Electronics Laboratory Manual

(B. Sc. II Sem)

Department of Pure & Applied Physics

Guru Ghasidas Vishwavidyalaya
(A Central University)
Bilaspur-495009
Chhattisgarh, India

DEPARTMENT OF PURE & APPLIED PHYSICS

B. Sc. II Sem

Electronic Minor Lab

Minor – II: Semiconductor Devices Lab

Course Code: PLUBLG2

List of Experiments

1.Study of the half wave rectifier and Full wave rectifier.

3. Study of the Colpitt's Oscillator.

4. Study of the Hartley's Oscillator.

5. Study of the Phase Shift Oscillator.

EXPERIMENT:- 01

INSTRUCTION MANUAL

FOR

HALF WAVE/ FULL WAVE & BRIDGE RECTIFIER

Objective : Study of Half Wave/ Full Wave & Bridge Rectifier.

Half Wave/Full Wave & Bridge Rectifier has been designed to study the following:

1. Half wave rectifier and effect of different filter circuits on AC ripple at different loads.
2. Full wave rectifier and effect of different filter circuits on AC ripple at different loads.
3. Bridge rectifier and effect of filter circuits on AC ripple at different loads.

The instrument comprises of the following built-in parts:-

1. AC stepdown transformer of secondary output taps 9V AC, 0V and 9V AC.
2. Four Diodes are mounted behind the front panel for rectification purposes.
3. Filter section consists of two filter (capacitor) selected using toggle switches.
4. Different types of load resistances from 500 to 5000 can be selected through band switch provided on front panel.
5. Two meters to measure voltage & current are mounted on the front panel & connections brought outon 4mmSockets.

STANDARD ACCESSORIES

1. Nine single point & Four interconnectable patch cords for interconnections.
2. Instruction manual.

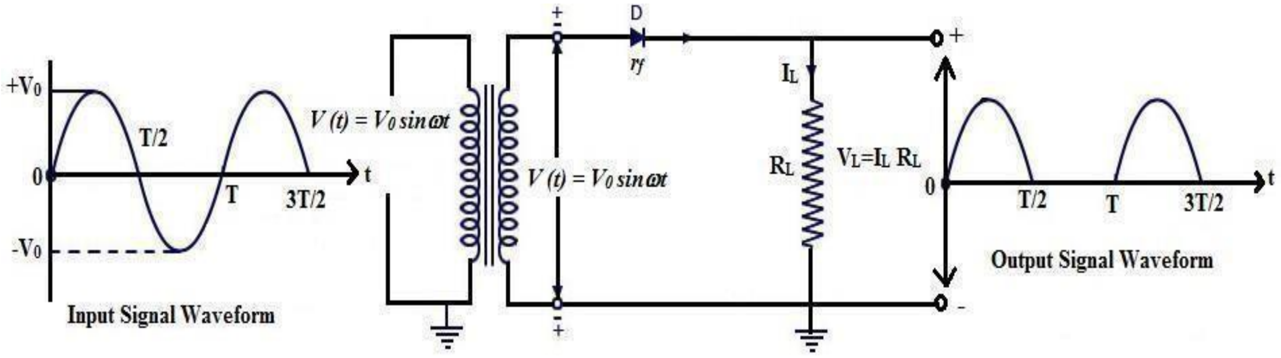
THEORY HALF WAVE RECTIFIER: -

Fig. (1a) shows the circuit diagram of a Half Wave Rectifier. In half wave rectification, the rectifier conducts current only during the positive half cycles of the input AC supply. The negative half cycles of a.c. supply is suppressed i.e, during negative half cycles, no current is conducted and hence no voltage appears across the load. Therefore, current always flows in one direction (ie DC) through the load after every half cycle. Fig (1) shows the circuit of a half-wave rectifier. The ac supply to be rectified is applied in series with the diode and load resistances RL Generally AC supply is given through a trans- former. The AC voltage across the secondary winding AB changes polarities after every half cycle. During the positive half cycle of input AC voltage, end A becomes positive w.r.t. end B This makes the diode forward biased and hence it conducts current. During the negative half cycle, end A is negative w.r.t. end B.

Under this condition, the diode is reverse biased and it conducts no current. Therefore current flows through the diode during positive half cycles of input AC voltage whereas it is locked during the negative half cycles. In this way, current flows through load R, always in the same direction. Hence DC output is obtained across

R_L. It may be noted that output across the load is pulsating DC. These pulsations in the output are further smooth-ended with the help of filters.

Figure(1) -



For $0 \le t \le T/2$ Diode D= **Forward biased** or **ON (Conducting)** state

For $T/2 \le t \le T$ = **Reversed biased** or **OFF (Non=Conducting)** State

The current flowing through the load resistance R_L is

$I_L = \frac{V_o \sin\omega t}{r_f + R_L}$ For $0 \le t \le T/2$

$I_L = 0$ For $T/2 \le t \le T$

Therefore, output voltage $V_L = I_L \times R_L$

$V_L = \frac{V_o \sin\omega t}{r_f + R_L} R_L$ For $0 \le t \le T/2$

$V_L = 0$ For $T/2 \le t \le T$

The output current and output voltage across load resistance consists of only half wave pulses, as clearly visible form the output waveform shown in **Figure(1)**. Though the output current and voltage signals are unidirectional but their magnitude varies with time. Therefore, one can conclude that the output signals are not purely direct current or voltage i.e. output signal is superimposition of alternating part and direct part.

$$V_L = V_{Ldc} + V_{Lac}$$

EFFICIENCY OF HALF WAVE RECTIFIER

The ratio of DC output power to the applied input AC power is known as rectifier efficiency i.e.Rectifier efficiency h = 0.406/1+r/RL Where r is the Diode resistance & RL is the Load resistance Because 'r' is very small as compared to RL then

h = 0.406 =40.6%

RIPPLE FACTOR:-

The AC components present in the output of a rectifier is called ripple. It is measure of AC components present in the output of the rectifier.

Ripple Factor = r.m.s. value of AC components/r.m.s. value of DC components

= AC (Ripple) Voltage / DC Voltage

= 1.21

Observed results are within 10% tolerance range as compared to standard results because of diode dropage and tolerances of load resistances.

This shows that AC components in the output of half wave rectifier exceeds the DC component, thus this is a poor device for converting AC to DC.

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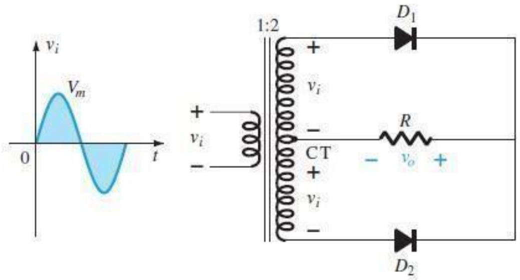
FULL WAVE RECTIFIER

In a full wave rectifier, current flows through the load in the same direction for both half cycles of input ac voltage. This can be achieved with two diodes working alternately, circuit diagram of a full wave rectifier is shown in Fig. (1b).

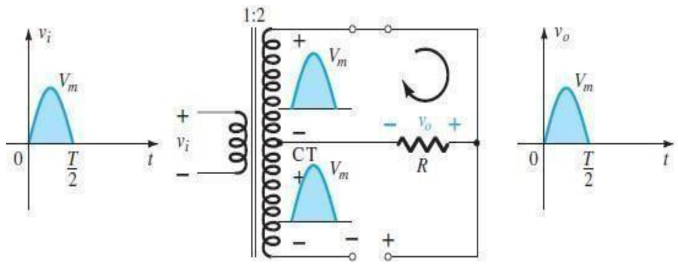
During the +ve half cycle of secondary voltage, end A of secondary winding becomes positive and end B negative This makes the diode D1 forward biased and diode D2 reverse biased. Therefore, diode D1 conducts while diode D2 does not.The conventional current flows through diode D1 load resistor RL and the upper half of secondary winding. During the negative half cycle, end A of secondary winding becomes negative arid end B positive. Therefore, diode D2 conducts while diode D1 does not. The conventional current flows through diode D2 load RL and lower half winding. The current flowing through load resistance RL is in the same direction for both half cycles of input AC voltage.

Therefore, DC is obtained across the load RL.

Centre – Tapped Full Wave Rectifier

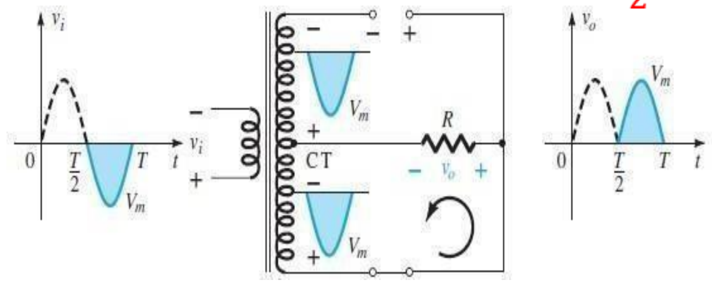


$$For\ 0 \le t \le \frac{T}{2}$$

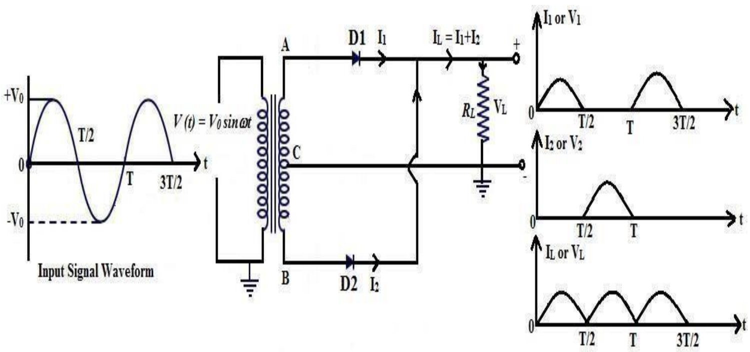


Diode D1 = Forwards biased, So in ON/Conducting state
Diode D2= Reversed biased So, OFF/Non-Conducting) State

$$For\ \frac{T}{2} \le t \le \text{T}$$



Diode D1 = Reversed biased So, OFF/Non-Conducting) State
Diode D2= Forwards biased, So in ON/Conducting state



If the voltage between A and C is

$V_{AC} = V_o \sin \omega t$

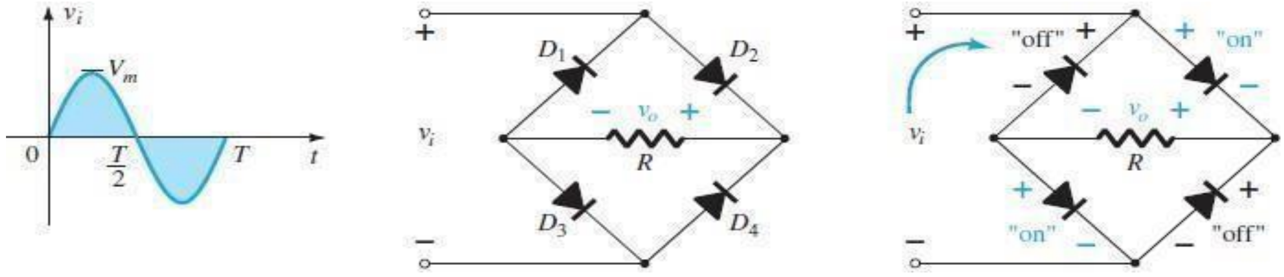
then, the voltage between B and C is

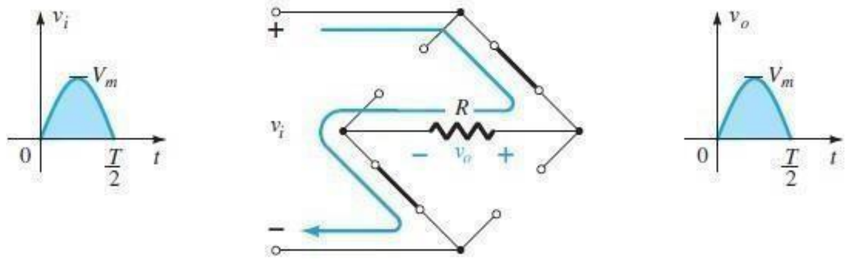
$V_{BC} = -V_o \sin \omega t$

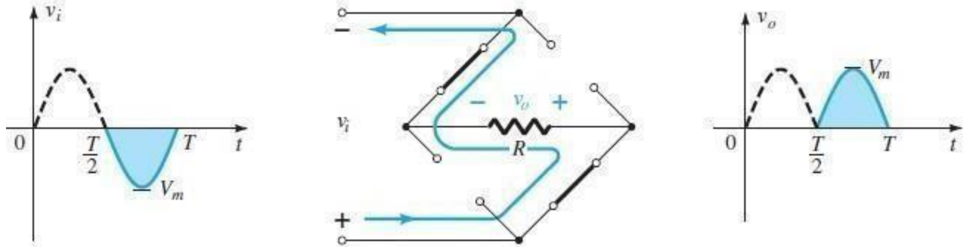
$I_1 = \frac{V_o \sin \omega t}{r_f + R_L}$, $\quad I_2 = 0 \quad$ For $\quad 0 \le t \le T/2$

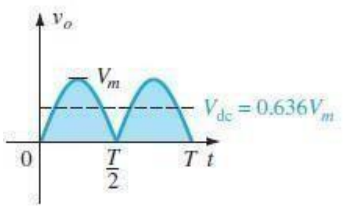
$I_1 = 0 \quad I_2 = -\frac{V_o \sin \omega t}{r_f + R_L}$, $\quad$ For $\quad T/2 \le t \le T$

Full Wave Bridge Rectifier





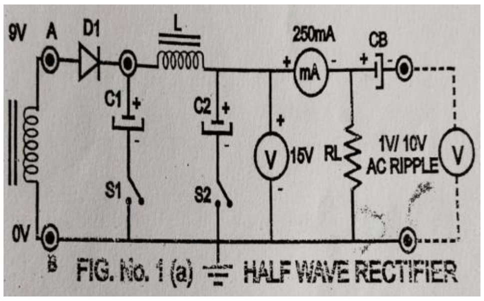




PROCEDURES

HALF WAVE RECTIFIER:-

1. Connect the circuit as shown in Fig. (1a). Also connects 15V DC Voltmeter and 250mA DC current meter in the spaceprovided on the front panel.
2. Connect electronic AC millivoltmeter/CRO across output to measure the ripple directly.
3. Connect load (R) in circuit for measuring DC output current.
4. Switch ON the instrument using ON/OFF toggle switch provided on the front panel
5. Note down the observations V A i.e. DC output voltage, DC current and AC ripples on the meters.
6. Switch ON the toggle switch S1 to connect the capacitor C1 in the circuit again check the DC output
7. voltage, DC current and AC ripples.
8. Switch ON toggle switch S2 so that capacitor C2 also connect in the circuit. Now the filter circuit is in p type configuration. Again note down output voltage, output current and AC ripple.
9. Repeat the experiment for different values of load resistances.



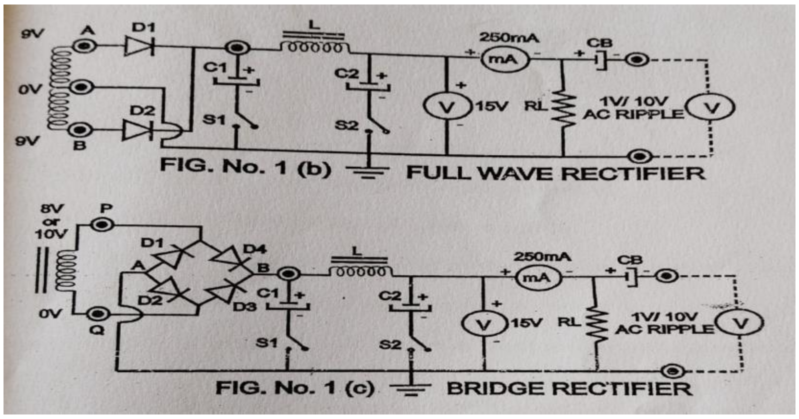
FULL WAVE RECTIFIER :-

1. Connect the circuit as shown in Fig. (1b).
2. Repeat steps 2-8 and take all the possible observations.

BRIDGE RECTIFIER :-

1. Connect the circuit as shown in Fig. 1(c).
2. Repeat steps 2 to 8 and note down all the possible observations.

NOTE :- AC ripples are maximum without filter circuit, but reduces as C1 is introduced and reduces further as C2 is also introduced. Ripples are minimum when (p) type filter is used.



OBSERVATION TABLE:

RESULT:

PRECAUTIONS:

1. The primary and secondary sides of the transformer should be carefully identified.
2. The polarities of the diode & capacitor should be carefully connected.
3. While determining the % regulation, first Full load should be applied and then it should be decremented in steps.
4. Avoid loose contact.
5. CRO must be handled carefully. Use CH1 for input and CH2 for output signal.

REFERENCES:

V.K.Mehta, (Principal of Electronics)
Louis Nashelsky and Robert Boylestand (Electronic devices and circuit theory)

EXPERIMENT - 02

INSTRUCTIONAL MANUAL

FOR

TRANSISTORISED COLPITT'S OSCILLATOR

Objective : Study of the transistorized Colpitt's Oscillator.

Transistorized Colpitts's Oscillator has been designed to study the wave shape & frequency produced by Colpitts Oscillator.The instrument comprises of the following built in parts:-

1. Fixed output DC regulated power supply of 12volts.
2. One medium wave frequency coil is mounted inside.
3. Amplifier circuit consists of Transistor (CL100), Inductance (45µH), Resistance & Capacitors combination.
4. Tank circuit consists of medium wave frequency coil in parallel with capacitor

THEORY

Oscillator is an important device for many electronic circuit applications and its prime function is to generate waveforms at constant amplitude and desired frequency Basically an oscillator is a electronic circuit which converts DC supply voltage to an output wave form of some frequency. The oscillator circuit must also be capable of producing constant oscillations. The oscillators are classified into two basic categories: Sinusoidal & Non - sinusoidal. If the wave form generated looks like sine wave, the circuit is called a sinusoidal oscillator and the circuit producing all other wave forms are called non- sinusoidal oscillator. Sometimes, the oscillators are also classified on the basis of frequency of the generated wave form, viz. Audio frequency, radio frequency and ultra-high frequency oscillators.

Each oscillator has a tank circuit. This tank circuit consists of inductance coil (L) connected in parallel with capacitor (C). The frequency of oscillations in the circuit depends upon the value of the coil and capacitance of capacitor. The frequency of the oscillation is determined by the values of the C1, C2 & L and is given by

$$f = 1/2\pi(LC)^{1/2}$$

where, $C = C1.C2/C1 + C2$

PROCEDURES

1. Connect the CRO probes across the output of the Colpitts Oscillator.

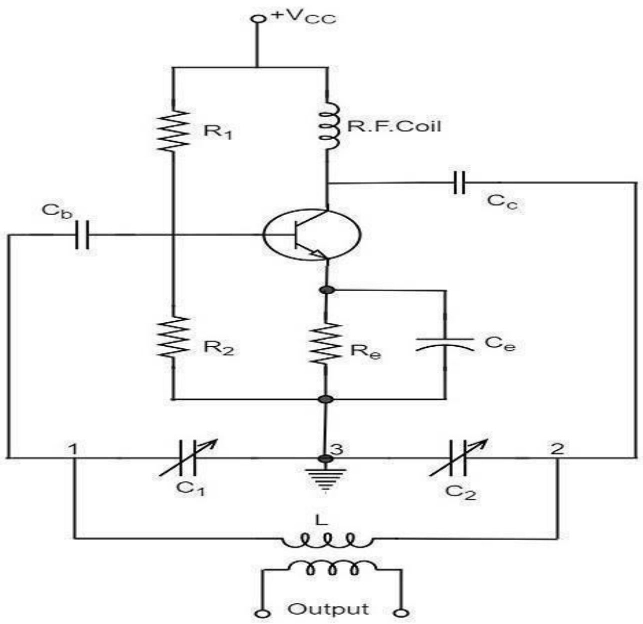
2. Switch ON the instrument as well as CRO

3. Observe the output waveform on CRO and note down the frequency of oscillations. The formula used to calculate the frequency of oscillations

$$f = 1/2\pi(LC)^{1/2}$$

where $C = C1.C2/C1 + C2$

4. Take different set of reading by changing the value of C using band switch.



Applications of Colpitts Oscillator

1. It is used for generation of sinusoidal output signals with very high frequencies.
2. The Colpitts oscillator using SAW device can be used as the different type of sensors such as temperature sensor. As the device used in this circuit is highly sensitive to perturbations, it senses directlyfrom its surface.
3. It is frequently used for the applications in which very wide range of frequencies are involved.
4. Used for applications in which undamped and continuous oscillations are desired for functioning.
5. This oscillator is preferred in situations where it is intended to withstand high and low temperatures frequently.
6. The combination of this oscillator with some devices (instead of tank circuit) can be used to achieve great temperature stability and high frequency.
7. It is used for the development of mobile and radio communications.

RESULT :

PRECAUTIONS: -

1) Check the continuity of the connecting terminals before going toconnect the circuit.

2) Identify the emitter, base, and collector of the transistor properly before connecting it the circuit.

3) The horizontal length between two successive peaks should accurately be measured.

EXPERIMENT- 03

INSTRUCTION MANUAL

FOR

HARTLEY OSCILLATOR

Objective: Study of Hartley Oscillator.

Hartley Oscillator has been designed to study the following-

1. RF Oscillations produced by the circuit
2. Change in the frequency of oscillations with the change in the inductance provided on front panel

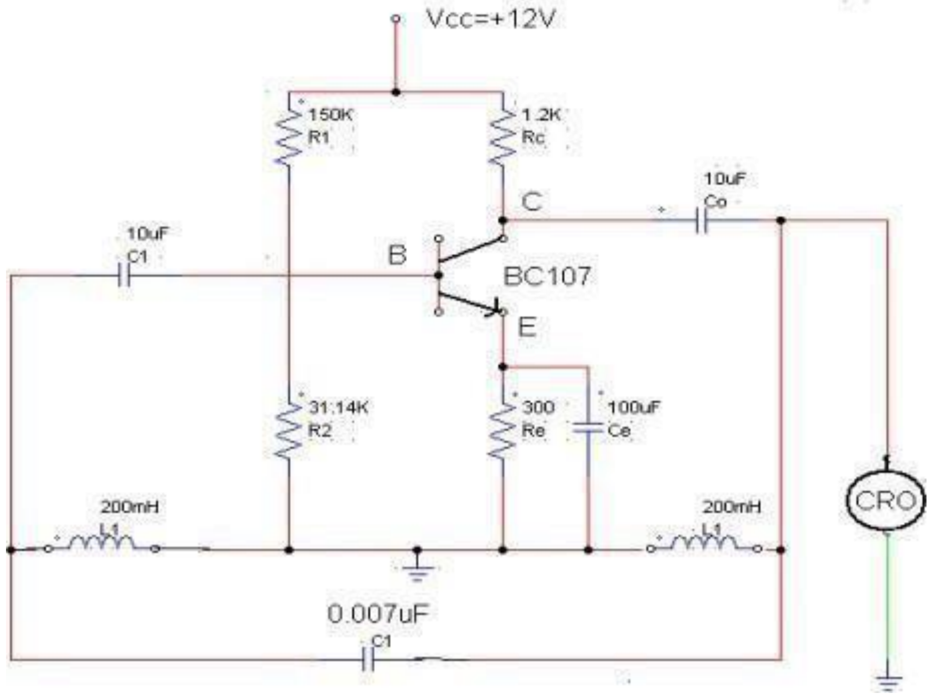
The instrument comprises of the following built in parts:-

1. Fixed output DC Power supply of 12V
2. Two inductance L1 & L2 have been provided & hence two different frequencies can be produced.
3. Transistor BC 109, Resistance and Capacitor are provided
4. Transistor (BC 109) & Biasing circuit is provided on the front panel to give 180° phase shift

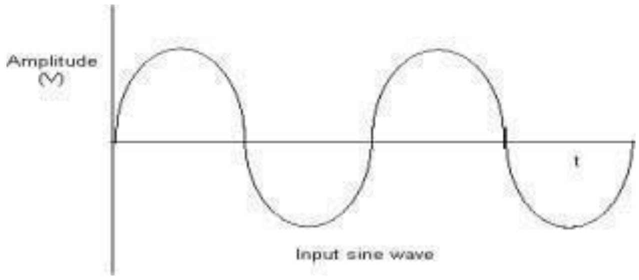
THEORY

Hartley Oscillator using a junction transistor in the common emitter mode is shown in the circuit diagram. Inductors L1, L2, and capacitor C form the tank circuit. Resistance RL and Vcc provide the biasing for the Hartley oscillator. Capacitor C1 and CB block and bypass capacitors since the transistor is operating in common emitter mode, it introduces a 180° phase difference between its input and output voltage, and the output voltage appears in the tank circuit. A part of this voltage appears across inductance L1 and is fed back to the input circuit. Feedback voltage is again 180° out of phase with the output so that a net 360° phase difference around the loop results in oscillations.

DAIGRAM



Model Graph



PROCEDURE

1. Connect the circuit by connecting dotted lines through patch cords, this connects inductor L1 in the circuit.

2. Connect Frequency Counter/ CRO across output sockets.

3. Switch ON the instruments using the ON/OFF toggle switch provided on the front panel.

4. Observe the wave shape on CRO and note down the frequency of oscillation from CRO

5. Repeat step 4 for the other coil L2 after having disconnected L1.

6. Compare the observed frequency with the calculated frequency by using the formula:

$$f = 1/2\pi(LC)^{1/2}$$

$$L1 = 12\mu H \pm 10\%$$

$$L2 = 25\mu H \pm 10\%$$

$$C1 = 0.01\mu F$$

Observation Table

SNO.	Amplitude(V)	Time (ms)	Frequency(KHz)

Results:

PRECAUTIONS:

1) Check the continuity of the connecting terminals before going to connect the circuit.

2) Identify the emitter, base and collector of the transistor properly before connecting it in the circuit.

3) The horizontal length between two successive peaks should accurately measured

EXPERIMENT-04

INSTRUCTION MANUAL

FOR

PHASE SHIFT OSCILLATOR

Objective: Study of Phase Shift Oscillator.

Transistor Phase shift oscillator has been designed to study the wave shape & frequency generated by Phase Shift Oscillator. The instrument comprises of the following built-in parts:

1. Fixed DC regulated power supply of-12V
2. A phase shift network consists of three sections R1C1, R2C2 & R3C3. The total phase shift produced by the RC network is 180°.
3. One PNP Transistor for further phase shift of 180°.

THEORY

Oscillators using RC network are known as RC Phase Shift Oscillators. LC oscillators are used for generating high frequencies. These are not suitable for low frequency ranges, such as audio frequencies the alternative is RC network. The above block diagram shows the essential components of a transistorized phase shift oscillator.

1. TANK CIRCUIT:-

The tank circuit consists of three resistances connected in parallel with three capacitors. It is known as frequency determining network. The frequency of oscillations in the circuit depends upon the values of resistances & capacitors.

2. TRANSISTOR AMPLIFIER :-

The function of the amplifier is to amplify the oscillations produced by RC circuit. The amplifier receives DC power from the battery & converts it into AC power supplied to the tank circuit. The oscillations produced in the tank circuit are applied to the input of the transistor. The transistor increases the output of these oscillations

3. FEEDBACK CIRCUIT :-

The function of feedback circuit is to transfer a part of the output energy to R.C. network in proper phase. When the feedback is positive, the overall gain of the amplifier is

Written as Af=A/1-AB where AB is feedback factor .

If AB=1, Afc. Thus the gain becomes infinity i.e., there is output without any input. In other words, the amplifier works as oscillator. The condition AB=1 is known as the Barkhausen criterion of oscillation

A transistor phase shift oscillator must introduce in-phase feedback from the output to the input to sustain oscillation. If a common emitter amplifier is used with a resistive collector load, there is a 180° phase shift between the base & collector. Hence the phase shift feed back network between collector & base must introduce an additional 180° phase shift. at some frequency if oscillation is to take place. A transistor connected as a phase shift oscillator is shown on the engraved front panel of the instrument. In this common emitter amplifier, feedback is from the collector to the base, i.e. from the output to the input. The 3- section phase shift network consists of C1R1, C2R2, C3R3. So that each section may introduce a 60° phase shift (approx.) at the resonant frequency.

The frequency of the oscillations may be expressed as

$$f = 1/2\pi c[6(R1+VR1)^2+4(R1+VR1)RL]^{1/2}$$

Where C = 0.047µF

RL=2.2kΩ

R1=1.2kΩ

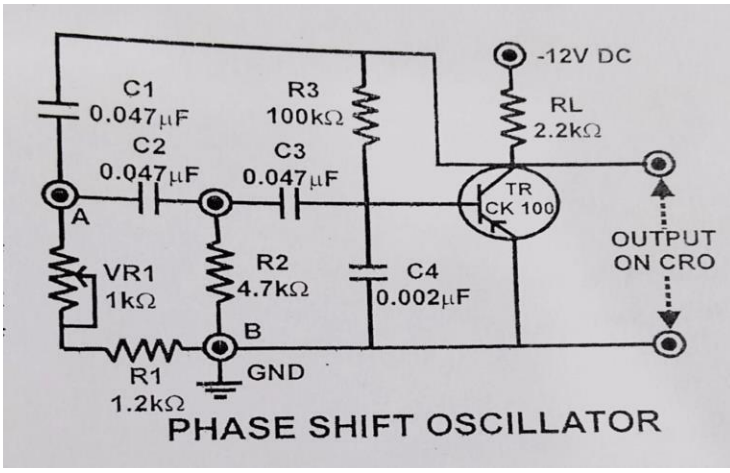
PROCEDURE

1. Connect 1k pot socket with ground.
2. Connect the CRO probe at output terminals. Switch ON the instrument with an oscilloscope. Observe & measure the output frequency and peak to peak values of the output wave form.
3. By setting the frequency control pot knob at different positions, measure the value of output frequency with an oscilloscope (CRO) Compare this observed frequency with actual calculated frequency.

STANDARD ACCESSORIES

1. Instruction Manual.

Circuit Diagram:



Results:

Precautions:

1. All the connections should be correct.
2. Transistor terminals must be identified properly.
3. Reading should be taken without any parallax error