G.L.A. University, Mathura
Department of Electrical & Electronics Engg.
Electrical & Electronics Engg. Lab
B. Tech, 1st Year (Common to all Branches)

LIST OF EXPERIMENTS

1. To verify the Thevenin's theorem (DC circuits).
2. To verify the maximum power transfer theorem (DC circuits). Also draw graph between power and load resistance.
3. To study the phenomenon of resonance in series R-L-C circuit and to draw the graph between frequency and current.
4. To determine the V-I characteristics of a semiconductor diode. Also calculate forward and reverse static and dynamic resistances.
5. To study the working of a Half-Wave & Full Wave (Bridge type) rectifier and determine the ripple factor for both cases.
6. To determine the efficiency of a single phase transformer by direct load testing and draw a graph between load and efficiency.
7. To study the application of CRO i.e. (current measurement, voltage measurement and frequency measurement).
8. To study single phase (induction type) energy meter and calibrate with a digital energy meter.
9. To study various logic gates such as OR, AND, NOT, NAND, NOR.
10. To verify the Superposition Theorem (DC circuits).

G.L.A. University, Mathura
Department of Electrical & Electronics Engg.
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B. Tech, 1st Year

Experiment No.: ……

OBJECT: To verify the Thevenin's theorem (in dc circuit).

PRE-EXPERIMENT QUESTIONS:
1. State Thevenin theorem.
2. How are independent current and voltage sources taken into account while calculating R_{th} (Thevenin equivalent resistance)?
3. For which type of circuits Thevenin theorem is applicable?

APPARATUS:

S. No.	Apparatus	Range	Qty.
1.	Regulated DC power supply	0-30V, 2A	1
2.	Voltmeter (PMMC)	0-30/60V	1
3.	Ammeter (PMMC)	0-1/2A	1
4.	Rheostat	0-30Ω, 5.5 A	3
5.	Multimeter	-	1

THEORY:

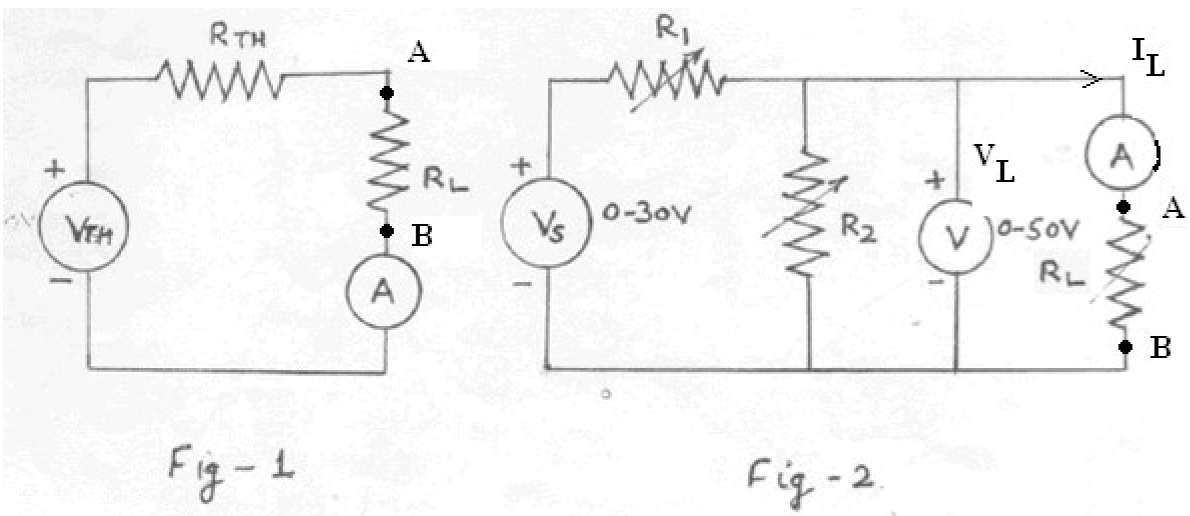
According to Thevenin's theorem, any two terminal linear network containing passive (resistance/impedance) and active elements (energy sources/generators) can be replaced with an equivalent circuit consisting of a voltage source, V_{th} (which is equal to open circuit voltage V_{oc}) in series with an equivalent resistance, R_{th}. Open circuit voltage, V_{oc} between the two terminals of network such as AB is obtained by opening the circuit at AB. The series resistance R_{th} is the resistance of the network looking back into the network from the terminals AB with the sources replaced by their internal resistances. Thevenin equivalent circuit is shown in figure 1. The current in the load resistance R_L is given by

$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

PROCEDURE:

1. Connect the circuit as shown in figure 2.
2. Measure the current I_L flowing through & voltage V_L across the load resistance R_L and note it.
3. Measure the resistance R_{th} of the circuit between the terminals A and B (with the voltage sources replaced by short circuit) with the help of multimeter.
4. Measure the open circuit Voltage V_{oc} across the terminals AB after disconnecting R_L from the circuit.
5. Calculate I_L, where $I_L = V_{oc}/(R_{TH} + R_L)$.
6. Compare the calculated value of I_L with the observed value.

CIRCUIT DIAGRAM:



OBSERVATION:

Supply Voltage V_{dc} = Load Voltage V_L =

Load Current I_L =

Open circuit Voltage V_{oc} =

CALCULATIONS:

$$R_{TH} = R_1 \parallel R_2 = \frac{R_1 \times R_2}{R_1 + R_2}$$

$$V_{oc} = V_{TH} = \frac{R_2 \times V_s}{R_1 + R_2}$$

$$I_L = \frac{V_{TH}}{R_{TH} + R_L}$$

RESULT:

1. I_L by observation and calculation are _________ and ___________.

2. $\%\,\text{error} = \dfrac{\text{observed value} - \text{calculated value}}{\text{calculated value}} \times 100$

PRECAUTIONS:

1. All connections should be tight.
2. Reading should be taken carefully.
3. Do not touch live terminals.

POST EXP. QUESTIONS:

1. Explain linear and non-linear circuits.
2. What do you mean by ideal and practical voltage & current sources?

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B. Tech, 1st Year

Experiment No.: ……

OBJECT: To verify the maximum power transfer theorem in D. C. Circuit and draw the graph between power transferred to the load and load resistance.

PRE EXP. QUESTIONS:

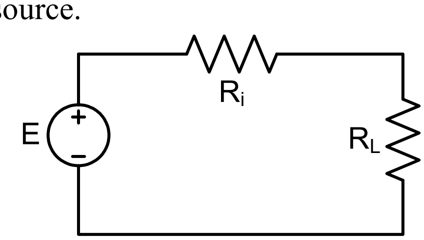
1. For which type of circuits, maximum power transfer theorem finds application?
2. What is the necessary condition for maximum power transfer in DC circuits?

APPARATUS:

S. No.	Apparatus	Range/Rating	Qty.
1	DC Regulated Power Supply	0-30 V, 2A	1
2	Ammeter (PMMC type)	0-1/0-2 A	1
3	Voltmeter (PMMC type)	0-30/60 V	1
4	Rheostat	0-30Ω, 5 A	2

THEORY:

Consider a source transmitting power to a load resistance R_L as shown in fig.1. Let E be the voltage generated at the source and R_i is the internal resistance of source.



The current delivered to the load resistance,

$$I = \frac{E}{R_i + R_L}$$

Power delivered to load resistance, $P = I^2 R_L$

$$= \frac{E^2 R_L}{\left(R_i + R_L\right)^2}$$

To find the maximum value of power, differentiating the above expression w.r.t. R_L and equating to zero. Thus

$$\frac{dP}{dR_L} = \frac{E^2\left(R_i + R_L\right)^2 - 2R_L\left(R_i + R_L\right)E^2}{\left(R_i + R_L\right)^4} = 0$$

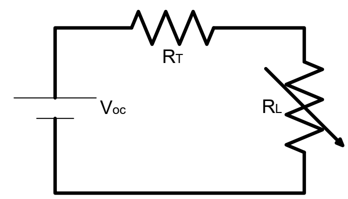
or $\quad R_L = R_i$

Thus the condition for the maximum power transfer is that the load resistance R_L should be equal to R_i. The value of maximum power transferred is:-

$$P_{\max} = \frac{E^2}{4R_i}.$$

Thus for D.C. networks, the theorem may be stated as follows:

A resistance load will abstract maximum power when the load resistance value R_L is same as the resistance viewed by the load as it looks back into the network, R_i.



If the resistance R_i is calculated using Thevenin's theorem, and is called R_T, then maximum power will be drawn, when $R_L = R_T$ and the value of maximum power will be equal to $\frac{V_{oc}^2}{4R_L}$, when V_{oc} is the open circuit voltage at the terminals from which R_L has been disconnected.

PROCEDURE:

1. Set up the circuit according to given figure.1.
2. Disconnected the load resistance, R_L from the circuit and measure the resistance between the terminals A and B using a multimeter. Let this resistance be R_i.
3. Reconnect the load resistance R_L at the terminals A, B. Now gradually increase the value of load resistance and take the reading of voltmeter and ammeter. Calculate the power transferred as $V_L I_L$.
4. Draw curve between power transferred Versus load resistance. The load resistance corresponding to peak of the curve is the value of the load resistance necessary to transfer maximum power.

The value of R_L at this reading can be obtained by ammeter and voltmeter readings. This value should be equal to R_i.

CIRCUIT DIAGRAM:

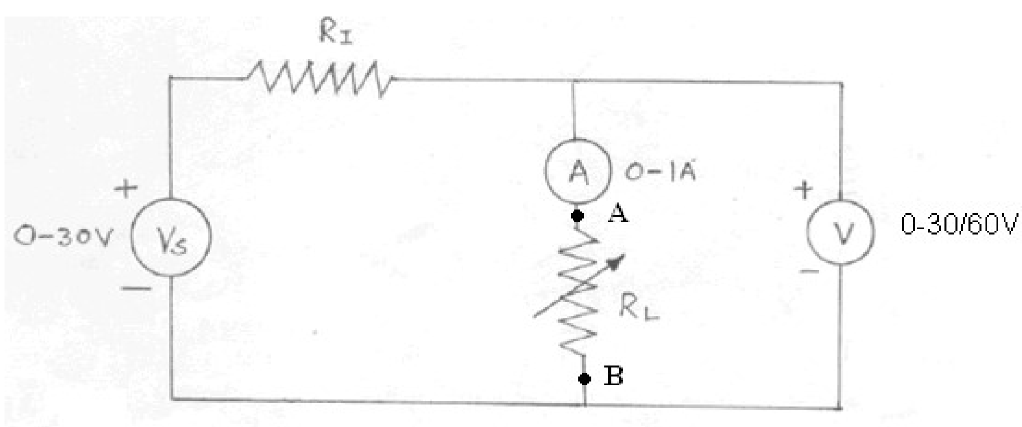


Fig - 1

OBSERVATION TABLE: R_i = …….Ω (as measured by the multi-meter)

S.No.	Voltage, V_l (Volts)	Current, I_l (Amps)	Power, W (Watts)	Load Resistance $R_l = V_l / I_l$ (Ohms)
1.				
2.				
3.				
4.				
5.				
6.				
7.				

CALCULATION: Power in a resistive circuit = $V_L I_L$ Watt

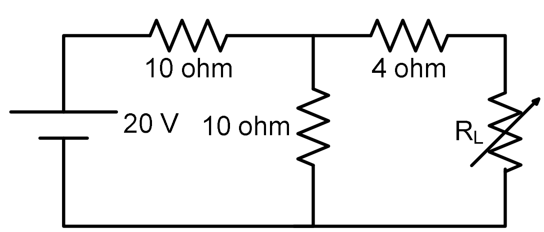
RESULT: Value of R_L at maximum power transfer …………….Ω.

PRECAUTIONS:

1. Apparatus should be of proper range.
2. Connections should be tight. Live terminals should not be touched.
3. Reading should be taken carefully.

POST EXP. QUESTIONS:

1. State and explain maximum power transfer theorem.
2. How is this theorem useful?
3. What is the efficiency at maximum power transfer condition?
4. In the network shown in figure, determine the value of load resistance R_L to give maximum power transfer and the power delivered to the load.



THE GRAPH BETWEEN POWERS TRANSFERRED TO THE LOAD AND LOAD RESISTANCE:

G.L.A. University, Mathura
Department of Electrical & Electronics Engg.
Electrical & Electronics Engg. Lab
B. Tech, 1st Year

Experiment No.: ….

OBJECT: To study the phenomenon of resonance in series R-L-C circuit and to draw the graph between frequency and current.

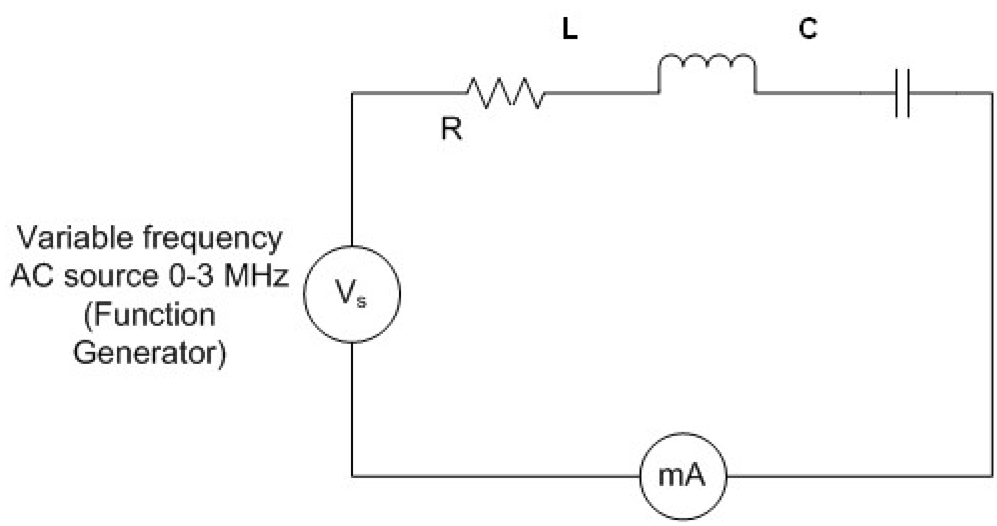
PRE EXP. QUESTIONS:

1. What do you mean by resonance?
2. What is resonant frequency in series RLC circuit?
3. What is the Q factor of a series circuit?

APPARATUS:

S. No.	Item	Range	Quality
1.	Function Generator	0-3 MHz	1
2.	Circuit elements	R_L=110 ohm, L=0.13 mH, C=0.47 μF	1
3.	Milli Ammeter	0-100 mA	1

CIRCUIT DIAGRAM:



THEORY:

Consider an ac circuit containing resistance R, an inductance L and a capacitance C connected in series as shown in figure. The impedance of the circuit is given by:-

$$Z = \frac{V}{I} = \sqrt{\left\{R^2 + \left(X_L - X_C\right)^2\right\}}$$

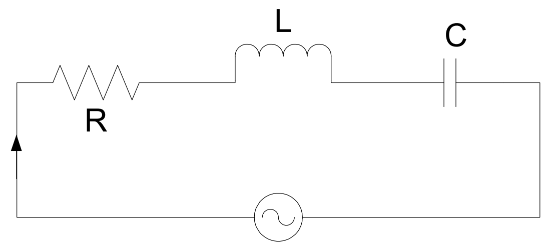


Fig.1 Circuit with R, L and C in series

where $X_L = 2\pi f L$, $X_C = 1/2\pi f C$

Figure 2 shows the effect of frequency upon the inductive and capacitive reactance and upon the resultant reactance and impedance of the circuit and variation of current. It will be seen that at a frequency OA, the inductive reactance AB and capacitive reactance AC are equal in magnitude and their resultant is zero. Consequently the impedance is equal to the resistance AD of the circuit. Furthermore as the frequency is reduced below OA or increased above OA, the impedance increases only and therefore current decreases. The voltage across L and C are equal and each is much greater than supply voltage. Such a condition is referred to as resonance.

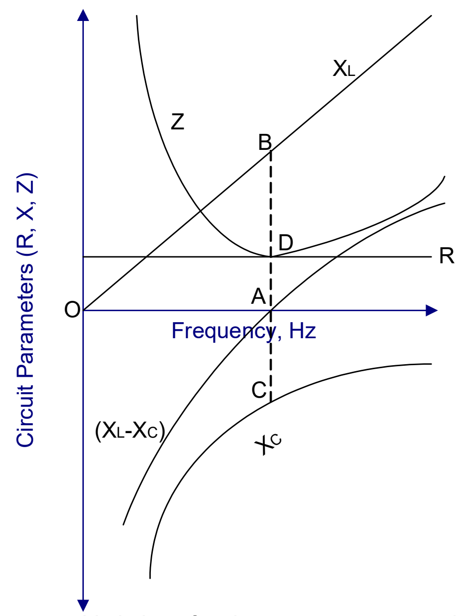
For resonance, $V_L = V_C$

$$IX_L = IX_C,\ X_L = X_C$$

$$2\pi fL = \frac{1}{2\pi fC},$$

then $f = \dfrac{1}{2\pi\sqrt{LC}}$, f is called resonant frequency

At this frequency Z =R and I = V/R, if the resistance is small compared to X_L or X_C then the potential drops across the latter namely $X_L \times I$ and $X_C \times I$ are many times the supply voltage.



Variation of resistance, reactance and impedance with frequency
Fig.2

It is an effect i.e. extremely important in communication for example radio as it provides a simple method of increasing the sensitivity of a receiver as it gives selectivity i.e. it enables a signal of given frequency to be considerable magnified so that it can be separated from signals of other frequencies.

The degree of predomination of energy oscillation between inductor and resistor is important since better is the ratio of predominance, better the circuit is able to accept current at resonant frequency to the exclusion of other frequency. The degree of predomination is given a factor of goodness termed the Q-factor. Thus

$$Q - factor = \frac{I^2 X_L}{I^2 R} = \frac{\omega_r L}{R}$$

$$= \frac{IX_L}{IR} = \frac{V_L}{V_R}, \text{ which is voltage magnification at resonance}$$

$$\therefore Q - factor = \frac{2\pi fL}{R}$$

The series resonant circuit is often referred to as an acceptor, since the current is maximum at resonance.

PROCEDURE:

1. Connect a series R-L-C circuit as shown in the fig.
2. Connect the circuit to a variable frequency ac voltage source.
3. Now vary the frequency of the source starting from 1 kHz in steps of 3 kHz so that the current first starts increasing, reaches a peak value and then decreases with increase in frequency of the source.
4. Note the value of the frequency corresponding to maximum current.
5. Draw the graph between current (mA) and frequency (kHz).

OBSERVATIONS TABLE:

R= L= C=

S. No.	Frequency (kHz)	Current (mA)	S. No.	Frequency (kHz)	Current (mA)

CALCULATION:

Resonant frequency

(i) By calculation

(ii) As obtained experimentally

RESULT:

PRECAUTIONS:

1. Take the readings of current in mA with equal intervals of frequency to get appropriate graph.
2. Take the readings accurately.
3. Do not touch the live terminals.

Post Exp. Questions:

1. What are half power points?
2. Explain Bandwidth.
3. What do you understand by the term quality factor?
4. What will be power factor of the circuit under resonant condition?
5. A circuit is having a resistance of 4 Ω, an inductance of 0.5 H and a variable capacitor in series is connected across 100 V, 50 Hz supply, calculate (a) capacitance to give resonance (b) voltage across the inductor and capacitor and (c) Q-factor of the circuit.

THE GRAPH BETWEEN FREQUENCY AND CURRENT

G.L.A. University, Mathura
Department of Electrical & Electronics Engg.
Electrical & Electronics Engg. Lab
B. Tech, 1st Year

Experiment No.: …….

OBJECT: To study V-I characteristics of a semi-conductor diode (a) Forward biased (b) Reverse biased.

PRE-EXPERIMENT QUESTIONS:

i. Define depletion layer. What is knee voltage?
ii. What is doping? Give its importance.

APPARATUS REQUIRED:

S. No.	Apparatus with specification	Range	Qty
1	Regulated D.C. Power Supply	0-30V, 2mA	1
2	D. C. Milli-Ammeter	0-50 mA	1
3	D. C. Micro-Ammeter	0-500 μA	1
4	D. C. Voltmeter	0-1 V	1
5	Rheostat	0-200 Ω	1
6	Connecting Wires		As per requirement

THEORY:

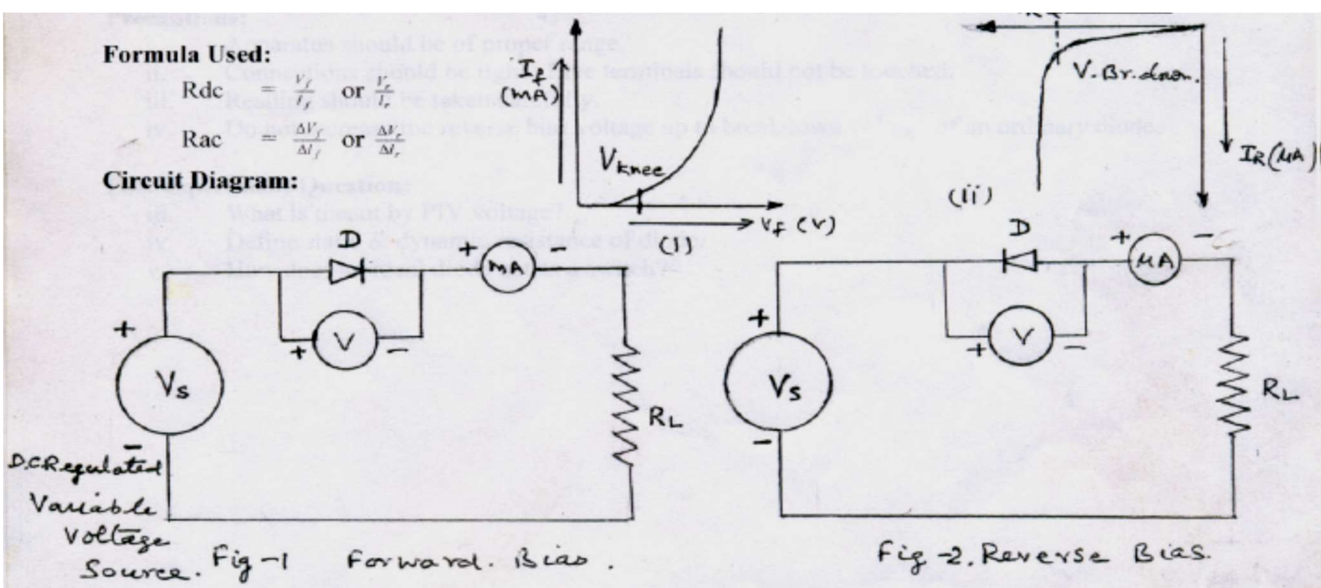
When the external voltage is zero i.e. when the circuit is open, the potential barrier at the junction does not allow the flow of current and therefore, the circuit current is zero.

Forward Characteristics:- With forward bias to the P-N junction(i.e. P-region connected to +ve terminal and N-region connected to -ve terminal of the battery) a very little current, called forward current flows until the forward voltage exceeds the junction barrier potential (0.3V for Ge and 0.7V for Si). The characteristics follow an exponential law. As the forward voltage is increased to the knee of the characteristic, the barrier potential is progressively reduced to zero, allowing more and more majority charge carriers to flow across the junction. Beyond the knee of the characteristics, the potential barrier is completely eliminated, forward current increases almost linearly with the increase in forward voltage and the P-N junction starts behaving as resistor. If the forward voltage is increased beyond a certain value extremely large current will flow and the P-N junction may get destroyed due to overheating.

Reverse Characteristics:- When the reverse bias is applied (i.e. when P-region is connected to the negative terminal and N-region is connected to the positive terminal), the potential barrier at junction is increased therefore, the junction resistance becomes very high and there is no possibility of majority carriers flowing across a reverse biased junction. But still minority carriers generated on each side can cross the junction. Electrons on the P-side are attracted across the junction to the positive potential on the N-side and holes on N-side may travel across the junction to the negative potential on the P-side. This results in a very small current. This current is called reverse current and is due to minority carriers. However on increasing reverse voltage, a point may reach at which the junction breaks down with sudden rise in reverse current. Breakdown voltage is defined as the reverse voltage at which P-N junction breaks down with sudden rise in reverse current. Peak Inverse Voltage (PIV) is the maximum reverse voltage that can be applied to the diode without damaging the junction.

A diode is a PN junction and is a unidirectional device. The current flowing in it depends upon the method of connecting the D.C. supply to it. If positive terminal is connected to P and negative to N of the PN junction this is called as forward biasing. The reversal of the above is known as reverse biasing. The magnitude of current in forward biasing is much more then the reverse biasing. The graph drawn in both cases shows the nature of change in I with V or VI characteristic. The forward characteristic is obtained by F.B. and reverse characteristic by R.B. as shown in figure.

CIRCUIT DIAGRAM:



PROCEDURE:

(a) **Forward Characteristic:**

1. Make the connections as shown in circuit diagram. Fig. 1
2. Apply the variable voltage across the diode gradually with the help of D.C. source.
3. Take the readings of voltmeter and milli-ammeter in the increasing order. Take at least five readings.
4. Plot a graph between V_f / I_f as shown in fig. 1

(b) **Reverse Characteristic:**

1. Connect the diode in reverse biasing as shown in fig. 2
2. Take the reading of voltmeter & micro-ammeter in the increasing order, by changing the supply voltage. Take 5-7 readings.
3. Draw the graph from the above reading as shown in fig.2

OBSERVATION TABLE:

S. No.	Forward Characteristic		Reverse Characteristic	
	V_f	I_f	V_r	I_r

RESULT:

PRECAUTIONS:

1. Apparatus should be of proper range.
2. Connections should be tight. Live terminals should not be touched.
3. Reading should be taken carefully.
4. Do not increase the reverse bias voltage up to breakdown voltage of an ordinary diode.

POST-EXPERIMENT QUESTIONS:

1. What is meant by PIV voltage?
2. Define static & dynamic resistance of diode.
3. How does an ideal diode act as a switch?

THE GRAPH BETWEEN VOLTAGE AND CURRENT WHEN THE DIODE IS FORWARD BIASED AND REVERSE BIASED

G.L.A. University, Mathura
Department of Electrical & Electronics Engg.
Electrical & Electronics Engg. Lab
B. Tech, 1st Year

Experiment No.

OBJECT – To study the working of a Half-Wave & Full Wave (Bridge type) rectifier and determine the ripple factor for both cases.

PRE–EXP. QUESTIONS –

1. How a bridge rectifier differs from Center-tap, F.W. rectifier?
2. What are the advantages of bridge rectifier over C.T. Type?

APPARATUS -

S.NO.	Item with Specification	Range	Quantity
1.	Semi conductor diode	20V,30mA	4
2.	C.T. Transformer	230/15-0-15V	1
3.	Load Resistance	1KΩ	1
4.	CRO	0-25MHz	1
5.	CRO Probes	-	1

THEORY – A rectifier is a device which converts AC voltage into DC voltage. P-N junction conducts in forward biased and practically does not conduct in reverse biased condition. It can be used for rectification. Basically there are two types of rectifiers circuits:

i. Half Wave Rectifier
ii. Full wave Rectifier
   a) Center Tapped
   b) Bridge Rectifier

The half-wave rectifier circuit consists of a semiconductor diode with a load resistance R_L as given in fig-1. The diode is connected in series with the secondary of the transformer and the load resistance R_L. The primary of the transformer is connected to the AC mains supply. During positive half cycle, the diode is forward biased and power is delivered to the load while during negative half cycle, the diode is reverse biased and no power is delivered to the load.

A bridge rectifier has 4-semiconductor diodes arranged in a bridge form and are connected in such a way that two diodes are connected in series for +ve half cycle and remain two for the –ve half cycle. Since two diodes are connected in series at a time so the input voltage is double to that of Center-tap 2-diodes rectifier. This is one of the main advantages of this type. Secondly, the diodes are also safe from twice of PIV as in C.T. rectifier.

CIRCUIT DIAGRAM –

1. Half-Wave Rectifier

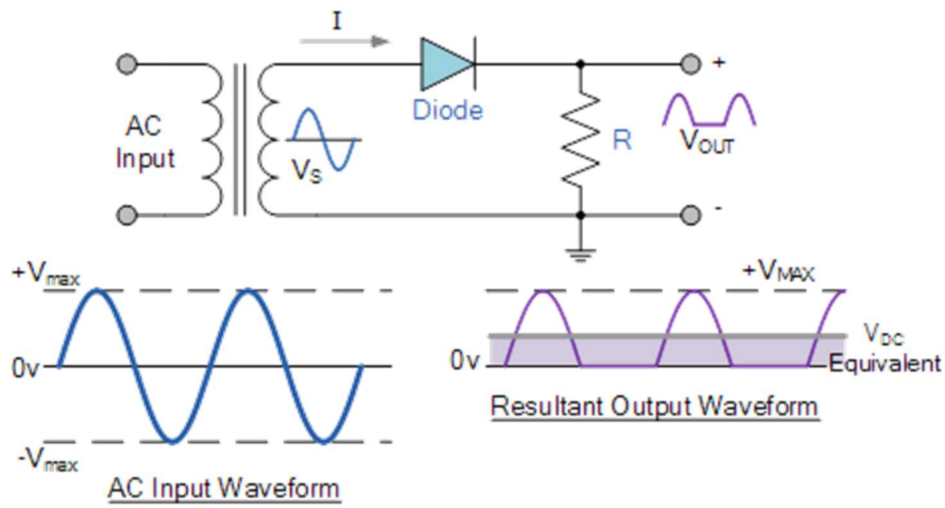


Fig.1:- Circuit Diagram and waveform for Half-Wave Rectifier

2. Full-Wave Bridge Rectifier

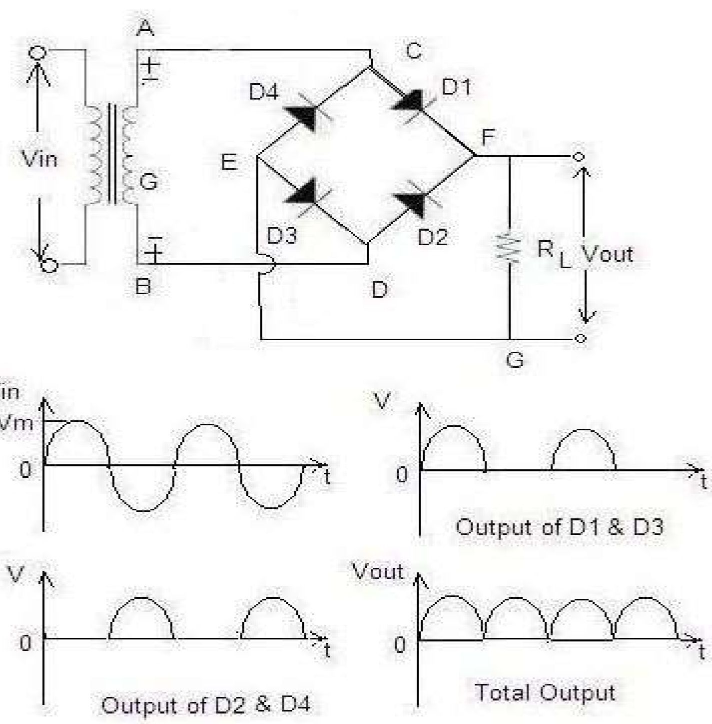


Fig.2:- Circuit Diagram and waveform for Full-Wave Bridge Rectifier

PROCEDURE –

1. Make the connections as per. circuit diagram with appropriate instruments for H.W. and Bridge rectifier.
2. Take the readings of input and output voltage and current for H.W rectifier.
3. Take the reading of input and output voltage and current for F.W. rectifier.

OBSERVATION TABLE –

Output (D.C)	Rectifier H.W.	Rectifier F.W.
V_m		
V_{DC}		
V_{rms}		
R.F (Ripple Factor)		

FORMULAS USED –

$$R.f. = \sqrt{\left(\frac{V_{rms}}{V_{DC}}\right)^2 - 1}$$

H.W.

$V_{DC} = V_m/\pi$

$V_{rms} = V_m/2$

F.W.

$V_{DC} = 2V_m/\pi$

$V_{rms} = V_m/\sqrt{2}$

RESULT –

PRECAUTIONS –

1. All connections should be tight.
2. All instruments should be of proper range.
3. Readings should be taken carefully.

POST-EXP. QUESTIONS –

1. What do you mean by Ripple factor & Rectification Efficiency?
2. What is the use of a filter circuit?
3. What is the difference in output waves of Bridge & Center – tape, F.W rectifier?

G.L.A. University, Mathura
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B. Tech, 1st Year

Experiment No.: ….

OBJECT: To determine the efficiency of a 1-ϕ transformer by directly loading it.

PRE EXP. QUESTIONS:
1. What is Transformer?
2. How can the efficiency of a transformer be determined?
3. Why is the direct loading method restricted to small transformer?

APPARATUS REQUIRED:

S. No	Apparatus	Range	Qty
1.	1- ϕ transformer	1.5 KVA, 50 Hz, 230/115V	1
2	Wattmeter	300/150V, 10/5A	2
3.	Voltmeter (M.I.)	0-300 V	1
4.	Ammeter (M.I.)	0-15A	1
5.	Auto Transformer	230V/0-260V	1
6.	Variable Load (Loading resistance)	2.5 KW, 250V	1
7.	Connecting Wires	----	As Required

THEORY:

A transformer is static electrical machine, which transfers electric power from one circuit to another at the same frequency but at different voltages. It can raise or lower the voltage in a circuit but with a corresponding decrease or increase in current. The basis on which a transformer operates is MUTUAL INDUCTION between two circuits linked by a common magnetic flux. In its simplest form, it consists of two windings, primary and secondary, which are electrically separated but magnetically linked through a magnetic path of low reluctance, known as CORE. If the primary winding is connected to an alternating voltage source, an alternating flux is produced in the laminated core, which is linked with the secondary winding and a voltage is induced in it, according to Faraday's laws of induction.

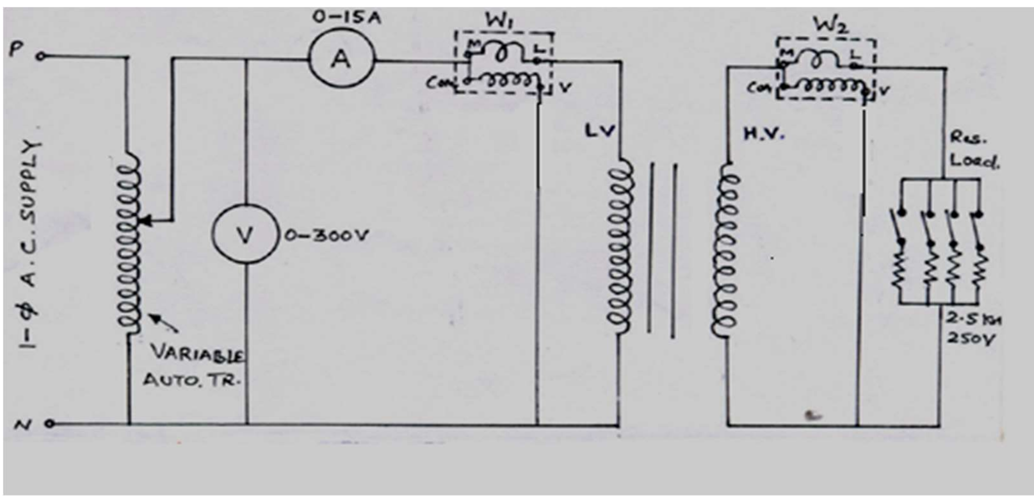
$$E = -N d\phi/dt$$

Where ϕ is the magnetic flux linking the winding having 'N' turns. The efficiency of transformer is given by

$$\eta = \frac{output\ power}{input\ power} \times 100\%$$

The efficiency of a transformer can be obtained by direct measurement of output and input power but it does not give accurate result as the power losses are quite low and it is difficult to differentiate between wattmeter reading for input and output due to the amount of errors in the instrument readings. Moreover, in case of large transformers, there is wastage of large amount of power and no information is available about the amount of proportion of iron and copper losses of transformer.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Make necessary connections with the help of circuit diagram using appropriate instruments.
2. Adjust the primary applied voltage equal to the rated voltage. Connect some load to the secondary.
3. Note the reading of both watt meters. Take 3-4 readings by varying the load on the transformer.
4. Take precautions that in any case, the current in the secondary winding does not exceed the rated full load current.

OBERVATION TABLE:

S. No.	Primary Voltage(V)	Primary Current(A)	Input Power(W)	Output Power(W)	Percentage Efficiency

CALCULATION:

The efficiency of the transformer is calculated by:-

$$\eta = \frac{\text{Output wattmeter reading } (w_2)}{\text{Input wattmeter reading } (w_1)} \times 100\%$$

RESULT:

PRECAUTION:

1. All connections should be tight.
2. All apparatus should be of suitable range.
3. Never touch live conductors or terminals.
4. Reading should be taken accurately.

POST EXP. QUESTIONS:

1. Why does the efficiency of a transformer increase as load increases?
2. Why is this method more accurate than O.C. & S.C. method?
3. What is the necessity of drawing efficiency curve of transformer?
4. What is the condition for maximum efficiency?

G.L.A. University, Mathura
Department of Electrical & Electronics Engg.
Electrical & Electronics Engg. Lab
B. Tech, 1st Year

Experiment No.: ……

OBJECT: To study the applications of CRO i.e. (current measurement, voltage measurement, frequency measurement).

PRE-EXP. QUESTION:
1. What is CRO?
2. What is function generator?

APPARATUS REQUIRED:

Sr.no.	Apparatus	Specification	Quantity
1.	CRO	20MHz scientech	1
2.	Function generator	0-3MHz,Scientech	1
3.	Resistance	100Ω	1

THEORY:

APPLICATIONS OF CRO:
The general purpose CRO, used as test equipment in a laboratory has following important applications
Study of waveforms: To study the waveform of an ac voltage, sinusoidal or other wave. It is fed to the Y-input. The size of the figure display on the screen can be adjusted suitably by adjusting the gain controls. The time-base frequency can is changed so as to accommodate one, two, or more cycles of the Y-input signal. Some oscilloscope has the provision of expanding only a part of the cycle of the signal so as to examine this part in greater detail.
I-Measurement of voltage:
A dc is measured by applying it between a pair of deflection usually vertical plates the displacement of the spot on the screen is measured usually. A gain control (attenuator) of the vertical amplifier is calibrated in term of deflection sensitivity. The deflection sensitivity of CRO can be defined as a amount of displacement of the spot on the screen when a potential of one volt is applied to its deflection plate.

An ac (sinusoidal) voltage is measured by applying it to the vertical deflection plates. A straight line trace is obtained measuring the length of this straight line traced and multiplying this length with the deflection sensitivity given in volt per centimeter. This gives the peak to peak value of AC voltage. Half of this is the peak or maximum value of AC dividing it by √2 gives the RMS value.

II- MEASUREMENT OF CURRENT: A CRO with an electrostatic deflection system is basically a voltage indicating device. For measuring current it is passed through a suitable known resistor. Then the potential developed across this resistance measured as explained above. The current can then easily be determined.

III- MEASUREMENT OF FREQUENCY:

One of the quickest and most accurate methods of determining frequencies is by using lissajous pattern. A lissajous pattern is produced on the screen when two sine wave voltages are applied simultaneously to both pair of deflection plate. A stable pattern is obtained when the ratio of two frequencies is an integer or a ratio of integer. The type of pattern observed depended on the ratio.

To measure the frequency of a sine wave voltage it is applied to one set of deflection plate (say y plate) to the other set (say X plate) we supply sine wave voltage obtained from a standard variable frequency oscillator.

IV- MEASUREMENT OF TIME INTERVAL

1. To set up time per division larger as much as possible so that waveform cycles may appear on the screen.
2. Place cal knob fully anticlockwise. please be careful as the measured value may be incorrect if you don't follow the instruction.
3. Use the vertical position control to position any two consecutive crests touching central horizontal reference line.
4. Use horizontal position control to position left most crest on any vertical line
5. Count no. of horizontal division multiply this by time per division switch setting
6. To determine frequency find out reciprocal of time interval
7. Repeat the same.

PROCEDURE:

a) Peak to Peak Voltage Measurement

1. Firstly check that all the push button are at off position
2. Select any channel and make concerned setting
3. Apply the signal from a function generator to the CRO through the probe.
4. Adjust the time per division switch for two or three cycle of the waveform and set volt per division switch applicable amplitude on the screen.
5. Press XY button, a vertical line will appear on the screen.

6. Use the vertical position control to position the line touching any horizontal line.
7. Use horizontal position control to position the line on the central vertical reference line. This line has additional calibration marks equal to 0.2 cm each.
8. Count numbers of the division from the line, multiply this number by volt per division switch setting to get peak to peak voltage. Note the same and calculate V_{RMS} (effective value), V_{max} (amplitude)
9. Repeat the same for the other observation.

OBSERVATION TABLE:

S.No.	**Division(cm)**	**Vpp=(dc*div)**	**V_{max}=Vpp/2**	**V_{rms}=Vpp/2√2**	**I_{rms}= V_{rms}/R**	**Frequency,f=1/T**

RESULT:

CONCLUSION: Measurement of different components by CRO are observed and verified.

PRECAUTIONS:
1. Ensure that the function switch is set for the proper operation.
2. Ensure that the AC/DC selector switch is set for the proper operation.
3. Increase the range by function switch as per requirement.

POST EXPERIMENT QUESTIONS:
Q 1 How magnitude can be measured of any waveform by C.R.O.?
Q 2 How time period can be measured of any waveform by C.R.O?
Q3 How it could be checked that C.R.O. is properly working or not?
Q4 Explain, working of all the knobs of C.R.O.

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Experiment No.: ……

OBJECT: To determine the error in a single phase energy-meter with the help of wattmeter.

PRE-EXPERIMENT QUESTIONS:

(i) Why is calibration of instrument essential?
(ii) What is the difference between induction type wattmeter and energy-meter?

APPARATUS REQUIRED:

S. No.	Apparatus	Range	Qty.
1	Ammeter (MI)	0-5 A	1
2	Voltmeter (MI)	0-300 V	1
3	1-ϕ Energy-meter	240 V, 20 A	1
4	Autotransformer	0-270 V	1
5	Variable Load (Loading resistance)	2.5 kW, 250V	1
6	1-ϕ Wattmeter	150/300v,5/10A	1
7	Stop Watch	-	1

THEORY:

A single phase induction type of EM is most commonly used to measure electrical energy in units (KWh) for domestic installations. It works on induction principle like single phase induction motor. This meter has two electromagnets. The current coil is placed on the series magnet while the potential coil is placed on the shunt magnet. The potential coil is made highly inductive so that the current in it lags behind by 90^0. A thin aluminum disc is placed in such a way that it cuts the flux of both the coils and is free to rotate. The torque applied to the disc is proportional to power drawn from the supply (VI cosϕ) and number of revolutions give the total energy consumed during a given period. Energy meter is designed for a definite meter constant which means rpm/KWh.

There are four main parts of the operating mechanism of Energy meter.

(i) Driving system
(ii) Moving system
(iii) Controlling or Braking system
(iv) Registering system

(i) Driving System: It consists of two electromagnets called series and shunt magnet. The coil associated with them are called current and voltage coil.

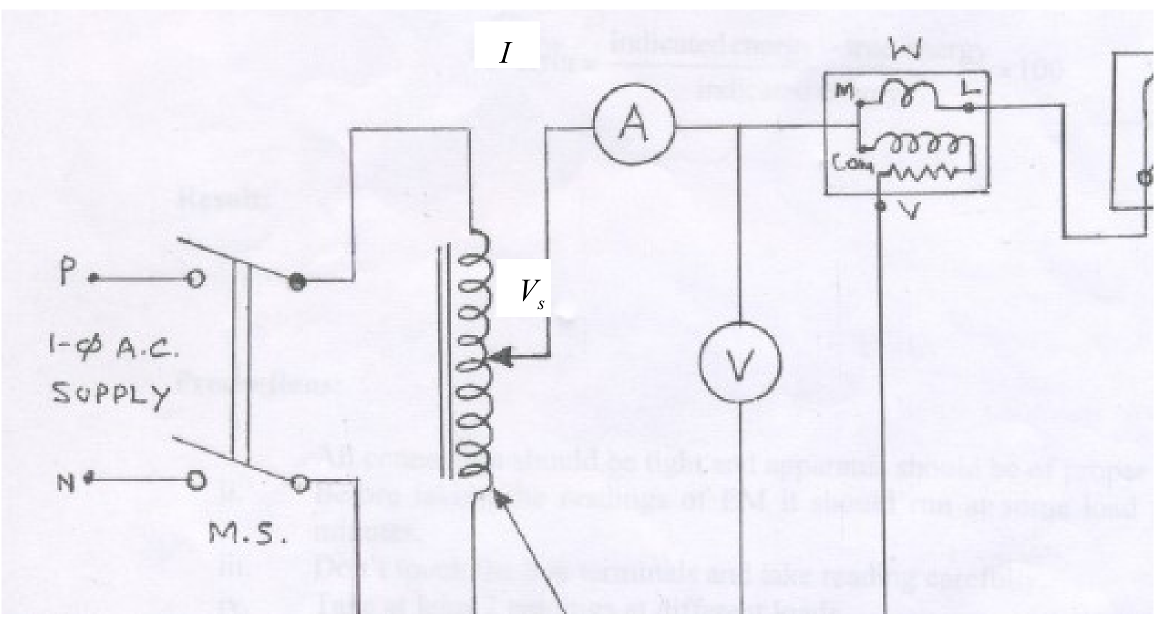
(ii) Moving System: The moving system consists of a thin aluminum disc mounted on spindle and is placed in air gap between series & shunt magnets. It cuts the fluxes of both the magnets. Forces are produced by the fluxes of each of the magnets with the eddy current produced in the disc by the flux of other magnets. Both of these forces opposing each other act on the disc. These two forces constitute driving torque.

(iii) Controlling or Braking system: The braking system consists of a permanent magnet called brake magnet. It is placed near edge of Aluminum disc. Braking torque can be varied by drawing the brake-magnet in or out radially.

(iv) Registering system: The disc spindle is connected to a counting mechanism. This mechanism records number of revolutions which is proportional to energy consumed. The counter is calibrated to indicate the energy consumed directly in kilo-watt-hours (KWh).

In this experiment the purpose is to calibrate the energy meter. This is needed to find out the error/correction in the energy meter reading. This calibration is possible only if some other source/instrument to know the correct reading is available. Here the ammeter, voltmeter and stopwatch are assumed to be correct. These are taken as reference. Energy meter is now calibrated with respect to voltmeter, ammeter and stopwatch.

CIRCUIT DIAGRAM:



PROCEDURE:

1. Connect the circuit as shown in fig. 1.
2. The autotransformer should be set at zero value.

3. Increase gradually the supply voltage with the help of autotransformer and increase it up to the rated value.
4. Note down the time taken by the disc to complete 5 revolutions in seconds. Also note down the readings of ammeter, voltmeter and wattmeter.
5. Increase the load in steps of 0.5 Amp and repeat the step.
6. Take at least 8-10 readings for increasing value of load up to rating of energy meter.

OBSERVATION:

S. No.	Vs (V)	Current I(A)	Wattmeter P(W)	Time t(sec)	True Energy KWh	Indicated Energy in KWh (W×t)	% Error

CALCULATIONS:

If N = meter constant = revolution/KWh

Then indicated energy consumed in 5 revolutions = $5\times\left(\frac{1\times1000\times60\times60}{N}\right)$ Watt-sec

True energy recorded by wattmeter = W×t
Where W = wattmeter reading in watts
t = time taken by meter for 5 revolutions in seconds

$$\therefore \text{ \% error} = \frac{Indicated\ energy - True\ energy}{True\ energy}\times 100\ \%$$

RESULT:

PRECAUTIONS:

1. Apparatus should be of proper range.
2. Connections should be tight. Live terminals should not be touched.
3. Reading should be taken carefully.

POST-EXPERIMENT QUESTION:

1. Why this energy meter is known as induction type?
2. What is meter constant?
3. What are frictional & creeping errors in energy meter?
4. Why are two holes made in disc?
5. Which type of damping is used in energy meter?

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Experiment No. …..

OBJECT: To understand the operation of the basic logic gates such as AND, OR, NOT, NAND, NOR gates and also to verify their truth tables.

PRE-EXPERIMENT QUESTIONS:
1. What is logic gate? Name different types.
2. Why are NAND and NOR gates said to be universal gates?
3. What is truth table? Give its importance in logic gates.

APPARATUS:

Sr. No.	Apparatus with specification	Range	No.
1	Logic Circuit	---	1
2	DC Power Supply	0-30 V	1
3	Bread Board	---	1

THEORY:

A gate is an electronic circuit which operates on one or more input signals to produce an output signal. Gates are often called logic circuits because they can be analyzed with the help of Boolean algebra.

1. AND gate (IC-7408):

The AND gate is a logic circuit that has two or more inputs and one output. If any of the input is 0 or (low) then the output will be 0 and if both the input are low or high the output will be correspondingly low or high i.e. 0 or 1.
The standard symbol of AND gate in as shown in fig. 1(b) and Boolean expression as below.

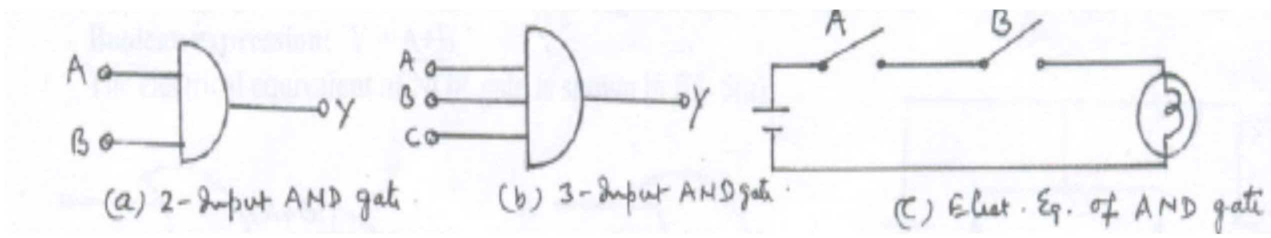

Fig.1

Boolean expression: Y = A. B. or Y= A x B

Here dot (.) or cross (x) is placed between symbols to represent AND operations. The above equation is to read as "Y equals to A dot B", Y = A.B.C (for three input AND gate). The electrical equivalent of switching circuit of two input AND gate is shown in fig. 1(c). The IC diagram is shown below in fig2.

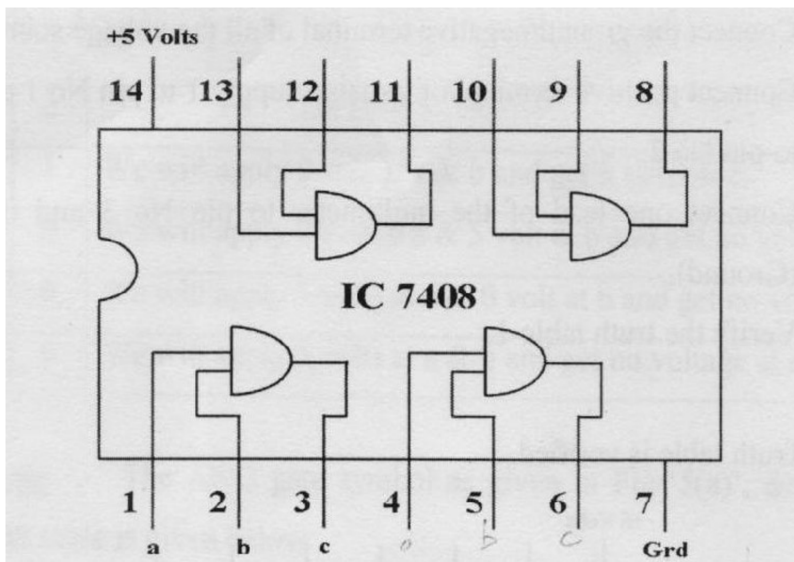

Fig.2

2. OR gate(IC-7432):

The OR gate has two or more inputs but only one output. If any input signal is high or 1 the output is one and if both the input are 0 then output will be 0 (or low). The OR gate can have as many inputs as desired. The standard symbol of the OR gate is as shown in fig. 3(b).

Boolean expression: Y = A+B (A OR B) Y = A+B+C (A OR B OR C)

The electrical equivalent of two input OR gate is shown in fig. 3(a).

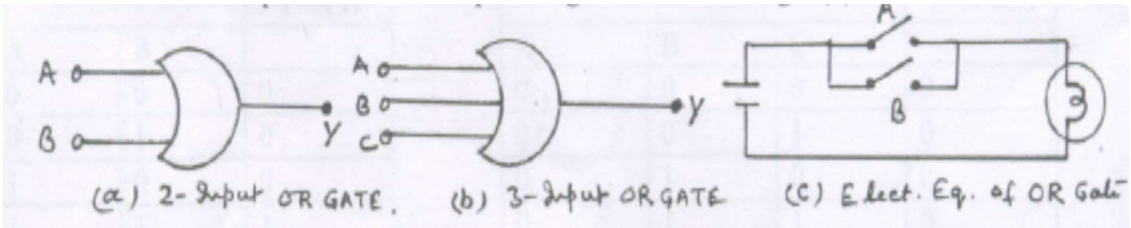

Fig.3

The IC diagram is shown below in fig4.

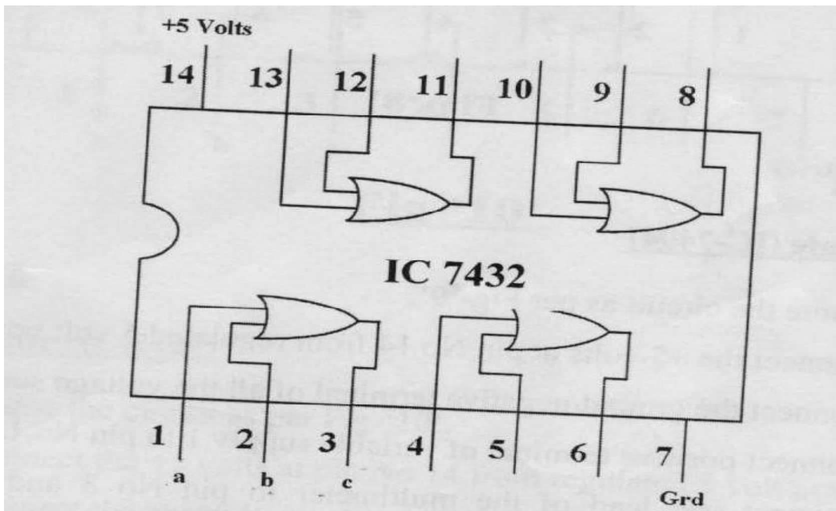

Fig.4

3. NOT gate (IC-7404):

The NOT gate is the simplest form of digital logic circuit. The other name of this gate is inverter gate. The term inverter can be defined as a gate with only one input signal and one output signal. The output state is always opposite to the input state i.e. if input is 0 then output is 1 and vice versa. The circuit symbol of NOT gate is shown in fig. 5(a). Here the triangle portion of the symbol represents amplifier while the circle designates the inversion or complimentary nature.

Boolean expression: $Y = \overline{A}$

If A = 0, the output Y = 1

If A = 1, the output Y = 0

The electrical equivalent of one input NOT gate is shown in fig. 5(b).

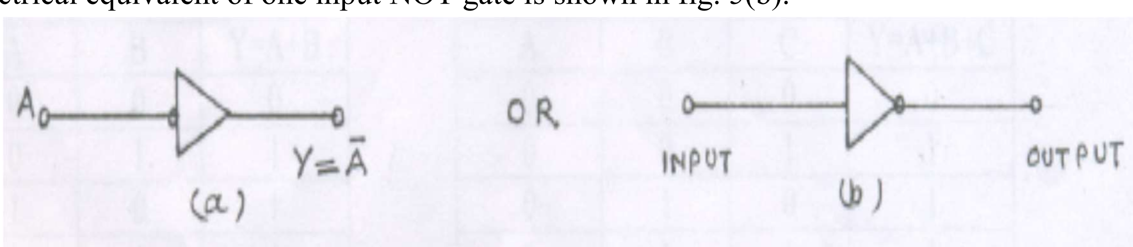

Fig.5

The IC diagram is shown in fig.6 below.

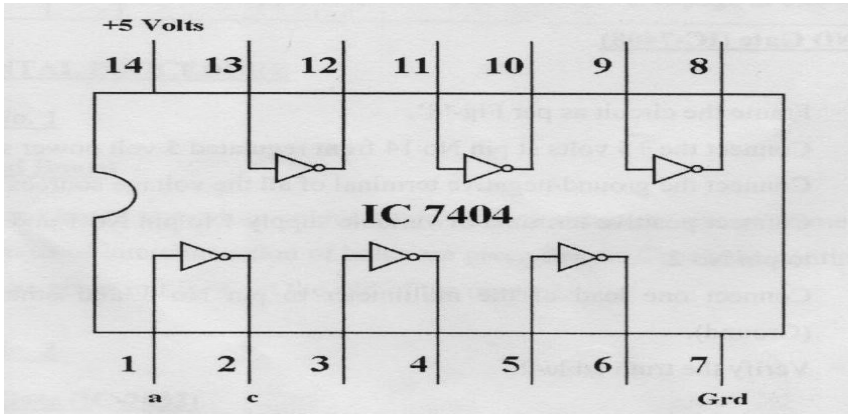

Fig.6

4. NAND gate (IC-7400):

The NAND gate is an improved logic element used for implementing decision making logic functions. The NAND gate is in fact a NOT-AND gate. It can be obtained by connecting a NOT gate in the output and AND gate as input. Fig. 7(b) shows the basic symbol of a NAND gate.

Boolean expression: $Y = \overline{A.B}$

The output of NAND gate is inverse of output of AND gate. The electrical equivalent of NAND gate is as shown in fig. 7(a).

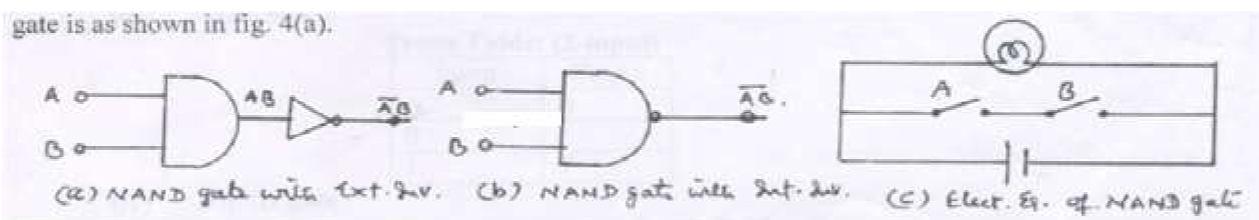

Fig.7

The IC diagram is shown in fig.8

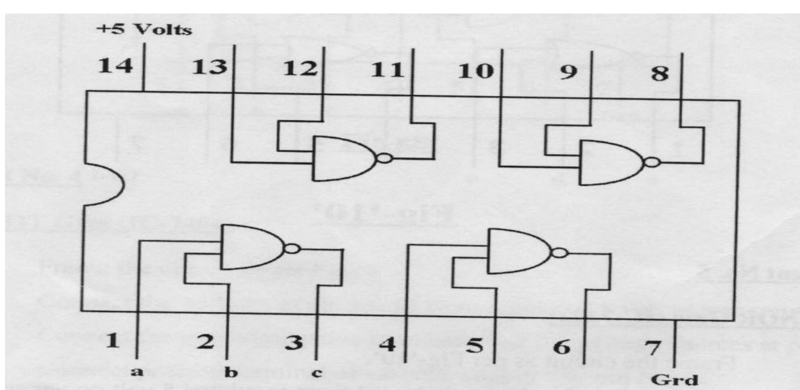

Fig.8

5. NOR gate (IC-7402):

The NOR gate is an improved logic element used for implementing decision making logic functions. The NOR gate is in fact a NOT-OR gate. It can be obtained by connecting a NOT gate in the output of OR gate. The basic diagram of NOR gate is shown in fig. 9(b).

Boolean expression: $Y = \overline{A+B}$

The electrical equivalent of NOR gate is shown in fig. 9(a).

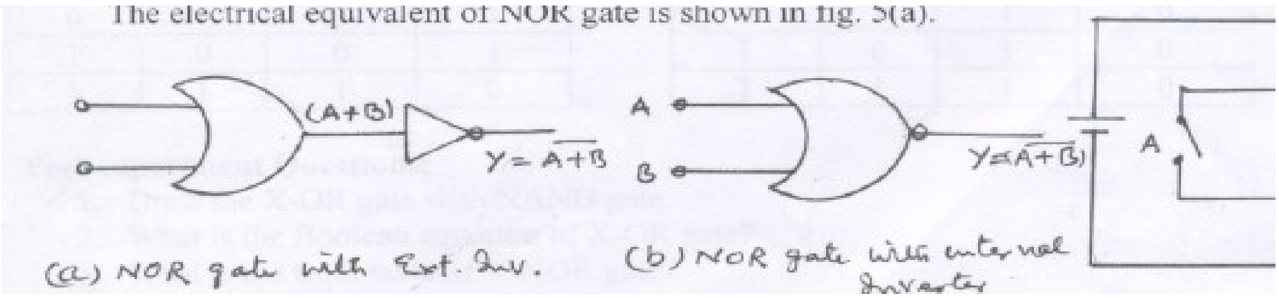

Fig.9

The IC diagram is shown in fig.10 below.

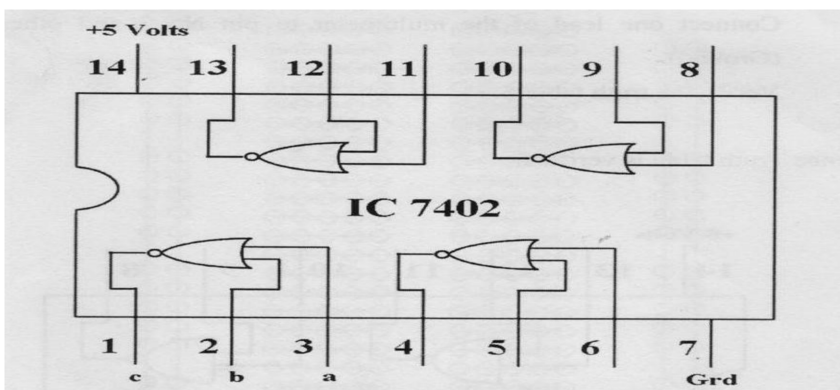

Fig.10

OBSERVATION TABLE:

(i) AND gate:

Truth Table: (2-input)

Input		Output Y=A.B
A	B	
0	0	0
0	1	0
1	0	0
1	1	1

AND gate

Truth Table: (3-input)

Input			Output Y=A.B.C
A	B	C	
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0

1	0	1	0
1	1	0	0
1	1	1	1

(ii) OR gate:

Truth Table: (2-input)

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

OR gate:

Truth Table: (3-input)

Input			Output
A	B	C	Y=A+B+C
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

(iii) NOT gate :

Truth Table: (2-input)

Input	Output
A	B
0	1
1	0

(iv) NAND gate:

Truth Table: (2-input)

Input		Output	
A	B	AB	Y= $\overline{A.B}$
0	0	0	1
0	1	0	1
1	0	0	1
1	1	1	0

(v) NOR gate:

Truth Table: (2-input)

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

RESULT:-

PRECAUTIONS –

4. All connections should be tight.
5. All instruments should be of proper range.
6. Readings should be taken carefully.

POST-EXPERIMENT QUESTIONS:

1. Draw the X-OR gate with NAND gate.
2. What is the Boolean equation of X-OR gate?
3. What is the truth table of X-NOR gate?

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Experiment No. ….

OBJECT:- To verify the Superposition theorem (DC circuit).

PRE-EXPERIMENT QUESTIONS:

1. State Superposition Theorem.
2. In which type of network is this theorem applicable?

APPARATUS USED:

S.No.	Name of Apparatus	Range / Rating	Qty
1	DC Power supply	0-30V, 0-2A	02
2	Milli-Ammeter(PMMC)	0-50 mA	03
3	Rheostat	0-200 Ω, 2.2A	03
4	Connecting Wire	---	As per requirement

THEORY:

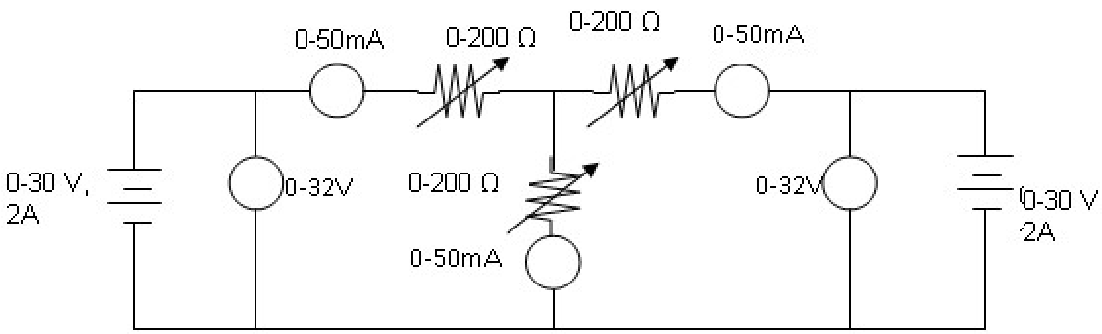
Superposition is a general principle that allows us to determine the effect of several energy sources (current sources and voltage source) acting simultaneously on a system by considering the effect of each source acting alone and then combining (superposing) these effects. The concept of superposition is very powerful in linear networks and linear system. Superposition theorem can be stated as follows.

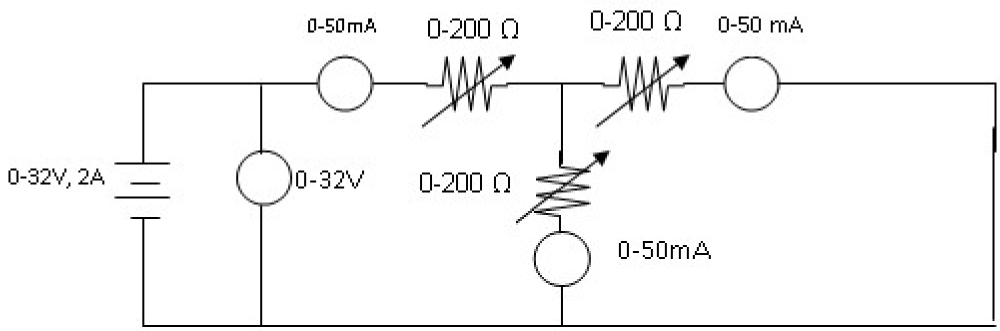
In a linear network, containing more than one independent energy sources, the current through or voltage across in any branch is equal to the sum of the response due to each independent source acting one at a time with all other ideal independent sources set equal zero.

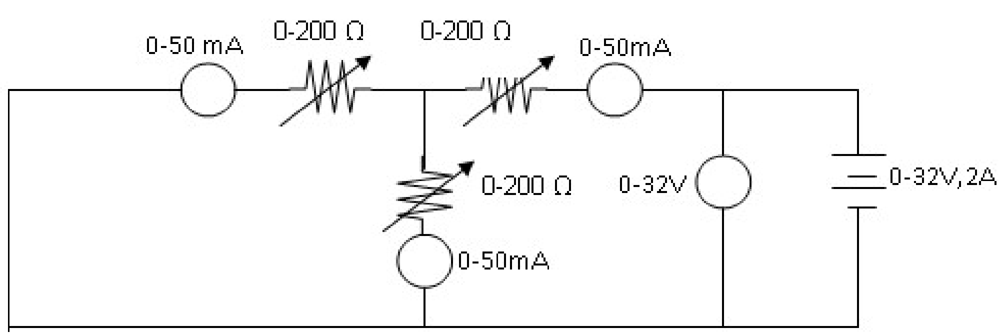
Setting an ideal current source to zero means that the source is replaced by an open circuit. Similarly, setting an ideal voltage source equal to zero means that the source is replaced by a short circuit.

The superposition theorem is extremely general. It is applicable to all linear networks time varying or time-invariant. It holds for all possible locations, types and waveforms of the independent sources. The theorem applies both in the time domain and s-domain. Since the power is proportional to the square (which is non-linear) of voltage (or current), superposition theorem can not be applied for calculation of power. It is specially very useful when the networks are excited by different types of source, that is , ac and dc, or ac with difference frequencies

CIRCUIT DIAGRAM:







PROCEDURE:

1. Make the connection according to circuit diagram.
2. Keep the polarity of the meters in order.
3. Note down the reading of ammeters and voltmeters in the observation table.
4. Repeat the process so that a number of readings can obtained.

OBSERVATION TABLE:

E_1(V)	E_2(V)	I_1(mA)	I_2(mA)	I_3(mA)

E_1(V)	I_1'(mA)	I_2'(mA)	I_3'(mA)

E_2(V)	I_1''(mA)	I_2''(mA)	I_3''(mA)

$I_1 = I_1' + I_1''$(mA)	$I_2 = I_2'' + I_2'$(mA)	$I_3 = I_3' + I_3''$(mA)

RESULT:

PRECAUTIONS:

1. Reading must be taken very carefully.
2. Connections should be sufficiently tight.

POST-EXPERIMENT QUESTIONS:

1. Distinguish between (i) linear & non-linear (ii) Active & Passive Elements.
2. State principle of homogeneity & proportionality.
3. Can one calculate the power dissipated across any branch by using this theorem? If yes, justify your answer.