

DIGITAL ELECTRONICS LAB MANUAL



BAPATLA ENGINEERING COLLEGE
DEPARTMENT OF ECE

DIGITAL ELECTRONICS LAB MANUAL
FOR
2/4 B.Tech (ECE)
COURSE CODE: EC-253

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ECE DEPARTMENT

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The Laboratory Notebook:

Each student must have their own laboratory notebook. All pre-lab exercises and laboratory reports are to be entered into your notebook.

Your notebook must be clearly labelled on the cover with the following information:

Module: Digital Electronics -

Name:

Register no: 4

Class:

Lab Partner Name:

STUDENTS GUIDELINES

There are 3 hours allocated to a laboratory session in Digital Electronics. It is a necessary part of the course at which attendance is compulsory.

Here are some guidelines to help you perform the experiments and to submit the reports:

1. Read all instructions carefully and carry them all out.
2. Ask a demonstrator if you are unsure of anything.
3. Record actual results (comment on them if they are unexpected!)
4. Write up full and suitable conclusions for each experiment.
5. If you have any doubt about the safety of any procedure, contact the demonstrator beforehand.
6. **THINK** about what you are doing!

The Breadboard

The breadboard consists of two terminal strips and two bus strips (often broken in the centre). Each bus strip has two rows of contacts. Each of the two rows of contacts are a node. That is, each contact along a row on a bus strip is connected together (inside the breadboard). Bus strips are used primarily for power supply connections, but are also used for any node requiring a large number of connections. Each terminal strip has 60 rows and 5 columns of contacts on each side of the centre gap. Each row of 5 contacts is a node.

You will build your circuits on the terminal strips by inserting the leads of circuit components into the contact receptacles and making connections with 22-26 gauge wire. There are wire cutter/strippers and a spool of wire in the lab. It is a good practice to wire +5V and 0V power supply connections to separate bus strips.

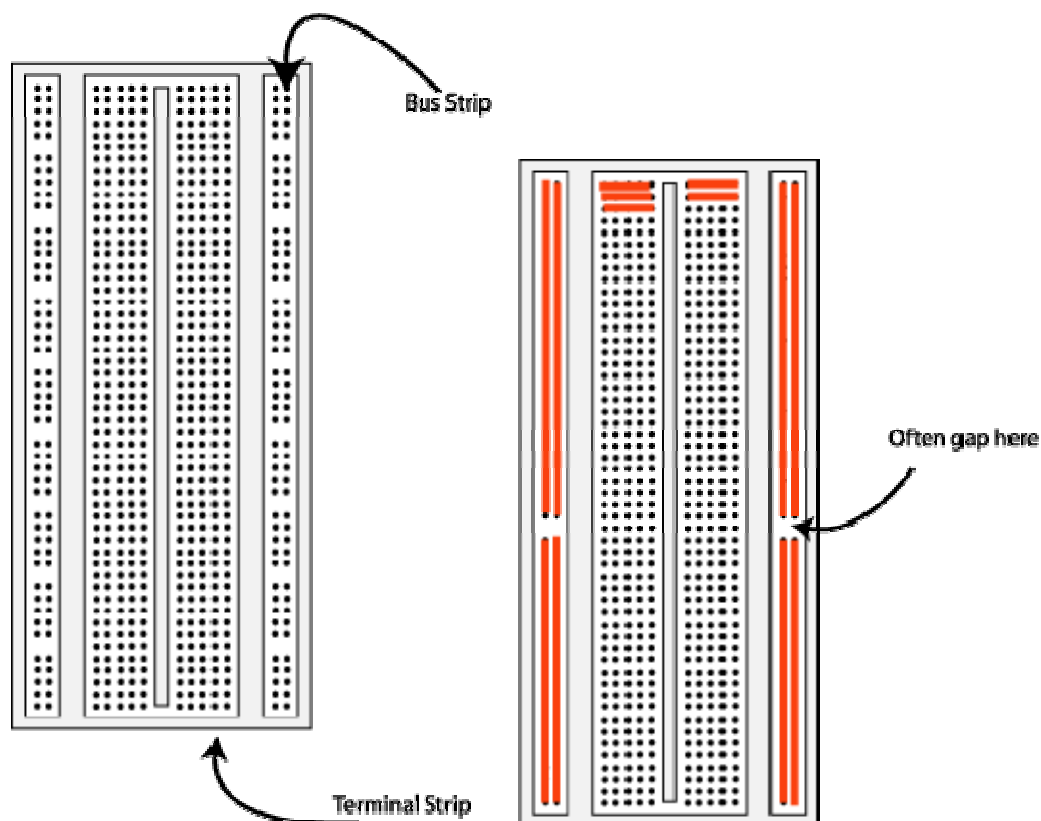


Fig 1. The breadboard. The lines indicate connected holes.

The 5V supply **MUST NOT BE EXCEEDED** since this will damage the ICs (Integrated circuits) used during the experiments. Incorrect connection of power to the ICs could result in them exploding or becoming very hot - with the **possible serious injury occurring to the people working on the experiment! Ensure that the power supply polarity and all components and connections are correct before switching on power .**

Building the Circuit:

Throughout these experiments we will use TTL chips to build circuits. The steps for wiring a circuit should be completed in the order described below:

1. Turn the power (Trainer Kit) off before you build anything!
2. Make sure the power is off before you build anything!
3. Connect the +5V and ground (GND) leads of the power supply to the power and ground bus strips on your breadboard.
4. Plug the chips you will be using into the breadboard. Point all the chips in the same direction with pin 1 at the upper-left corner. (Pin 1 is often identified by a dot or a notch next to it on the chip package)
5. Connect +5V and GND pins of each chip to the power and ground bus strips on the breadboard.
6. Select a connection on your schematic and place a piece of hook-up wire between corresponding pins of the chips on your breadboard. It is better to make the short connections before the longer ones. Mark each connection on your schematic as you go, so as not to try to make the same connection again at a later stage.
7. Get one of your group members to check the connections, **before you turn the power on.**
8. If an error is made and is not spotted before you turn the power on. Turn the power off immediately before you begin to rewire the circuit.
9. At the end of the laboratory session, collect you hook-up wires, chips and all equipment and return them to the demonstrator.
10. Tidy the area that you were working in and leave it in the same condition as it was before you started.

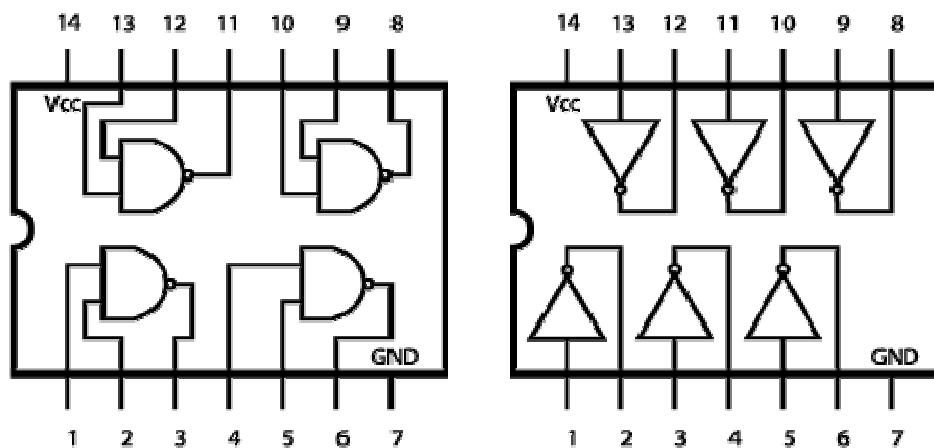
Common Causes of Problems:

1. Not connecting the ground and/or power pins for all chips.
2. Not turning on the power supply before checking the operation of the circuit.
3. Leaving out wires.
4. Plugging wires into the wrong holes.
5. Driving a single gate input with the outputs of two or more gates
6. Modifying the circuit with the power on.

In all experiments, you will be expected to obtain all instruments, leads, components at the start of the experiment and return them to their proper place after you have finished the experiment. Please inform the demonstrator or technician if you locate faulty equipment. If you damage a chip, inform a demonstrator, don't put it back in the box of chips for somebody else to use.

Example Implementation of a Logic Circuit:

Build a circuit to implement the Boolean function $F = \overline{A/B}$, please note that the notation $\overline{A}$ refers to $\bar{A}$. You should use that notation during the write-up of your laboratory experiments.



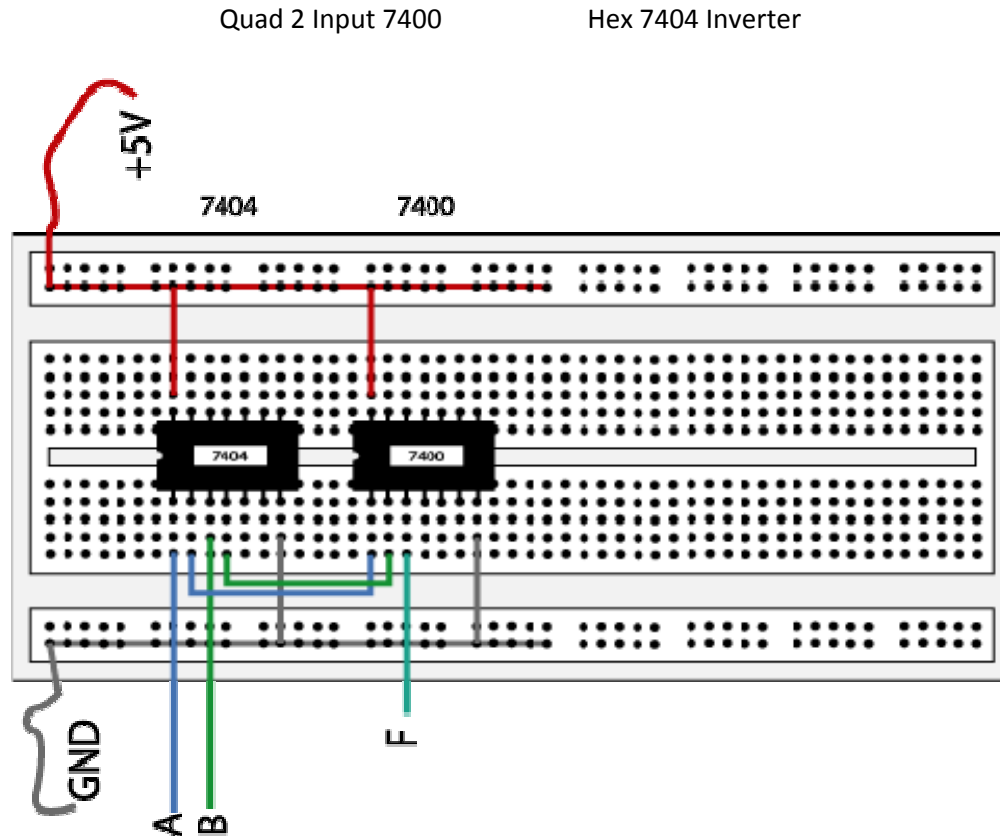


Fig 2. The complete designed and connected circuit

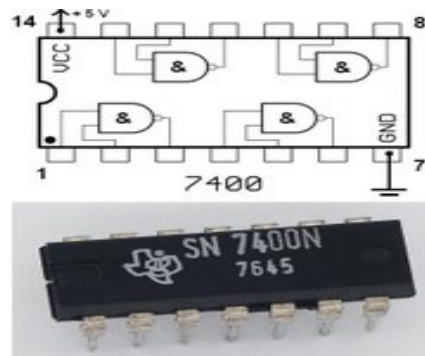
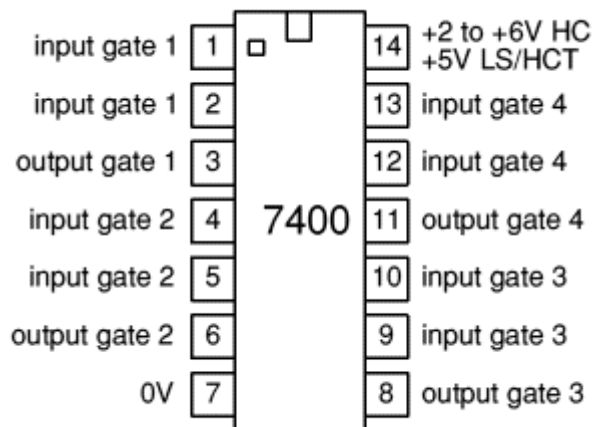
Sometimes the chip manufacturer may denote the first pin by a small indented circle above the first pin of the chip. Place your chips in the same direction, to save confusion at a later stage. Remember that you must connect power to the chips to get them to work.

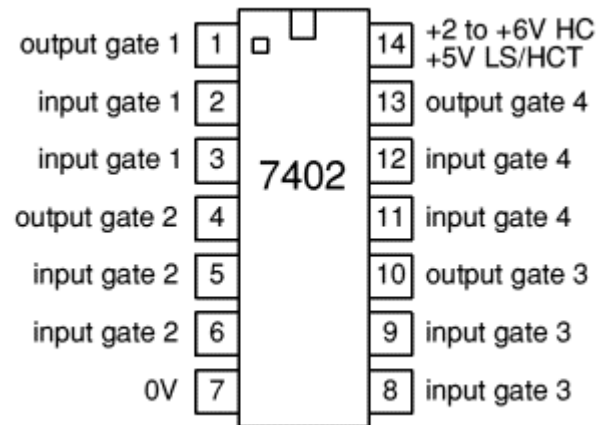
Useful IC Pin details

IC NUMBER	Description of IC
7400	Quad 2 input NAND GATE
7401	Quad 2input NAND Gate (open collector)
7402	Quad 2 input NOR Gate
7403	Quad 2 input NOR Gates (open collector)
7404	Hex Inverts
7421	Dual 4 input AND Gates
7430	8 input NAND Gate
7432	Quad 2 input OR Gates
7486	Quad 2 input EX-OR Gate
74107	Dual j-k Flip Flop
74109	Dual j-k Flip Flop
74174	Hex D Flip Flop
74173	Quad D Flip Flop
7473	Dual j-k Flip Flop
7474	Dual D Flip Flop
7475	Quad Bi-stable latch

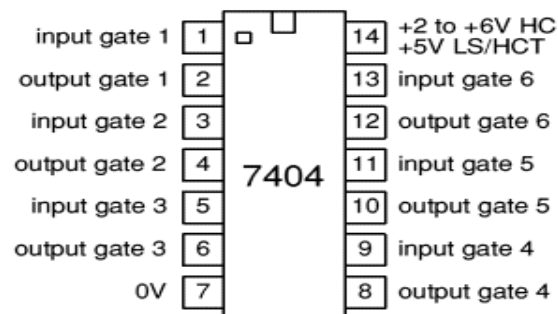
7476

Dual j-k Flip Flop

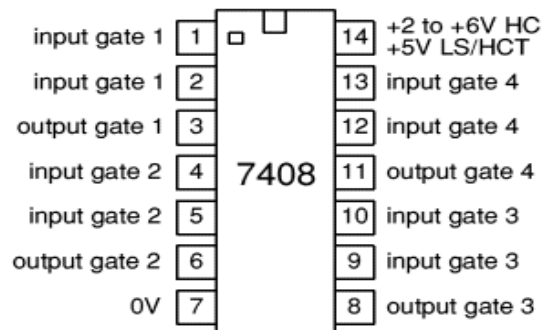
**7400(NAND)****7402(NOR)**



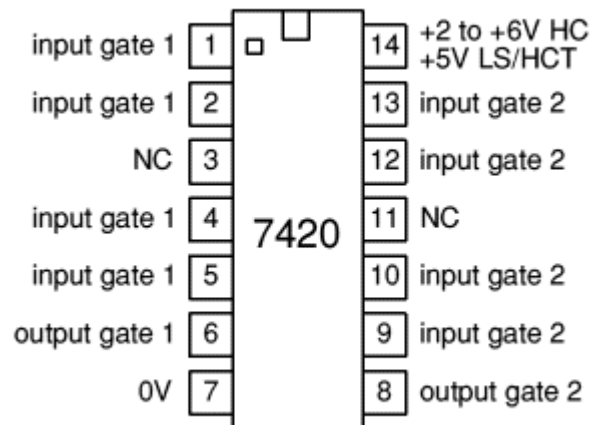
7404(NOT)



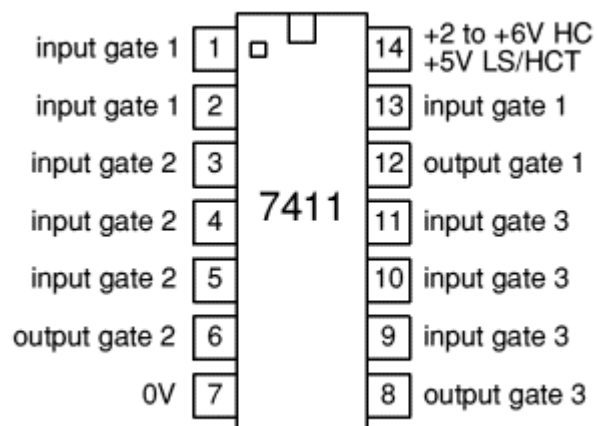
7408(AND)



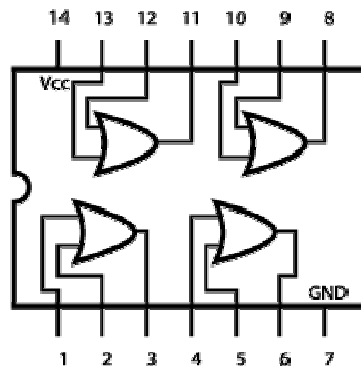
7420(4-i/p NAND)



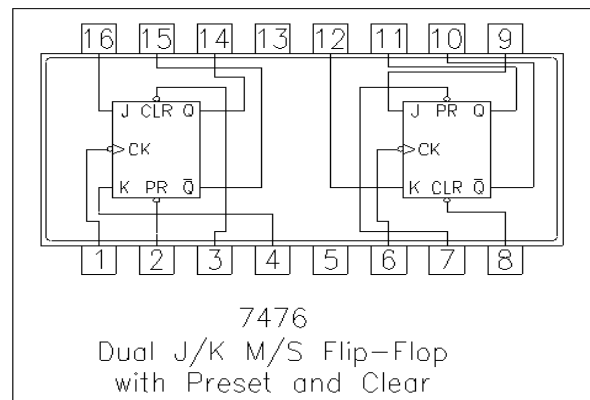
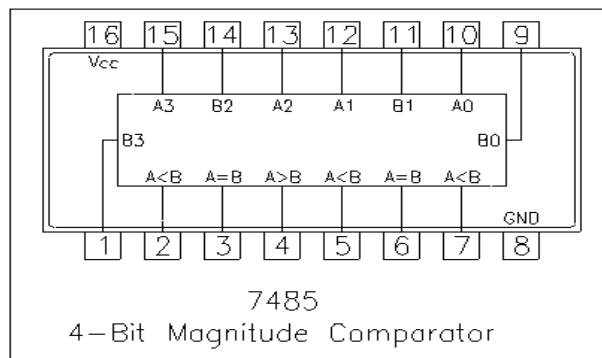
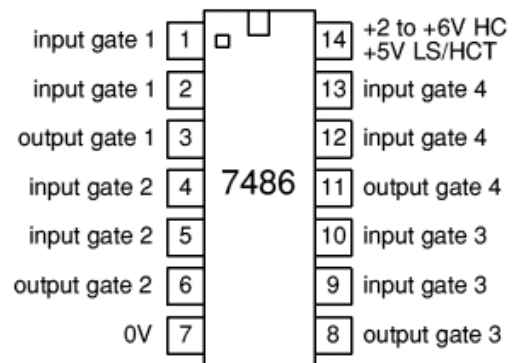
7411(3-i/p AND)



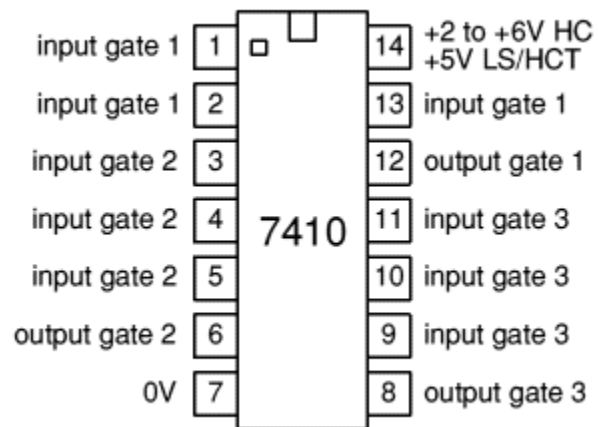
7432(OR)



7486(EX-OR)



7410(3-i/p NAND)

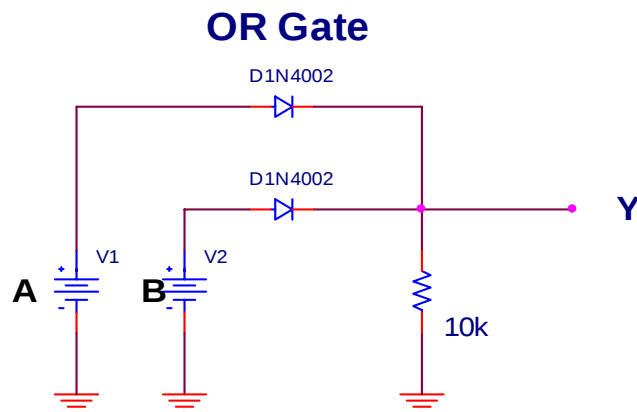


EXPERIMENT 1**REALIZATION OF GATES USING DISCRETE COMPONENTS**

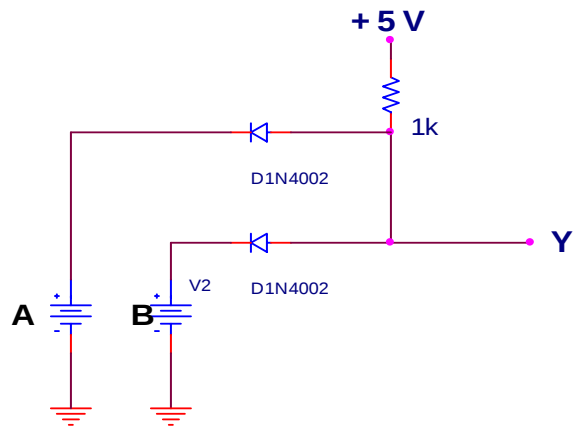
Aim: To construct logic gates **OR, AND, NOT, NOR, NAND** gates using discrete components and verify their truth tables

Apparatus:

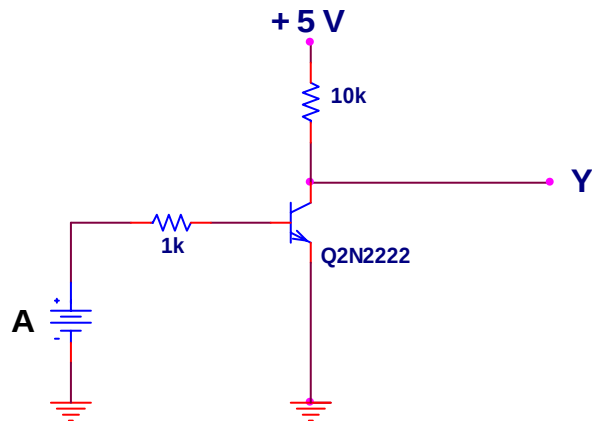
1. Electronic circuit designer
2. Resistors 10k,1k,220ohms
3. Transistors 2N2222(NPN)
4. Diodes 1N 4001
5. Connecting wires

Circuit Diagrams:**TRUTH TABLE**

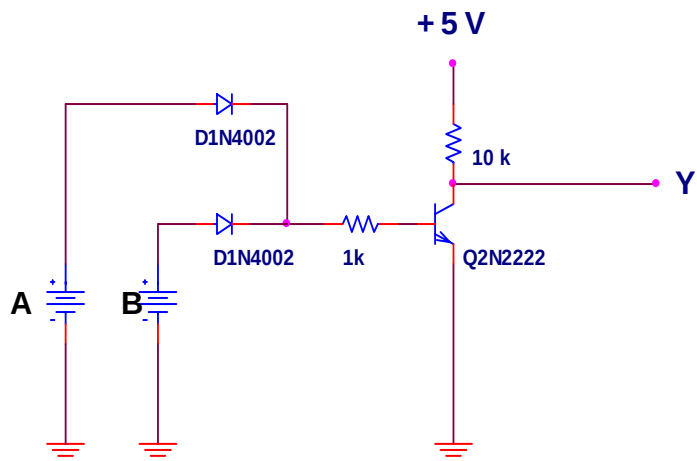
A	B	Y
0v	0v	0v
0v	5v	5v
5v	0v	5v
5v	5v	5v

AND Gate

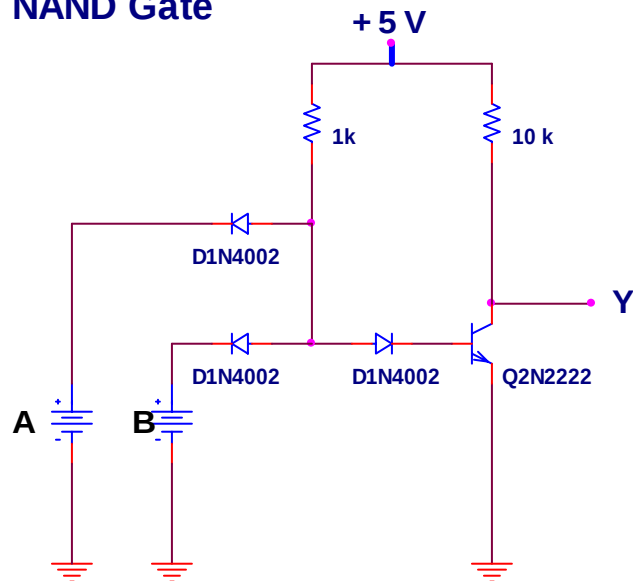
A	B	Y
0v	0v	0v
0v	5v	0v
5v	0v	0v
5v	5v	5v

NOT Gate

A	Y
0v	5v
5v	0v

NOR Gate

A	B	Y
0v	0v	5v
0v	5v	0v
5v	0v	0v
5v	5v	0v

NAND Gate

A	B	Y
0v	0v	5v
0v	5v	5v
5v	0v	5v
5v	5v	0v

Procedure:

1. Connections are made as per the circuit diagram
2. Switch on the power supply
3. Apply different combinations of inputs and observe the outputs; compare the outputs with the truth tables.

Precautions:

All the connections should be made properly.

Result: Different logic gates are constructed and their truth tables are verified.

Questions:

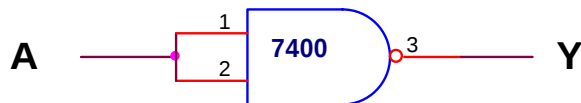
1. Explain the operation of each circuit.

EXPERIMENT 2**REALIZATION OF GATES USING UNIVERSAL BUILDING BLOCKS (NAND ONLY)**

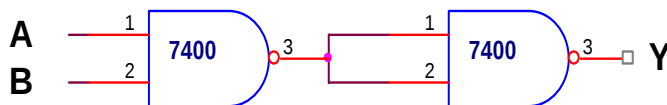
Aim: To construct logic gates NOT, AND, OR, EX-OR, EX-NOR of basic gates using NAND gate and verify their truth tables .

Apparatus:

1. IC's - 7400
2. Electronic Circuit Designer
3. Connecting patch chords.

Circuit Diagrams:**TRUTH TABLE****NOT Gate**

A	Y
0v	5v
5v	0v

AND Gate

A	B	Y
0v	0v	0v
0v	5v	0v
5v	0v	0v
5v	5v	5v

Procedure:

1. Connect the logic gates as shown in the diagrams.
2. Feed the logic signals 0 or 1 from the logic input switches in different combinations at the inputs A & B.
3. Monitor the output using logic output LED indicators.
4. Repeat steps 1 to 3 for NOT, AND, OR, EX – OR & EX-NOR operations. and compare the outputs with the truth tables.

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result: Different logic gates are constructed using NAND gates and their truth tables are verified.

Questions:

1. Why NAND & NOR gates are called universal gates?
2. Realize the EX – OR gates using minimum number of NAND gates?
3. Give the truth table for EX-NOR (EX-OR+NOT) and realize using NAND gates
4. Realize the given logic function using NAND gates?

$$f = ABC + ABC + ABC$$

EXPERIMENT 3**DESIGN OF COMBINATIONAL LOGIC CIRCUITS**

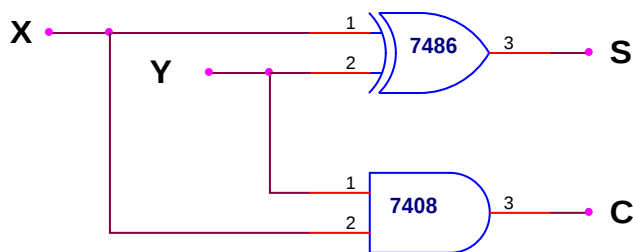
Aim: - To design and construct Half-adder, Full-adder, Half-subtractor, Full- subtractor

Apparatus: -

1. IC's - 7486, 7432, 7408, 7400
2. Electronic Circuit Designer
3. Connecting patch chords.

Circuit Diagram:-

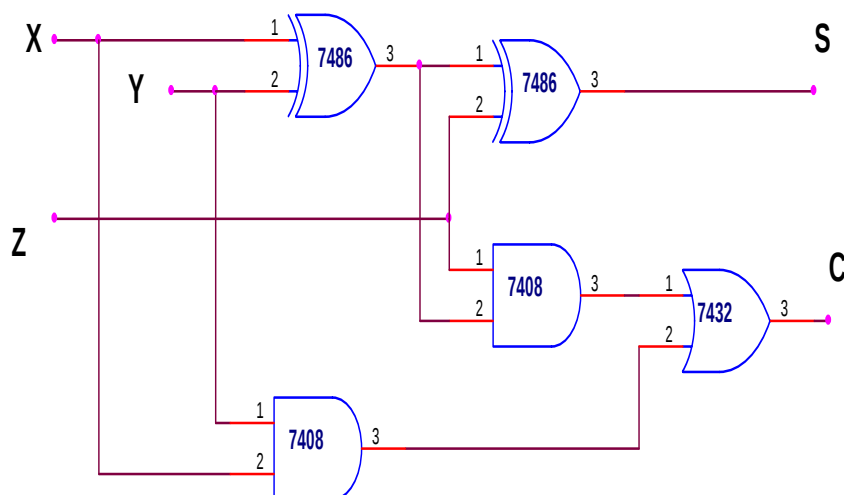
Half Adder:



TRUTH TABLE

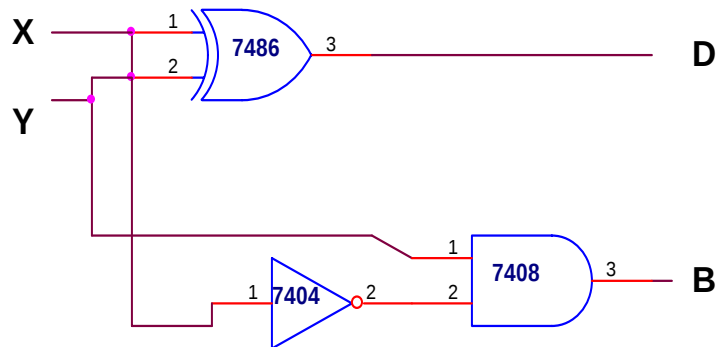
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Full Adder:



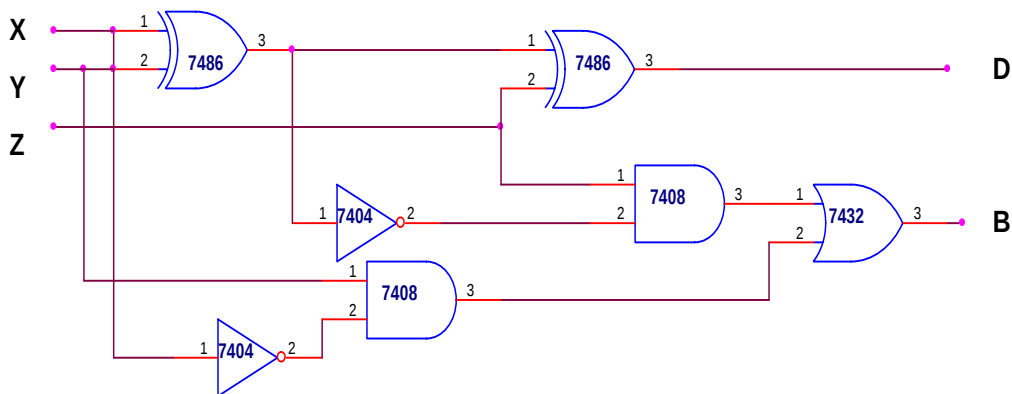
A	B	C _{N-1}	S	C
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

Half Subtractor



A	B	D	B
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

Full Subtractor



A	B	C	D	B
		N-1		
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

Procedure: -

1. Verify the gates.
2. Make the connections as per the circuit diagram.
3. Switch on V_{CC} and apply various combinations of input according to truth table.
4. Note down the output readings for half/full adder and half/full subtractor, Sum/difference and the carry/borrow bit for different combinations of inputs verify their truth tables.

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result: Combinational logic circuits like Half-adder, Full-adder, Half-subtractor, Full-subtractor are constructed and truth tables are verified.

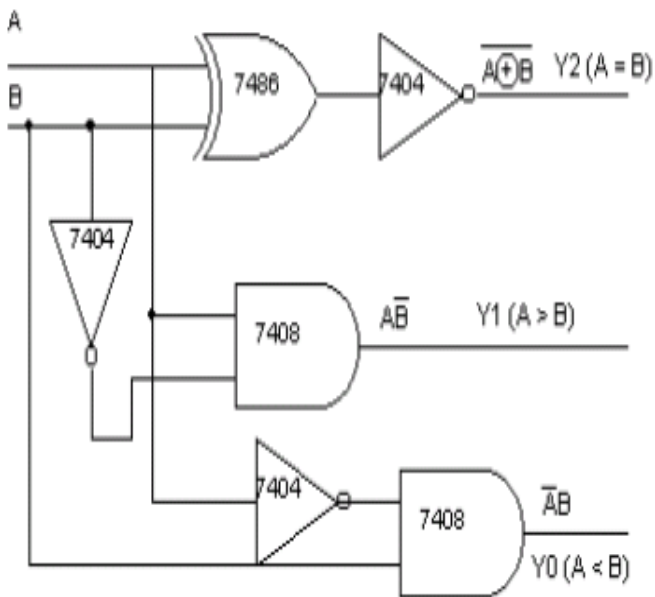
Questions:

1. Describe the difference between half-adder and full-adder.
2. Describe the difference between half-subtractor and full-subtractor.

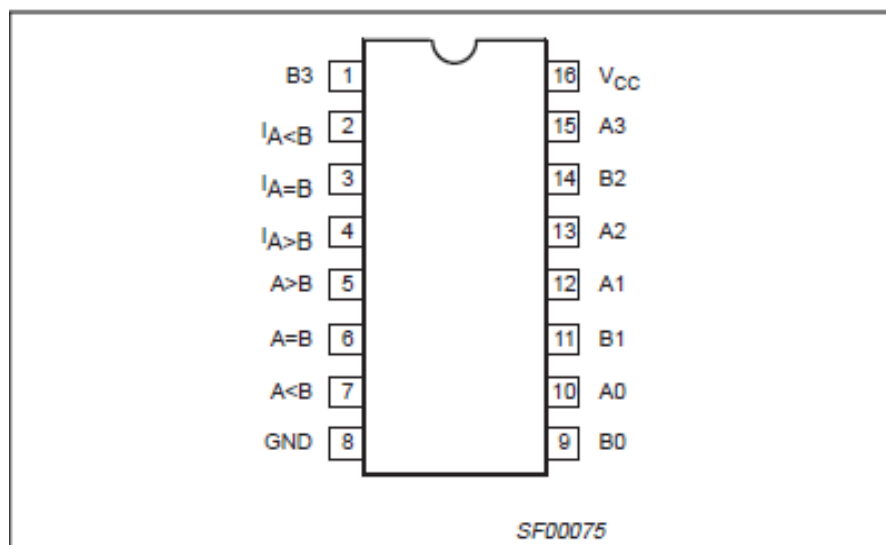
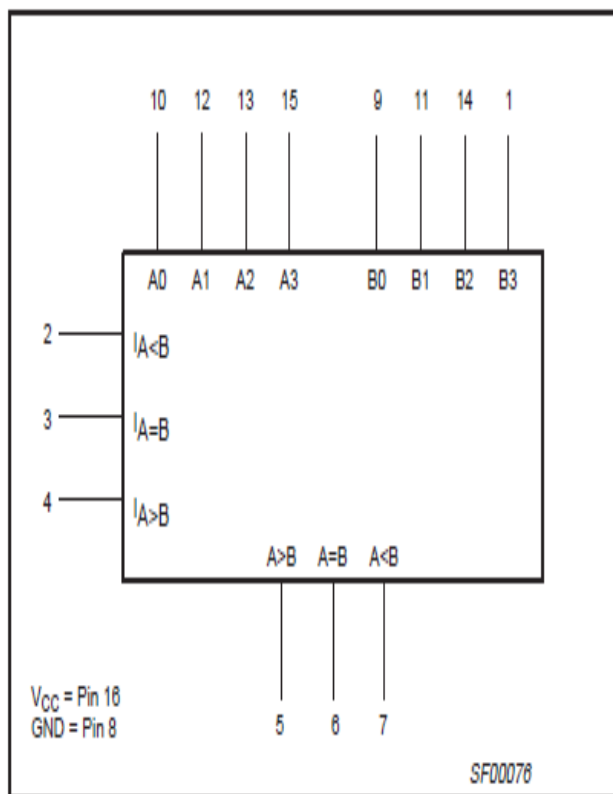
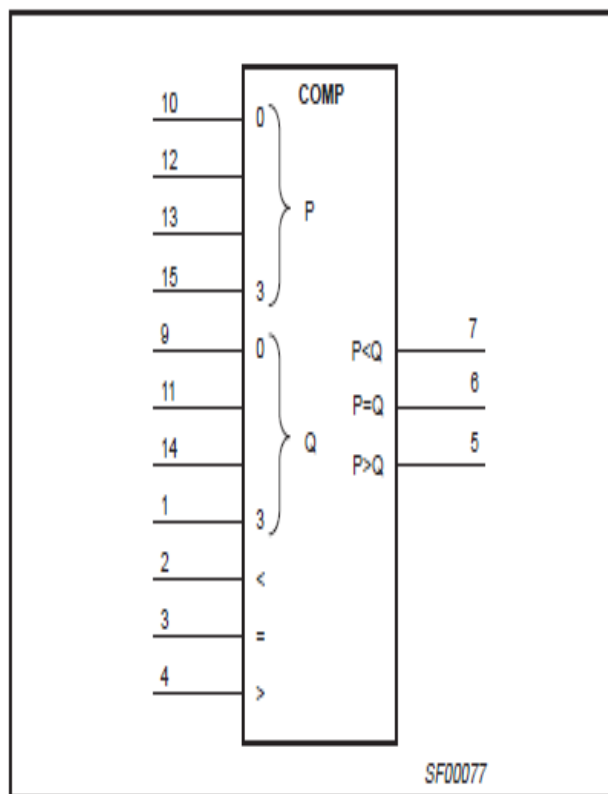
EXPERIMENT 4**VERIFICATION OF 4-BIT MAGNITUDE COMPARATOR**

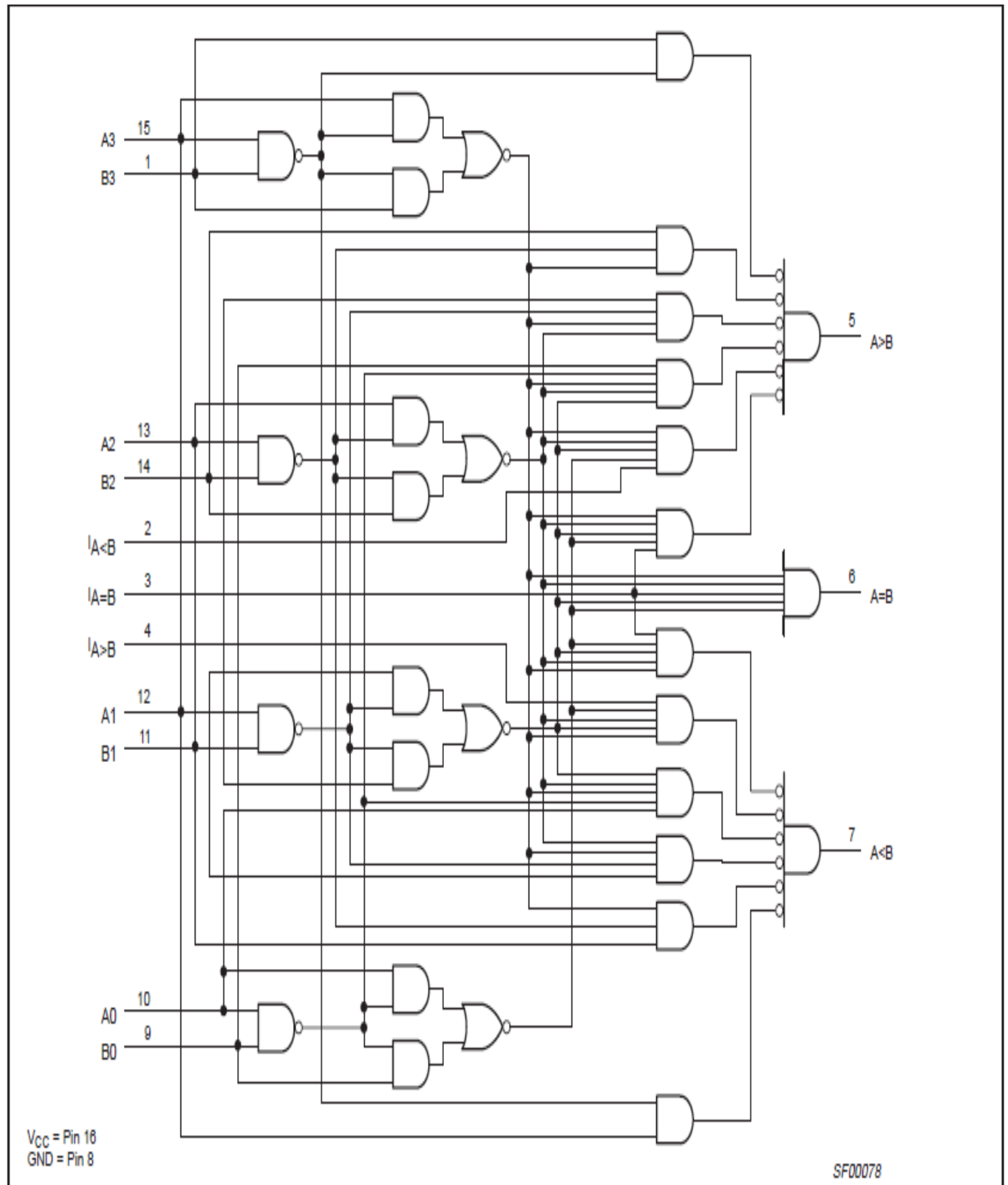
Aim: - To verify the truth table of one bit and four bit comparators using logic Gates and IC 7485

Apparatus : -
IC's -7486, 7404, 7408 and 7485

Circuit diagrams:**One Bit Comparator: -**

A	B	Y1 (A > B)	Y2 (A = B)	Y3 (A < B)
0	0	0	1	0
0	1	0	0	1
1	0	1	0	0
1	1	0	1	0

IC 7486 (4 bit Magnitude comparator) pin configuration:**LOGIC SYMBOL****IEC/IEEE SYMBOL**

IC 7486 (4 bit Magnitude comparator) Logic diagram:

FUNCTION TABLE

COMPARING INPUTS				EXPANSION INPUTS			OUTPUTS		
A3,B3	A2,B2	A1,B1	A0,B0	I _{A>B}	I _{A<B}	I _{A=B}	A>B	A<B	A=B
A3>B3	X	X	X	X	X	X	H	L	L
A3<B3	X	X	X	X	X	X	L	H	L
A3=B3	A2>B2	X	X	X	X	X	H	L	L
A3=B3	A2<B2	X	X	X	X	X	L	H	L
A3=B3	A2=B2	A1>B1	X	X	X	X	H	L	L
A3=B3	A2=B2	A1<B1	X	X	X	X	L	H	L
A3=B3	A2=B2	A1=B1	A0>B0	X	X	X	H	L	L
A3=B3	A2=B2	A1=B1	A0<B0	X	X	X	L	H	L
A3=B3	A2=B2	A1=B1	A0=B0	H	L	L	H	L	L
A3=B3	A2=B2	A1=B1	A0=B0	L	H	L	L	H	L
A3=B3	A2=B2	A1=B1	A0=B0	L	L	H	L	L	H
A3=B3	A2=B2	A1=B1	A0=B0	X	X	H	L	L	H
A3=B3	A2=B2	A1=B1	A0=B0	H	H	L	L	L	L
A3=B3	A2=B2	A1=B1	A0=B0	L	L	L	H	H	L

H = High voltage level

L = Low voltage level

X = Don't care

Verification Table :

A3 A2 A1 A0	B3 B2 B1 B0	OUTPUT
1 1 1 1	1 1 1 0	A>B
1 0 0 0	1 0 0 0	A=B
0 0 0 0	1 1 1 1	A<B

DESCRIPTION:

The 74F85 is a 4-bit magnitude comparator that can be expanded to almost any length. It compares two 4-bit binary, BCD, or other monotonic codes and presents the three possible magnitude results at the outputs. The 4-bit inputs are weighted (A0–A3) and (B0–B3) where A3 and B3 are the most significant bits. The operation of the 74F85 is described in the Function Table, showing all possible logic conditions. The upper part of the table describes the normal operation under all conditions that will occur in a single device or in a series expansion scheme. In the upper part of the table the three outputs are mutually exclusive. In the lower part of the table, the outputs reflect the feed-forward conditions that exist in the parallel expansion scheme.

The expansion inputs $IA > B$, $IA = B$ and $IA < B$ are the least significant bit positions. When used for series expansion, the $A > B$, $A = B$ and $A < B$ outputs of the least significant word are connected to the corresponding $IA > B$, $IA = B$ and $IA < B$ inputs of the next higher stage. Stages can be added in this manner to any length, but a propagation delay penalty of about 15ns is added with each additional stage. For proper operation, the expansion inputs of the least significant word should be tied as follows: $IA > B = \text{Low}$,

Procedure: -

1. Connect the circuit as shown in fig. Feed the 4-bit binary words A0, A1, A2, A3 and B0, B1, B2, B3 from the logic input switches.
2. Pin 3 of IC 7485 should be at logic 1 to enable compare operation.
3. Observe the output $A > B$, $A = B$, and $A < B$ on logic indicators. The outputs must be 1 or 0 respectively.
4. Repeat the steps 1, 2 and 3 for various inputs A0, A1, A2, A3 and B0, B1, B2, B3 and observe the outputs at $A > B$, $A = B$ and $A < B$.

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result: The truth tables of one bit and four bit magnitude comparators are verified.

Questions :-

1. What is Comparator?
2. What are the applications of Comparator?
3. Which logic is used as 1 bit comparator?

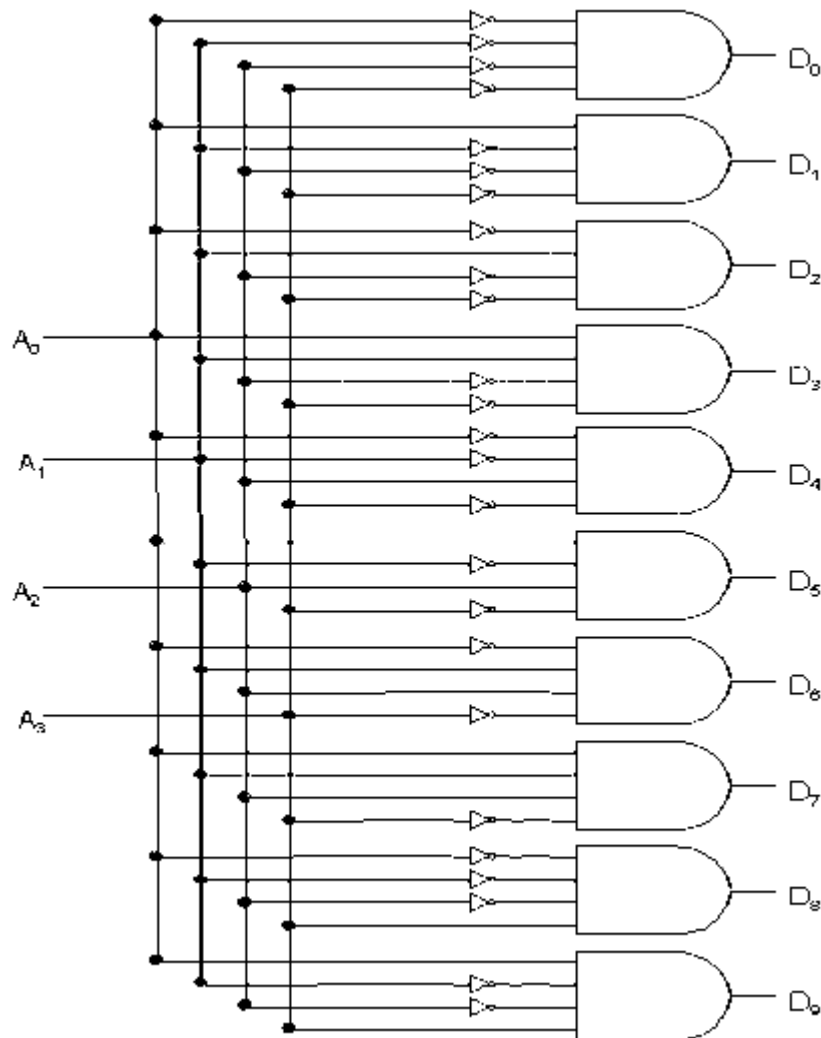
EXPERIMENT 5**DESIGN OF DECODERS LIKE BCD-DECIMAL DECODER**

Aim: To design BCD-Decimal Decoder

Apparatus:

1. IC's - 7432, 7400
2. Electronic Circuit Designer
3. Connecting patch chords.

Circuit Diagram:-



Truth Table:

Decimal Digit	Binary Inputs				Logic Function
0	0	0	0	0	$\overline{A_3} \overline{A_2} \overline{A_1} \overline{A_0}$
1	0	0	0	1	$\overline{A_3} \overline{A_2} \overline{A_1} A_0$
2	0	0	1	0	$\overline{A_3} \overline{A_2} A_1 \overline{A_0}$
3	0	0	1	1	$\overline{A_3} \overline{A_2} A_1 A_0$
4	0	1	0	0	$\overline{A_3} A_2 \overline{A_1} \overline{A_0}$
5	0	1	0	1	$\overline{A_3} A_2 \overline{A_1} A_0$
6	0	1	1	0	$\overline{A_3} A_2 A_1 \overline{A_0}$
7	0	1	1	1	$\overline{A_3} A_2 A_1 A_0$
8	1	0	0	0	$A_3 \overline{A_2} \overline{A_1} \overline{A_0}$
9	1	0	0	1	$A_3 \overline{A_2} \overline{A_1} A_0$

Procedure:

1. Connections are made as per the circuit diagram
2. Switch on the power supply
3. Apply different combinations of inputs and observe the outputs; compare the outputs with the truth tables.

Precautions: All the connections should be made properly.

Result: BCD-Decimal decoder is designed and truth table is verified.

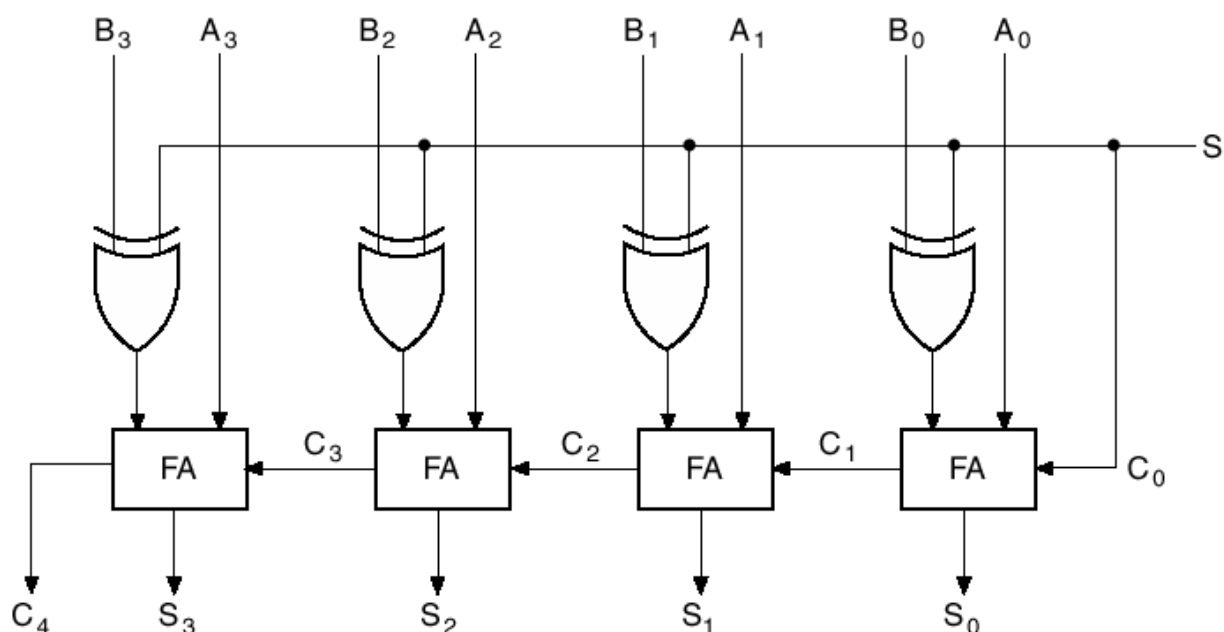
EXPERIMENT 6
APPLICATIONS OF IC PARALLEL ADDER
(1'S AND 2'S COMPLIMENT ADDITION)

Aim: Design of 4-bit IC parallel adder

Apparatus : -

IC's -7486, 7404, 7408 and 7485

Circuit diagrams:



Description:

The circuit performs addition as well as subtraction. When 's' input is low the circuit performs **addition**. The EX-OR gate acts as a **controlled inverter** (i.e., it inverts input when control is high, otherwise it passes the input to the output). The output of EX-OR gate is B when 's' input is low. The output of the circuit is sum of two input numbers when 's' input is low. When 's' input is HIGH the EX-OR gate acts as **inverter** and its output is the complement of input. The carry input of the first full adder is '1'. The output of the circuit is the sum A, complement of B and 1. This performs 2's complement subtraction. The output of the circuit is in true magnitude form if the $A > B$. The output of the circuit is in 2's complement form if the $A < B$.

Procedure:

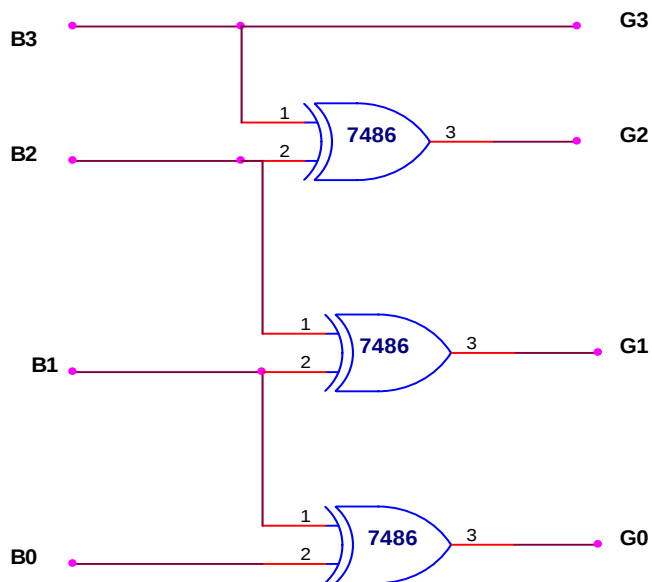
1. Connections are made as per the circuit diagram
2. Switch on the power supply
3. Apply different combinations of inputs and observe the outputs.

Precautions: All the connections should be made properly.

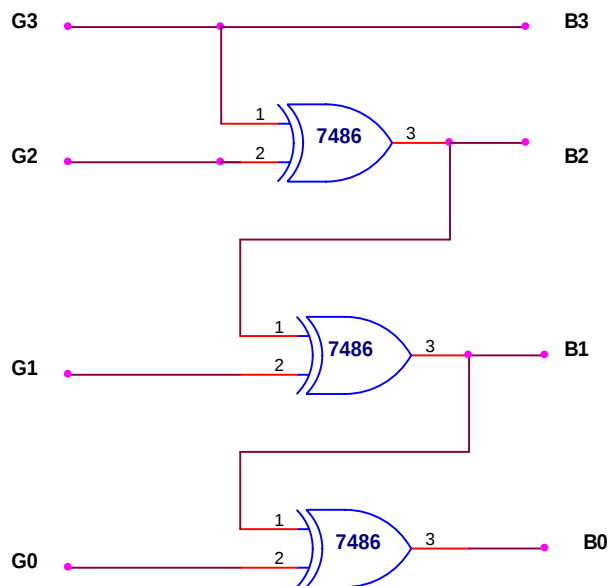
Result: 4-bit IC parallel adder is designed and 1's & 2's complement addition is performed

EXPERIMENT 7**DESIGN OF CODE CONVERTORS (BINARY TO GRAY AND GRAY TO BINARY CONVERSION)****Aim:** To design code converters and verify their truth tables**Apparatus:**

1. IC - 7486
2. Electronic circuit designer
3. Connecting patch chords

Circuit Diagrams:**Binary to Gray Code Converter****Truth table**

B3	B2	B1	B0	G3	G2	G1	G0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	1
0	0	1	1	0	0	1	0
0	1	0	0	0	1	1	0
0	1	0	1	0	1	1	1
0	1	1	0	0	1	0	1
0	1	1	1	0	1	0	0
1	0	0	0	1	1	0	0
1	0	0	1	1	1	0	1
1	0	1	0	1	1	1	1
1	0	1	1	1	1	1	0
1	1	0	0	1	0	1	0
1	1	0	1	1	0	1	1
1	1	1	0	1	0	0	1
1	1	1	1	1	0	0	0

Gray to Binary Code Converter

G3	G2	G1	G0	B3	B2	B1	B0
0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1
0	0	1	0	0	0	1	1
0	0	1	1	0	0	1	0
0	1	0	0	0	1	1	1
0	1	0	1	0	1	1	0
0	1	1	0	0	1	0	0
0	1	1	1	0	1	0	1
1	0	0	0	1	1	1	1
1	0	0	1	1	1	1	0
1	0	1	0	1	1	0	0
1	0	1	1	1	1	0	1
1	1	0	0	1	0	0	0
1	1	0	1	1	0	0	1
1	1	1	0	1	0	1	1
1	1	1	1	1	0	1	0

Procedure: -

1. The circuit connections are made as shown in fig.
2. Pin (14) is connected to +Vcc and Pin (7) to ground.
- 3 In the case of binary to gray conversion, the inputs B0, B1, B2 and B3 are given at respective pins and outputs G0, G1, G2, G3 are taken for all the 16 combinations of the input.
4. In the case of gray to binary conversion, the inputs G0, G1, G2 and G3 are given at respective Pins and outputs B0, B1, B2, and B3 are taken for all the 16 combinations of inputs.
5. The values of the outputs are tabulated.

Result: code converters are designed and their truth tables are verified.

Precautions: All the connections should be made properly.

Questions:

1. Convert binary 100100 to gray code.

EXPERIMENT 8**DESIGN OF MULTIPLEXERS/DEMULTIPLEXERS**

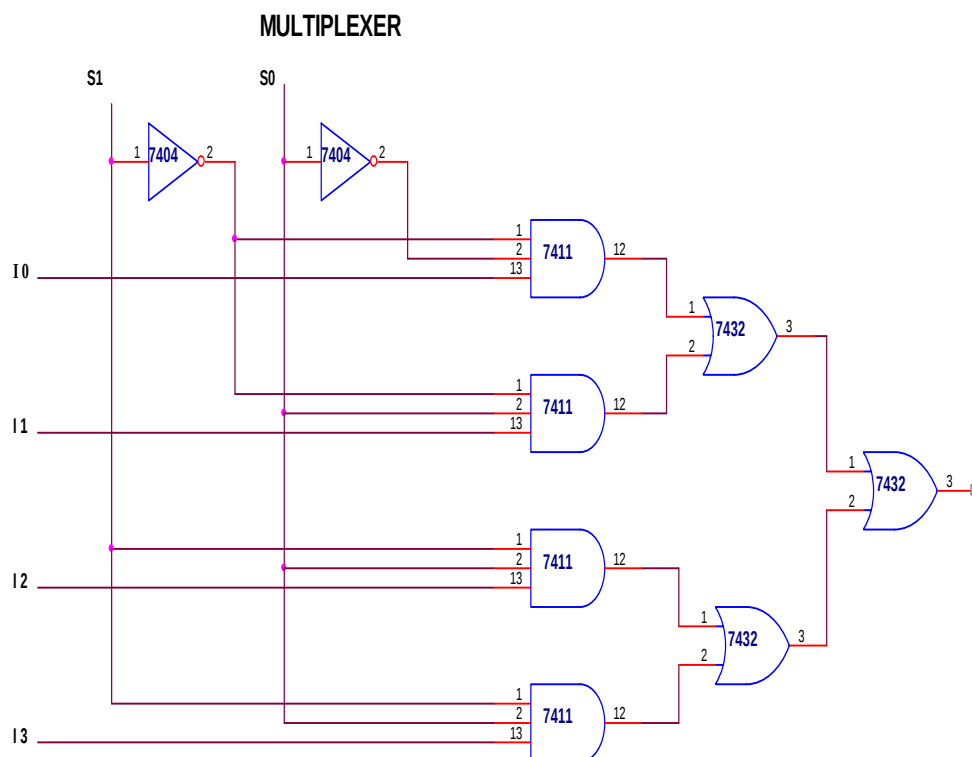
Aim: To design Multiplexer and Demultiplexer and verify their truth tables

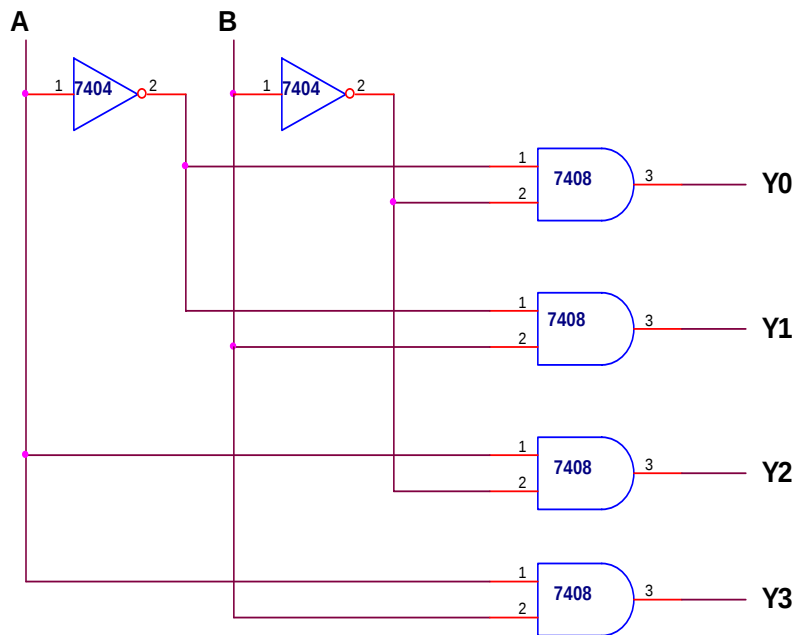
Apparatus:

1. IC - 7404,7411,7432,7408
2. Electronic circuit designer
3. Connecting patch chords

Circuit Diagrams:

S1	S0	Y
0	0	I0
0	1	I1
1	0	I2
1	1	I3



Demultiplexer

A	B	Y3	Y2	Y1	Y0
0	0	0	0	0	1
0	1	0	0	1	0
1	0	0	1	0	0
1	1	1	0	0	0

Procedure:

1. Connections are made as per the circuit diagram
2. Switch on the power supply
3. Apply different combinations of inputs and observe the outputs; compare the outputs with the truth tables.

Precautions: All the connections should be made properly.

Result: Multiplexer and Demultiplexer are constructed and the truth tables are verified

Questions:

1. What is the difference between multiplexer and decoder

EXPERIMENT 9

VERIFICATION OF TRUTH TABLES OF FLIPFLOPS USING GATES

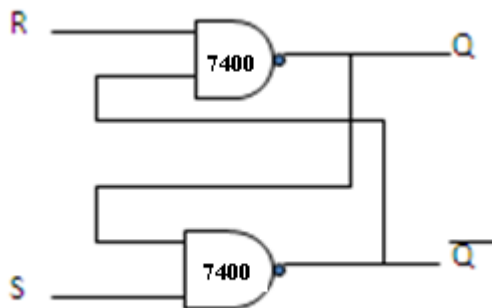
Aim: - To design and construct basic flip-flops R-S ,J-K,J-K Master slave flip-flops using gates and verify their truth tables

Apparatus: -

1. IC's - 7404, 7402, 7400
2. Electronic circuit designer
3. Connecting patch chords

Circuit Diagrams:-

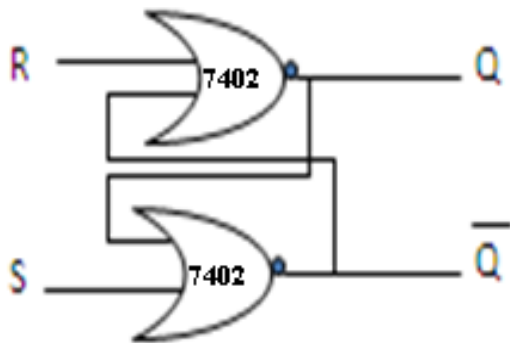
Basic flipflop using NAND gates



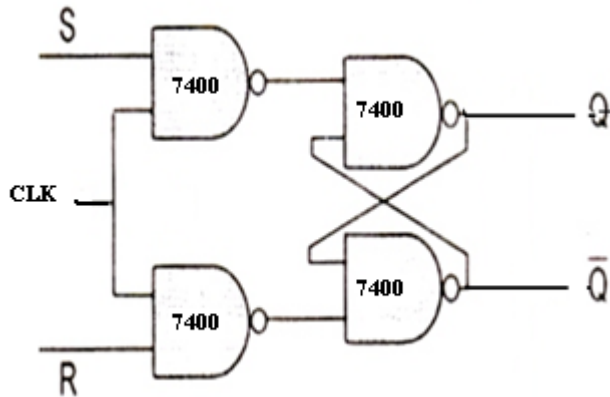
Truth Table

S	R	Q
0	0	Forbidden
0	1	1
1	0	0
1	1	No Change

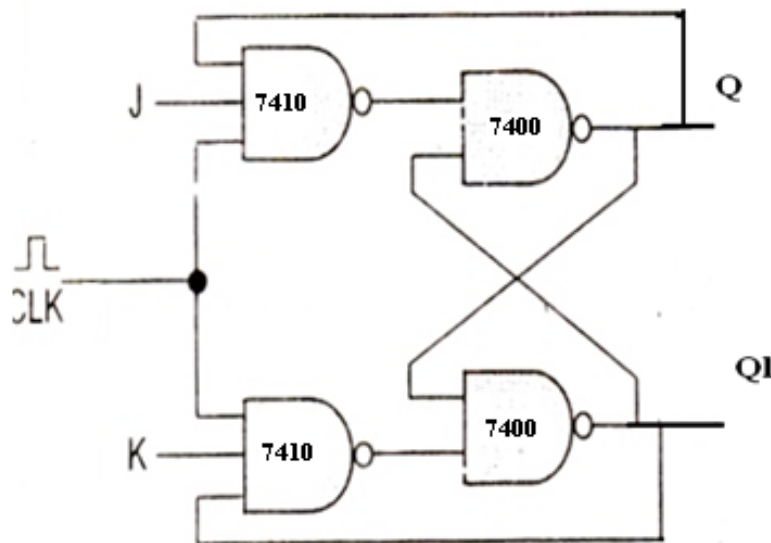
Basic flipflop using NOR gates



S	R	Q
0	0	No Change
0	1	0
1	0	1
1	1	Forbidden

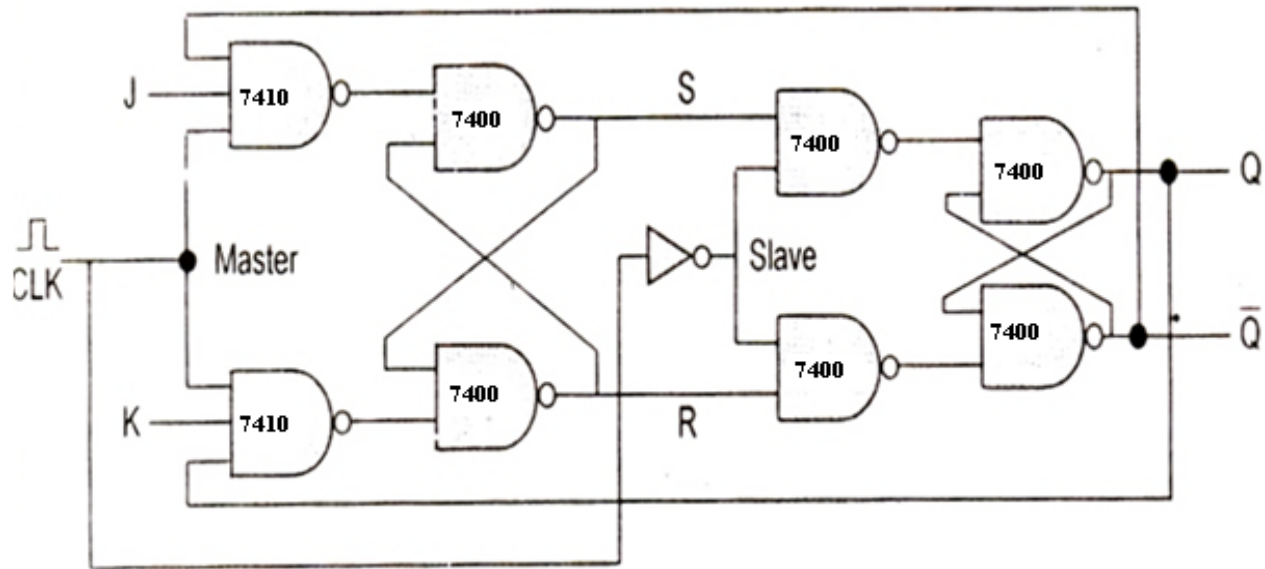
R-S flip-flop using NAND gates

S	R	Q
0	0	No Change
0	1	0
1	0	1
1	1	Forbidden

J-k flip-flop using NAND gates

J	K	Q
0	0	No Change
0	1	0
1	0	1
1	1	Race around

J-K Master Slave using NAND gates



J	K	Q
0	0	
0	1	0
1	0	1
1	1	

Procedure:

1. Connect the Flip-flop circuits as shown above.
2. Apply different combinations of inputs and observe the outputs

Precautions: All the connections should be made properly.

Result: Different Flip-flops using gates are constructed and their truth tables are verified

Questions: 1. List four Basic Flip-flop applications?

2. What advantage does a J-K Flip-flop have over an S-R?

3. What is meant by Race around condition?

EXPERIMENT 10**DESIGN OF SHIFT REGISTER(TO VERIFY SERIAL TO PARALLEL,PARALLEL TO SERIAL,SERIAL TO SERIAL,PARALLEL TO PARALLEL)USING FLIP-FLOPS**

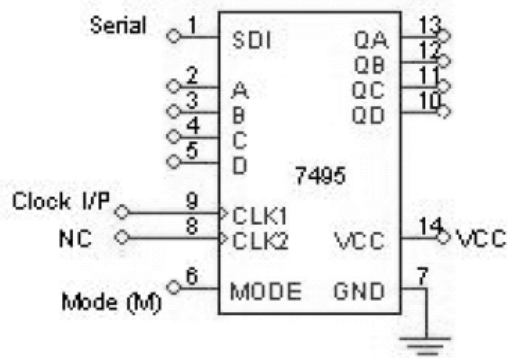
Aim:- To study shift register using IC 7495 in all its modes i.e.

SIPO/SISO, PISO/PIPO.

Apparatus:- IC 7495, etc.

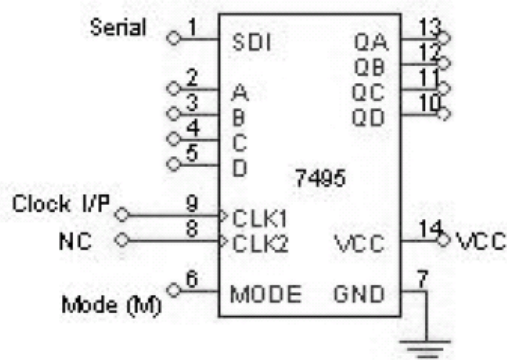
Circuit diagram :-

SIPO (Right Shift):-

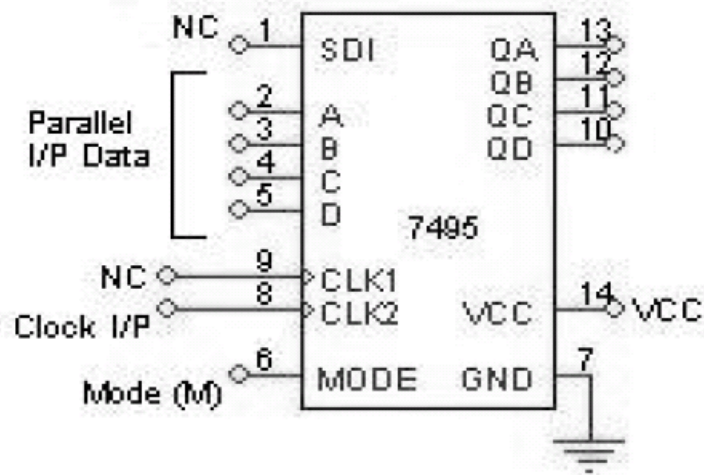


Clock	Serial i/p	QA	QB	QC	QD
1	0	0	X	X	X
2	1	1	0	X	X
3	1	1	1	0	X
4	1	1	1	1	0

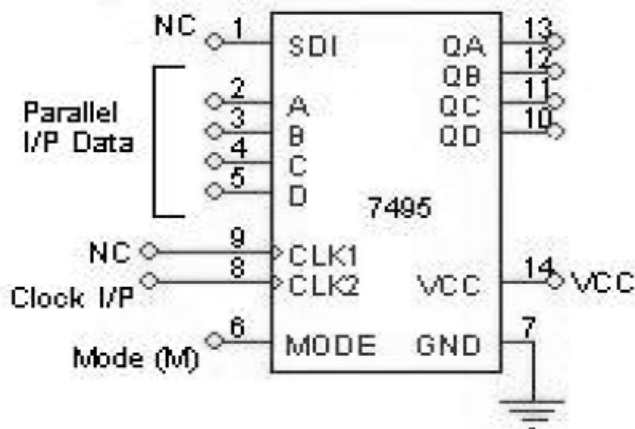
SISO:-



Clock	Serial i/p	QA	QB	QC	QD
1	d0=0	0	X	X	X
2	d1=1	1	0	X	X
3	d2=1	1	1	0	X
4	d3=1	1	1	1	0=d0
5	X	X	1	1	1=d1
6	X	X	X	1	1=d2
7	X	X	X	X	1=d3

PISO:-

Mode	Clock	Parallel i/p				Parallel o/p			
		A	B	C	D	QA	QB	QC	QD
1	1	1	0	1	1	1	0	1	1
0	2	X	X	X	X	X	1	0	1
0	3	X	X	X	X	X	X	1	0
0	4	X	X	X	X	X	X	X	1

PIPO:-

Clock	Parallel i/p				Parallel o/p			
	A	B	C	D	QA	QB	QC	QD
1	1	0	1	1	1	0	1	1

Procedure :**Serial In Parallel Out(SIPO):**

1. Connections are made as per circuit diagram.
2. Apply the data at serial i/p
3. Apply one clock pulse at clock 1 (Right Shift) observe this data at QA.
4. Apply the next data at serial i/p.
5. Apply one clock pulse at clock 2, observe that the data on QA will shift to QB and the new data applied will appear at QA.
6. Repeat steps 2 and 3 till all the 4 bits data are entered one by one into the shift register.

Serial In Serial Out (SISO):

1. Connections are made as per circuit diagram.
2. Load the shift register with 4 bits of data one by one serially.
3. At the end of 4th clock pulse the first data 'd0' appears at QD.
4. Apply another clock pulse; the second data 'd1' appears at QD.
5. Apply another clock pulse; the third data appears at QD.
6. Application of next clock pulse will enable the 4th data 'd3' to appear at QD. Thus the data applied serially at the input comes out serially at QD

Parallel In Serial Out (PISO):

1. Connections are made as per circuit diagram.
2. Apply the desired 4 bit data at A, B, C and D.

3. Keeping the mode control M=1 apply one clock pulse. The data applied at

A, B, C and D will appear at QA, QB, QC and QD respectively.

4. Now mode control M=0. Apply clock pulses one by one and observe the

Data coming out serially at QD

Parallel In Parallel Out (PIPO):

1. Connections are made as per circuit diagram.

2. Apply the 4 bit data at A, B, C and D.

3. Apply one clock pulse at Clock 2 (Note: Mode control M=1).

4. The 4 bit data at A, B, C and D appears at QA, QB, QC and QD respectively.

Precautions: All the connections should be made properly.

Result: shift registers using IC 7495 in all its modes i.e.SIPO/SISO, PISO/PIPO are verified.

EXPERIMENT 11

DESIGN OF RING AND JOHNSON COUNTERS USING FLIP-FLOPS

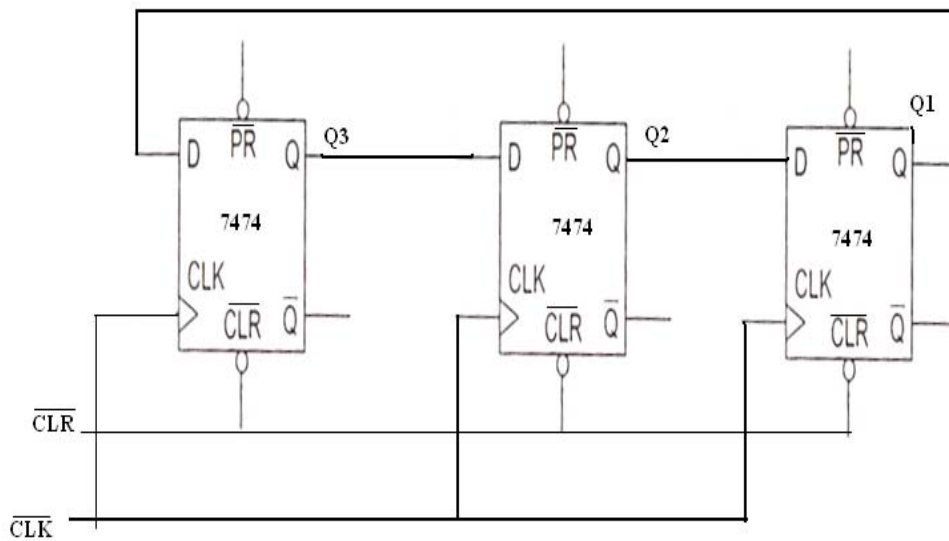
Aim: To design Ring counter and Johnson counter and verify their truth tables

Apparatus:

1. IC's - 7404, 7402, 7400
2. Electronic circuit designer
3. Connecting patch chords

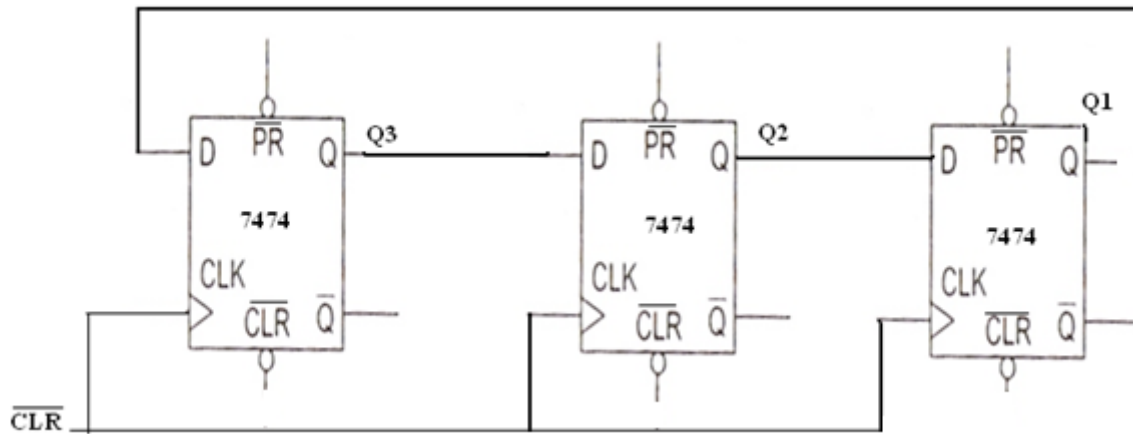
Circuit Diagram:

Ring Counter:



Truth Table

Clk	Q3	Q2	Q1
0	0	0	1
1	1	0	0
2	0	1	0

Johnson Counter:**Truth Table**

Clk	Q3	Q2	Q1
0	0	0	0
1	1	0	0
2	1	1	0
3	1	1	1
4	0	1	1
5	0	0	1

Procedure:

1. Connections are made as per the circuit diagram
2. Switch on the power supply.
3. Apply clock pulses and note the outputs after each clock pulse

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result: Ring counter and Johnson counter are designed and their truth tables are verified.

EXPERIMENT 12

CONVERSION OF FLIP-FLOPS (JK-T,JK-D)

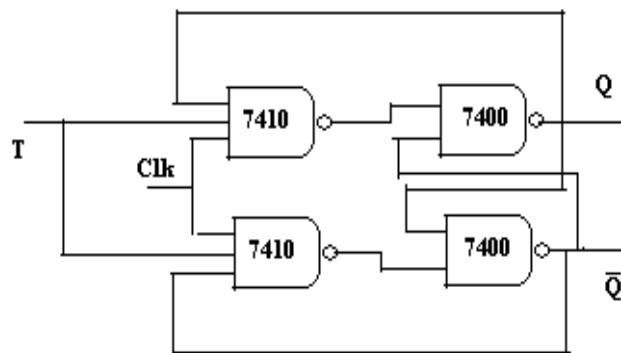
Aim: To design and construct T and D Flip-flop from JK- flip-flop and verify their truth tables

Apparatus:

1. IC's - 7410, 7400
2. Electronic circuit designer
3. Connecting patch chords

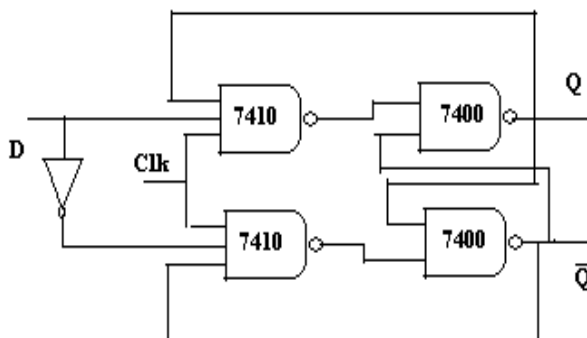
Circuit diagram:

T-Flip Flop



T	Q	Q_{t+1}
0	0	0
0	1	1
1	0	1
1	1	0

D-Flip Flop



D	Q	Q_{t+1}
0	0	0
0	1	0
1	0	1
1	1	1

Procedure:

1. Connections are made as per the circuit diagram
2. Switch on the power supply
3. Apply different combinations of inputs and observe the out puts

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result: T and D Flip-flop are designed and constructed from JK- flip-flop and their truth tables are verified.

EXPERIMENT 13**DESIGN OF BINARY/DECADE COUNTER**

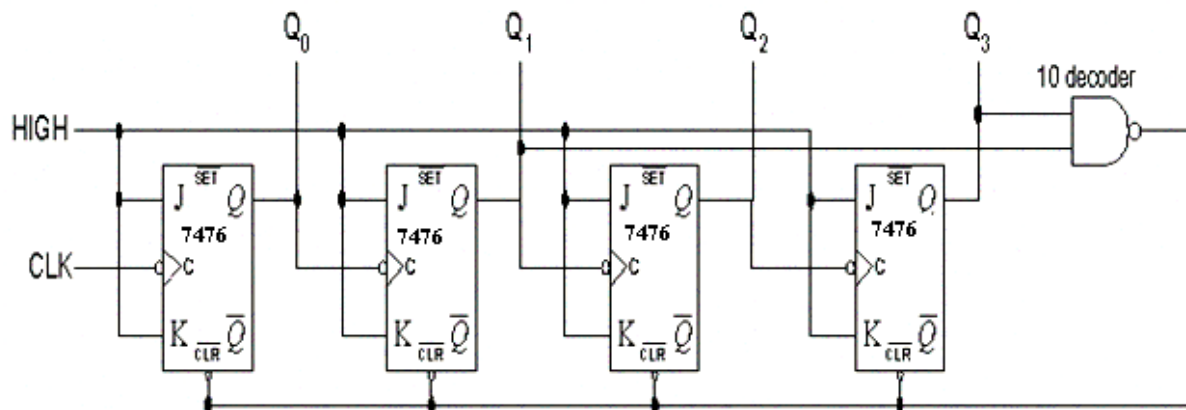
Aim: To design and construct decade counter and verify the truth table

Apparatus:

1. IC's - 7410, 7400
2. Electronic circuit designer
3. Connecting patch chords

Circuit diagram:

**Decade
Counter:**

**Truth Table**

CLK	Q3	Q2	Q1	Q0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

Procedure:

1. Connections are made as per the circuit diagram
2. Switch on the power supply.
3. Apply clock pulses and note the outputs after each clock pulse and note down the outputs Q3, Q2, Q1, Q0.

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result: Decade counter is designed and truth tables are verified.

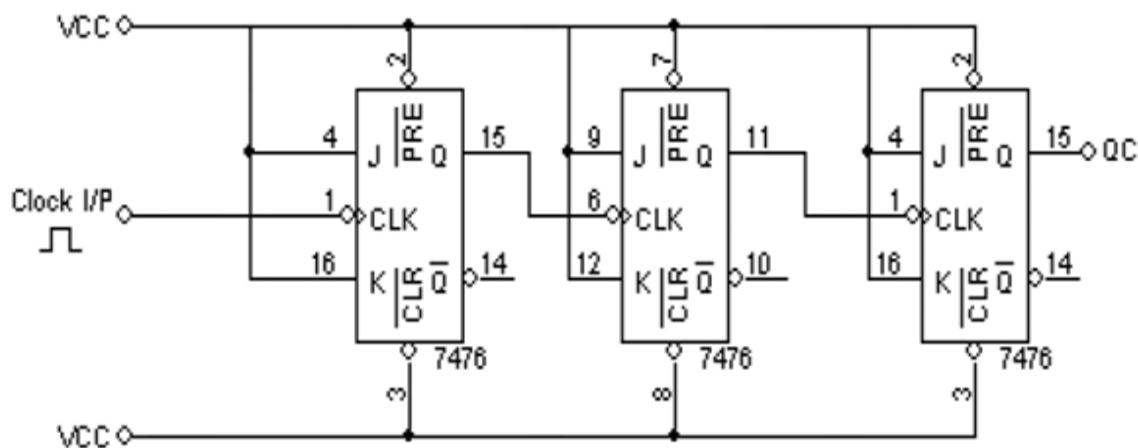
EXPERIMENT 14

**DESIGN OF ASYNCHRONOUS COUNTER, MOD COUNTER,
UP COUNTER, DOWN COUNTER AND UP/DOWN COUNTER
USING FLIP FLOPS**

Aim:- To design and construct of 3-bit Asynchronous up and down counters, 2-bit up/down counter.

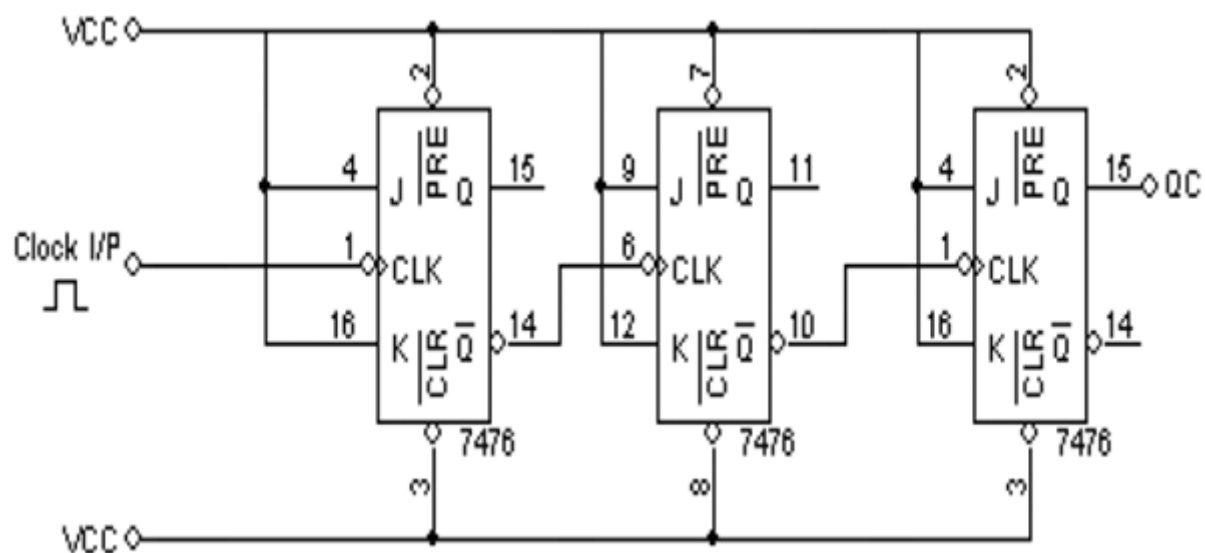
Apparatus:

1. IC's - 7408, 7476, 7400, 7432
2. Electronic circuit designer
3. Connecting patch chords

Circuit Diagram:**3-bit Asynchronous up counter:**

3-bit Asynchronous up counter			
Clock	QC	QB	QA
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1
8	0	0	0

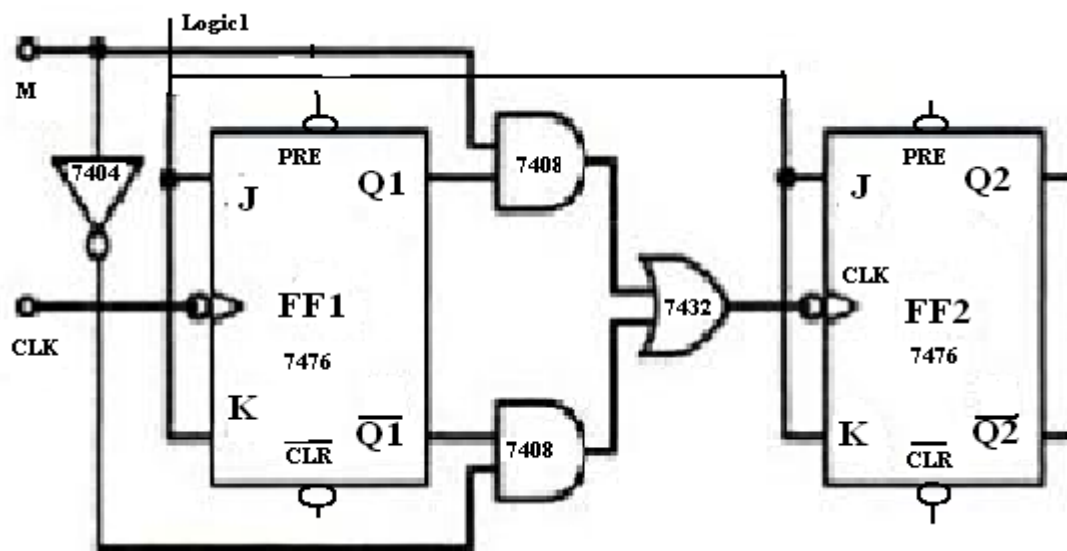
3-bit Asynchronous down counter:



TRUTH TABLE

3-bit Asynchronous down counter			
Clock	QC	QB	QA
0	1	1	1
1	1	1	0
2	1	0	1
3	1	0	0
4	0	1	1
5	0	1	0
6	0	0	1
7	0	0	0
8	1	1	1
9	1	1	0

Two Bit up/Down Counter using negative edge-triggered flip-



flops

WHEN M=1

WHEN M=0

CLK	Q2	Q1
0	1	1
1	1	0

CLK	Q2	Q1
0	0	0
1	0	1
2	1	0
3	1	1

2	0	1
3	0	0

Procedure:

1. Connections are made as per the circuit diagram
2. Switch on the power supply.
3. Apply clock pulses and note the outputs after each clock pulse and note down the outputs.

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result: 3-bit Asynchronous up and down counters, 2-bit up/down counter are designed and truth tables are verified.

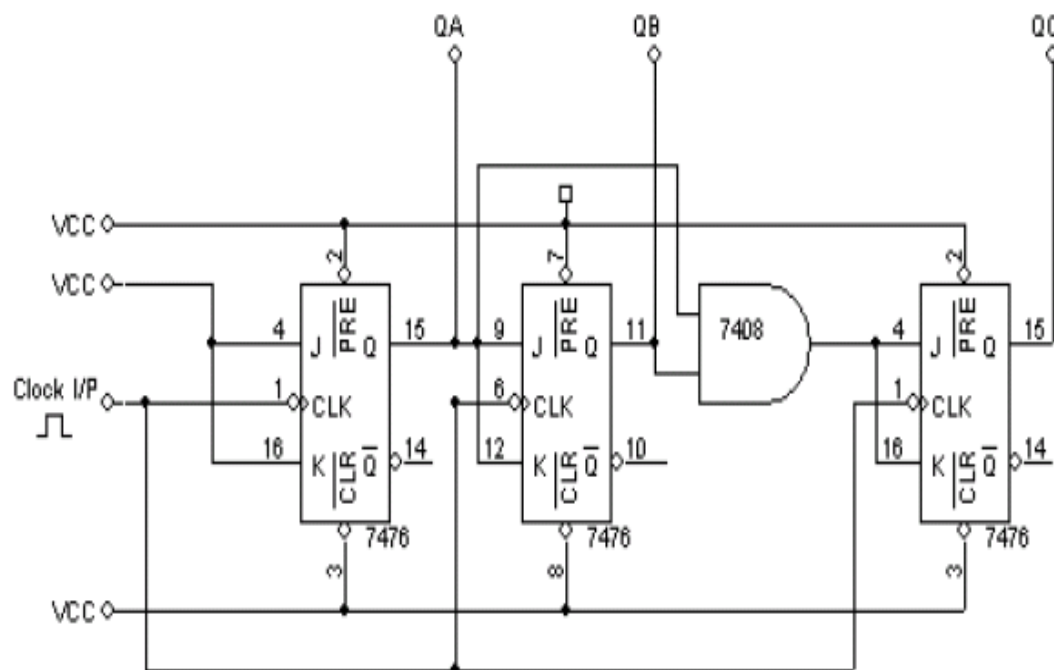
EXPERIMENT 15

**DESIGN OF SYNCHRONOUS COUNTER, MOD COUNTER,
UP COUNTER, DOWN COUNTER AND UP/DOWN COUNTER
USING FLIP FLOPS**

Aim:- To design and construct of 3-bit Synchronous up and down counters, 2-bit up/down counter.

Apparatus:

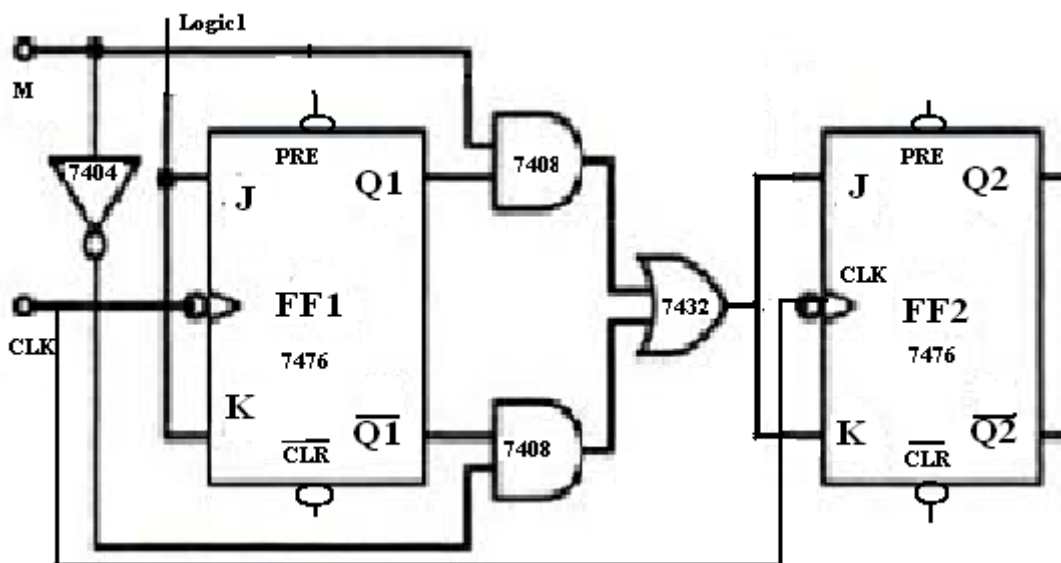
1. IC's - 7408, 7476, 7400, 7432
2. Electronic circuit designer
3. Connecting patch chords

Circuit Diagram:**3-bit Synchronous Counter:-**

Truth Table

3-bit synchronous up counter			
Clock	QC	QB	QA
0	0	0	0
1	0	0	1
2	0	1	0
3	0	1	1
4	1	0	0
5	1	0	1
6	1	1	0
7	1	1	1
8	0	0	0

Two Bit up/Down Counter using negative edge-triggered flip-flops



WHEN $M=1$

CLK	Q2	Q1
0	0	0
1	0	1
2	1	0
3	1	1

WHEN $M=0$

CLK	Q2	Q1
0	1	1
1	1	0
2	0	1
3	0	0

Procedure:

1. Connections are made as per the circuit diagram
2. Switch on the power supply.
3. Apply clock pulses and note the outputs after each clock pulse and note down the outputs.

Precautions:

1. All the connections should be made properly.
2. IC should not be reversed.

Result: 3-bit Synchronous up and down counters, 2-bit up/down counter are designed and truth tables are verified.