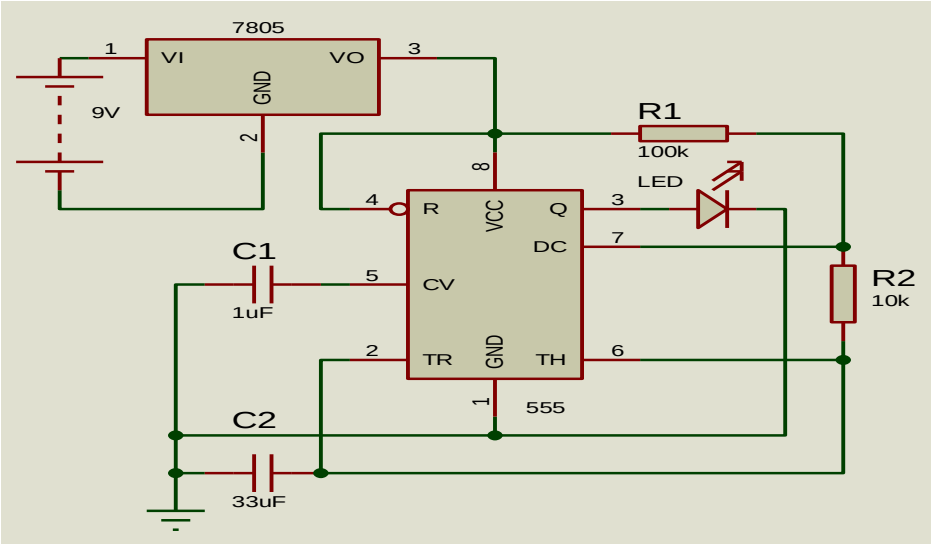
- 555 timer IC
- LED
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Theory:

555 Timer IC: The 555 timer IC is an integrated circuit (chip) used in a variety of timer, pulse generation, and oscillator applications. The 555 can be used to provide time delays, as an oscillator, and as a flip-flop element. Derivatives provide up to four timing circuits in one package.



Circuit diagram:



Procedure:

a) Place the IC and 7-segment display at the middle separation line of breadboard.
b) Take the input and make its connection with voltage regulator to give IC and 7-segment display constant 5V.
c) Give connection of positive input to pin 1 of voltage regulator and give negative input to 2nd pin.
d) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator. In case of taking from front side, it will give -9V which is not compatible with our circuit.
e) Then make all the connections according to circuit diagram.
f) Connect the Led to the 3rd pin of 555 IC and connect its other end to ground.
g) Observe on and off time of LED.
h) Replace the R_2 resistance of 10K with 100K.
i) At the end, observe carefully the on and off time of LED and compare the results.

Calculations:

1) **R_2=10KΩ**

Timer on = ln(2)*(R_1+R_2)*C

=(0.693)*(100+10)x10^3*(33x10^{-6})

=2.516 sec

Timer off = ln(2)*(R_2)*C

=(0.693)*(10x10^3)*(33x10^{-6})

=0.229 sec

2) **R_2=100KΩ**

Timer on = ln(2)*(R_1+R_2)*C

=(0.693)*(100+100)x10^3*(33x10^{-6})

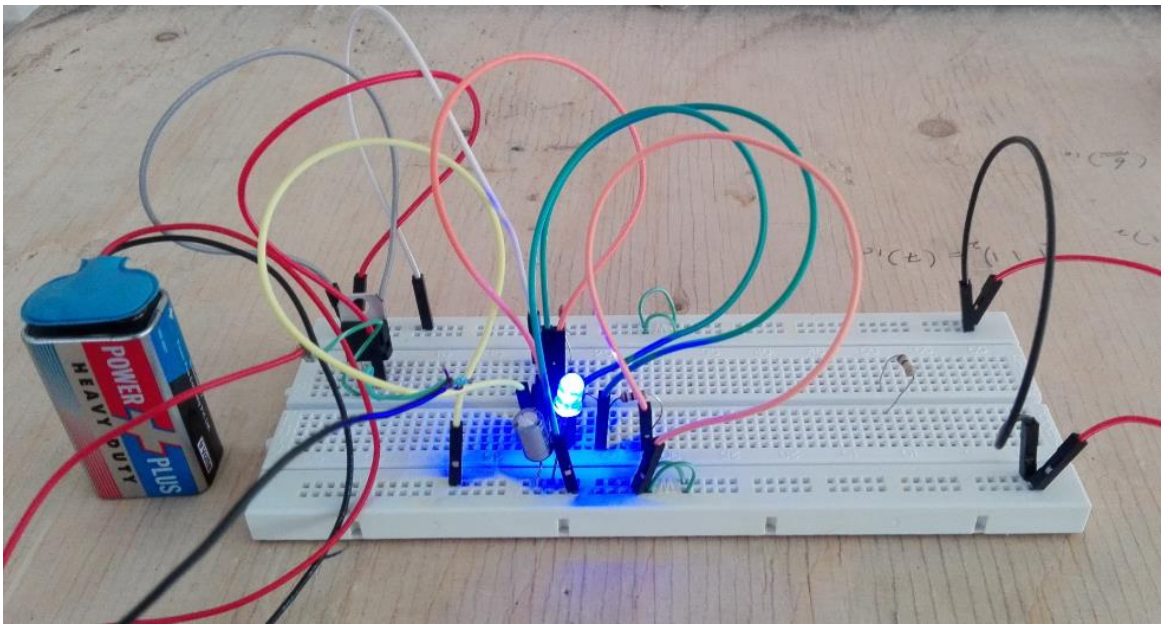
=4.57 sec

Timer off = ln(2)*(R_2)*C

=(0.693)*(100x10^3)*(33x10^{-6})

=2.28 sec

Circuit:



Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Note down all the readings carefully.

Experiment: 11

Objective: Implementation of sequential circuit using D-flip flop.

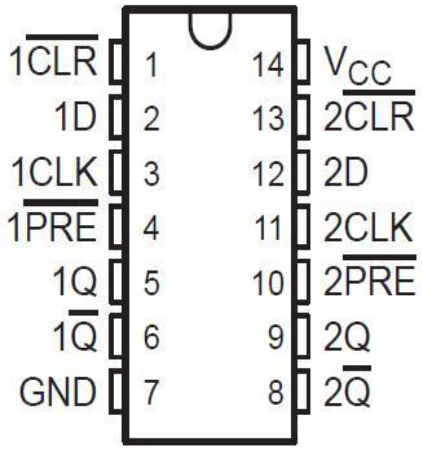
Apparatus:-

- IC 74HC74
- LED
- Push button
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

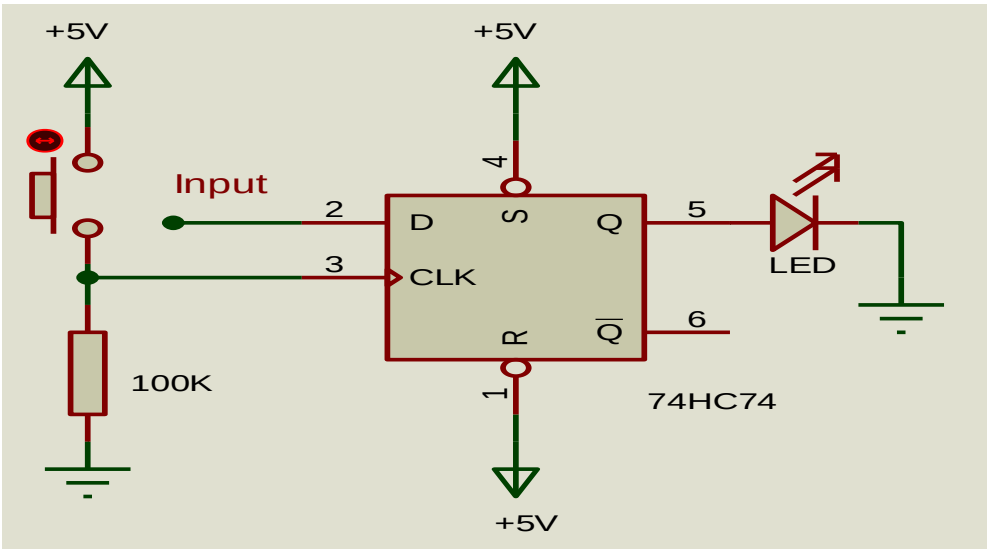
Theory:

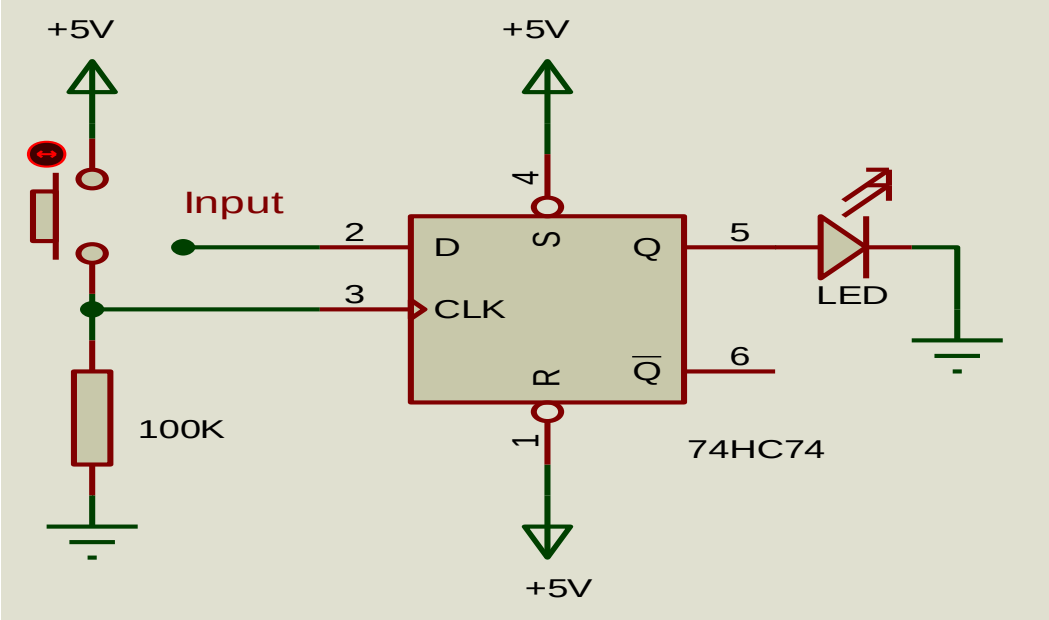
The D flip-flop tracks the input, making transitions with match those of the input D. The D stands for "data", this flip flop stores the value that is on the data line. It can be thought of as a basic memory cell

IC 74HC74: The 74HC74 is a dual positive-edge-triggered D-type Flip-flop with clear and preset. This device contains two independent D-type positive-edge-triggered flip-flops. A low level at the preset (PRE\) or clear (CLR\) inputs sets or resets the outputs, regardless of the levels of the other inputs. When PRE\ and CLR\ are inactive (high), data at the data (D) input meeting the setup time requirements are transferred to the outputs on the positive-going edge of the clock (CLK) pulse.



Circuit diagram:





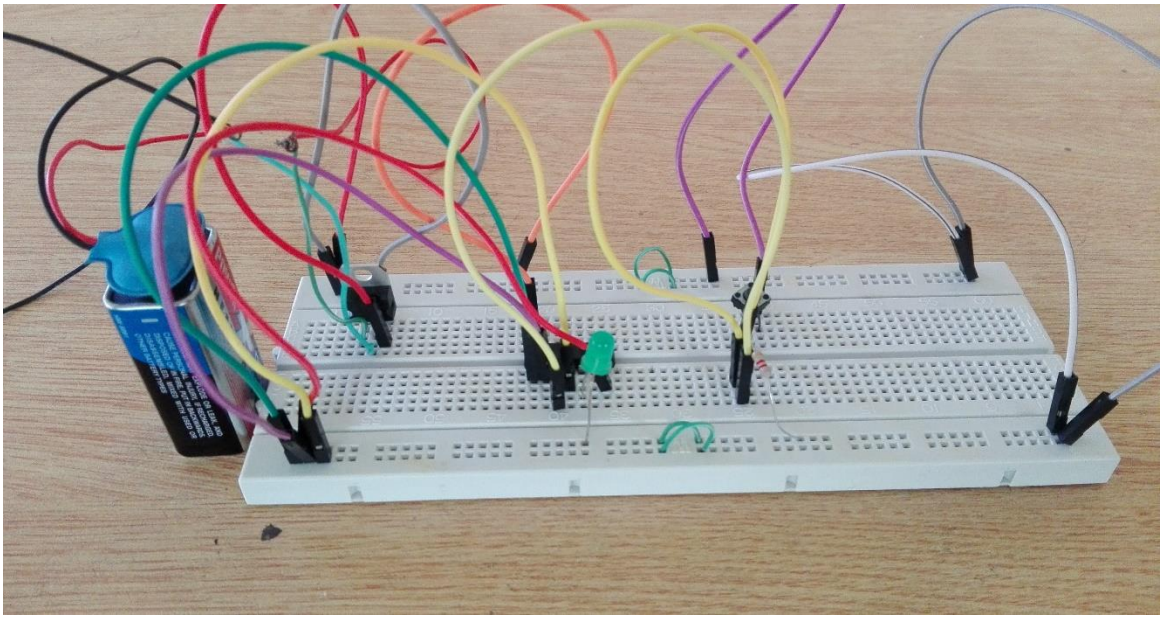
Procedure:

1. We make connections of positive edge triggered D-flip flop IC on bread board carefully according to the circuit diagram.
2. We place the voltage regulator on bread board in such a way that it must not get connected to either of any pin of IC.
3. We mount the push button on the bread board to provide clock pulse to flip flop.
4. Then we attach the resistance of 8.2 KΩ in series with push button.
5. Similarly we evaluate the other outputs to find square of the given 3-bit numbers.
6. Then we placed LED on pin no. 5 representing Q and another LED on pin no. 6 as compliment of Q.
7. Then we verify the state table by providing the clock pulse using push button.

State table:

Present state	**Input**	**Clock**	**Next state**	**Flip flop input**
Q	**X**	**Clk**	**Q (t + 1)**	**D**
0	1	↑	1	1
1	X	↓	1	1
1	0	↑	0	0
0	X	↓	0	0

Circuit:



Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Note down all the readings carefully.

Experiment: 12

Objective: Implementation of shift register using D-flip flop.

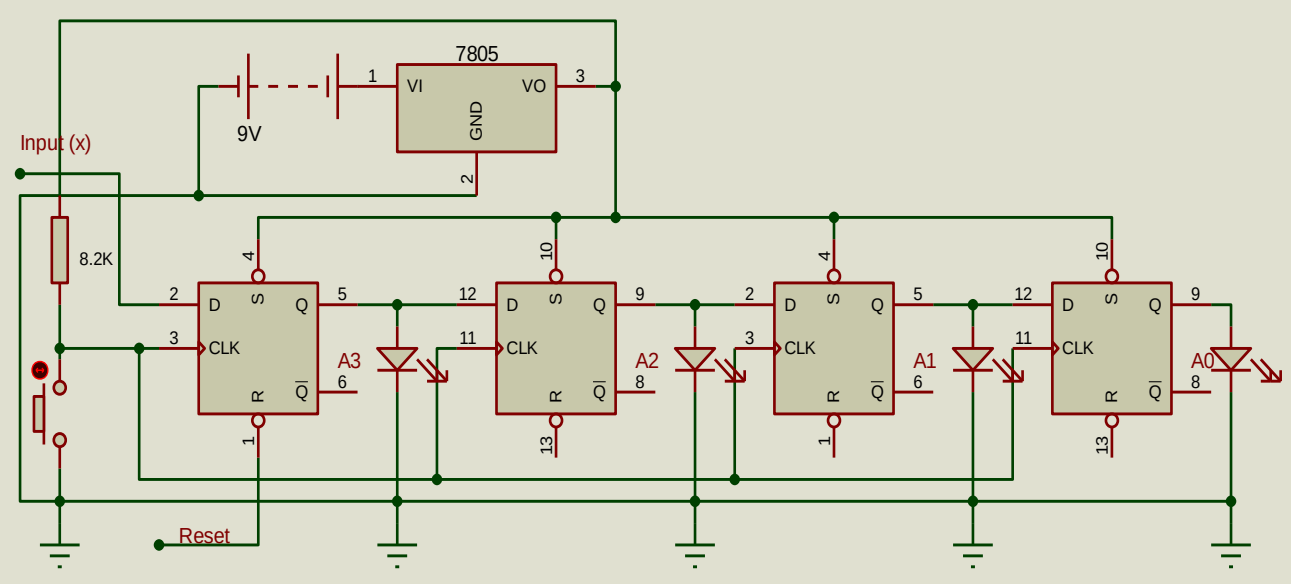
Apparatus:-

- IC 74HC74
- LED
- Push button
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Theory:

Shift registers are a type of sequential logic circuit, mainly for storage of digital data. They are a group of flip-flops connected in a chain so that the output from one flip-flop becomes the input of the next flip-flop. Most of the registers possess no characteristic internal sequence of states. All the flip-flops are driven by a common clock, and all are set or reset simultaneously.

Circuit diagram:



Procedure:

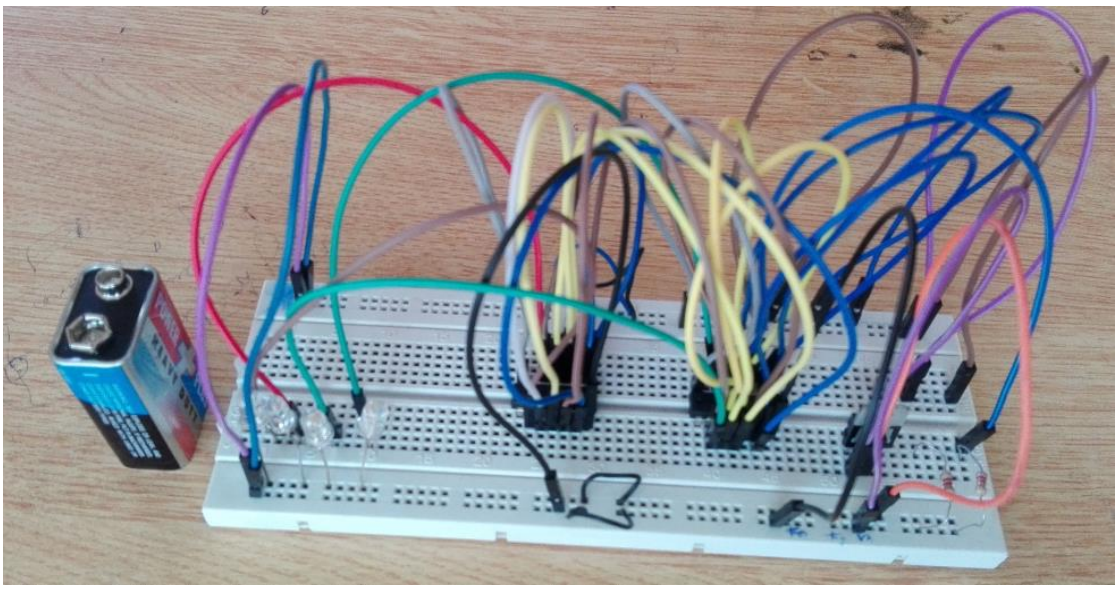
a) Place all required ICs at the middle separation line of breadboard.
b) Take the input and make its connection with voltage regulator to give ICs constant 5V.
c) Give connection of positive input to pin 1 of voltage regulator, give negative input to 2nd pin.
d) Take constant +5V output from pin 3 and for negative output, take the connection from 2nd pin but take it from the backside of voltage regulator

e) Make all the connections according to the circuit diagram.
f) First give reset 0. So that it can clear all flip flops.
g) Then store the given 4-bit input value one by one through input pin.

State table:

PR	CLR	CLK	x	A_3	A_2	A_1	A_0

Circuit preview:



Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Don't apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.

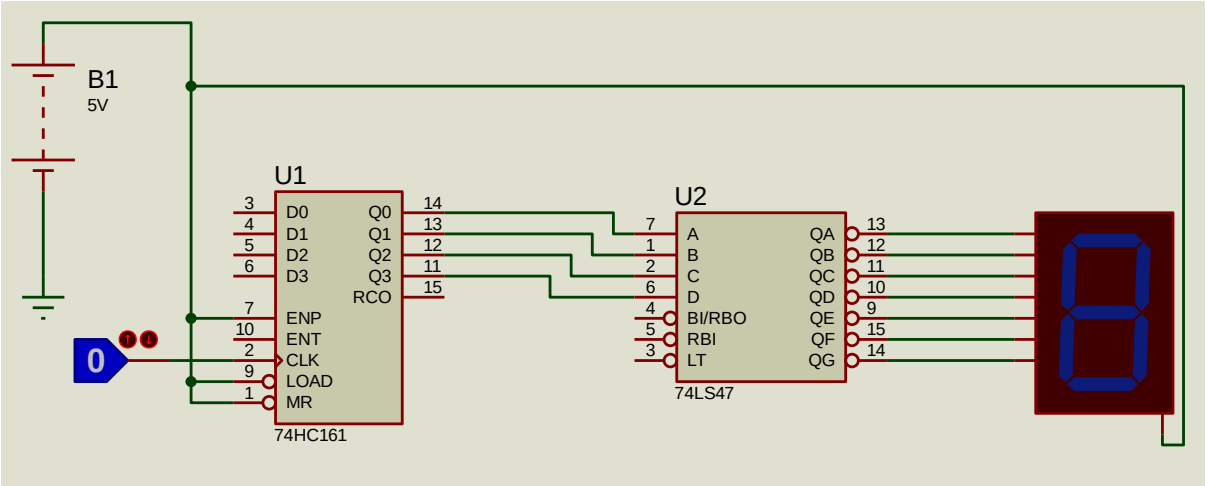
Experiment: 13

Objective: To implement 4 bit synchronous counter.

Apparatus:-

- IC 74HC74
- LED
- Push button
- DC power supply
- Breadboard
- LM7805 voltage regulator
- Jumper wires

Circuit Diagram:



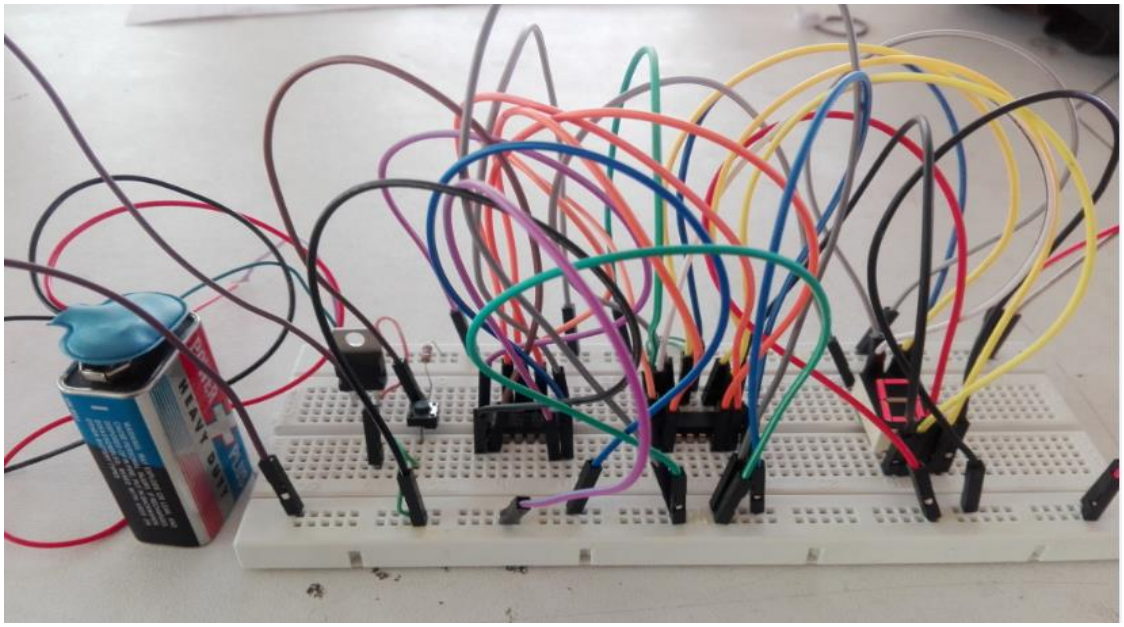
Procedure:

a) First of all make all the connections on the bread board as shown in the circuit diagram.
b) The connections of the 7-segment should be according to the types of the 7-segment.
c) Then we should be using the push button as the clock.
d) Push button can be positive edge trigger & negative edge trigger.
e) We then connect the battery to the 7805 and it will deliver 5V to the whole circuit.
f) These 5V first go the IC 7HC161 and the outputs given to the IC 74HC47 or the 7-segment decoder.
g) Then we connect the outputs of the decoder to the &-segment led display.
h) The 7-segment will show us 0 at the start.
i) Then we input the clock by using push buttons to the circuit. Then we can see from 0-9 on the display by pushing the button.

State table:

MR	CLK	A	B	C	D	7-Segment
0	X	0	0	0	0	0
1	↑	0	0	0	1	1
1	↑	0	0	1	0	2
1	↑	0	0	1	1	3
1	↑	0	1	0	0	4
1	↑	0	1	0	1	5
1	↑	0	1	1	0	6
1	↑	0	1	1	1	7
1	↑	1	0	0	0	8
1	↑	1	0	0	1	9

Circuit preview:



Precautions:

a) Make all the connections according to circuit diagram.
b) Make sure that all the connections are perfect.
c) Apply voltage after connecting all the components.
d) The voltage should not exceed than specified value, otherwise components will burn.
e) Don't apply ±9V to components except voltage regulator, otherwise they would burn.
f) Note down all the readings carefully.