SEMESTER – II/IV/VI

19MMU311/19CHU312 PHYSICS PRACTICALS –II 4H– 2C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objective

- To enhance the students to understand the concepts in integrated chips.
- To understand the optical and electronic properties of solids through experimentations

Course Outcomes:

Students can able to

- Perform basic experiments in mechanics, heat and electricity and analyze the data
- Acquire engineering skills and Practical knowledge, which help the student in their everyday life.
- know the physical Principles and applications of Electronics.

Any 8 Experiments

1. Determine the magnetic dipole moment (*m*) of a bar magnet - Tan A
2. Determine the magnetic dipole moment (*m*) of a bar magnet - Tan B
3. Field Intensity-Circular coil- Vibration magnetometer
4. Moment of a magnet-Circular coil-Deflection Magnetometer
5. Study of logic gates using IC's.
6. Study of NOR gate as Universal building block.
7. Study of NAND gate as Universal building block.
8. Verification of Basic logic gates using discrete components.
9. To study the variation in current and voltage in a series LCR circuit
10. To study the variation in current and voltage in a parallel LCR circuit
11. Transistor characteristics – CE &CB

SUGGESTED READINGS

1. Ouseph C.C., U.J. Rao and V. Vijayendran 2007, Practical Physics and Electronics, S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai
2. Singh S.P., 2003, Advanced Practical Physics – 1, 13th Edition, Pragathi Prakashan, Meerut
3. Singh S.P., 2000, Advanced Practical Physics – 2, 12th Edition, Pragathi Prakashan, Meerut

Comparison of magnetic moments deflection magnetometer – Tan A position

Aim

To compare the magnetic moments of the given two magnets in Tan A position.

Apparatus

Deflection magnetometer, two magnets, meter scale

Tabulation

Equal distance method

S.No	Distance d x 10^{-2} m	Magnet	Deflection in degrees								Mean θ	M_1/M_2=Tan θ_x/ Tan θ_y
			Θ_1	Θ_2	Θ_3	Θ_4	Θ_5	Θ_6	Θ_7	Θ_8		
1	M_1 M_2										Θ_x= Θ_y=	
2	M_1 M_2										Θ_x= Θ_y=	
3	M_1 M_2										Θ_x= Θ_y=	

Mean =

Null deflection method

S.No	Distance of I Magnet d_1 x 10^{-2}m	Distance of II Magnet d_2 x 10^{-2}m				Mean d_2 x 10^{-2}m	M_1/M_2= d_1^3/d_2^3
		d_2'	d_2''	d_2'''	d_2''''		
1							
2							
3							

Mean =

Result

The ratio of magnetic moments of the two bar magnets by

i. Equal distance method = (no unit)
ii. Null deflection method = (no unit)

Comparison of magnetic moments deflection magnetometer – Tan B position

Aim

To compare the magnetic moments of the given two magnets in Tan B position.

Apparatus

Deflection magnetometer, two magnets, meter scale

Tabulation

Equal distance method

S.No	Distance d x 10^{-2} m	Magnet	Deflection in degrees								Mean θ	M_1/M_2=Tan θ_x/ Tan θ_y
			Θ_1	Θ_2	Θ_3	Θ_4	Θ_5	Θ_6	Θ_7	Θ_8		
1	M_1 M_2										Θ_x= Θ_y=	
2	M_1 M_2										Θ_x= Θ_y=	
3	M_1 M_2										Θ_x= Θ_y=	

Mean =

Null deflection method

S.No	Distance of I Magnet d_1 x 10^{-2}m	Distance of II Magnet d_2 x 10^{-2}m				Mean d_2 x 10^{-2}m	M_1/M_2= d_1^3/d_2^3
		d_2'	d_2''	d_2'''	d_2''''		
1							
2							
3							

Mean =

Result

The ratio of magnetic moments of the two bar magnets by

i. Equal distance method = (no unit)
ii. Null deflection method = (no unit)

Experiment no 3:

Field intensity circular coil - Vibration Magnetometer

The equation of motion of the bar magnet suspended horizontally in the earth's magnetic field is
$I\ddot{\theta} + mB_H \sin\theta = 0$

Thus its period of oscillation, for small θ , is approximately.

$$T = 2\pi\sqrt{I / mB_H} \qquad (2)$$

where I = moment of inertia of the magnet about the axis of oscillation
m = magnetic moment of the magnet
B_H = horizontal intensity of the earth's magnetic field.
For a rectangular bar magnet,

$$I = M\frac{L^2 + b^2}{12} \qquad (3)$$

Where
M = mass of the magnet
L = length of the magnet (longest horizontal dimension)
b = breadth of the magnet (shortest horizontal dimension)
Squaring equation (2)

$$T^2 = 4\pi^2 \frac{I}{mB_H} \qquad (4)$$

which gives us,

$$mB_H = 4\pi^2 \frac{I}{T^2} \qquad (5)$$

Thus, by measuring vibration (oscillation) period T and calculating the moment of inertia I of the bar magnet, mB_H is determined using the vibration magnetometer. We will call this value x.

Working principle

Tan-A position

In Tan A position (Fig. 1), prior to placement of the magnet, the compass box is rotated so that the (0-0) line is parallel to the arm of the magnetometer. Then the magnetometer as a whole is rotated till pointer reads (0-0). Finally, the bar magnet (the same one that was previously suspended in the Vibration Magnetometer) is placed horizontally, parallel to the arm of the deflection magnetometer, at a distance d chosen so that the deflection of the aluminum pointer is between 30° and 60°.

The magnet is a dipole. Suppose that, analogous to an electric dipole, there are two magnetic poles *P* (though in reality no single magnetic pole can exist), one positive and one negative, separated by a distance $L = 2l$, with the positive pole labeled *N* and the negative pole labeled *S*. By analogy with Coulomb's law, for each pole we would have a field.

$$B = \frac{\mu_0}{4\pi}\frac{P}{r^2},$$

and a magnetic dipole moment.

$$m = PL = 2Pl.$$

$$B = \frac{\mu_0 P}{4\pi}\left[\frac{1}{(d-l)^2} - \frac{1}{(d+l)^2}\right] = \frac{\mu_0}{4\pi}\frac{2md}{\left(d^2 - l^2\right)^2}$$

where $l = L/2$ is the half-length of the magnet
m = magnetic moment of the magnet
$4\pi \times 10^{-7}\ TmA^{-1}$ - the magnetic permeability of free space, and
θ = deflection of aluminium pointer.
Therefore, by the tangent law, at equilibrium

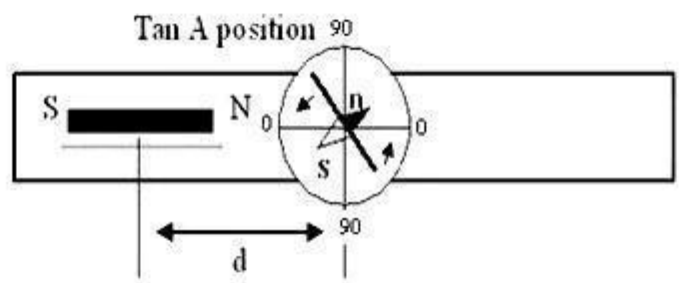


Figure 1

$$B_H \tan\theta = \frac{\mu_0}{4\pi}\frac{2md}{\left(d^2 - l^2\right)^2} \qquad (6)$$

Solving for m/B_H we get:

$$\frac{m}{B_H} = 10^7\,\frac{(d^2 - l^2)^2}{2d} \times \tan\theta \qquad (7)$$

We will call this value *y*.

Tan-B position

In this position (Fig. 2), prior to placement of the magnet, the compass box alone is rotated so that the (90-90) line is parallel to the arm of the magnetometer. Then the magnetometer as a whole is rotated so that the pointer reads (0-0). Finally, the magnet is placed horizontally, perpendicular to the arm of the magnetometer, at distances *d* chosen so that the deflection of the aluminium pointer is between 30°and 60°.

From Fig. 5, at point C,

$$B = B_N \sin \alpha + B_S \sin \alpha = \frac{2\mu_0 P}{4\pi}\left(\frac{1}{(d^2+l^2)}\frac{l}{(d^2+l^2)^{1/2}}\right)$$

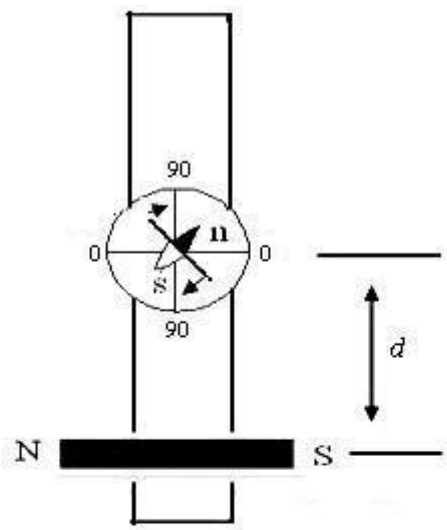


Figure 2

Thus the field due to the bar magnet in the center of the compass is,

$$B = B_H \tan\theta = \frac{\mu_0}{4\pi}\frac{m}{(d^2+l^2)^{3/2}}$$

which leads to,

$$\frac{m}{B_H} = \frac{4\pi}{\mu_0}(d^2+l^2)^{3/2}\tan\theta \qquad (8)$$

Equation (8) gives us a second value of *y*, which we average with the first, from equation (7). Now using (5), (7) and (8) we can calculate *m* and B_H.

$$mB_H = x \qquad (9)$$

$$\frac{m}{B_H} = y \qquad (10)$$

Hence, the magnetic moment of the bar magnet is,

$$m = \sqrt{xy} \qquad (11)$$

And the horizontal component of earth's magnetic field is,

$$B_H = \sqrt{x/y} \qquad (12)$$

Tan C position

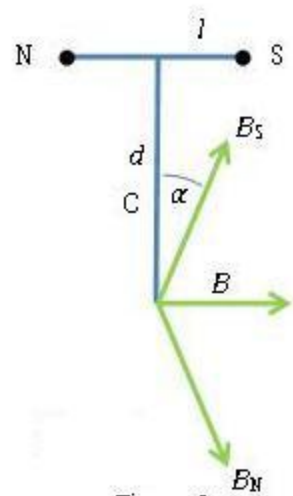


Figure 3

In this position (Fig. 4), the bar magnet is placed *vertically*, in contrast to the Tan A and Tan B positions, where it is placed horizontally. The bottom end of the bar magnet is placed a distance d from the center of the compass box, chosen so that the deflection of the aluminum pointer is between 30° and 60°. From Fig. 7, the horizontal component of the field from the bar magnet at the center of the compass is

$$B_{hbar} = B_N - B_S \cos\beta = \frac{\mu_0 P}{4\pi}\left(\frac{1}{d^2}\right.$$

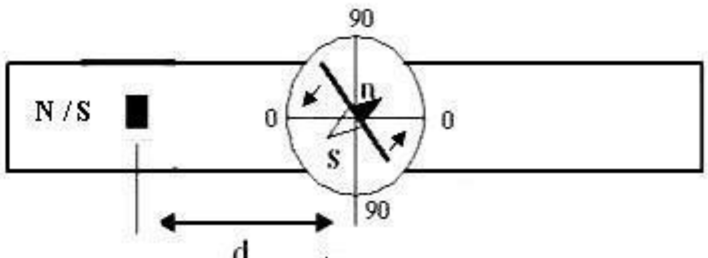


Figure 4

which reduces to,

$$B = \frac{\mu_o}{4\pi}P\left(\frac{1}{d^2} - \frac{d}{(d^2+L^2)^{3/2}}\right)$$

(13)

Where P is the pole strength in Amp-meters (A m) and L is the length of the bar magnet in meters. In equation (1), the horizontal component of the field from the bar magnet B_H bar corresponds to the external field B, so we have . Substituting this in (13) and solving for the pole strength P of the bar magnet,

$$P = \frac{4\pi B_H \tan\theta}{\mu_o\left(\frac{1}{d^2} - \frac{d}{(d^2+L^2)^{3/2}}\right)}$$

(14)

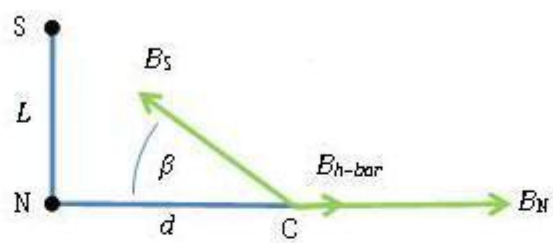


Figure 5

Experiment no 4:

Moment of magnetic circular coil deflection magnetometer

Aim

To determine the magnetic dipole moment (m) of a bar magnet and horizontal intensity (B_H) of earth's magnetic field using a deflection magnetometer.

Apparatus

Deflection magnetometer, box-type vibration magnetometer, timer, bar magnet.The deflection magnetometer consists of a large compass box with a small magnetic needle pivoted at the center of a circular scale so that the needle is free to rotate in a horizontal plane .
A large aluminium pointer is rigidly fixed perpendicular to the magnetic needle. The circular scale is graduated in degrees. (0-0) and (90-90) readings are marked at the ends of two perpendicular diameters. The compass box is placed at the center of a wooden board one meter long. The wooden board has a millimeter scale along its axis. The zero of this scale is at the center of the compass box.

The box-type vibration magnetometer consists of a rectangular box with glass sides. A vertical tube is fitted at the top and a torsion-free fiber is suspended from the top of this tube carries a light aluminum stirrup in the box below. The bar magnet can be placed horizontally in this stirrup. At the bottom of the box two leveling screws are provided .

Theory

The horizontal component of earth's magnetic field, B_H, is the component of the magnetic field of the earth along a horizontal plane whose normal vector passes through the center of the earth. B_H is measured in Tesla, T.

The magnetic dipole moment m of a magnetic dipole is the property of the dipole which tends to align the dipole parallel to an external magnetic field. m is measured in Ampere-square meters ($A\ m^2$) or, equivalently, in Joules per Tesla (J/T).

Tangent law

Consider a bar magnet with magnetic moment m, suspended horizontally in a region where there are two perpendicular horizontal magnetic fields, and external field B and the horizontal component of the earth's field B_H. If no external magnetic field B is present, the bar magnet will align with B_H. Due to the field B, the magnet experiences a torque τ_D , called the deflecting torque, which tends to deflect it from its original orientation parallel to B_H. If θ is the angle between the bar magnet and B_H, the magnitude of the deflecting torque will be,

$$\tau_D = mB\cos\theta$$

The bar magnet experiences a torque τ_R due to the field B_H which tends to restore it to its original orientation parallel to B_H. This torque is known as the restoring torque, and it has magnitude.

$$\tau_R = mB_H \sin\theta$$

The suspended magnet is in equilibrium when,

$$\tau_R = \tau_D$$

$$mB_H \sin\theta = mB \cos\theta$$

$$B = B_H \tan\theta \qquad (1)$$

The above relation, called the tangent law, gives the equilibrium orientation of a magnet suspended in a region with two mutually perpendicular fields.

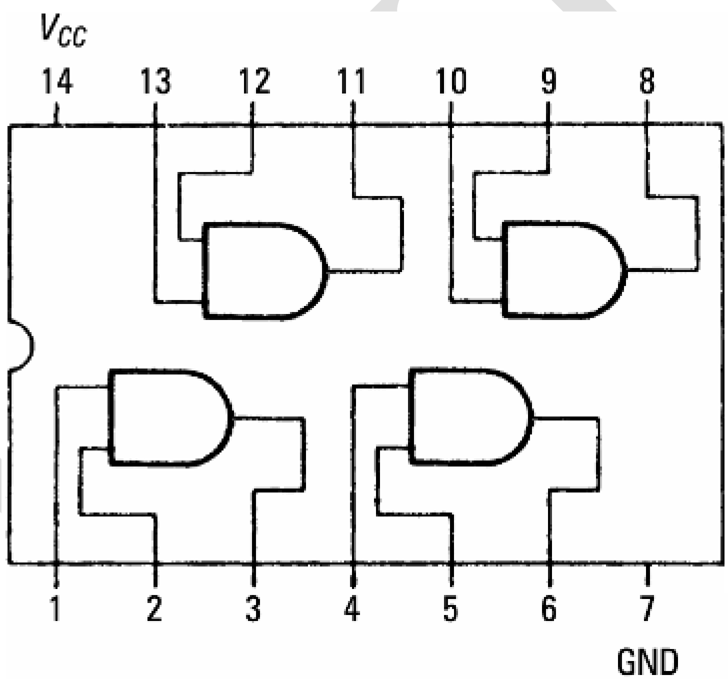
Experiment 5

Study of Logic Gates using IC's

Apparatus: Logic trainer kit, logic gates / ICs, wires.
Theory: Logic gates are electronic circuits which perform logical functions on one or more inputs to produce one output. There are seven logic gates. When all the input combinations of a logic gate are written in a series and their corrresponding outputs written along them, then this input/ output combination is called **Truth Table**. Various gates and their working is explained here.

AND Gate

AND gate produces an output as 1, when all its inputs are 1; otherwise the output is 0. This gate can have minimum 2 inputs but output is always one. Its output is 0 when any input is 0.



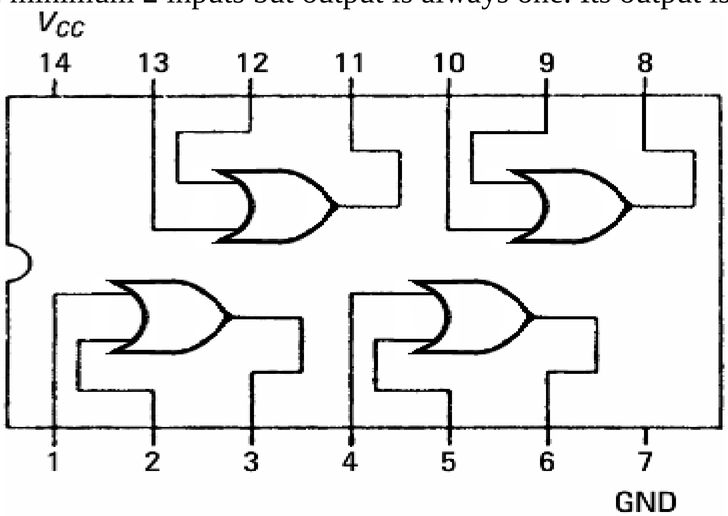
Y=A.B

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

IC 7408

OR Gate

OR gate produces an output as 1, when any or all its inputs are 1; otherwise the output is 0. This gate can have minimum 2 inputs but output is always one. Its output is 0 when all input are 0.



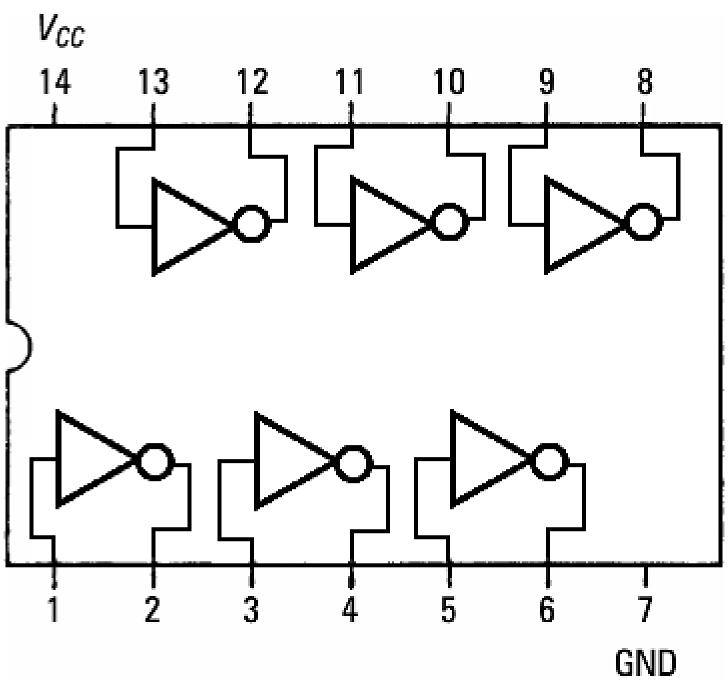
Y=A+B

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

IC 7432

NOT Gate

NOT gate produces the complement of its input. This gate is also called an INVERTER. It always has one input and one output. Its output is 0 when input is 1 and output is 1 when input is 0.



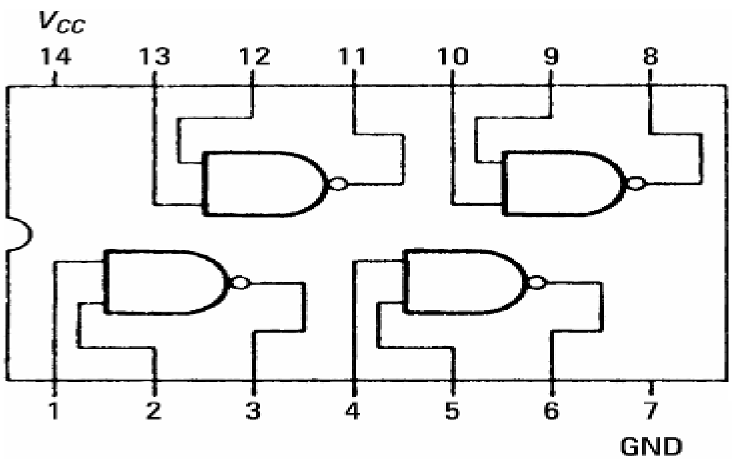
$Y=\overline{A}$

A	Y
0	1
1	0

IC 7404

NAND Gate

NAND gate is actually a series of AND gate with NOT gate. If we connect the output of an AND gate to the input of a NOT gate, this combination will work as NOT-AND or NAND gate. Its output is 1 when any or all inputs are 0, otherwise output is 1.



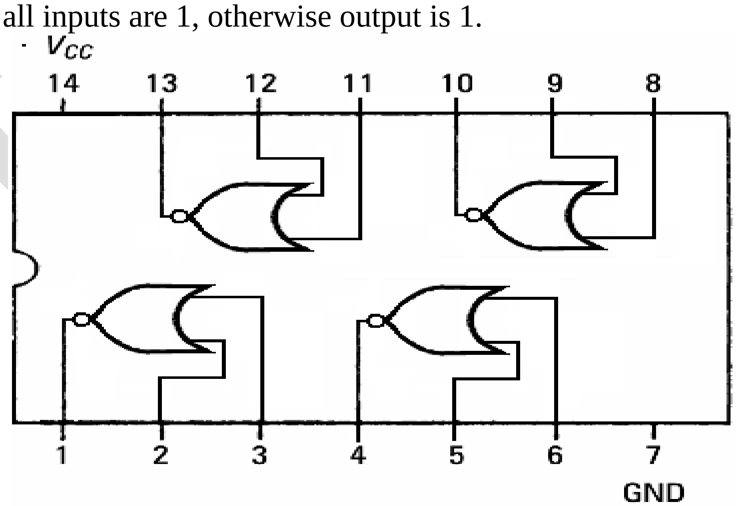
$Y = \overline{A.B}$

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

IC 7400

NOR Gate

NOR gate is actually a series of OR gate with NOT gate. If we connect the output of an OR gate to the input of a NOT gate, this combination will work as NOT-OR or NOR gate. Its output is 0 when any or all inputs are 1, otherwise output is 1.



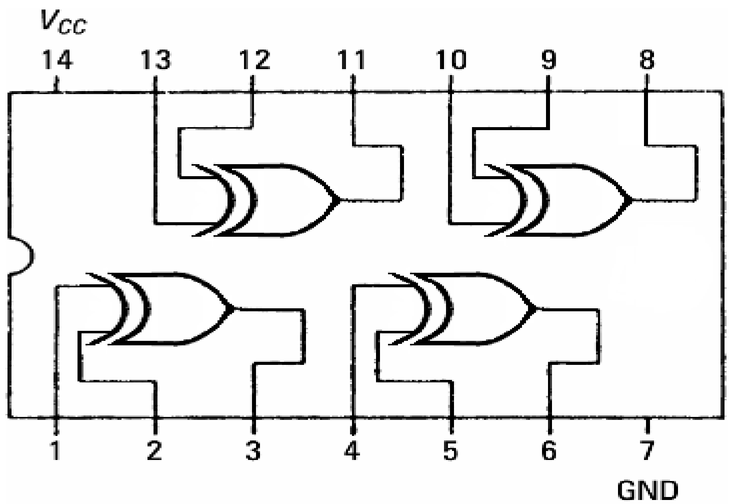
$Y = \overline{A+B}$

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

IC 7402

Exclusive OR (X-OR) Gate

X-OR gate produces an output as 1, when number of 1's at its inputs is **odd**, otherwise output is 0. It has two inputs and one output.



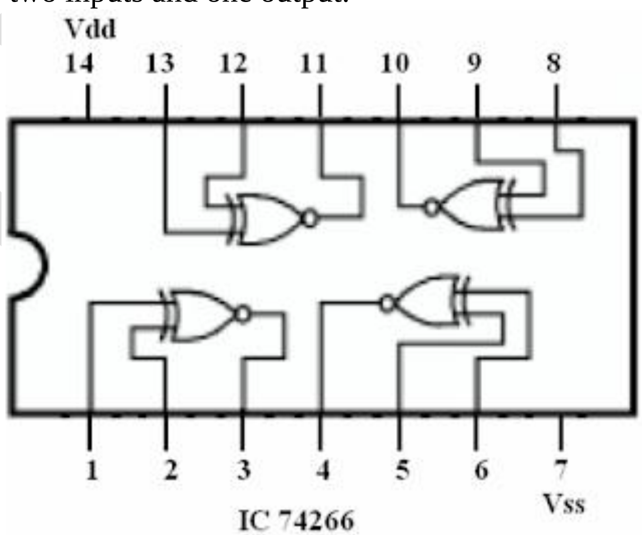
Y=A⊕B

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

IC 7486

Exclusive NOR (X-NOR) Gate

X-NOR gate produces an output as 1, when number of 1's at its inputs is **not odd**, otherwise output is 0. It has two inputs and one output.



Y = A ⊙ B

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

Procedure:

1. Connect the trainer kit to ac power supply.
2. Connect the inputs of any one logic gate to the logic sources and its output to the logic indicator.
3. Apply varous input combinations and observe output for each one.
4. Verify the truth table for each input/ output combination.
5. Repeat the process for all other logic gates.
6. Switch off the ac power supply.

Experiment No: 6

Study of NOR gate as universal building block

Apparatus: logic trainer kit, NOR gates (IC 7402), wires.

Theory:

NOR gate is actually a combination of two logic gates: OR gate followed by NOT gate. So its output is complement of the output of an OR gate.

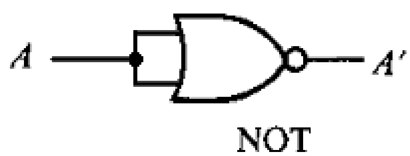
This gate can have minimum two inputs, output is always one. By using only NOR gates, we can realize all logic functions: AND, OR, NOT, X-OR, X-NOR, NAND. So this gate is also called universal gate.

NOR gates as NOT gate

A NOT produces complement of the input. It can have only one input, tie the inputs of a NOR gate together. Now it will work as a NOT gate. Its output is

$$Y = (A+A)'$$

=> $$Y = (A)'$$

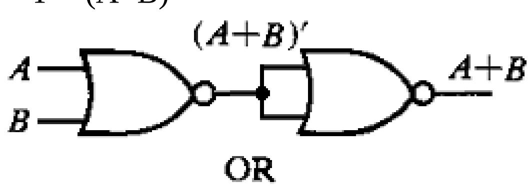


NOR gates as OR gate

A NOR produces complement of OR gate. So, if the output of a NOR gate is inverted, overall output will be that of an OR gate.

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

=> $$Y = (A+B)$$

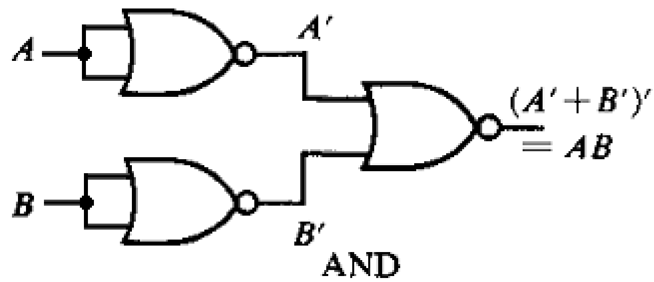


NOR gates as AND gate

From DeMorgan's theorems: $(A+B)' = A'B'$

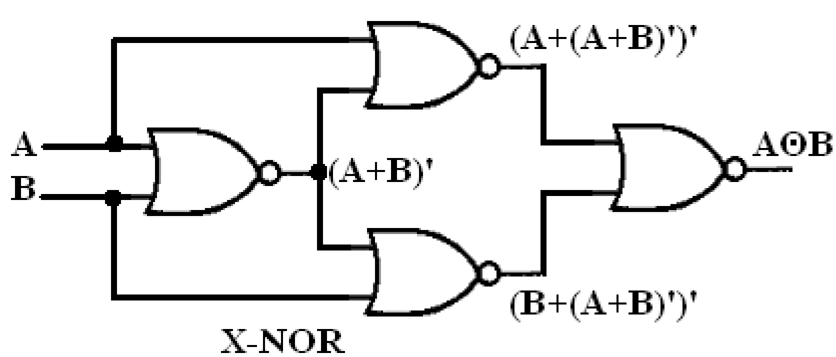
=> $$(A'+B')' = A''B'' = AB$$

So, give the inverted inputs to a NOR gate, obtain AND operation at output.



NOR gates as X-NOR gate

The output of a two input X-NOR gate is shown by: Y = AB + A'B'. This can be achieved with the logic diagram shown in the left side.



Gate No.	Inputs	Output
1	A, B	(A + B)'
2	A, (A + B)'	(A + (A+B)')'
3	(A + B)', B	(B + (A+B)')'
4	(A + (A + B)')', (B + (A+B)')'	AB + A'B'

Now the ouput from gate no. 4is the overall output of the configuration.

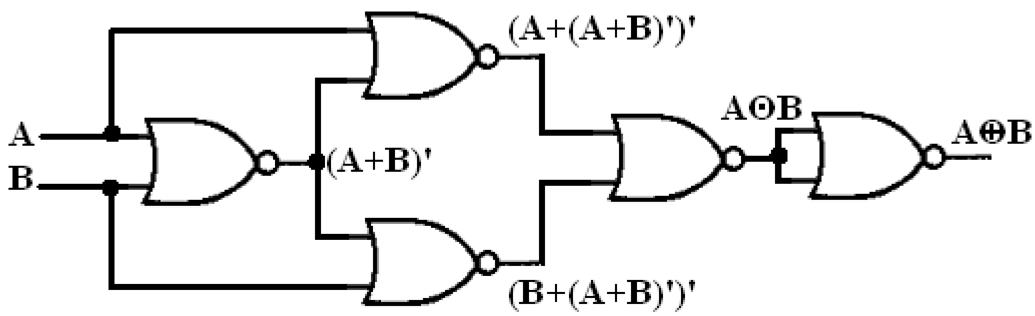
$$
\begin{aligned}
Y &= ((A + (A+B)')' (B +(A+B)')')' \\
&= (A+(A+B)')''.(B+(A+B)')'' \\
&= (A+(A+B)').(B+(A+B)') \\
&= (A+A'B').(B+A'B') \\
&= (A + A').(A + B').(B+A')(B+B') \\
&= 1.(A+B').(B+A').1 \\
&= (A+B').(B+A') \\
&= A.(B + A') +B'.(B+A') \\
&= AB + AA' +B'B+B'A' \\
&= AB + 0 + 0 + B'A' \\
&= AB + B'A'
\end{aligned}
$$

=> Y = AB + A'B'

NOR gates as X-OR gate

X-OR gate is actually X-NOR gate followed by NOT gate. So give the output of X-NOR gate to a NOT gate, overall ouput is that of an X-OR gate.

Y = A'B+ AB'

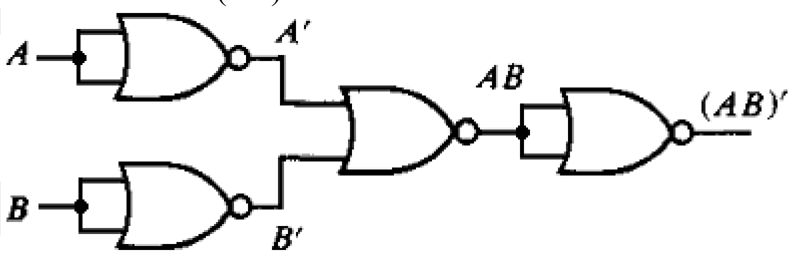


X- OR

NOR gates as NAND gate

A NAND gate is an AND gate followed by NOT gate. So connect the output of AND gate to a NOT gate, overall output is that of a NAND gate.

Y = (AB)'



NAND

Procedure:

1. Connect the trainer kit to ac power supply.
2. Connect the NOR gates for any of the logic functions to be realised.
3. Connect the inputs of first stage to logic sources and output of the last gate to logic indicator.
4. Apply varous input combinations and observe output for each one.
5. Verify the tructh table for each input/ output combination.
6. Repeat the process for all logic functions.
7. Switch off the ac power supply.

Experiment No: 7

Study of NAND gate as universal building block

Apparatus: logic trainer kit, NAND gates (IC 7400), wires.

Theory:

NAND gate is actually a combination of two logic gates: AND gate followed by NOT gate. So its output is complement of the output of an AND gate.

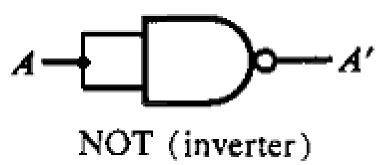
This gate can have minimum two inputs, output is always one. By using only NAND gates, we can realize all logic functions: AND, OR, NOT, X-OR, X-NOR, NOR. So this gate is also called universal gate.

NAND gates as NOT gate

A NOT produces complement of the input. It can have only one input, tie the inputs of a NAND gate together. Now it will work as a NOT gate. Its output is

Y = (A.A)'

=> Y = (A)'



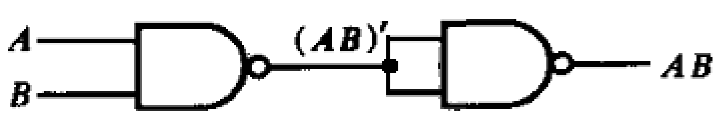
NOT (inverter)

NAND gates as AND gate

A NAND produces complement of AND gate. So, if the output of a NAND gate is inverted, overall output will be that of an AND gate.

Y = ((A.B)')'

=> Y = (A.B)



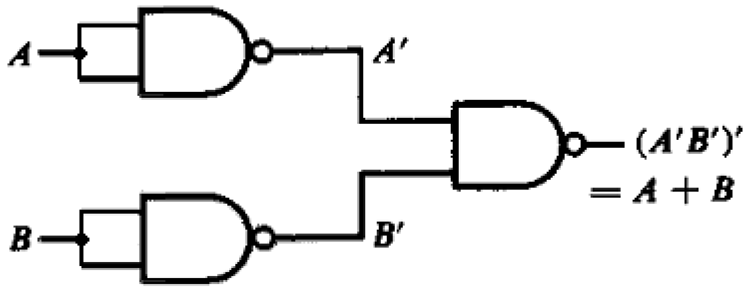
AND

NAND gates as OR gate

From DeMorgan's theorems: (A.B)' = A' + B'

=> (A'.B')' = A'' + B'' = A + B

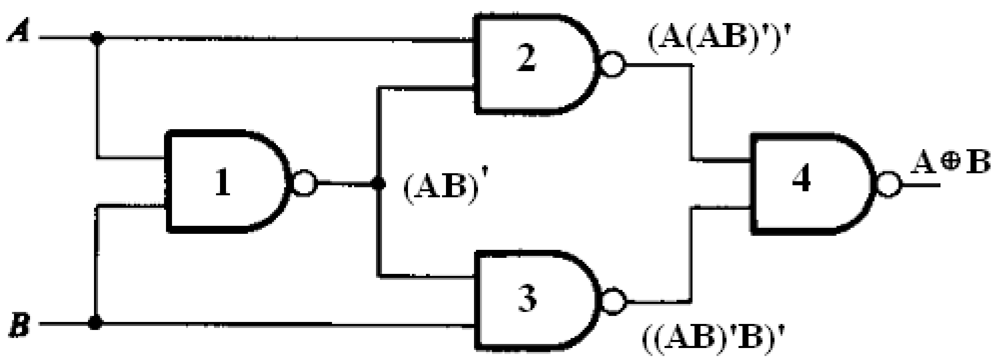
So, give the inverted inputs to a NAND gate, obtain OR operation at output.



OR

NAND gates as X-OR gate

The output of a to input X-OR gate is shown by: Y = A'B + AB'. This can be achieved with the logic diagram shown in the left side.



X-OR

Gate No.	Inputs	Output
1	A, B	(AB)'
2	A, (AB)'	(A (AB)')'
3	(AB)', B	(B (AB)')'
4	(A (AB)')', (B (AB)')'	A'B + AB'

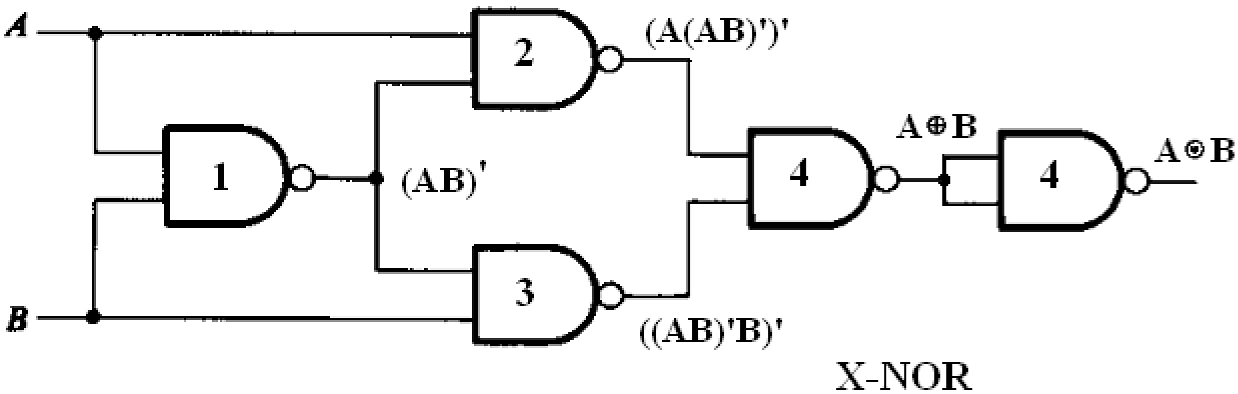
Now the ouput from gate no. 4 is the overall output of the configuration.

$$Y = ((A(AB)')'(B(AB)')')'$$
$$= (A(AB)')'' + (B(AB)')''$$
$$= (A(AB)') + (B(AB)')$$
$$= (A(A' + B')) + (B(A' + B'))$$
$$= (AA' + AB') + (BA' + BB')$$
$$= (0 + AB' + BA' + 0)$$
$$= AB' + BA'$$
$$\Rightarrow Y = AB' + A'B$$

NAND gates as X-NOR gate

X-NOR gate is actually X-OR gate followed by NOT gate. So give the output of X-OR gate to a NOT gate, overall ouput is that of an X-NOR gate.

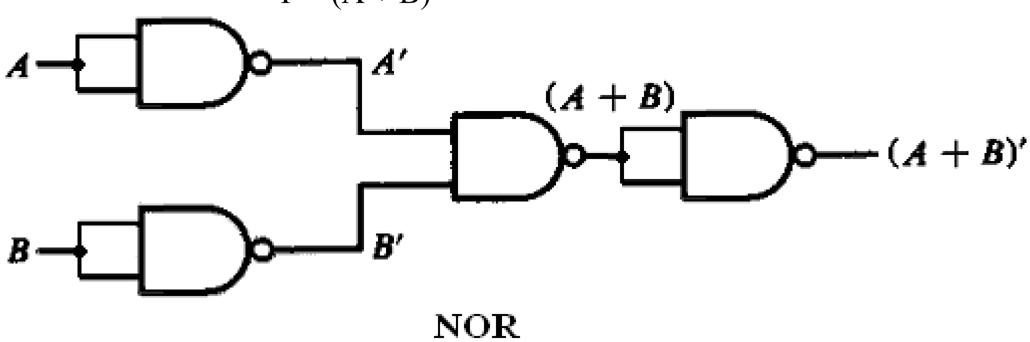
Y = AB+ A'B'



NAND gates as NOR gate

A NOR gate is an OR gate followed by NOT gate. So connect the output of OR gate to a NOT gate, overall output is that of a NOR gate.

Y = (A + B)'

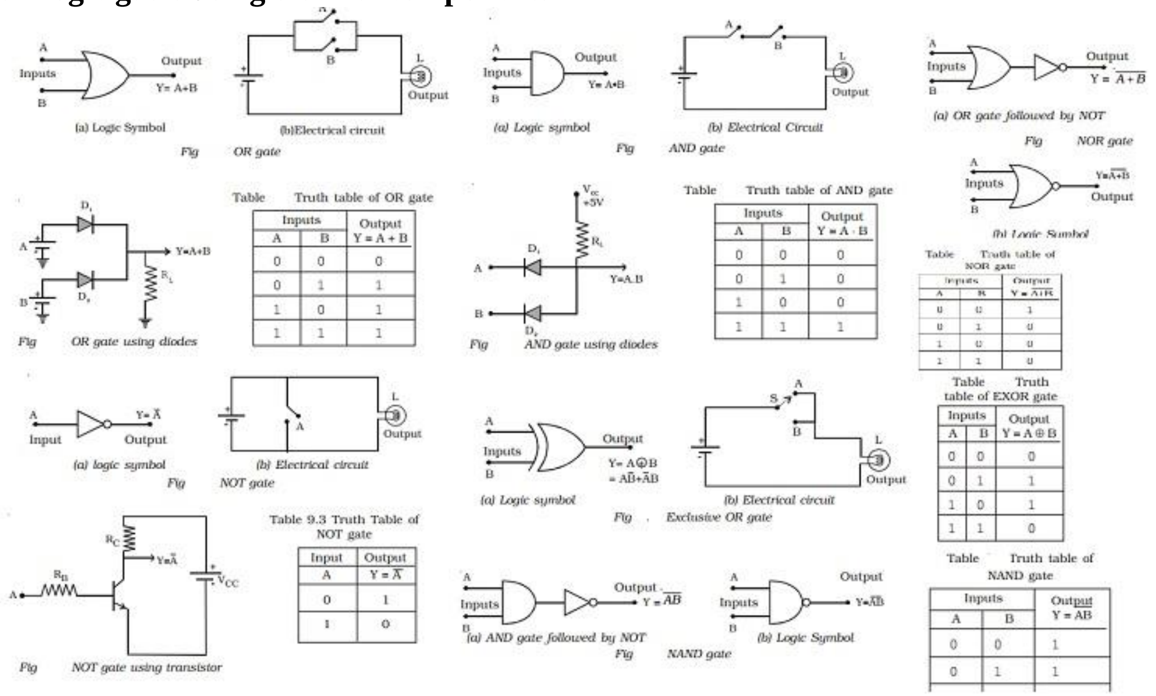


<u>Procedure:</u>

1. Connect the trainer kit to ac power supply.
2. Connect the NAND gates for any of the logic functions to be realised.
3. Connect the inputs of first stage to logic sources and output of the last gate to logic indicator.
4. Apply varous input combinations and observe output for each one.
5. Verify the tructh table for each input/ output combination.
6. Repeat the process for all logic functions.
7. Switch off the ac power supply.

Experiment No: 8

Basic logic gates using discrete components



The basic elements that make up a digital system are 'OR', 'AND' and 'NOT' gates. These three gates are called basic logic gates. All the possible inputs and outputs of a logic circuit are represented in a table called TRUTH TABLE. The function of the basic gates are explained below with circuits and truth tables.

Logic gates

Circuits which are used to process digital signals are called logic gates. They are binary in nature. Gate is a digital circuit with one or more inputs but with only one output. The output appears only for certain combination of input logic levels. Logic gates are the basic building blocks from which most of the digital systems are built up. The numbers 0 and 1 represent the two possible states of a logic circuit. The two states can also be referred to as 'ON and OFF' or 'HIGH and LOW' or 'TRUE and FALSE'.

Basic logic gates using discrete components

The basic elements that make up a digital system are 'OR', 'AND' and 'NOT' gates. These three gates are called basic logic gates. All the possible inputs and outputs of a logic circuit are represented in a table called TRUTH TABLE. The function of the basic gates are explained below with circuits and truth tables.

(i) OR gate

An OR gate has two or more inputs but only one output. It is known as OR gate, because the output is high if any one or all of the inputs are high. The logic symbol of a two input OR gate is shown in Fig a.

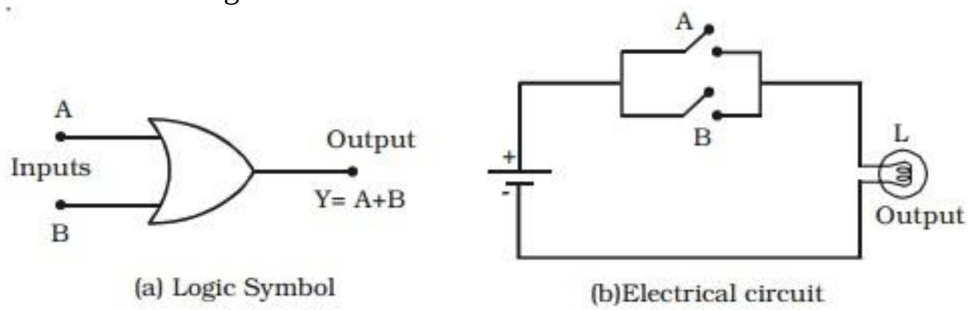


Fig OR gate

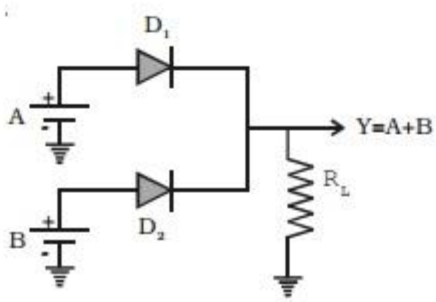


Fig OR gate using diodes

Table Truth table of OR gate

Inputs		Output
A	B	Y = A + B
0	0	0
0	1	1
1	0	1
1	1	1

The Boolean expression to represent OR gate is given by Y= A+B (+ symbol should be read as OR)

The OR gate can be thought of like an electrical circuit shown in Fig b, in which switches are connected in parallel with each other. The lamp will glow if both the inputs are closed or any one of them is closed.

Diode OR gate

Fig shows a simple circuit using diodes to build a two input OR gate. The working of this circuit can be explained as follows.

Case (i) A = 0 and B = 0

When both A and B are at zero level, (i.e.) low, the output voltage will be low, because the diodes are non-conducting.

Case (ii) A = 0 and B = 1

When A is low and B is high, diode D_2 is forward biased so that current flows through R_L and output is high.

Case (iii) A = 1 and B = 0

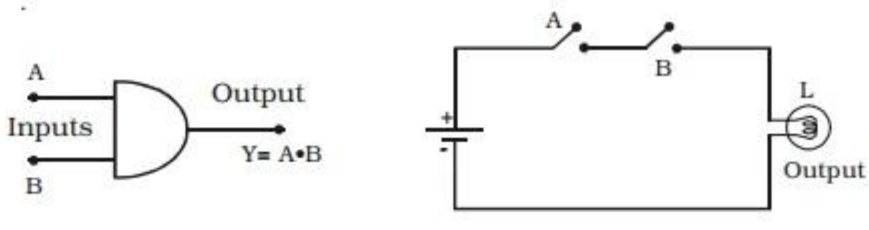
When A is high and B is low, diode D_1 conducts and the output is high.
Case (iv) A = 1 and B = 1

When A and B both are high, both diodes D_1 and D_2 are conducting and the output is high. Therefore Y is high. The OR gate operations are shown in Table

(ii) AND gate

An AND gate has two or more inputs but only one output. It is known as AND gate because the output is high only when all the inputs are high. The logic symbol of a two input AND gate is shown in Fig a.
Y = A·B (· should be read as AND)

AND gate may be thought of an electrical circuit as shown in Fig b, in which the switches are connected in series. Only if A and B are closed, the lamp will glow, and the output is high.



(a) Logic symbol (b) Electrical Circuit

Fig AND gate

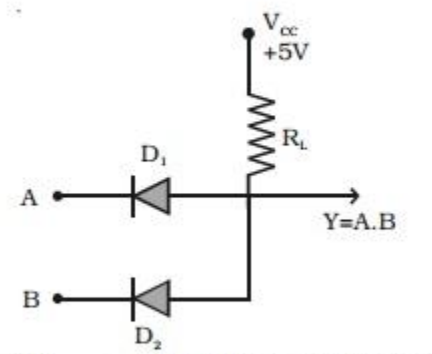


Fig AND gate using diodes

Table Truth table of AND gate

Inputs		Output
A	B	Y = A · B
0	0	0
0	1	0
1	0	0
1	1	1

Diode AND gate

Fig shows a simple circuit using diodes to build a two-input AND gate. The working of the circuit can be explained as follows :

Case (i) A = 0 and B = 0

When A and B are zero, both diodes are in forward bias condition and they conduct and hence the output will be zero, because the supply voltage V_{CC} will be dropped across R_L only. Therefore Y = 0.

Case (ii) A = 0 and B = 1

When A = 0 and B is high, diode D_1 is forward biased and diode D_2 is reverse biased. The diode D_1 will now conduct due to forward biasing. Therefore, output Y = 0.

Case (iii) A = 1 and B = 0

In this case, diode D_2 will be conducting and hence the output Y = 0.

Case (iv) A = 1 and B = 1

In this case, both the diodes are not conducting. Since D_1 and D_2 are in OFF condition, no current flows through R_L. The output is equal to the supply voltage. Therefore Y = 1.

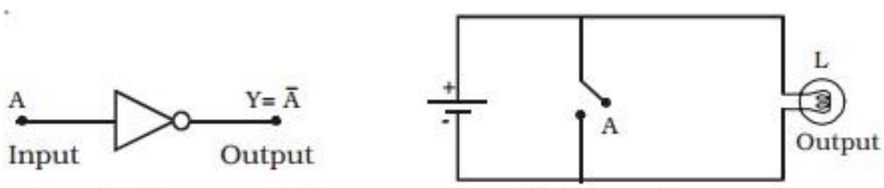
Thus the output will be high only when the inputs A and B are high. The Table 9.2 summarises the function of an AND gate.

(iii) NOT gate (Inverter)

The NOT gate is a gate with only one input and one output. It is so called, because its output is complement to the input. It is also known as inverter. Fig a shows the logic symbol for NOT gate.

The Boolean expression to represent NOT operation is $Y = A$.

The NOT gate can be thought of like an electrical circuit as shown in Fig b. When switch A is closed, input is high and the bulb will not glow (i.e) the output is low and vice versa.



(a) logic symbol (b) Electrical circuit

Fig NOT gate

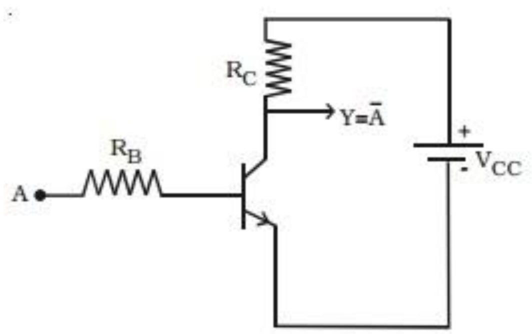


Fig NOT gate using transistor

Table 9.3 Truth Table of NOT gate

Input	Output
A	$Y = \bar{A}$
0	1
1	0

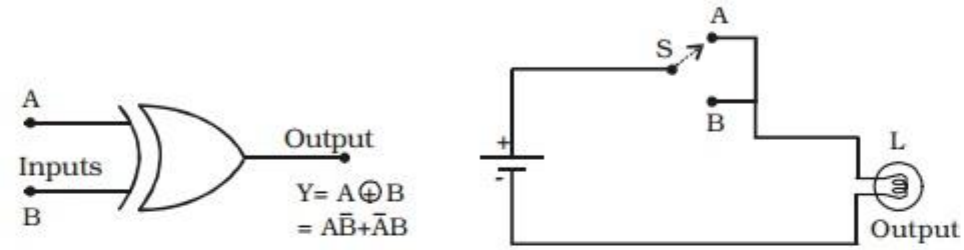
Fig is a transistor in CE mode, which is used as NOT gate. When the input A is high, the transistor is driven into saturation and hence the output Y is low. If A is low, the transistor is in cutoff and hence the output Y is high. Hence, it is seen that whenever input is high, the output is low and vice versa. The operation of NOT gate is shown in Table 9.3.

Exclusive OR gate (EXOR gate)

The logic symbol for exclusive OR (EXOR) gate is shown in

The Boolean expression to represent EXOR operation is

Y = A ⊕ B
EXOR gate has an output 1, only when the inputs are complement to each other.
The equivalent switching circuit is shown in Fig b.



(a) Logic symbol (b) Electrical circuit

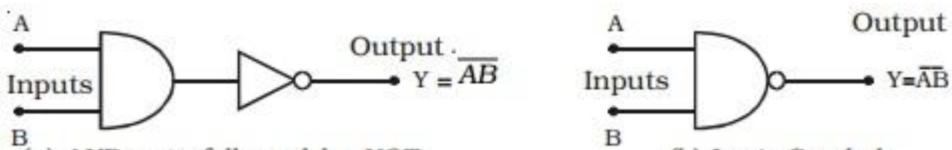
Fig . Exclusive OR gate

Table Truth table of EXOR gate

Inputs		Output
A	B	Y = A ⊕ B
0	0	0
0	1	1
1	0	1
1	1	0

Switch positions A and B will individually make the lamp to be ON. But the combination of A and B is not possible.
The EXOR operation is represented in Table.

NAND gate
This is a NOT-AND gate. It can be obtained by connecting a NOT gate at the output of an AND gate (Fig a).
The logic symbol for NAND gate is shown in Fig b.
NAND gate function is reverse of AND gate function. A NAND gate will have an output, only if both inputs are not 1. In other words, it gives an output 1, if either A or B or both are 0. The
operation of a NAND gate is represented in Table.



(a) AND gate followed by NOT *(b) Logic Symbol*

Fig NAND gate

Table Truth table of NAND gate

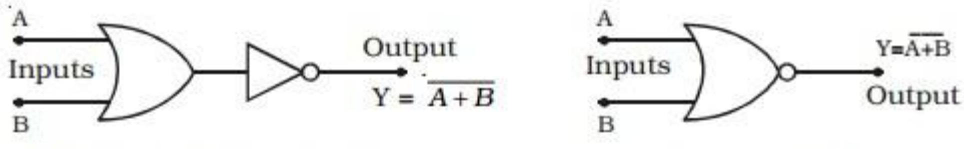
Inputs		Output Y = AB
A	B	
0	0	1
0	1	1

NOR gate

This is a NOT-OR gate. It can be made out of an OR gate by connecting an inverter at its output (Fig a).

The logic symbol for NOR gate is given in Fig b

The NOR gate function is the reverse of OR gate function. A NOR gate will have an output, only when all inputs are 0. In a NOR gate, output is high, only when all inputs are low. The NOR operation is represented in Table.



(a) OR gate followed by NOT *(b) Logic Symbol*

Fig NOR gate

Table Truth table of NOR gate

Inputs		Output
A	B	Y = $\overline{A+B}$
0	0	1
0	1	0
1	0	0
1	1	0

Experiment No: 9

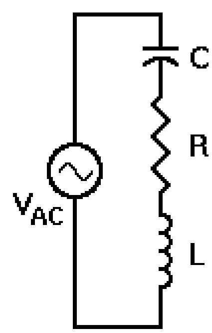
To study the variation in current and voltage in Series LCR Circuits

Aim:

1.To study the variation in current and voltage in a series LCR circuit
2.To find the resonant frequency of the circuit.

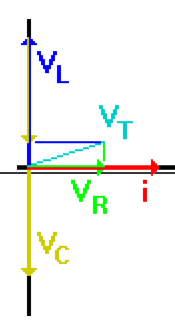
Theory:

f = 10 Hz
E= 100 V RMS
L = 2 H
C = 0.0003 F
R = 10 Ω
Our measured voltages come out as follows:
V_L = 171.66 V
V_C = 72.6 V
V_R = 13.68 V



The Vectors:

We must take into account the different phase angles between voltage and current for each of the three components in the circuit. The vector diagram to the right illustrates this concept.



Since this is a series circuit, the same current passes through all the components and therefore our reference is at a phase angle of 0°. This is shown in red in the diagram. The voltage across the resistor, V_R, is in phase with the current and is shown in green. The blue vector shows V_L at +90°, while the gold vector represents V_C, at -90°. Since they oppose each other diametrically, the total reactive voltage is $V_L - V_C$. It is this difference vector that is combined with V_R to find V_T (shown in cyan in the diagram).

We know that V_T = 10 V RMS. Now we can see thatV_T is also the vector sum of ($V_L - V_C$) and V_R. In addition, because of the presence of R, the phase angle between V_T and "i" will be arc tan((V_L-V_C)/V_R), and can vary from -90° to +90°.

The Mathematics:

Voltage and current calculation for this circuit are based on Ohm's Law. Our basic expressions are:

$$i_L = \frac{V_L}{X_L} \quad ; \quad i_C = \frac{V_C}{X_C} \quad ; \quad i_R = \frac{V_R}{R} \quad ; \quad i = \frac{V}{Z}$$

Since this is a series circuit, the value of "i" in each expression is the same. That is

$$i_L = i_C = i_R = i$$

and we can use i as our reference value for our calculations. We will also need to know the value of ω (= 2πf) to determine X_L and X_C. For f = 10 Hz,

$$\omega = 2\pi f = 62.831853$$

Now we can complete our calculations, starting with X_L, X_C, and Z:

$$X_L = \omega L \approx 125.6637\ \Omega$$

$$X_C = 1/\omega c \approx 53.0618\ \Omega$$

$$Z = ((X_L - X_C)^2 + R^2)^{1/2} \approx 73.2874\ \Omega$$

$$i = \frac{V}{Z} \approx 1.37\ A$$

$$V_L = i \times X_L \approx 171.4\ V$$

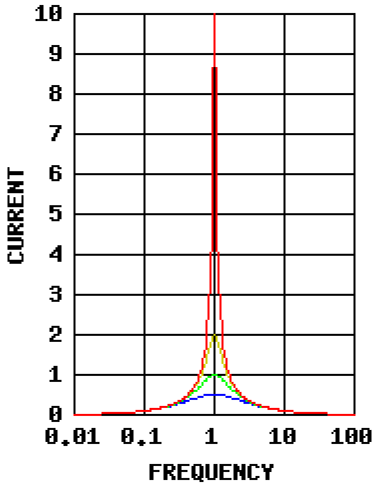
$$V_C = i \times X_C \approx 72.4\ V$$

$$V_R = i \times R \approx 13.6\ V$$

$$V = ((V_L - V_C)^2 + V_R^2)^{1/2} \approx 99.9288\ V \approx 100\ V$$

Allowing for calculator round-off errors through all these calculations, the total voltage V is exactly 100 volts, which is what we initially specified. Therefore our calculations check out and our results are valid.

Resonance and Effect of R:



At very low frequencies, capacitor C will be an open circuit, and virtually no current will flow through the circuit. At very high frequencies, inductor L will be an open circuit, and again no current will flow. However, at intermediate frequencies, both X_C and X_L will be moderate, and the difference between them will be small. At resonance, that difference will be zero, and only R will limit the current flow in the circuit.

The graph to the right shows normalized values of current through a series RLC circuit at frequencies ranging from 0.01 times the resonant frequency, to 100 times that frequency. Beyond that range, as you can see from the graph, no significant current will flow at all. Within that range, current depends primarily on the value of R.

(Note that these values are used specifically to obtain a normalized graph. Once we have the graph, we can change the component values. Even though the resonant frequency and relative value of R changes, the shape of the curve will always be the same, as long as the ratio L/C remains constant. We'll see shortly what happens as that ratio changes.)

In a fully normalized circuit, R = 1Ω. This will permit a current of 1 A to flow at resonance, as indicated by the green curve on the graph. Similarly, if we set R as 2Ω the current will be 0.5 A at resonance. The blue curve shows this.

The remaining curves show what happens if we reduce R. The yellow curve shows current when R = 0.5Ω, while the red curve is for R = 0.1Ω.

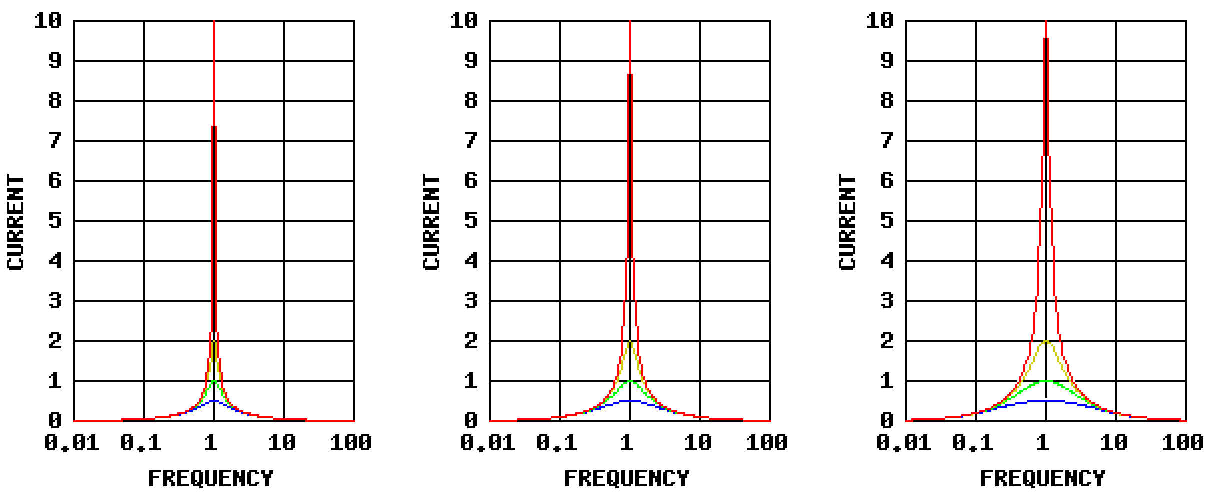
Note that for low values of R, the current at resonance peaks much higher, but falls off very quickly as frequency changes. For higher values of R, the curve is much broader, and maximum current remains much lower. This is the standard trade-off between bandwidth and maximum current, and the value of R is critical for controlling this factor.

Changing the Ratio of L/C:

When we change the ratio of L/C, we change the reactance of both components at any given frequency without changing the resonant frequency. This is accomplished by making sure that the product of L and C remains constant even when we change their ratio. Thus, if L = 1H and C = 1f, LC = 1 and L/C = 1. However, if L = 2H and C = 0.5f, we still have LC = 1, but now L/C = 4. Or, if L = 0.5H and C = 2f, L/C = 0.25.

By changing L and C in this manner, we change the values of XL and XC at and near the resonant frequency without changing the resonant frequency itself. This controls the overall impedance of the circuit at frequencies near resonance and gives the resistor, R, either more or less control over current at those frequencies. The result is a change in the frequency range over which this circuit will conduct significant amounts of current. The following three graphs illustrate this:

L/C = 4
L/C = 1
L/C = 0.25



When we plot the curves this way, it becomes clear that as we increase the L/C ratio, we limit the circuit to passing current over an increasingly narrow band of frequencies. However, as we reduce the L/C ratio, we widen the frequency band over which this circuit will pass significant amounts of current. This becomes very important when we deal with certain types of filters, and especially with tuned circuits.

This can be verified using the simulator by creating the above mentioned series LCR circuit and by measuring the current and voltage across the inductor, capacitor and resistor. The values should be consistent with the earlier findings.

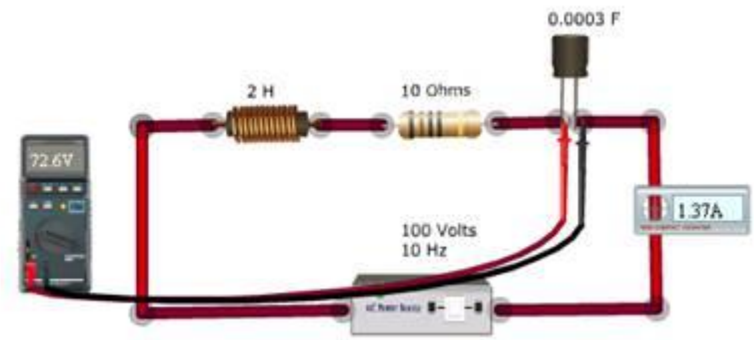


fig:1

Applications:

1. LCR series circuit is also known as tuned or acceptor circuit.They have many applications particularly for oscillating circuits.
2. Series LCR circuit has applications in radio and communication engineering.
3. They can be used to select a certain narrow range of frequencies from the total spectrum of ambient radiowaves.For eg:AM/FM radio with analog tuners use a RLC circuit to tune a radio frequency.

Experiment No: 10

To Study the of variation in current and voltage in Parallel LCR Circuits

Aim:

1. To study the variation in current and voltage in a parallel LCR circuit.
2. To find the resonant frequency of the designed parallel LCR circuit.

Apparatus:
AC power source, Rheostat, Capacitor, Inductor, Reisistor, Voltmeter, Ammeter, connection wire etc.

Theory:

The schematic diagram below shows three components connected in parallel and to an ac voltage source: an ideal inductor, and an ideal capacitor, and an ideal resistor. In keeping with our previous examples using inductors and capacitors together in a circuit, we will use the following values for our components:

1. $V_{ac} = 100\ VRMS$
2. $f = 10\ Hz$
3. $L = 2\ H$
4. $C = 0.0003\ F$
5. $R = 10\ \Omega$

According to Ohm's Law:

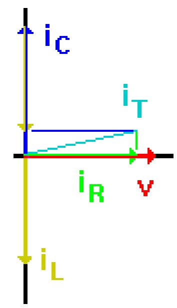
$$i_L = \frac{V_L}{X_L} = 0.8\ A \quad ; \quad i_C = \frac{V_C}{X_C} = 1.89\ A \quad ; \quad i_R = \frac{V_R}{R} = 10\ A$$

If we measure the current from the voltage source, we find that it supplies a total of 10.06 A to the combinedload.

So we now have 10 A of resistive current and just over 1.09 A of reactive current and yet the measured total current is 10.06 A. By now, you probably expected this, and you're familiar with the reasons for this apparent discrepancy. Nevertheless, it is worthwhile to complete the exercise and study this circuit in detail.

The Vectors:

As usual, the vectors, shown to the right, tell the story. Since this is a parallel circuit, the voltage, V ,is the same across all components. It is the current that has different phases and amplitudes within the different components. Since voltage is the same throughout the circuit, we use it as the reference at 0°. Current through the resistor is in phase with the voltage dropped across that resistor, so i_R also appears at 0°.



Current through an inductor lags the applied voltage, so i_L appears at -90°. Current through a capacitor leads the applied voltage, so i_C appears at +90°. Since i_C is greater than i_L, the net reactive current is capacitive, so its phase angle is +90°.

Now the total current, i_T, is the vector sum of reactive current and resistive current. Since i_R is significantly greater than the difference, i_C - i_L, the total impedance of this circuit is mostly resistive, and the combined vector for i_T is at only a small phase angle, as shown in the diagram.

The Mathematics:

Now we have a pretty clear idea of how the currents through the different components in this circuit relate to each other, and to the total current supplied by the source. Of course, we could draw these vectors precisely to scale and then measure the results to determine the magnitude and phase angle of the source current. However, such measurements are limited in precision. We can do far better by calculating everything and then using experimental measurements to verify that our calculations fit the real-world circuit.

We start with a few basic expressions:

$$i_T = (i_X^2 + i_R^2)^{1/2}$$

$$\emptyset = arctan\ \frac{i_X}{i_R}$$

Where,

$$i_X = i_C - i_L$$

$$\emptyset = Phase\ angle$$

Now simply insert the values we determined earlier and solve these expressions:

$$i_T = (i_X^2 + i_R^2)^{1/2}$$

$$= 10.06\ A$$

$$\emptyset = arctan\ \frac{i_X}{i_R}$$

$$= 6.214°$$

These figures match the initial measured value for current from the source and fit the rough vector diagram as well. Therefore, we can be confident that our calculations and diagram are accurate.

When $X_L = X_C$

When a circuit of this type operates at resonance, so that $X_L = X_C$, it must also follow that $i_L = i_C$. Therefore, $i_C - i_L = 0$, and the only current supplied by the source is i_R.

This is in fact the case. At resonance, current circulates through L and C without leaving these two components, and the source only needs to supply enough current to make up for losses. In this case, R represents the energy losses within the circuit and R is the only component that draws current from the source. The effective impedance of the circuit is nothing more than R, and the current drawn from the source is in phase with the voltage.

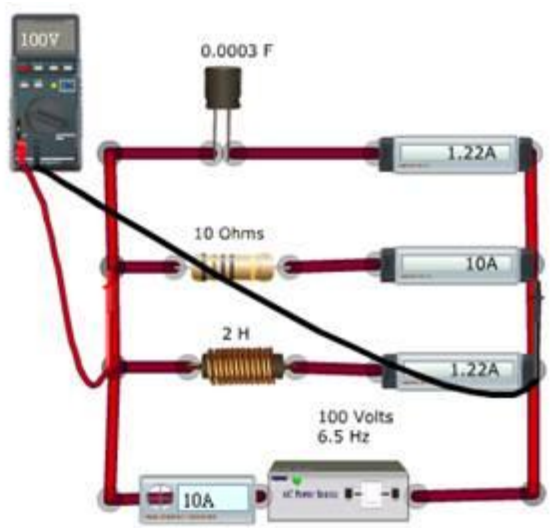
This can be verified using the simulator by creating the above mentioned parallel LCR circuit and by measuring the current and voltage across the inductor, capacitor and resistor. The values should be consistent with the earlier findings.

Applications:

It can be used as

1. Voltage multiplier
2. Pulse discharge circuit
3. Signal Processing
4. Filters
5. Oliver Heaviside

   At resonance the effective impedance of the circuit is nothing more than R, and the current drawn from the source is in phase with the voltage. The resonance frequency in our example is 6.5 Hz.



Experiment No: 11

Transistor characteristics - CE & CB

Aim:

To determine the CE and CB transistor characteristics of the given transistor.

Material required:

- Rheostat
- Voltmeter

- Ammeter
- Battery
- One way key
- Transistor
- Bread board

Real Lab Procedure:

- Connections are made as shown in the circuit diagram.
- The rheostat Rh_1 is used to vary base voltage (input voltage) V_{BE} and it is read from voltmeter V_1. The base current (input current) I_B is measured using a microammeter (μA). The collector voltage (output voltage) V_{CE} is varied using the rheostat Rh_2 and readings are noted from voltmeter V_2. The collector current (output current) I_C is measured by the milliammeter (mA).

Input Characteristics

- The collector voltage V_{CE} is kept constant (eg. 1V) by adjusting the rheostat Rh_2.
- The base voltage V_{BE} is varied from zero by adjusting the rheostat Rh_1.
- The base current I_B is noted in each step.
- A graph is drawn with V_{BE} along X-axis and I_B along Y-axis.
- The experiment is repeated with V_{CE} kept constant say 2V, 3V, 4V etc. and corresponding graphs are plotted.

Output characteristics

- The base current I_B is kept constant (eg. 20μA) by adjusting the rheostat Rh_1.
- Now the collector voltage is increased by adjusting the rheostat Rh_2.
- The corresponding collector current I_C is noted.
- A graph is drawn with V_{CE} along X-axis and I_C along Y-axis.
- The experiment is repeated with keeping IB constant, say 40μA, 60μA, 80μA etc and similar graphs are plotted.

Observations:
Input characteristics

V_{CE} (1V)	V_{BE} (V)		
	I_B (μA)		

V_{CE} (2V)				
V_{CE} (3V)				
V_{CE} (4 V)				

Output characteristics

I_B (μA)	V_{CE} (V)			
	I_C (mA)			
I_B (μA)				
I_B (μA)				
I_B (μA)				

Results:
The graphs shows the input and output characteristics of a transistor.