CONSTRUCTION OF AN EXPERIMENTAL TRAINER MODULE FOR AC DC SOURCES

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MATRIC NO: 05/0115

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CONSTRUCTION OF AN EXPERIMENTAL TRAINER MODULE FOR AC/DC SOURCES

BY

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MATRIC NO: 06/135

A PROJECT SUBMITTED TO THE DEPARTMENT OF ELECTRICAL/ELECTRONICS ENGINEERING.

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF NATIONAL DIPLOMA (ND) IN ELECTRICAL ELECTRONICS ENGINEERING.

JUNE, 2009.

CERTIFICATION

This is to certify that this project was carried out by ADEYEMI MOSHOOD ADEMOLA of Matriculation Number 06/135 in partial fulfillment of the requirements for the award of National Diploma (ND) in Electrical Engineering under my supervision.

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DEDICATION

I dedicated this write-up to God Almighty, the creator, author and finisher of all things in the world.

I also dedicated to my parents CHIEF and MRS. ADEYEMI, and also to my brothers and sisters Serah, Adeniyi, Omolara, Abayomi and Serifat.

APPRECIATION

My profound gratitude goes to Almighty God, for his infinite support, provision and guidance.

My immeasurable appreciation goes to my Parents CHIEF AND MRS. ADEYEMI for their care, encouragements, and financial support to me from my Childhood to this day. Dad and Mum, I really appreciate everything, I pray that as long as you still living you will enjoy the reward of your labour by the grace of Almighty God.

To Mr. Abiodun Odumosu (HOD Electrical Electronics), I say a very big thanks for your support, all through these years, I really appreciate you sir.

To my Supervisor and Dean of School of Engineering Technology in the person of ENGR. OBORKHALE. Sir, I appreciate your fatherly role in the success of this project.

To my siblings, (Adenike), Adeniyi, Omolara, Abayomi and Serah, I am really grateful for your love, care and support.

My appreciation also goes to my friends and my love ones for their encourage and advice throughout my stay in Ijebu – Igbo, Miss. Osonubi Titilola, Ibrahim Alalafia, Gbenga Oseni, Adejare Oluwadayo, Brother Segun, Brother Kehinde, Brother Bukonla, Biokaz Ventures and others.

Finally to the Rector, all teaching and non-teaching staff of the ABRAHAM ADESANYA POLYTECHNIC, my profound gratitude goes to you all for your role directly or indirectly in the success of this project. Glory be to Almighty God.

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CHAPTER ONE

1.0 INTRODUCTION

The experimental trainer for AC/DC sources is a useful, low cost, multi-purpose mini-lab for learning the basic discrete and passive components starting from these characteristics to simple and more complex applications. The kit saves time and money in experimentation as no soldering is required to dry out new circuits and components can be reused again and again. All inputs/outputs and components for experimentation are terminated on 4mm base terminal. Interconnection is through 4mm patch cords. Various DC/AC regulated power supplies are built-in. the kit is housed in a sturdy designed power coated metal enclosure.

1.1 AIMS OF THE PROJECT

- To expose readers to various parts and components rating that can be used in constructing an experimental trainer module source for AC/DC.
- To construct an experimental training module source AC/DC to be used in the lab for experiments.

1.2 OBJECTIVES OF THE STUDY

- To study the principles of kirchoff's current law
- To study the principle of kirchoff's voltage law
- To verify the low pass RC circuit and find out its cut off frequency
- To verify ohm's laws
- To observe that the low pass RC circuit also works as an integrator

- To verify the high pass RC circuit and find out its cut off frequency
- To observe that the high pass RC circuit also works as a differentiator
- To implement a band pass filter using RC.
- To implement a low pass RL circuit and find out its cut off frequency
- To implement a high pass RL circuit and find out its cut off frequency
- To implement a RLC Band Pass circuit and to find the cut-off frequency from graph.
- To implement a RLC Band Reject circuit and to find the cut-off frequency from graph.
- To implement series RLC Resonant circuit and find the Resonant frequency
- To implement parallel RLC Resonant circuit and the Resonant frequency.

1.3 SIGNIFICANCE OF THE STUDY

The experimental trainer for AC/DC sources is a device that is basically design to meet the demand of individuals, co-operate bodies and as well as individuals. It is very essential in reducing errors in values during electricity experiments.

1.4 SCOPE OF THE PROJECT

- Measure the value of the resistor using the multi-meter
- Construct the circuit as shown in the circuit diagram with the help of patch cords.

- Select the appropriate current range on the multi-meter
- Turn the kit and measure the current on the multi-meter

1.5 LIMITATION

ENERGY AND TIME FACTOR => It took time and energy to gather together the required component and material that should be used to carry out the construction and the necessary information on how to construct.

CHAPTER TWO

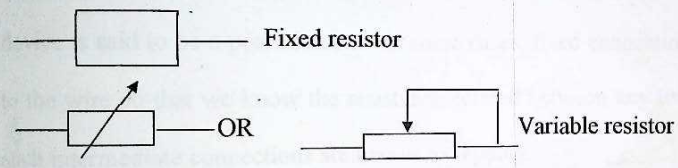
2.0 LITERATURE REVIEW

2.1 RESISTORS

A resistor is a passive component which exhibit the property of resisting the flow of current. The magnitude of the current is inversely proportional to the value of the resistance.

NOTE:- Resistor may be assumed to be linear i.e their resistance will be assumed to remain constant when the temperature is maintained constant. Effect of temperature can be ignored, since all resistor dissipate heat when operating.

SYMBOL OF A RESISTOR



TYPES OF RESISTORS

There are two types of resistor

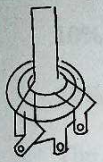
1. Fixed Resistor
2. Variable Resistor

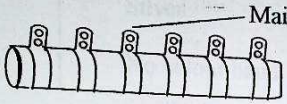
Fixed Resistor is a resistor whose value is constant. Examples are:

1. Wire Wound Resistor
2. Carbon Composition Resistor

Wire wound resistor may be wound on what looks like a large washer made from an insulating material such as card. An arm is mounted through the centre of the washer, by rotating the arm, the length of wire between the point of contact and the end of the coil is varied.

ii. Variable Resistors





Mains dropper resistor with Fixed tappings cement coated on a ceramic former

Variable resistors have three connections, being each end of the coil plies the connection from the wiper arm. When all the three connections are used, the device is said to be a potentiometer. In some cases, fixed connections are made to the wire so that we know the resistance offered between any two terminals, such intermediate connections are known as tapping.

RESISTORS COLOUR CODING

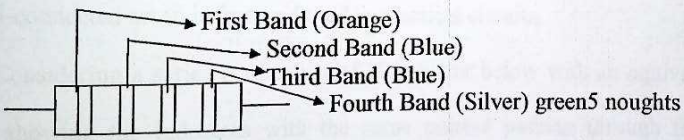
DIGIT	COLOUR
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue

7	Violet
8	Grey
9	White

TOLERANCE	COLOUR
5%	Gold
10%	Silver
20%	No colour band

The application of this code is best explained by the diagram below.

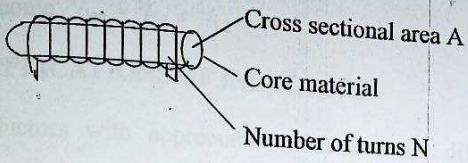
The first bands are the orange and blue which, from the table are 3 and 6 respectively. Therefore, we are being told that the resistance has a numerical value of 36, the third band tells us how many zeros to put after the number. In this case, the third band is green and there should be five zeros which resistance becomes 3600,0000Ω



2.2 INDUCTORS

This is a passive element designed to store energy in its magnetic field. Inductors find numerous applications in electronics and power systems, and are used in power supplies, transformers, radios, Tv's, radio's, and electric motors.

NOTE=> Any conductor of electric current has inductive properties and may be regarded as an inductor, but in order to enhance the inducfive effect, a practical inductors is usually formed into a cylindrical coil with many turns of conducting wire shown below.

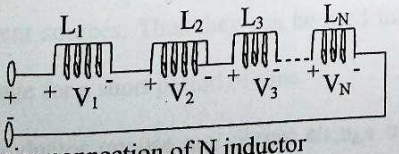


It is formed that the voltage across the inductor is directly proportional to the time rate of change of the current, if current is allowed to pass through an inductor.

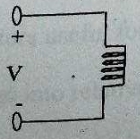
SERIES AND PARALLEL INDUCTORS

It is necessary to extend the powerful tool of series-parallel combination, we need to know how to find the equivalent inductance of series- connected or parallel-connected set to inductors found in practical circuits.

Considering a series connection of N inductor below with an equivalent circuit showing the inductors with the same current passing through them. Applying Kirchoff's Voltage Law (KVL) to the loop.



A series connection of N inductor



Equivalent circuit for the series inductor

NOTE=> Inductors in parallel are combined in the same way as resistors in parallel for two inductors in parallel (N = 2)

$^1/_{leq} = {}^1/_{L1} + {}^1/_{L2} + {}^1/_{L3} + \text{-------} + {}^1/_{LN}$

Become $^1/_{leq} = {}^1/_{L1} + {}^1/_{L2}$

APPLICATIONS OF INDUCTORS

Inductors with appreciable inductance are difficult to produce on a substance, hence inductor coils usually come in discrete form and tend to be more bulky and expensive, in this case, inductors are not as versatile as capacitors and resistor, and they are more limited in application. However, there are several application substitutes, they are routinely used in relays, delays, sensing device, pick-up heads, telephone circuits, radio and Tv receivers.

PROPERTIES OF INDUCTORS

The following properties make an inductor very useful in electric circuits

(i) Inductors are frequency sensitive, this property makes them useful for frequency discrimination.

(ii) For the store of energy and makes them useful as temporary voltage or current sources. Thus they can be used for generating a large amount of voltage for a short period of time.

(iii) An inductor oppose any abrupt change in current, this property makes inductors useful for spark or suppression and for converting pulsating DC voltage into relatively smooth DC voltage.

2.3 BIASED DIODE

Forward Biased Diode

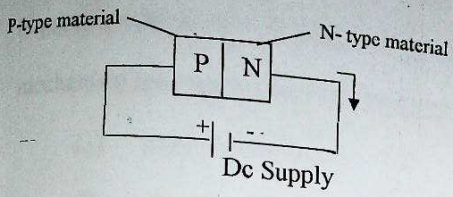


Fig A.

Under forward bias condition, the positive terminal of the Dc supply is connected to the P-type semi conductor and negative terminal of the Dc supply is connected to the n-type semi conductor as shown in figure A above.

Initially, no current flows due to the barrier potential. The applied forward potential repels the charge carriers and have hence pushes it forward through the junction.

Reverse Biased Diode

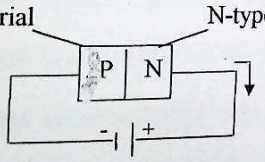


Fig B.

In reverse biased condition, the positive terminal of the Dc supply is connected to the n-type semi conductor and negative terminal of the Dc supply is connected to the P-type semi conductor as shown in fig. B above.

DIODE BREAKDOWN

A breakdown can occur in a diode due to two mechanisms, each of them requires a critical electric field E at the depletion region of the diode. The two mechanism are responsible for breakdown in PN-junction diode namely

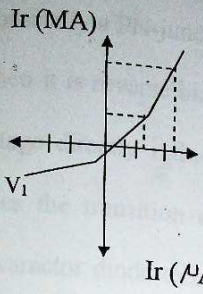
(1) Zener breakdown

(2) Avalanche multiplication

ZENER BREAKDOWN: In a doping of high concentration of atom, the depletion layer is very narrow, which results in tunneling of electrons from the P-type valence band to the N-side conduction band, constitutes a reverse current from n to p, this is called zener effect. The basic requirement for tunneling current is a large number of electrons separated from a large number of empty states by a narrow potential barrier.

AVALANCHE MULTIPLICATION:- A diode is said to be reverse biased when carrier acquires sufficient energy from thermal energy along with the applied reverse bias resulting in the high electric field E in the depletion region. An electron entering from P side may be accelerated to a high kinetic energy to cause an ionizing collision, the ionizing collision result in the generation of new electron hole pair. The original and the generated electron are both swept to the side of the junction and the generated hole is swept to the p-side, the generation of new electron hole pair results in the generation of enormous energy by the process called fission.

DIODE CHARACTERISTICS



Dynamic resistance $r = \Delta V / \Delta I$ (ohms)

On forward biasing, the diode current increase exponentially with an increase in the forward voltage after the cut-in voltage is reached or the barrier potential is overcome. When the diode is reverse biased, the applied voltage is negative.

Thus, on reverse biasing, the reverse current independent of the applied reverse voltage is equal to the reverse saturation current. When the reverse voltage is increased beyond a certain limit, the diode breaks down and the reverse current shorts up to a very large value. The breakdown in diode is due to either zener breakdown or avalanche multiplication since reverse saturation current is temperature depend parameter.

DIODE RATING

The two important diode rating, that must be known for any application are

(i) The maximum forward current

(ii) The maximum reverse voltage or peaks reverse voltage

VARACTOR DIODE

It is basically a PN-junction diode which exploits the junction capacitance property when it is reverse biased. In the earlier section, it was shown how the reverse voltage directly influence the space charge region (depletion) region which causes the transition capacitance to vary with voltage, this property enable the varactor diode to be used as a voltage controlled oscillator (VCO), where the input voltage varies the capacitance.

APPLICATIONS

(i) It is used as a high frequency tuner

(ii) It is used in parametric amplifiers

(iii) It is used in microware frequency multiplication

(iv) It is used in active filters

(v) It is used in a harmonic generation.

TUNNEL DIODE

This is a PN-junction diode that operate in a certain region of its V-I characteristics, by a quantum mechanism, tunneling of electrons through the potential barrier. When the semiconductor is continuously doped with impurities, a point is reached at which the impurities becomes so closely packed within the crystal lattice that interactions between the charge carrier dominate.

UN-BIASED TUNNEL DIODE

A tunnel diode is said to be un-biased when the Fermi energy level distribute uniformly through of the junction. The Fermi energy level lies

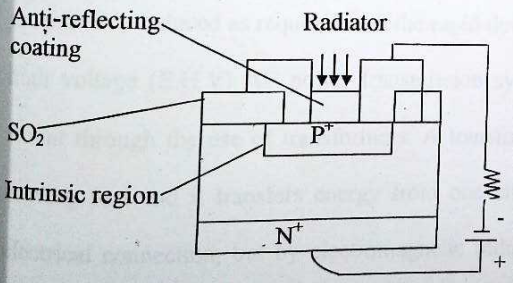
between the valence band energy level of n-side, the conduction band energy level over laps with valance band energy level on the Fermi scale.

PIN DIODE PRINCIPLE

When a diode is reverse biased, the current flow is mainly due to minority carrier current/ reverse saturation current) blocking the majority carrier current across the depletion layer. The amount of minority carrier increases with the amount of light-absorbed, which in turn increases the width of the depletion region, by depletion layer width, not rely entirely only on the bias voltage.

CONSTRUCTION OF A PIN DIODE

Pin diode is constructed by sandwiching an intrinsic (pure) semi-conductor between heavily doped P and N semi-conductor. An anti-reflecting coating is applied at the top face of the pin diode to receive light radiation and avoid secondary emission.



ADVANTAGES OF A PIN DIODE

(i) By concentrating absorption at the intrinsic region, it reduces the noise and slow switching response when it radiate to light as in the case of conventional photo diode.

(ii) The reduced noise and increased speed can also be achieved due to the fact that it has higher resistively than other device of its family.

(iii) The speed of the pin diode is limited by variation in the time it takes electrons to pass through the device. The time can reduce in two ways.

a. By increasing the bias voltage

b. By reducing the thickness layers

TYPES OF PIN DIODE

There are two types of Pin Diode

(i) Metal semi-conductor pin diode

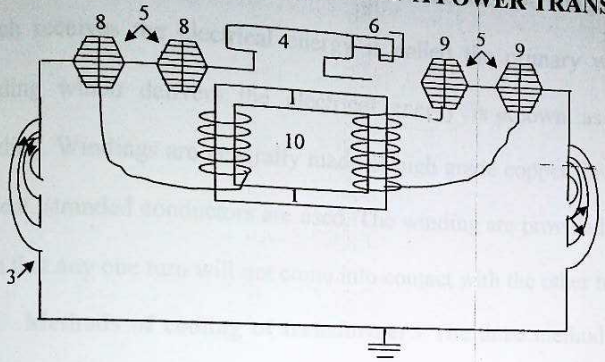
(ii) Hetero-junction pin diode

2.4 TRANSFORMERS

A transformer is a device which is widely used to change the voltage and current relations in on AC electric circuit. The voltage and current can either be increased or reduced as required with the rapid development. The fields of extra high voltage (E.H.V) AC power transmission system are possible to a great extent through the use of transformers. A transformer is a device that has no moving part and it transfers energy from one circuit to another without any electrical connection, but by electromagnetic induction. The energy is always transferred without changes in frequency, but usually with changes in voltage and delivers it at a higher voltage. Conversely, a step-down transformer receives energy at one voltage and delivers it at a lower voltage. Transformers require

little care and maintenance because of their simple, rugged and durable construction.

CONSTRUCTIONAL DETAILS OF A POWER TRANSFORMER



- Laminated core
- Windings
- Tank
- Conservator
- Bushing
- Breather
- Radiators
- Winding leads (input)
- Winding leads (output)
- Transformer oil

LAMINATED CORE:- The transformer core is made of silicon steel or sheet with 4% silicon. In addition to this, the sheets are laminated and are

coated with an oxide layer to reduce the iron losses. The thickness of the lamination is 0.35mm for 60Hz operation and 5m for 25Hz operation.

WINDINGS:- A conventional transformer has two winding. The winding which receives the electrical energy is called the primary winding and the winding which delivers the electrical energy is known as the secondary winding. Windings are generally made of high grade copper for carrying higher current, stranded conductors are used. The winding are provided with insulation such that any one turn will not come into contact with the other turn.

Methods of cooling of transformer:- The three method are commonly used for cooling of the transformers windings and the core which are given below

(a) **Natural** :- Used for transformer having low voltage and output rating (i.e up to 500V and 5KVA)

(b) **Oil filled and self cooled**:- Used for large sized transformers with rating up to 132KV and 100MVA

(c) **Forced cooling with air-blast**:- Used for machines with rating higher than 33KV and 100MVA.

CONSERVATOR TANK:- When a transformer is oil filled and self cooled and the oil in the tank is subjected to heat, thus naturally expand and contract due to the conservator tank provides the means for the oil to settle down by expanding under heavy loads.

BUSHINGS:- Brushing provide proper insulation for the output leads to be taken out from the transformer tank. Bushings used are generally of two types.

(a) Porcelain type which are used for voltage rating of up to 33K and

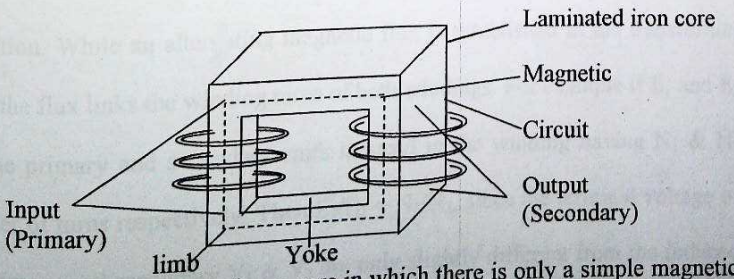
(b) Condenser type and oil filled type which are used for voltage rating higher than 33KV.

BREATHER:- Moisture and dust from the environment may occur if a transformer is exposed directly to the atmosphere to avoid this from happening a breather is provided. The breather completely prevents moisture and dust from coming into contact with the oil in the conservator tank when it expands or contracts.

TYPES OF TRANSFORMER

1. **CORE TYPE TRANSFORMER**:- There are two types namely (a) the core type (b) the distributed core type

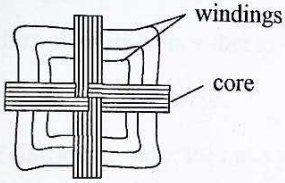
(A) CORE TYPE



The simple core-type has a core in which there is only a simple magnetic circuit, each of the two vertical members called the limbs carry one half of the

primary and one half of the secondary winding. Horizontal member of the core are called the yolks, hence, there are as many parallel magnetic circuit as these are parts of the distributed core. The general form of those coils may be circular oval or rectangular in small sized core type transformer and is used with cylindrical coil which are either circular or rectangular in shape, while the circular cylindrical coils give mechanical strength and are insulated from each other by paper.

(B) DISTRIBUTED CORE TYPES



PRINCIPLE OF OPERATION

Operating a transformer is based on the principle of electrical energy that can be transferred efficiently from one winding to another by electromagnetic induction. While an alternating magnetic flux is established in the transformer core, the flux links the winding turns of both windings. For example if E_1 and E_2 are the primary and secondary emfs induced in the winding having N_1 & N_2 number of turns respectively. Then $E_1/E_2 = N_1/N_2$, since the terminal voltage of the primary and secondary V_1 & V_2 are only slightly different from the induced emfs E_1 and E_2.

EMF EQUATION OF A TRANSFORMER

Looking at an alternating current which flows through it set up as an alternating magnetic flux. Some of the lines of force which link with the secondary winding consequently, an alternating emf is induced in the secondary winding. If N_1 and N_2 are the number of turns on the primary and secondary, and if Φm is the maximum value of the flux in Weber's having a frequency of fHZ then.

The average rate of change of flux $= \frac{2\Phi m}{(1/2f)} = 4f\Phi m$ wb/se .

Then the flux changes from + Φm to - Φm in half a cycle or in ½f (se)

:- average induced emf/turn = $4f\Phi mv$

In case of sinusoidal wave, the r.m.s value = 1.11x, average value.

R.M.S value of the induced emf/turn

$= 1.11 \times 4f\Phi mv$

$= 4.44f\Phi mv$

Hence, the induced emf in the primary having N_1 turns is $E_1 = 4.44f\Phi m\, N_1 v$.

Equally, the induced emf in the secondary having N_2 turns $E_2 = 4.44f\Phi m\, N_2 v$

From the equation $E_1 = 4.44f\Phi mN_1V$ and

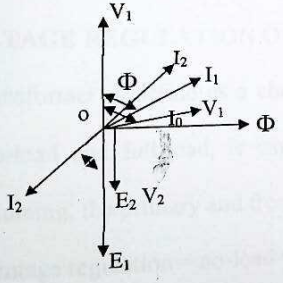
$$E_2 = 4.44f\Phi mN_2V$$

It follows that $\frac{E_1}{E_2} = \frac{N_1}{N_2}$

It is also the same as $\frac{V_1}{V_2} = \frac{N_1}{N_2}$

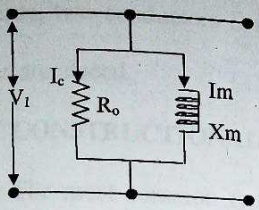
AN IDEAL TRANSFORMER

A transformer is said to be an ideal when the primary and secondary winding resistance are neglected, the secondary induced voltage E_2 will be equal to its terminal voltage V_2, likewise, on the primary side, the induced emf E_1 will be equal to the applied voltage V_1. It is an ideal transformer, hence, V_1 and E_1 will oppose each other. Consider a load on the transformer secondary such that it gives a lagging power factor 0.2. Then the load current in the secondary I_2 will lag the secondary voltage V_2 by an angle P_2. The secondary causes a current I_2 to flow in the primary such that ($I_1 = I_2 (N_1/N_2)$ neutralizes the demagnetizing effect of I_2. In addition to I_2, the no- load current Io (discussed in the previous section) also flows in the primary as shown below.



EQUIVALENT CIRCUIT OF A TRANSFORMER ON NO-LOAD

A secondary transformer is open circuited when it takes only a very small current and the losses are mainly due to the iron losses only, which remain constant at all loads. Which means that 2 transformer on no-load can be represented by an equivalent shown below.



Secondary Open

EQUIVALENT CIRCUIT OF A TRANSFORMER

A transformer can be better understood and analyzed if we first assume it to be an ideal transformer having no leakage of infinite permeability, which is zero magnetizing current, and then its giving that the winding resistances, magnetic leakage and the magnetizing circuit are inserted externally.

VOLTAGE REGULATION OF A TRANSFORMER

A transformer is define as a change in the secondary terminal. Voltage between no-load and full-load, is expressed as a percentage of the no-load voltage, assuming, the primary and frequency to be held constant, that is

$$\text{Percentage regulation} = \text{no-load voltage} - \frac{\text{full-load voltage}}{\text{No-load voltage}}$$

If V_2 is the secondary terminal voltage on full-load and V_{20} is secondary voltage on no-load. Then % regulator $= \frac{(V_{20} - V_2)}{V_{20}} \times 100$

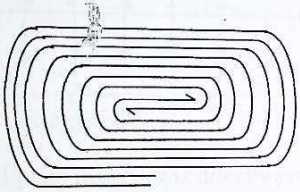
2.5 CAPACITOR

The property of a capacitor is to store electrical energy when its plates are at different potentials which is called its capacitance and its unit in farad (F).

The capacitance depends on the physical dimension of the system of bodies. In this case, two conductors S and the permittivity of the medium in which the bodies are placed.

CONSTRUCTIONAL DETAILS OF A CAPACITOR

The most common types of capacitors used in practice consist of two stage of metal coil, separated by strips of waxed or impregnated paper shown by the clotted line below, both the metal coil and impregnated paper are wound spirally to increase the area and the entire assembly is impregnated in hot paraffin wax.



TYPES OF CAPACITORS

There are two types of capacitors, if the capacitance of the capacitor is a fixed value, as in most of the cases, they are known as fixed value capacitors. They are used in radio receiver, and for tuning purposes. This can be achieved by having a set of movable capacitors that varies with respect to another set of fixed values. It can be classified according to the nature of dielectric employed as:

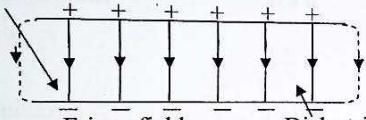
i. Air capacitors
ii. Mica capacitors
iii. Ceramic capacitors

iv. Electrolytic capacitors

v. Paper capacitors

FACTORS AFFECTING THE CAPACITORS

One of the factors that affect capacitors is the parallel plate. Parallel plates have two large plates separated by small distances between them. A dielectric material is placed between the plate as shown below, let the area of plate be A and Er be K. Assume that the electric field between the two plates is uniform and the field at the ends is neglected.



Fringe field Dielectric with Er = k

The parallel plate capacitor is directly proportional to the area of the plate and the permittivity of the dielectric material is inversely proportional to the distance between the plates. This suggest that the capacitance of a mica filled capacitor is more than that of an air filled capacitor for the same physical dimension, the value of the dielectric constant (Er = k) of some important dielectric materials used in capacitors are given below in table.

MATERIAL	DIELECTRICAL CONSTANT
Vacuum	1.0
Air	1.0006
Dry paper	2.0 – 2.5
Bakelite	4.5 – 5.5

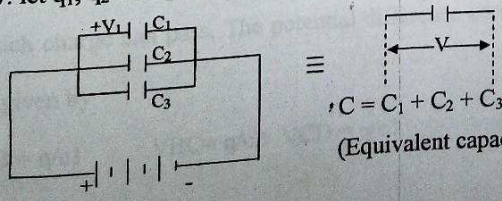
Glass	5.0 – 10.0
Rubber	2.0 – 3.5
Mica	3.0 – 7.0
Porcelain	6.0 – 7.0
Mylar	3.1
Polyethylene	2.25
Polyvinyl chloride	3.2
Water	80.4
Titanium dioxide	173.0
Teflon	2.1
Germanium	16.0

ARRANGEMENT OF CAPACITORS

Capacitors can be arranged in two ways either in parallel or in series, when both of them are combined, the calculation of the equivalent capacitance in such cases is necessary.

CAPACITORS IN PARALLEL

The arrangement below shows a capacitor in parallel l_1, l_2 and l_3, are the three capacitors connected in parallel. The voltage across each capacitor is the same volts v. let q_1, q_2 and q_3 be the corresponding change on C_1 C_2.



$\therefore C = C_1 + C_2 + C_3$

(Equivalent capacitance)

The total charge of the system of capacitor is given by

$q = q1 + q2 + q3$

$= C_1V + C_2V + C_3V = (C_1 + C_2 + C_3)\,V$

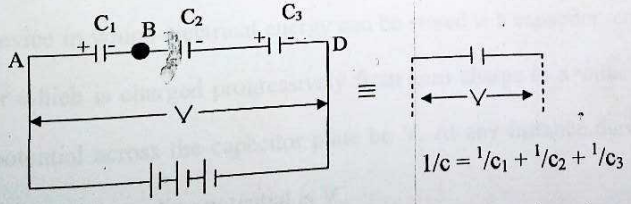
Therefore, the equivalent capacitance C is given by

$C = C_1 + C_2 + C_3$

Thus, when arranging capacitors in a parallel system, the equivalent capacitance (c) is always greater than any individual capacitance and is equal to the sum of the capacitance in parallel.

CAPACITORS IN SERIES

The arrangement of capacitors C_1, C_2 and C_3 in series is shown below, the right hand plate of the first capacitors is connected to the left plate of the second one to the left hand plate of the third. Finally, all the three capacitors are connected in series to the battery supply providing the emf across the points A & D



$1/c = {}^1/c_1 + {}^1/c_2 + {}^1/c_3$

A charge q passes through each capacitor since there is only one path through which charge can pass. The potential difference across each capacitors different is given by

1. $VAB = q/c1$ $VBC = q/c2$ $VCD = q/c3$

From the circuit above, it is seen that the sum of the three voltages.

2. $VAB + VBC + VCD = V$

$V - {}^{q}/_{c1} + {}^{q}/_{c2} + {}^{q}/_{c3}$

$V = q\,({}^{1}/_{c1} + {}^{1}/_{c2} + {}^{1}/_{c3})$

∴ If c is the equivalent capacitance of the three capacitor in series then,

$C = {}^{q}/_{v}$

∴ From equator i & ii

$({}^{1}/_{c}) = {}^{1}/_{c1} + 1/c2 + 1/c3$

Thus, in general, if n capacitor of value C_1, C_2, C_3 ….. (n are connected in series, their equivalent capacitance is given as

${}^{1}/c = {}^{1}/c_1 + {}^{1}/c_2 + {}^{1}/c_3 + \ldots\ldots\ldots + {}^{1}/cn$

NOTE => When capacitors are connected in series, the equivalent capacitance is always less than any individual capacitance in the circuit.

ENERGY STORED IN A CAPACITOR

A device in which electrical energy can be stored is a capacitor, consider a capacitor which is charged progressively from zero charge to a value q. Let the final potential across the capacitor plate be V. At any instance during the charge, let the corresponding potential is V.

If dq be the additional charge placed on the capacitor, then the work required to do so will be.

$dw = Vdq = Cv\,dv$ since $q = cv$,

Total work done during charging process

$w = c \{vdv = \frac{\{cv^2\}^4}{2} = \frac{cv^2}{2}$ joules

$W - {}^{q-c}/_2$ since $cv = q$

:- energy in a capacitor is equal to work done which is given by

$w = {}^{qc}/_2 = {}^{1}/_2 cv^2$

where q is express in coulombs, c is farads and v in volts.

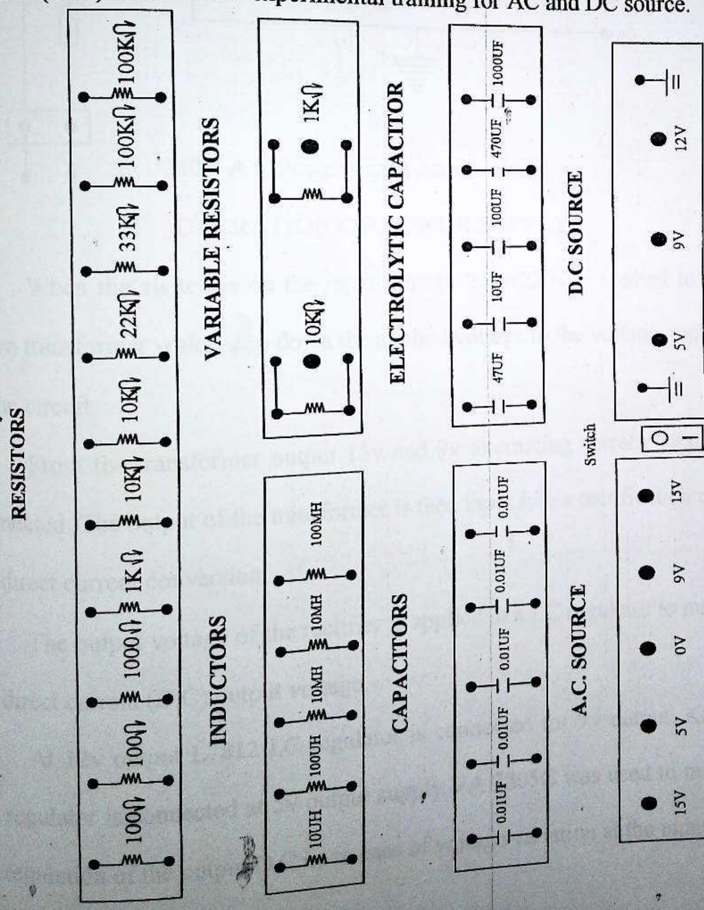
CHAPTER THREE

3.0 CONSTRUCTION

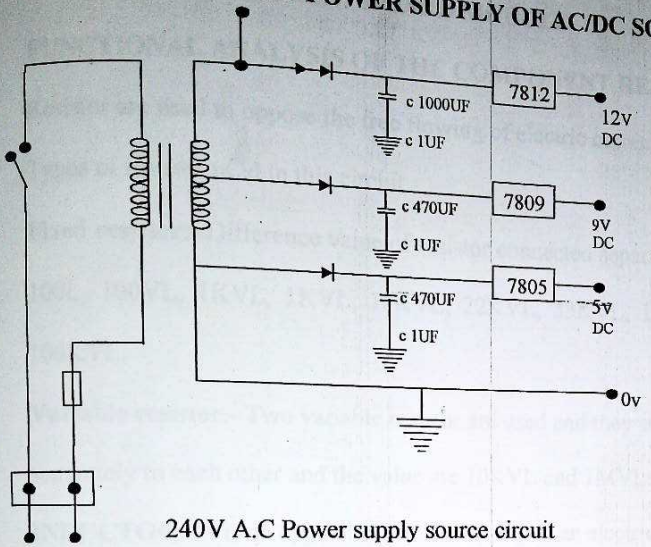
3.1 CIRCUIT DIAGRAM

In electrical engineering technology, the construction involved method, principle, processing and activities carry out to perform a specific work.. This methods are used in the construction of alternating current {A.C} and direct current {D.C} source in an experimental training for AC and DC source.

THE CIRCUIT DIAGRAM OF AN EXPERIMENTAL TRAINER FOR AC/DC SOURCE



CIRCUIT DIAGRAM OF POWER SUPPLY OF AC/DC SOURCE



240V A.C Power supply source circuit

OPERATION OF POWER SUPPLY

When the switch is on the input voltage 240v/220v is applied to a step down transformer which step down the applied voltage to the voltage applicable to the circuit.

From the transformer output 15v and 9v alternating current supply was connected. The output of the transformer is then input into a rectification circuit, for direct current conversion.

The output voltage of the rectifier is applied to a I.C regulator to maintain the direct current (D.C) output voltage.

At 12v output L7812 I.C regulator is connected for 9v output, KA7809 I.C regulator is connected at 5v output supply VA 7805C was used to maintain the regulation of the output D.C i.e in case of voltage variation at the input.

COMPONENT BOARD MODULE

FUNCTIONAL ANALYSIS OF THE COMPONENT RESISTOR

Resistor are used to oppose the free flowing of electric current in a circuit

Types of resistor used in this circuit

Fixed resistor:- Difference value of resistor connected separately such as 100L, 100VL, 1KVL, 1KVL, 10KVL, 22KVL, 33KVL, 100KVL and 100KVL.

Variable resistor:- Two variable resistor are used and they are connected separately to each other and the value are 10KVL and 1MVL.

INDUCTOR:- It is an opposition to the flowing of an electric current in a circuit. It is common in an alternating current circuit (A.C)

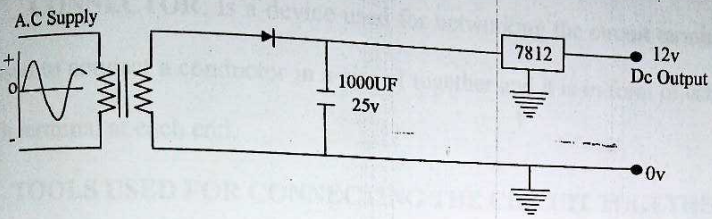
In this circuit five inductors are used and the value are 100UH, 100UH, 10MH, 33MH and 100MH and it's connected separately to each other.

CAPACITOR:- It is a device used in storing electric charges. Five capacitors are used in this circuit and the values are 0.01UF, 0.01UF, 0.1UF, 0.1UF, 0.1UF and is connected separately.

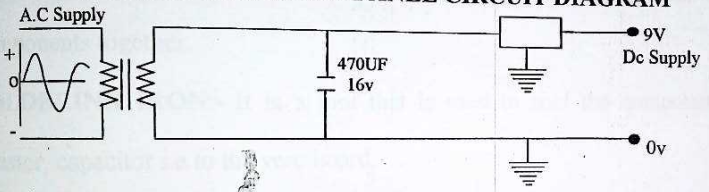
ELECTROLYTE CAPACITOR:- Electrolyte capacitor are devices used in storing electrical charges and also used in smoothly the output of a direct current {D.C} source. Five electrolyte capacitor were used in this circuit and the values are 4.7UF, 10UF, 100UF, 470UF, and 1000UF and they are connected separately to each other.

RECTIFICATION:- This is the process of obtaining direct current from an alternating current (A.C) source through the use of diode.

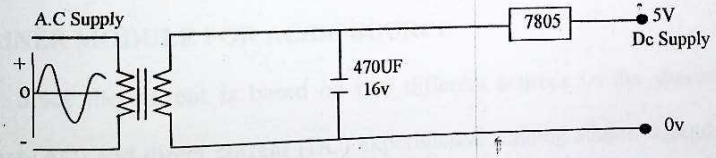
FIRST RECTIFIER PANEL CIRCUIT DIAGRAM



SECOND RECTIFIER PANEL CIRCUIT DIAGRAM



THIRD RECTIFIER PANEL CIRCUIT DIAGRAM



I.C REGULATOR (I.C REGULATOR):- It is used to regulate or maintain output voltage of a direct current (D.C) supply source.

SWITCH:- Is a device used to open or close the circuit terminal, when opening the terminal, there will not be flow of current, while when the terminal is closed, the flow of current will occur.

TRANSFORMER:- Is a device that employed an alternating current (AC) system to change the magnitude of the current or voltage in one section to another.

CONNECTOR: Is a device used for networking the circuit terminals. It is used to connect a conductor in a circuit together and it is in form of cable but with terminal at each end.

TOOLS USED FOR CONNECTING THE CIRCUIT TOGETHER

LEAD:- This is used when it has been heated with a soldering iron to sold components together.

SOLDERING IRON:- It is a tool that is used to sold the component like resistor, capacitor i.e to the vero board.

PRINCIPLE OF OPERATION OF AN EXPERIMENTAL TRAINER MODULE FOR AC/DC SOURCE

Since the current is based on two different sources i.e the alternating current (AC) and direct current (DC) experimental training source depends on the principle of ohm's for operation.

When the switch is on the current will flow through the conductor to the transformer input and the output of the transformer. It will step down the magnitude of the alternating current source. 15v and 9v source are connected to the alternating source of 15v and 9v of the transformer.

Then, the rectifier diode was connected to the transformer output source, so the direct current produced are 12v, 9v and 5v.

At the direct current (DC) source, the electronic equipment can be connected to the source for experimental purpose.

At the A.C side the 15v and 9v, the current flow in it was reverse direction.

At the D.C side the 12v, 9v and 5v, the current flowing in them has constant value and direction with respect to time.

CHAPTER FOUR

4.0 TESTING AND RESULT

The experimental trainer for AC/DC sources kit in it is a self contained unit without any measuring instrument.

It works on 230v, 50Hz power. Connection to 230v power point is by means of the power cord of the trainer.

Turn this main ON/OFF switch or the front panel to "ON" position. By this switch, the various D.C and A.C supply will be available on the front panel.

All the connections including supply and ground to and from a device index supply are made using of 4mm stackable patch cords. It is a good practice to turn the main power ON switch to OFF position while making circuit connections. The power can be restored after connections are made and thoroughly checked.

The trainer is now ready for conducting the experiment on different active and passive devices which are described in the subsequent experiment.

4.1 EXPERIMENT ONE

VERIFICATION OF OHM'S LAW

AIM

To study and verify ohm's law

EXPERIMENT EQUIPMENT REQUIRE

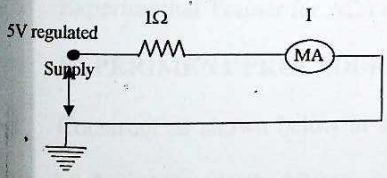
Experimental trainer for AC/DC sources

Volt meter / Digital multi-meter

Ammeter or 0-25MA/ Digital Multi-meter Resistor & Patch Cords.

EXPERIMENT PROCEDURE

- Measure the value of the resistor using the multi-meter
- Construct the circuit as shown in the circuit diagram below with the help of patch cords.
- Select the appropriate current range on the multi-meter
- Turn on the last and measure the current of the multi-meter
- Replace the 470 ohms with 1k resistor and repeat the procedure to find the current flowing through it.
- Measure the exact value of the resistance using a multi-meter, since the tolerances are found for resistance value given by colour codes.



THEORY

As the physical state of the conductor remains constant the current flowing through the conductor is directly proportional to the potential applied between the ends of the conductor that is V = JR.

Actual Resistor Value (Ω)	Current through Resistor (I)	Voltage = Current x Resistor
200Ω	0.024	5V
1KΩ	0.0055	5V

CONCLUSION

From the above calculation and observation in the table above, we can see that the calculated current and observed current are the same thus proving the ohm's law.

4.2 EXPERIMENT TWO

VERIFICATION OF KIRCHOFF'S CURRENT LAW

AIM

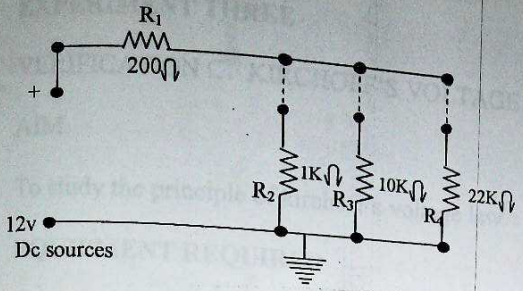
- To study the principle of kirchoff's current law

EQUIPMENT REQUIRED

- Digital multi-meter (3 to 4 nos)
- Resistors and Patch Cord
- Experimental Trainer for AC/DC source

EXPERIMENT PROCEDURE

- Construct as shown below in the circuit diagram with the help of patch cords and turn on the kit.
- Select 12volts DC supply and connect it at the input of the circuit.
- Connect 3 nos of ammeters between the terminals shown by dotted lines.
- Note the following current value $R_2\{IR_2\}$ $R_3\{IR_3\}$ and $R_4\{IR_4\}$
- Now remove the current meters and short the R_1 to ground terminal
- Measure the current from R_1 by connecting the current meter in series with R_1 and ground name it as IR_1.
- Verify that $IR_1 = IR_2 + IR_3 + IR_4$



RESULT

Kirchoff's current law = $IR_1 = IR_2 + IR_3 + IR_4$

$IR_1 = 11.5MA$

$IR_2 = 10MA$

$IR_3 = 1MA$

$IR_4 = 0.5MA$

$\therefore IR_1 = IR_2 + IR_3 + IR_4$

$=10.0 + 1 + 0.5 = 11.5MA$

From the above calculation we know that the amount of current which flows in a circuit is determined by the amount of voltage applied and the total resistance of the circuit. Kirchoff's current law is expressed as follows:-

The sum of the current flowing through to a point in a circuit is equal to the sum of current flowing away from that point. This is a very simple statement, which is fundamental to the understanding of electrical circuit.

In this laboratory activities. You will study the application of kirchoff's current law for a combination circuit. This law explain the distribution of current in a circuit.

4.3 EXPERIMENT THREE

VERIFICATION OF KIRCHOFF'S VOLTAGE LAW

AIM

To study the principle of kirchoff's voltage law

EQUIPMENT REQUIRED

- Digital multi-meters {3 to 4 nos)
- Resistors and Patch cords
- Experimental Trainer for AC/ DC source

OBJECTIVE

Kirchoff's voltage law is basic to the understanding of electrical circuitry. We may express this voltage law in two way:-

1. The sum of the voltage drop in ay current path of a circuit is equal to the voltage applied to that path.
2. The algebraic sum of the voltage drop and voltage source of current path in a circuit is equal to zero.

In this laboratory activity, you will study the application of kirchoff's voltage law for circuits with one voltage source and those with more than one voltage source. Single source circuit problems can ordinarily be easily solved by applying ohm's law, however multiple source circuit are not as simple. The most practical application of kirchoff's voltage law may be seen by applying this algebraic method of the solution of a multiple source circuit problem.

EXPERIMENT PROCEDURE

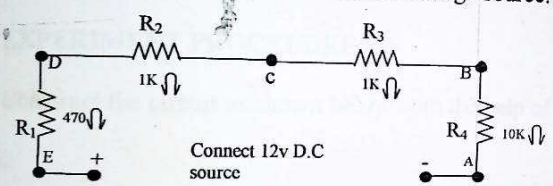
Construct the circuit as shown in the circuit diagram below with the help of patch cord and turn on the kit.

Connect 12v DC source to the Vs input of the circuit.

Observe the voltage drop across R_1(VDE), R_2(VCD), R_3(VBC) & R_4(VAB) by using the digital volt meter.

Now apply the formula and verify that total of VAB +VBC + VCD + VDE is equal to 12volt.

Repeat the experiment with different voltage source.



V_B = 12 volts

V_B = VAB + VBC + VCD +VDE = 0

RESULT

VB = IR_1

V = IR_1 + IR_2 + IR_3 + IR_4 = 0

VAB = IR_4 = 0.09v

VBC = IR_3 = 0.96v

VCD = IR_2 = 0.97v

VDE = IR_1 = 9.87v

11.89v ≃ 12v

$V_{AB} + V_{BC} + V_{CD} + V_{DE} = 7 + 2 + 2 + 1 = 12v$

$V_B - V_{AB} + V_{BC} + V_{CD} + V_{DE} = 12 - 12 = 0v$

4.4. EXPERIMENT FOUR

AIM:

To show that the High Pass RC circuit also work as a Differentiator

EQUIPMENT REQUIRED:

1. Experimental Trainer for AC/DC sources
2. Function Generation (100KHZ/1MHZ)
3. Dual Trace C.R.O

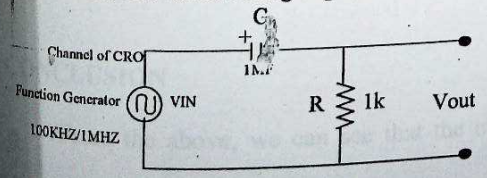
EXPERIMENT PROCEUDRE:

1. Construct the circuit as shown below with the help of patch cords

NOTE:

i. The unit need not be switched ON as are using passive devices and using input from function generator and observing the output on C.R.D

ii. The function generator and CRO should be connected to the mains supply and switched ON when doing experiments.

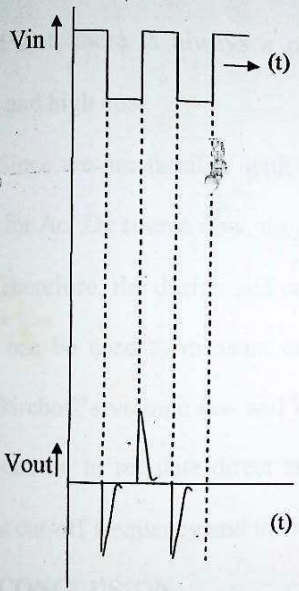


2. Select square wave on function generator and set frequency 100HZ and amplitude 5Vpp and observe the signal on, channel 1 of CRO. Let the input signal be denoted as Vin.

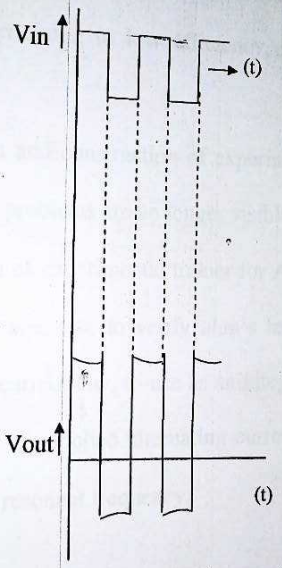
3. Observe the output of the circuit on the channel 2 of CRO let this be denoted as Vout.

4. Vary the square wave and observe the output for frequencies below cut-off and above cut-off. The wave forms will be shown below.

OBSERVATIONS:



i. For Frequency below cut-off



ii. For Frequency above cut-off

CONCLUSION

From the above, we can see that the circuit acts as a High Pass Filter allowing frequencies above cut-off to pass and attenuate those frequencies below cut-off. Also the circuit works as an differentiator.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION, RECOMMENDATION

5.1 SUMMARY

In summary, this project (Experimental trainer for Ac/ Dc sources). We noticed that, there is always a problem pertaining to low efficiency, heavy weight and high cost.

Since we are familiar with the design and construction of experimental trainer for Ac/ Dc source now, the errors and problems are no longer visible.

Therefore, the design and construction of experimental trainer for Ac/Dc source can be used to measure current, voltage, also to verify ohm's law, to verify kirchoff's voltage law and kirchoff's current law, to use as an integrator in RC-circuit, to regulate direct current and to supplied alternating current, to find out cut-off frequency and to find out the resonant frequency.

5.2 CONCLUSION

The project provides solution to continuous problems, students in engineering are facing in the construction and design, with the maintenance of the experimental trainer for Ac/Dc source. It has also contribute to the knowledge and skills on how to operate unit and enabled them to put into practice knowledge acquired during the course of study.

5.3 RECOMMENDATION

After the completion work on this project (Experimental trainer for AC/DC source), the following analysis should always be put unto consideration, namely:-

i. The project work (Experimental trainer for Ac/ Dc source) should be repair and maintain by a specialist when ever there is a specified fault or it.

ii. The moisture part should be cleaned to avoid rusting.

iii. The experimental trainer for Ac / Dc source should be kept under normal temperature.

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