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Project Report on

THE HARTLEY OSCILLATOR

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शास. नवीन महा. हसौद
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Rahul

Signature of the candidate

DECLARATION BY THE CANDIDATE

I hereby declare that the dissertation entitled " **THE HARTLEY OSCILLATOR** " submitted Rahul yadav , Enrollment no: 2018054312 to Govt. NAVEEN COLLEGE HASOUD,DIST-JANJGIR CHAMPA (C. G.), in fulfillment of the requirement for the award of the degree of master of science on physics is a record of bonafide research work carried out by me under the guidance of professor R. P. Upadhyay during the course of the year 2020-2021. Further declare that the work reported in this dissertation has not been submitted , and will not be submitted either in part or in full, for the award of any other degree or diploma of this University or of any other institute or University.

Rahul

Date...27-10-2020

Signature of the candidate

THE HARTLEY OSCILLATOR

TITLE: Hartley oscillator has been designed to study the RF Oscillator produced by the circuit . Change in the frequency of oscillations with the change in the capacitor(Gang) of tank circuit.

ABSTRACT: This is the report of our semester final project of the circuit lab. This report will give the reader an overview about the steps which are involved in the making of a HARTLEY OSCILLATOR. The project is about the making of Hartley oscillator that will generate approximately ....

CONTENTS (KEY POINTS):

1. INTRODUCTION :-

Many electronic devices require a source of energy at a specific frequency which many range from a few Hz to several MHz. This is achieved by an electronic device called an oscillator.

Oscillator are extensively used in electronic equipment for example in radio and television receivers ,oscillators are used to generally high frequency wave(called carrier wave) in the tuning stages .

Audio frequency and radio frequency signals are required for the repair of radio television and other electronic equipment, oscillator are also widly used in radar , electronic computer and other electronic devices .

Oscillator can provides sinusoidal or non sinusoidal (e. g square wave) wave. In this project, we shall continue our attention to sinusoidal oscillators i.e which produce sine wave signals.[1]

HARTLEY OSCILLATOR CAME INTO EXISTENCE:

The Hartley oscillator is an electronic oscillator circuit in which the oscillation frequency is determined by a tuned circuit consisting of capacitors and inductors that is an LC OSILLATOR.
The circuit was invented in 1915 by American engineer RALPH HARTLEY.
The distinguishing feature of the Hartley oscillator is that the tuned circuit consists of single capacitor in parallel with two inductors in series. The feedback signal needed for oscillation is taken from the center connection of the two inductor.[2]

WHICH ONE IS THE BEST LC AND RC OSCILLATORS??

One desirable feature of oscillator is that it should feedback energy of correct phase to the tank circuit to overcome the losses occurring in it. In the oscillator circuits discussed so far the tank circuit employed inductive (L) and capacitive(C) elements. In such circuit a phase of 180 was obtained due to inductive or capacitive coupling and a further phase of 180 was obtained due to transistor properties. In this way energy supplied to the tank circuit was in phase with the generated oscillations. The oscillator circuits employing LC elements have two general draw back. Firstly low frequencies because they becomes too much and expensive.

Good frequency stability and wave from can be obtained from oscillators employing resistivity and capacitive element such amplifiers are called RC or phase shift oscillator.

Have the additional advantage that they can be used for every low frequencies .in a phase shift oscillator ,further phase shift of 180 is introduced due to the transistor properties thus energy supplied back to the tank circuit is assumed of correct phase.[3]

Hartley oscillator invented and patented the design in 1915 while overseeing bell system's transatlantic radiotelephone test it was awarded on October 26 1920 and patented no 1356763

In 1946 Hartley oscillator was awarded the IRE medal for honor for its early work on oscillating circuits employing triode tubes and likewise for this early recognition and clear exposition of total amount of information which may be transmitted over a transmission system of limited band width and the time required.[2]

2. REVIEW OF LITERATURE :-

I. ELECTRONIC OSCILLATOR:-

An electronic oscillator is an electronic circuit that produces a periodic, oscillating electronic signal, often a sine wave or a square wave.[4]

The first practical oscillators were based on electric arc, which were used for lighting in the 19th century. The current through an arc light is unstable due to its negative resistance and aften breaks into spontaneous oscillation, causing, thaqrc to make hissing, humming or howling sound .[5]

II. LC TUNED CIRCUIT:-

An oscillator was built by ELIHU THOMSON in 1892 by placing an LC TUNED CIRCUIT in parallel with an electric arc and included a magnetic blowout. In 1902 DANISH PHYSICISTS VALDAMER POULSEN and P.O. PEDERSON were able to increase the frequency produce into the radio range by operating the arc in a hydrogen atmosphere with a magnetic field ,inventing the POLSON arc radio transmitter ,the first continuous wave radio transmitter,which was used through the 1920s.[6]

III. THE VACUUM TUBE FEEDBACK OSCILLATOR:-

The vacuum tube feedback oscillator was invented around 1912, when it was discovered that feedback ("regeneration") in recently invented audion vaccum tube could produced oscillation.[7]

The first and most widely used relaxation oscillator circuit, theastable multivibrator was invented in 1917 by French engineers HENRI ABRAHAM AND ENGENE BLOCH.[8]

Mathematical condition for feedback oscillations, now called the BARKHASEN CRITERION, were derived by HEINRICH GEORG BARKHASEN in 1921,the first analysis of a non linear electronic oscillator model ,the van der pol oscillator, was done by BALTHASAR VAN DER POL in 1927.[9]

IV. ARMSTRONG OSCILLATOR:-

The Armstrong oscillator is an LC OSCILLATOR electronic oscillator and to generate this oscillator we are using the inductor and the capacitor. In 912 the US engineer ADWIN ARMSTRONG has invented the Armstrong oscillator.[10]

It was first oscillator and also in 1913 this oscillator was used in the first vacuum tube by the ALEXANDER MEISSER as an Austrian engineer.

V. WIEN BRIDGE OSCILLATOR :-

Wien bridge oscillator is a type of electronic oscillator that generates sine waves. the oscillator based on bridge circuit originally development by wien in 1891 for measurement of impedances.[11]

VI. COLPITTS OSCILLATOR:-

A colpitts oscillators invented in 1918 by AMERICAN engineer EDWIN H.COLPITTS is one of a number of designs for LC OSCILLATORS.[12]

Electronic oscillators that use a combination of inductors(L) and capacitor(c) to produce on oscillation at a certain frequency the distinguishing feature of the colpitts oscillator is that the feedback for the active device is taken from a voltage divider made of two capacitors in series across the inductor.[13]

VII. THE TANK CIRCUIT OF HARTLEY OSCILLATOR:-

One of the main disadvantages of the basis LC Oscillator circuit we looked at in the previous. So that they have no means of controlling the amplitude of the oscillations and also it is difficult to tune the oscillator to the required frequency. it the commutative electromagnetic coupling between L1 and L2 is too small there would be insufficient feedback and the oscillation would eventually die way to zero.

Likewise if the feedback was too strong the oscillation would continue to increase in amplitude until they were limited by the circuit conditions producing signal distortion so it become very difficult to "tune" the oscillator.

However it is possible to feed back exactly the right amount of voltage for constant amplitude oscillators if we feedback more than is necessary the

amplitude of the oscillations can be controlled by biasing the amplifier in such a way that if the oscillations if the oscillation increase in the amplitude the bias in increased and the gain of the amplifier in reduced.

If the amplitude of the oscillations decrease the bias decreased and the gain of the amplifier increase, thus increase the feedback in this way the amplitude of the oscillations ate kept constant using a process known as automatic base bias. One big advantage of automatic base bias in a voltage controlled is that the oscillator can be made more efficient by providing a class-B or class-c bias condition for the transistor. This has the advantage that the collector current only flows during part of the oscillation cycle so the quiescent collector current is very small then this "self-tuning" base oscillator circuit from one of the most common type of LC parallel resonant feedback oscillator configuration called the Hartley oscillator circuit.

3.MATERIALS AND METHODS :-

1 MATERIALS:-

Hardware used with technical specifications:-

Resistor

Capacitor

Transistor

Inductors

CRO(CATHOD RAY OSCILLOSCOPE)

oject two resistor RL and R1 are used. In which

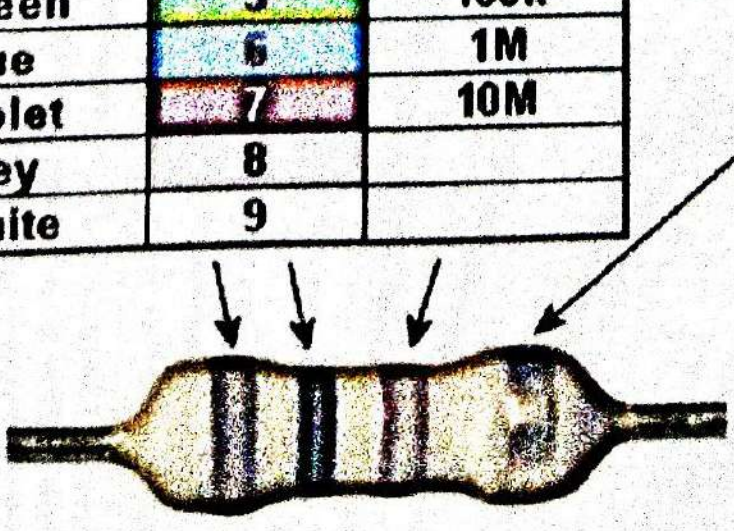
k Ω

0k Ω

Resistor Color Codes

	Value	Multiplier
Black	0	1
Brown	1	10
Red	2	100
Orange	3	1k
Yellow	4	10k
Green	5	100k
Blue	6	1M
Violet	7	10M
Grey	8	
White	9	

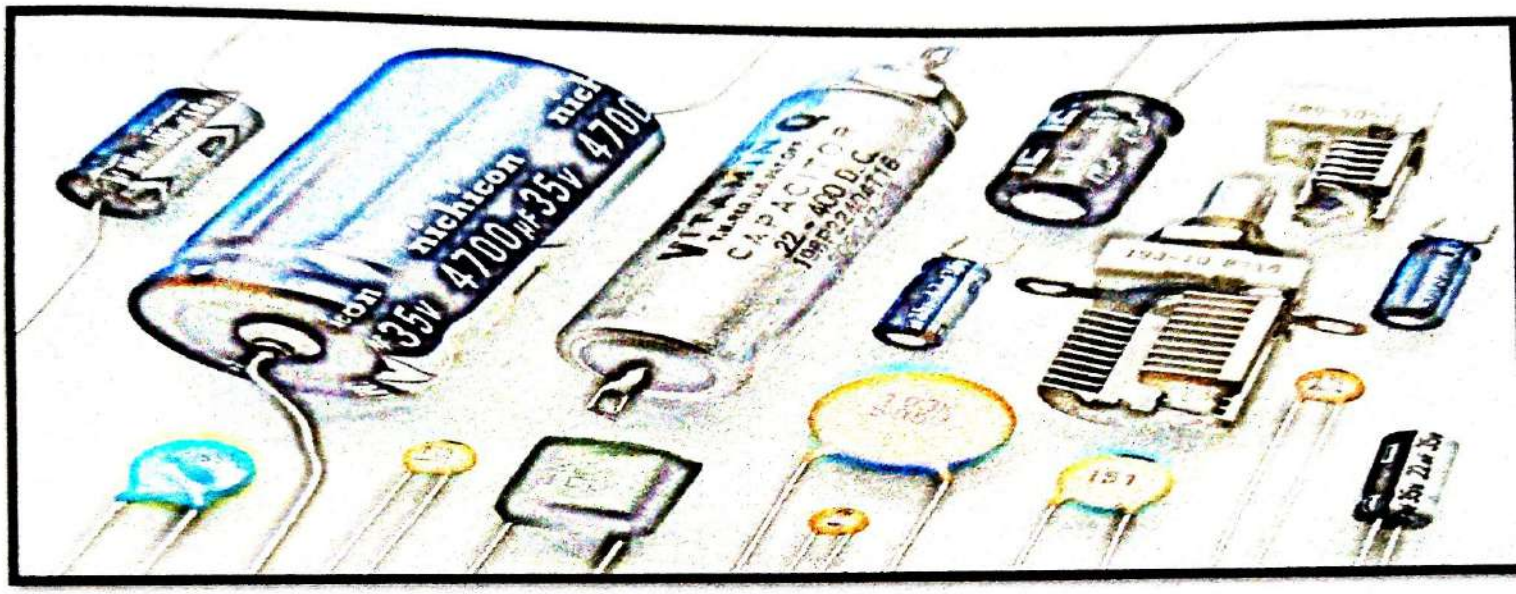
	Tolerance
Silver	10%
Gold	5%
Red	2%
Brown	1%



1 0 2 = 10*100 = 1k Ohm

II. CAPACITORS:-

Capacitor is a passive two terminals electrical component used to store energy in an electric field.the forms of practical capacities very widely but all contain at least two electrical conductors separated by a dielectric.[15]



In this project two capacitors are used C_1 and C_a

Also C (Gang capacitor).

$C_1 = 0.01\ \mu f$

$C_a = 0.001 \mu f$

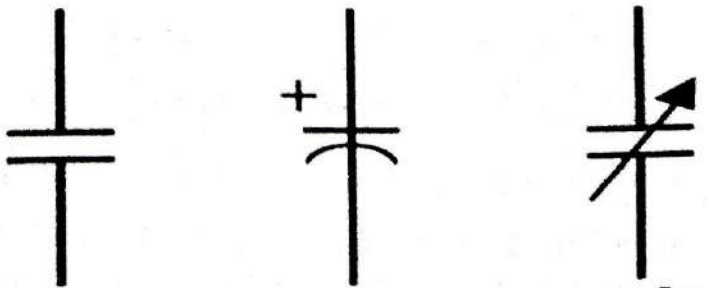


Fig.Capacitor

III. CRO (CATHOD RAY OSCILLOSCOPE):-

An Oscilloscope previously called an oscillograph and informally known as a scope, CRO (for cathod ray oscilloscope)or DSO (for the more modern digital storage oscilloscope), is a type of electronic test instrument that allows observation of constantly varying signal voltages usually as a two dimensional graph of one or more electrical potential differences using the vertical or Y-axis plotted as a functions of time (horizontal or X-axis). Many signals can be converted to voltage, so and displayed as a steady picture. Many oscilloscopes (storage oscilloscopes) can also capture non repeating waveforms for a specified time shows a steady displays of the captures segment.[16]

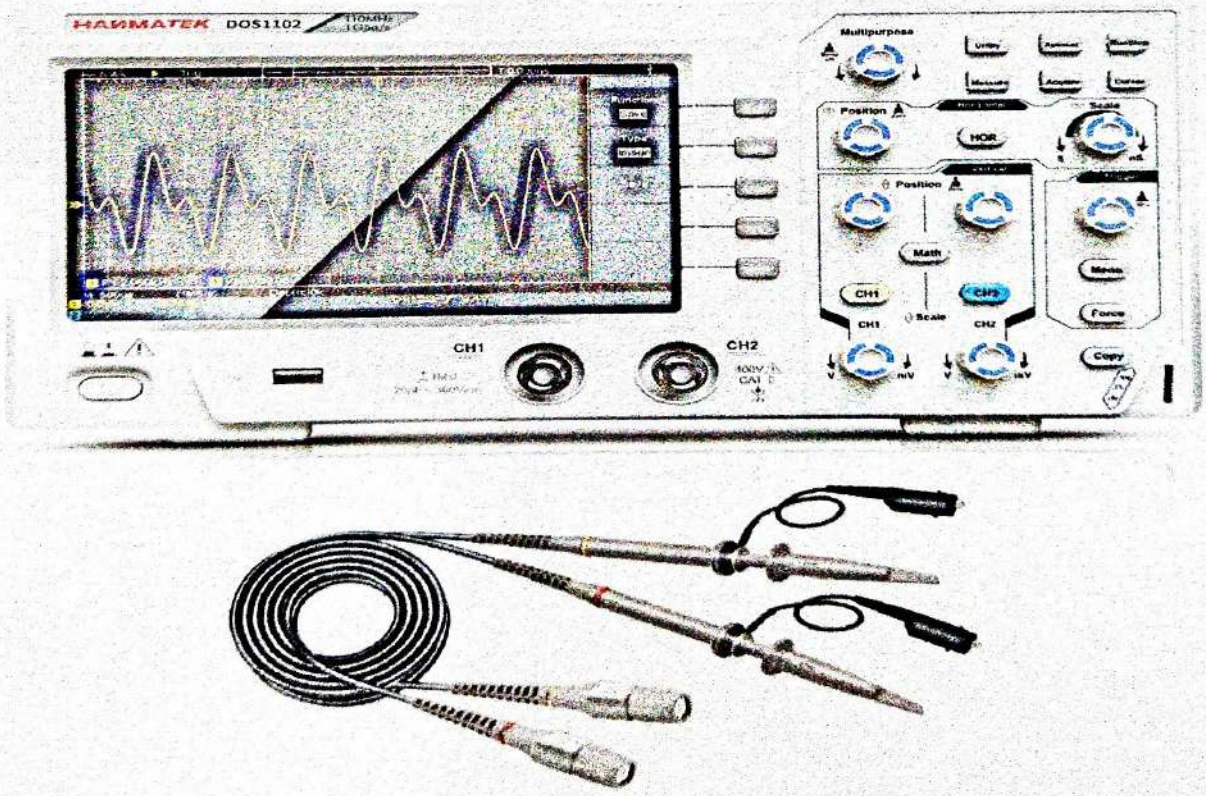


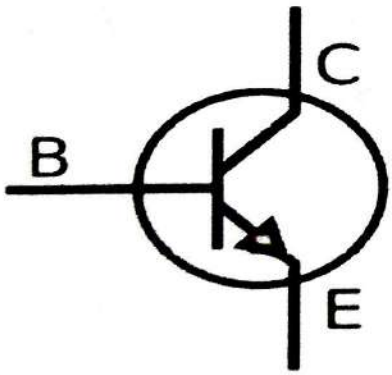
Fig. Digital Cathode Ray Oscilloscope(CRO)

IV. TRANSISTORS (BD 115):-

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. it is composed of semiconductor materials usually with a least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power a transistor can amplify a signal.

A transistor consists of two PN JUNCTION formed by sandwiching either p-type or n-type semiconductor between a pair of opposite types. Accordingly there are NPN transistor

An N-p-N transistor is composed of two n type.[17]



NPN
Bipolar Junction
Transistor

Fig. npn Transistor

V. INDUCTORS:-

An inductor also called a coil, choke or reactor is a passive two terminal electrical component that stores energy in a magnetic field when electric current flows through it .[18]

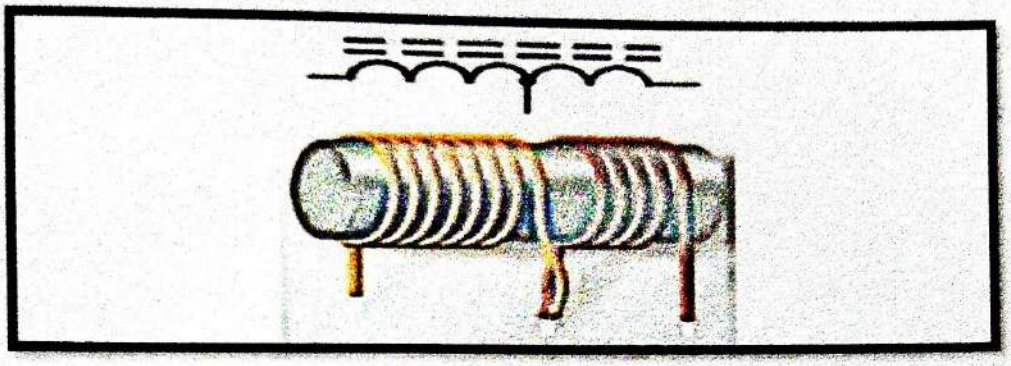


Fig.Tapped Inductor

VI. DMM:-

A multi meter is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter would include basic feature such as the ability to measure voltage, current, resistance and diode voltage.

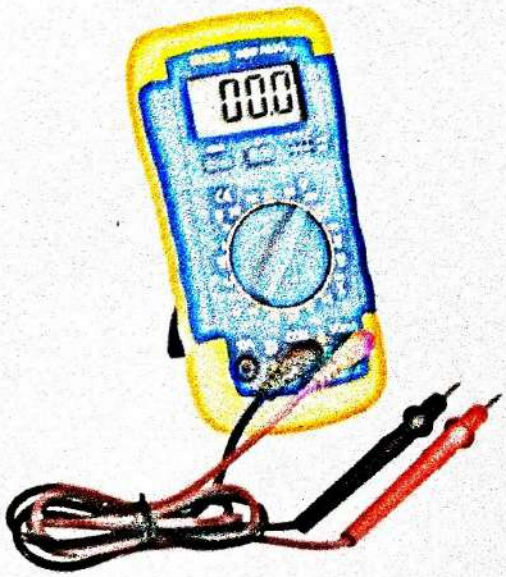


Fig. Digital Multimeter

2 METHODS:-

Design of the investigation/algorithms Hardware:-

The Hartley oscillator is a pre define circuit so have to less work in the investigation of the circuit and making it's logic. in the circuit transfer have in the forword bias condition and it work ass amplify the feedback signal in the face with input and output.

CIRCUIT DAIGRAM:-

Hartley oscillation using a junction transistor in common emitter mode is shown in the circuit diagram inductors L1 ,L2 and C from the tank circuit resistance RL and Vcc provides the biasing for Hartley oscillator capacitor C1 and CB are blocking and by pass capacitor since the transistor is operating in common emitter mode. It introduces 180 phase difference between its input and output voltage. The output voltage appears in the tank circuit. A part of this voltage appears across inductance L1 and is fed back to input circuit feedback voltage is gain 180 out of phase with the output so that a net 360 phase difference around the loop resulting in oscillations.

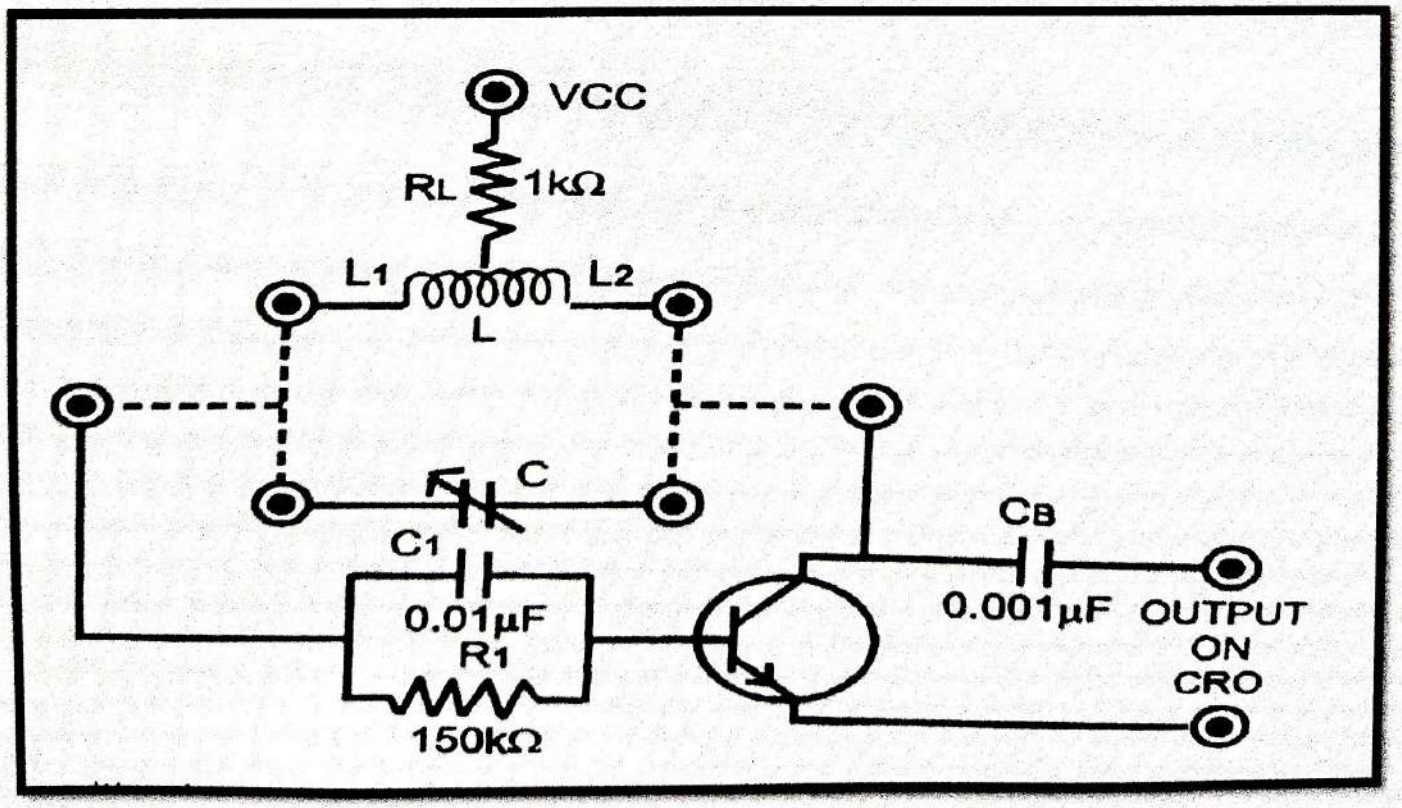


Fig. Circuit Diagram of Hartley Oscillator

ANALYSIS PROCEDURES:-

Hard and difficult process of the project is analysis of the project after making it on this hardware as measure the current and voltage by using DMM at difficult point of the circuit and by processing that analysis the circuit output frequency that the output of circuit was correct or not.

IMPLEMENTATION PROCEDURE:-

Implementation process made after the complete analysis of the circuit draw the circuit first on the helping software make it confirm that the circuit is 100% in working condition.

4. RESULTS AND DISCUSSIONS:-

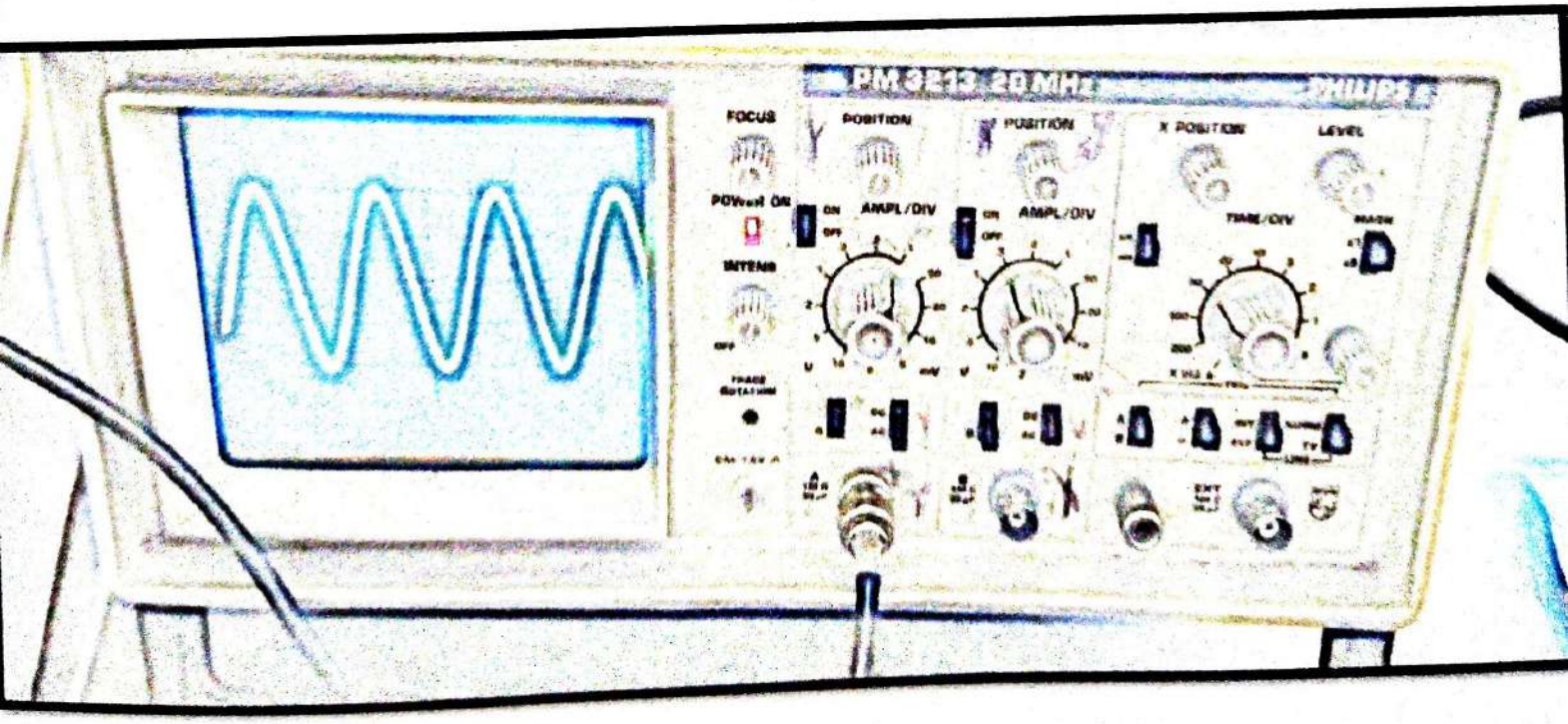


Fig. Result of Hartley Oscillator producing Sinusoidal sine wave

The amplitudes of the output remains constant over the working frequency range.

The Hartley oscillator produce a sine wave with desired frequency

The Hartley oscillator is suitable for oscillations in RF (radio frequency) range upto 30 MHz.

ADVANTAGE OF HARTLEY OSCILLATOR:-

a) It is easy to tune.
b) It can operate over a wide frequency typically from few Hz and several MHz.
c) It is easy to change the frequency by means of a variable capacitor.

DISADVANTAGES OF HARTLEY OSCILLATORS:-

a) It can not be used as a low frequency oscillation since the value if inductors becomes large and the size of the inductors becomes large.
b) Poor frequency stability.

APPICATIONS OF HARTLEY OSCILLATORS:-

a) The harmonic content of in the output of this oscillator very high and hence it is most suitable for the applications which required a pure sine wave.
b) Hartley oscillators are mainly used as radio receivers also note that due to its wide range of frequencies. It is most popular oscillator.
c) In function generator.
d) In RF sources.[19]

5. SUMMARY OF HARTLEY OSCILLATOR:-

Hartley oscillator is a device that generate oscillatory output (sinusoidal) signals or wave.

It consists of an amplifier linked to an oscillatory circuit also function of tank circuit is to tune a certain frequency LC OSCILLATOR are designed to operate in the radio frequency range.

This Hartley oscillator configuration has a tuned tank circuit with its resonant coil tapped to feed a fraction of the output signal back to the emitter of transistor. since the output of the transistor emitter is always "in-phase" with output of the collector this feedback signal is positive the oscillating frequency which is sine wave voltage is determine by the resonance frequency of the thank circuit.

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