G.H.RAISONI COLLEGE OF ENGINEERING, NAGPUR
Department:-Electronics & Communication Engineering
Branch:-3rd Semester[Electronics &Telecommunication]
Subject:- Electronic Devices &Circuits

List of Experiment

CYCLE-1.

1. To plot the V- I characteristics of PN junction diode & to perform simulation on Micro-cap Software.
2. To plot the characteristics of Zener diode & to perform simulation on Micro-cap Software.
3. To calculate the ripple factor and plot waveforms with and without capacitive filter of half wave rectifier & to perform simulation on Micro-cap Software.
4. To Plot I/P & O/P Characteristics of Common Emitter Transistor Configuration in Active Region.Find I/P & O/P Resistance ,Current Gain & also perform simulation on Micro-cap Software.
5. To Plot I/P & O/P Characteristics of Common Base Transistor Configuration in Active Region .Find I/P & O/P Resistance,Current Gain & also perform simulation on Micro-cap Software.

CYCLE-2.

6. To study Hartley Oscillator.
7. To plot the Drain and Transfer characteristics of FET in CS mode & to perform simulation on Micro-cap.
8. (a) To Study Fixed Bias circuit of transistor
   (b) To Study Self Bias circuit of transistor
9. To Study single stage RC coupled Amplifier & to perform simulation on Micro- cap Software.

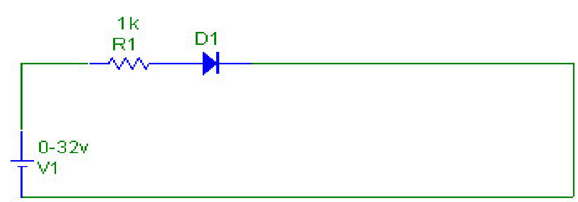
Experiment No. 1

Aim: - To plot the V- I characteristics of PN junction diode & to perform simulation on Micro-cap Software.

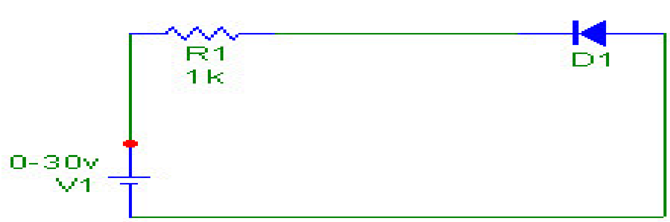
Apparatus: - DC voltmeter- 0-1/0-15v
DC ammeter- 0-25mA/0-1mA
Resistor - 1k
PN junction diode
DC regulated power supply

Circuit Diagram:-

FORWARD BIAS



REVERSE BIAS



Theory:-

A p-n junction diode conducts in forward direction i.e. when anode is connected to positive terminal of supply voltage and cathode is connected to negative terminal of supply voltage.

With forward bias the barrier potential at a junction reduces and majority carriers diffuse across the junction. This results in forward current through diode. Changing a potentiometer can vary the amount of this forward bias voltage and series resistor R decides the maximum forward current flow through diode.

In reverse bias mode there is no flow of electrons and hence no flow of electric current. Diode conducts only in forward bias mode & it has the property of rectifier.
This circuit is similar to that of forward bias condition except two changes i.e. diode terminals are reversed and flow of current is in microamperes.

In reverse direction it draws negligible small amount of current I_0 , when reverse voltage is continuously increased. At breakdown voltage Vz, the diode draws heavy current at an almost constant voltage.

Dynamic and static resistance of diode at a point:

a) Dynamic diode resistance is $r_{ac} = \Delta Ve / \Delta If$
b) Static diode resistance is Rf=V / I.

The voltage at which diode starts conducting is called knee voltage or cut in voltage or threshold voltage. The knee voltage is designated by Vr or Vv. Its value is 0.6V for Si and 0.2V for Ge.

Procedure:-

FOR FORWARD BIAS

1) Connect the diode as shown in the circuit diagram.
2) Vary the external forward bias voltage in the steps from 0.1 to 1.5V
3) Measure the voltmeter and ammeter reading.

FOR REVERSE BIAS

1) Connect the diode in the reverse bias.
2) Vary the external voltage in the different steps of 0.1 to 15V.
3) Measure the voltmeter and ammeter reading.

Observation table:-

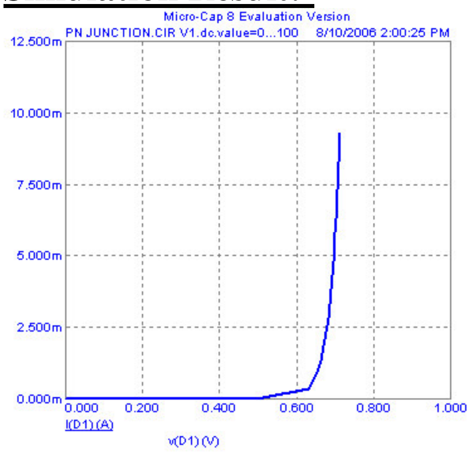
FORWARD BIAS:

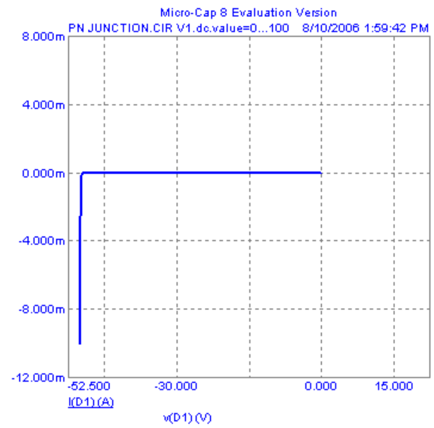
Vf (volts)	If (mA)

REVERSE BIAS:

Vr(volts)	Ir(uA)

Simulation Result:-





Forward Characteristics **Reverse Characteristics**

Result :- The V-I characteristics of p-n junction diode are studied. Dynamic resistance=_________________ and static resistance___________.

Viva Questions:-

1. What is avalanche breakdown mechanism?
2. What are different types of diodes?

Experiment No. 2

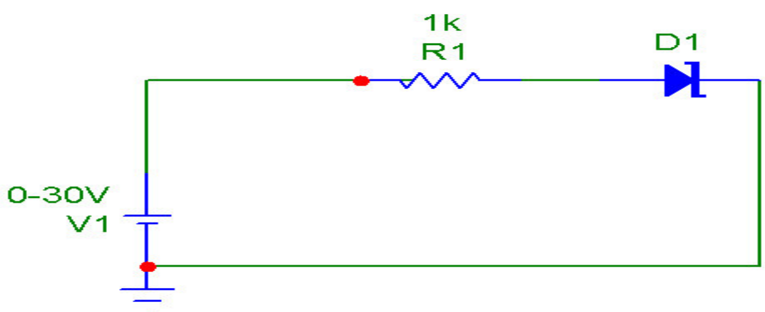
Aim:- To plot the characteristics of Zener diode & to perform simulation on Micro-cap Software.

Apparatus:-

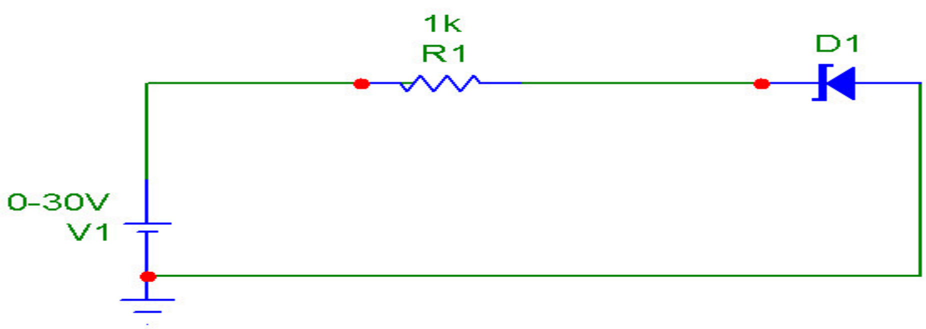
DC voltmeter- 0 – 1 V/ 0 – 15V
DC ammeter - 0 – 25mA/ 0 – 1mA
Resistor - 1 K
DC regulated power supply (0 – 30 V, 2A) &
Breadboard.

Circuit Diagram:-

Forward bias



Reverse bias



Theory:-

A properly doped crystal having a sharp breakdown voltage is known as zener diode. Breakdown of zener voltage depends upon the amount of doping. If the diode is heavily doped, depletion layer will be thin and consequently the breakdown of the junction will occur at lower reverse voltage. On the other hand a lightly doped diode has higher breakdown voltage. An ordinary crystal diode, properly doped to have sharp breakdown is called as Zener diode.

When forward biased, its characteristics are just those of ordinary diode. A zener diode is mainly used in reverse bias mode. It has a sharp breakdown voltage called zener voltage Vz. When the reverse voltage across a zener diode exceeds the breakdown voltage Vz, the current increases very sharply. In this region the curve is almost vertical. It means that the voltage across zener diode is almost constant at Vz even though the current through the circuit changes. Hence zener diode can be used as voltage regulator to provide a constant voltage from source whose voltage may vary over sufficient range.

Procedure:-

1) Connect the diode in forward bias.
2) Increase the input voltage in steps and note the voltage across diode and current through the diode.
3) Now connect the diode in reverse bias.
4) Repeat step 2.

Observation Table:-

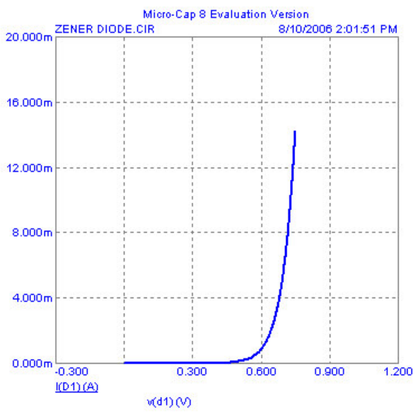
FORWARD CHAR.

S. No.	I_f (mA)	V_f (V)

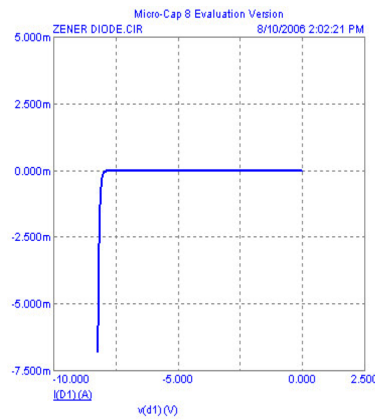
REVERSE CHAR.

S. No.	I_R (µA)	V_R (V)

Simulation Result:-



Forward Characteristics



Reverse Characteristics

Result: - Characteristics of zener diode are studied. The cut in voltage is found to be

Viva Questions:

1. What is voltage regulation?
2. State difference between p-n junction diode and zener diode?

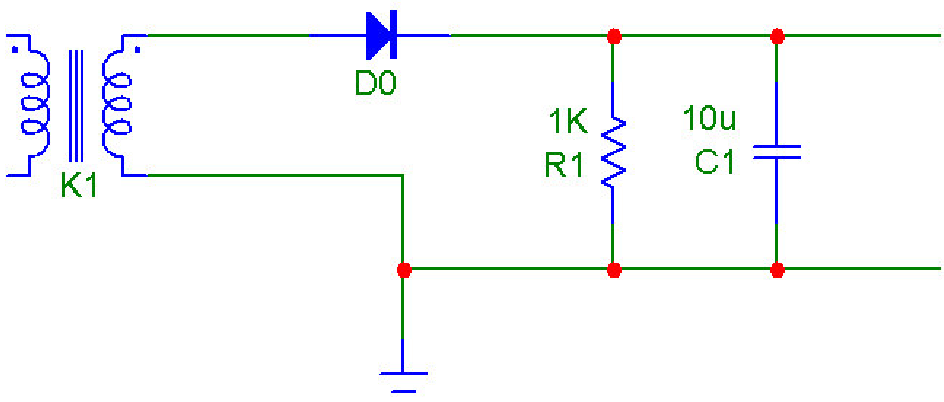
Experiment No. 3

Aim:- To calculate the ripple factor and plot waveforms with and without capacitive filter of half wave rectifier & to perform simulation on Micro-cap Software.

Apparatus:-

Transformer
PN junction diode
Resistor
Capacitor

Circuit diagram:-



Theory:-

Any electrical device which converts bidirectional quantity into unidirectional quantity is called rectifier. Rectifier along with filter converts AC into DC.
Peak Inverse Voltage-When the input voltage reaches its maximum value V_m during the negative half cycle the voltage across the diode is also maximum. This maximum voltage is known as the peak inverse voltage.

Ripple Factor- Ripple factor is defined as the ratio of rms value of ac component to the dc component in the output.

Ripple factor,

$$r = \frac{RMS\ value of\ the\ ac\ component}{dc\ value of\ the\ component}$$

Procedure:-

1) Connect CRO probes across the secondary of the transformer and note down the input waveform to rectifier.
2) Similarly observe output waveform across load with and without capacitor.
3) To calculate the ripple factor , measure a.c. and d.c. voltage across R_L with multimeter for with and without capacitor.
4) Take ratio of ac to dc to have ripple factor.

Observation table:-

<table>
<tr><td colspan="2">INPUT</td><td colspan="2">O/P WITHOUT C</td><td colspan="2">O/P WITH C
RIPPLE
VOLTAGE</td><td colspan="4">MULTIMETER
READINGS</td></tr>
<tr><td rowspan="2">Vin</td><td rowspan="2">T</td><td rowspan="2">Vo/p</td><td rowspan="2">T</td><td rowspan="2">Vo/p</td><td rowspan="2">T</td><td colspan="2">WITH C</td><td colspan="2">WITHOUT C</td></tr>
<tr><td>AC</td><td>DC</td><td>AC</td><td>DC</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
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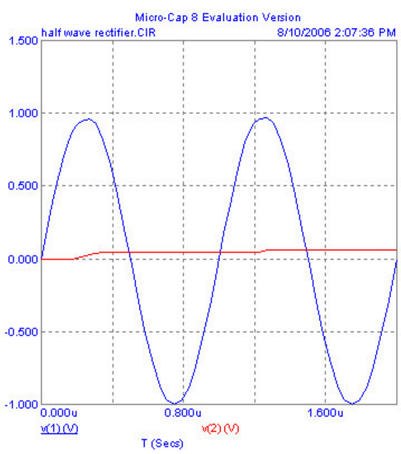
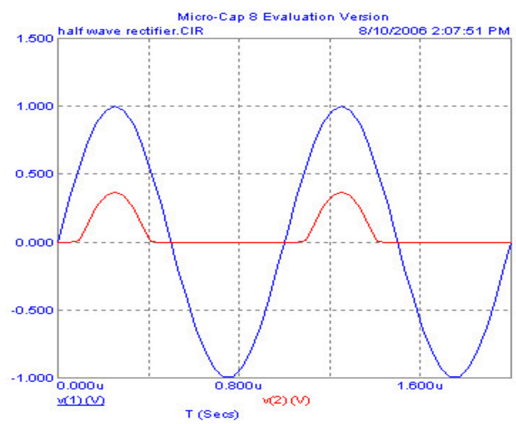
Simulation Result:-



O/P with filter



O/P without filter

Result:-

The ripple factor without filter is ___________ .

The ripple factor with filter is ___________ .

Viva Questions:

1) What is the importance of PIV in semiconductor diode?
2) Why do we need filters in power supply?

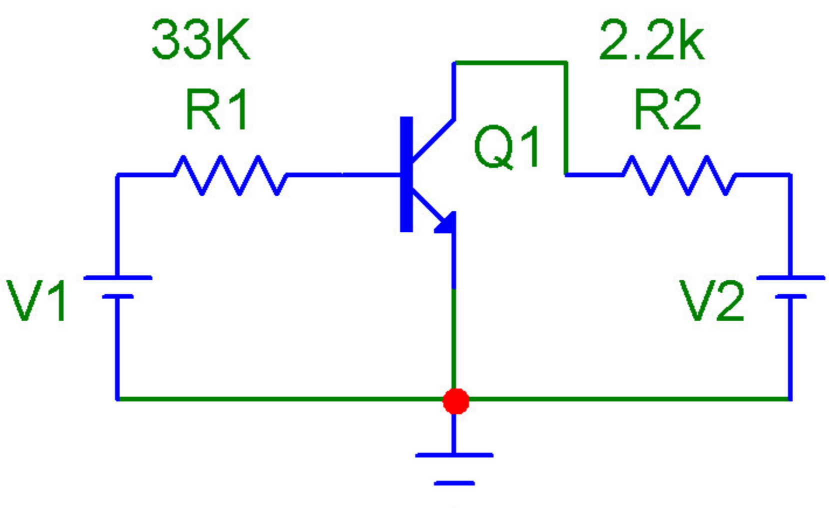
Experiment No. 4

Aim :- To Plot I/P & O/P Characteristics of Common Emitter Transistor Configuration in Active Region.Find I/P & O/P Resistance ,Current Gain & also perform simulation on Micro-cap Software.

Apparatus:-

Transistor- SL 100
Resistor – 33 K Ohm , 2.2K Ohm
Ammeter - 0-15mA , 0-1mA
Voltmeter- 0-1.5V , 0-15V
Power Supply-0-30V

Circuit Diagram :-



Theory:-

In this configuration, base current Ib is the i/p current & collector current Ic is the o/p current. The i/p signal is applied between the emitter & base whereas, o/p is taken out from the collector & emitter as shown in circuit diagram. The o/p characteristics can be plotted between Ic(Y-axis) & Vce(X-axis) for constant Ib.

In active region, the collector junction is reversed biased.As Vce increases , reversed bias increases. This causes the depletion to spread more in the base than in the collector. This reduces the chances of recombinations in the base. This increases the value of άdc. This early effect causes collector current to rise more sharply with increasing Vce in the linear region of o/p characteristics of CE transistor. The saturation value is of Vce, designated Vce(sat) usually ranges between 0.1 to 0.3V.

In CE configuration ,

Current gain = (Ic/Ib)_ > 1 Voltage gain = (Vce/Vbe) > 1

This CE is used for current & voltage amplification. CE configuaration is also called as power amplifier.

Procedure :-

I/P Char: 1) Bias transistor in active region.
2) Fix Vce at 1,2,3 V
3) Increase Vbe in steps of 0.1V & note down corresponding Ib.(10 reading)
4) Plot Graph of Vbe vs Ib.

O/P Char: 1) Keep Ib constant at 0.1, 0.2mA .
2) Increase Vce in steps of 1V & note down the corresponding of Ic. .(10 reading)
3) Plot Graph of Vce vs Ic.

Formulae:-

Ri=Vbe/Ib at constant Vce
Ro=Vce/Ic at constant Ib.
Current Gain=Ic/Ib.

Observations Table:-

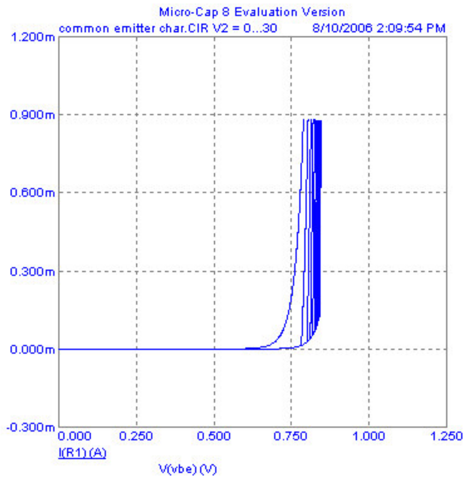
I/P Char: At constant Vce

Sr No.	Vbe	Ib

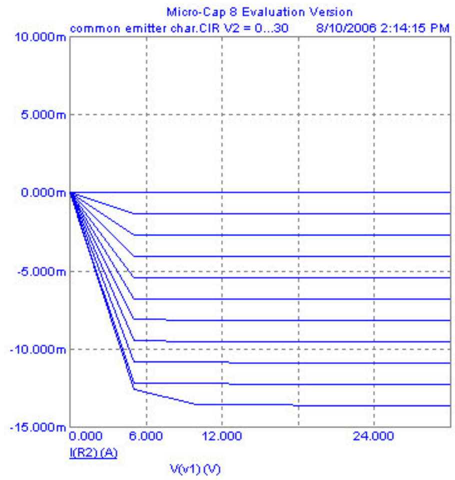
O/P Char: At constant Ib

Sr No.	Vce	Ic

Simulation Result:-



I/P Characteristics



O/P Characteristics

Result :-

Ri=
Ro=
Current Gain=

Precaution :-

1. Do not heat-up the transistor more than the specified time duration.
2. Measure the value of currents and voltages accurately because the change in some parameter values may be minute.

Viva Questions:

1) What is Early Effect?
2) What is I_{CBO}? On which factors did leakage current depends?

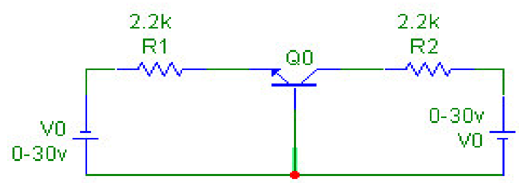
Experiment No. 5

Aim :- To Plot I/P & O/P Characteristics of Common Base Transistor Configuration in Active Region .Find I/P & O/P Resistance,Current Gain & also perform simulation on Micro-cap Software.

Apparatus:-

Transistor- SL 100
Resistor – 2.2 K Ohm, 2.2K Ohm,
Ammeter - 0-15mA , 0-1mA
Voltmeter- 0-1.5V , 0-15V
Power Supply-0-30V

Circuit Diagram :-



Theory :-

In this configuration, emitter current Ie is the i/p current & collector current Ic is the o/p current. The i/p signal is applied between the emitter & base whereas, o/p is taken out from the collector & base as shown in circuit diagram. The o/p characteristics can beplotted between Ic(Y axis) & Vcb(X axis) for constant Ie. In active region, emitter to base junction Je is forward biased while collector to base junction Jc is reversed biased.

It may be noted that i/p characteristics is linear in the upper region. But non-linear in the lower region. Therefore, the AC i/p resistance (dynamic resistance) depends upon the location of the operating point selected along the curve. It's value in the linear region of curve is about 50Ω.

Procedure :-

I/P Char: 1) Bias transistor in active region.
2) Fix Vcb at 1,2,3 V
3) Increase Vbe in steps of 0.1V & note down corresponding Ie.(10 reading)
4) Plot Graph of Vbe vs.Ie.

O/P Char: 1) Keep Ie constant at 1,2mA .

2) Increase Vcb in steps of 1V & note down the corresponding of Ic. .(10 reading)

3) Plot Graph of Vcb vs.Ic.

Formulae:

Ri=Vbe/Ie at constant Vcb

Ro=Vcb/Ic at constant Ie.

Current Gain=Ic/Ie**.**

Observation Table:-

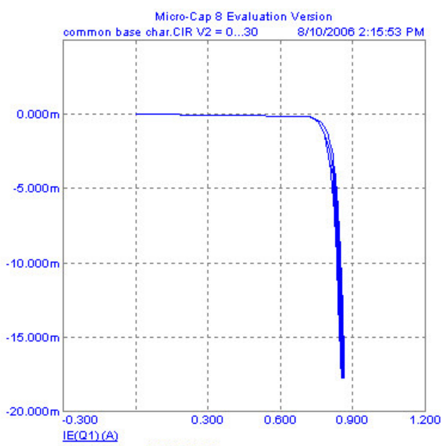
I/p Char: At constant Vcb

Sr No.	Vbe	Ie

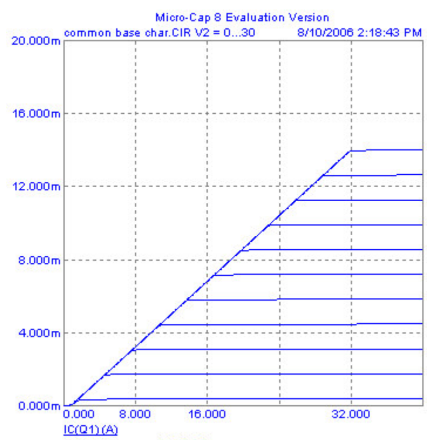
O/p Char: At constant Ie

Sr No.	Vcb	Ic

Simulation Result:-



I/P Characteristics



O/P Characteristics

Result :

Ri=

Ro=

Current Gain=

Precaution :-

1) Do not heat-up the transistor more than the specified time duration.
2) Measure the value of currents and voltages accurately because the change in some parameter values may be minute.

Viva Questions:-

1) What is the range in volts for V_{BE} between cut in & saturation for a Si transistor?

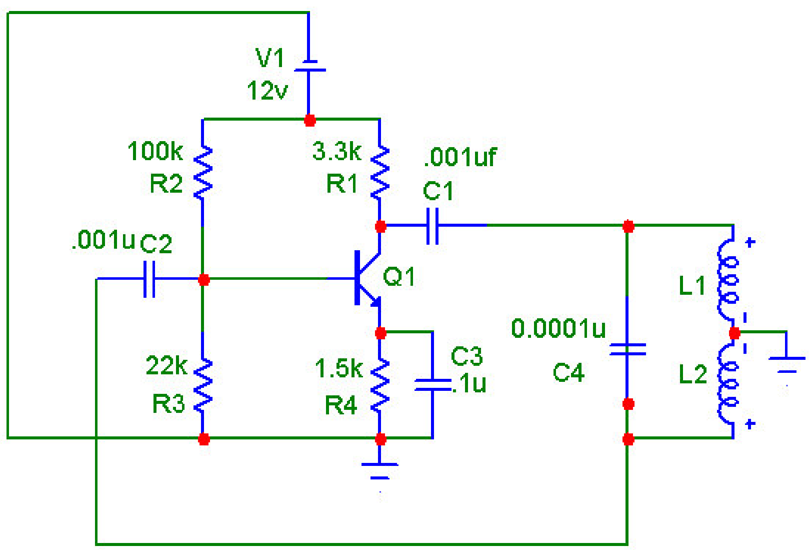
2) Define Base spreading resistance for a transistor.

Experiment No. 6

Aim:- To study Hartley Oscillator.

Apparatus:- CRO(20-30MHz)
Transistor (BC 547/548)
Resistors:-100K,22K,3.3K,1K
Capacitors:- 0.01µF(2),0.1µF,27pF

Circuit diagram:-



Theory:-

It is tank circuit consisting of two coils L1 and L2 .The coil L1 is inductively coupled to coil L2 and the combination works as an auto- transformer . RFC is connected between the collector and the Vcc supply. It acts as a load for the collector and also permits an early flow of d.c. current but blocks a.c. current .The feedback between the output and the input circuit is accomplished through transformer action, which also introduces a phase shift of 180 ˚ . The transistor also introduces a phase shift of 180 ˚ . Hence the total phase shift is 360˚ . The feedback fraction is given by

$$\beta = L2 / L1$$

For oscillations to start , the voltage gain must be greater than 1/ β.
The capacitor Cc , connected between the collector and the tuned circuit , is called as coupling capacitor . The capacitor Cb is called blocking capacitor which blocks d.c.current reaching at the base . The resistors R1,R2 and Re are used to provide d.c. bias to the transistor . The frequency of oscillation is given by

$$fo = 1/ 2\pi\sqrt{L.C}$$

where , L = L1+L2

Procedure:-

1. Connect CRO at output terminal.
2. Observe & note the frequency of oscillations & amplitude on CRO.
3. Calculate theoretical frequency of oscillations using formula.

Observations:-

1).Practical frequency:-
2) Theoretical Frequency:-

Result:- Practical frequency & theoretical frequency are near about same.

Viva Questions:-

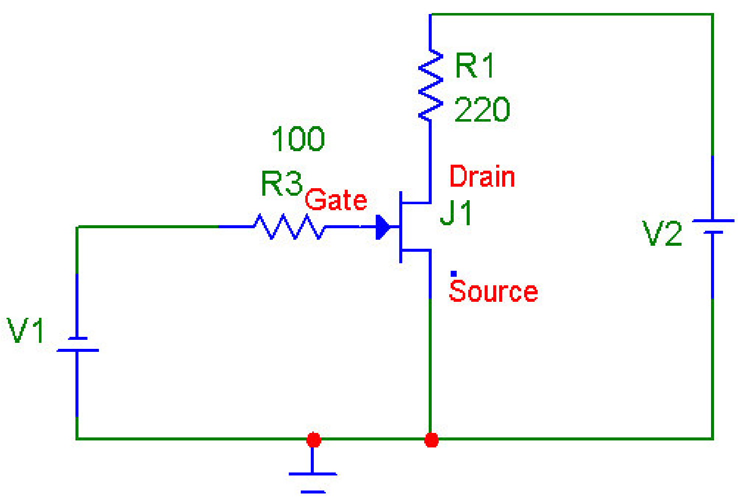
1) State Nyquist criterion for stability.
2) Give two Barkhausen conditions required in order for sinusoidal oscillations to be sustained.

Experiment No. 7

Aim:- To plot the Drain and Transfer characteristics of FET in CS mode & to perform simulation on Micro-cap Software.

Apparatus:- FET (BFW10)
Resistor (100 ohm, 220 ohm)
Voltmeter-(0-15 v)-2 no,
Ammeter-(0-25mA),
DC regulated power supply.

Circuit diagram:-



Theory:-

A junction field effect transistor is a 3 terminal semiconductor device in which current conduction is due to one type of current carrier i.e. electrons or holes.

The weak signal is applied between gate & source & amplified o/p is obtained in the drain source circuit. For the proper operation of JFET, the gate must be negative w.r.t.source i.e the i/p ckt should always be reversed baised this is either achieved by battery Vee. During positive half cycle of the signal, the reversed bais of the gate decreases, this increases the channel width & drain current. During the negative half cycle , the reverse voltage of the gate increases. This large change in the drain current produces large o/p across load Rl. In this way JFET acts as amplifier.

Drain current characteristics: The curve between drain current & source voltage (Vds) of JFET at constant source voltage Vgs is known as drain characteristics of JFET.

Transfer characteristics: As reverse gate source voltage is increased the cross sectional area of channel decreases. This in term decreases the drain current.

Procedure:-

1) Assemble the circuit as shown in the figure.
2) Fix the Vgs at 0,-1,-2… V
3) Vary Vds in steps of 1V and note down corresponding I_D. Repeat for different Vgs.
4) Now keep Vds constant at 12V or transfer characteristics.
5) Vary Vgs in steps of 1V and note down corresponding Id.

Observation table:

Transfer characteristics:-

At constant **Vds=12v**

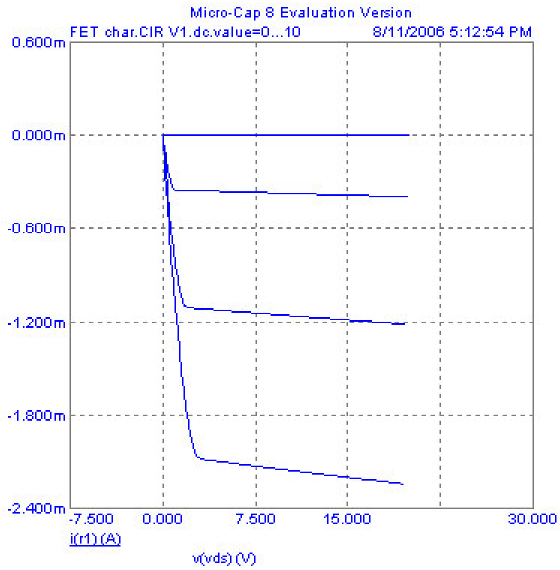
Vgs	Id

Drain characteristics:-

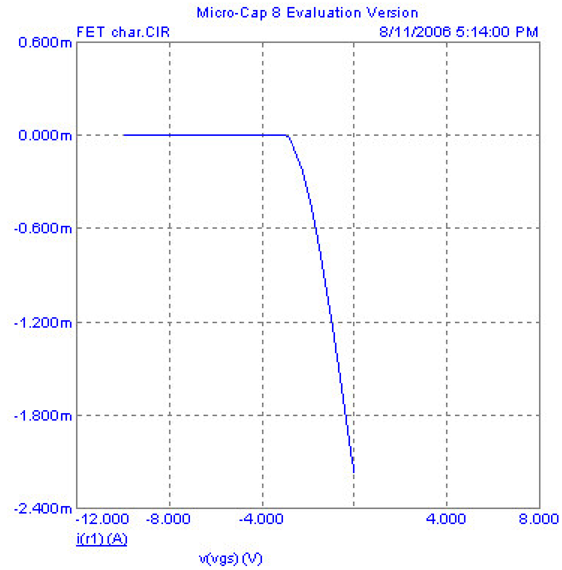
At constant **Vgs= -1,-2,-3,-4**

Vds	Id

Simulation Result:-



Drain characteristics



Transfer characteristics

Result:-

1) Vgs(off) =

2) I_{DSS} =

Viva Questions:-

1) Why FET is used as voltage variable resistance?
2) Define tansconductance, pinch –off voltage & drain resistance.

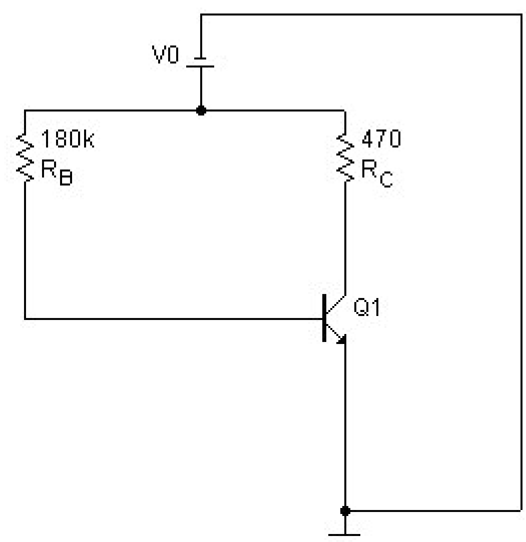
Experiment No. 8(a)

Aim:- To Study Fixed Bias circuit of transistor.

Apparatus:-

Resistor – 180 K Ohm, 470 Ohm
Transistor - SL 100,
Multimeter.

Circuit Diagram:-



Theory :-

The first biasing method, called BASE CURRENT BIAS or sometimes FIXED BIAS, was used in figure. It consisted basically of a resistor (R_B) connected between the collector supply voltage and the base. This simple arrangement is quite thermally unstable. If the temperature of the transistor rises for any reason (due to a rise in ambient temperature or due to current flow through it), collector current will increase. This increase in current also causes the dc operating point, sometimes called the quiescent or static point, to move away from its desired position (level). This reaction to temperature is undesirable because it affects amplifier gain (the number of times of amplification) and could result in distortion. When we apply kvl to the circuit we get the equation as Vcc-IbRb-Vbe = 0 Where Vcc is constant, when the value of Ib is fixed it is assumed that Ic will be constant but also $Ic = \beta Ib + (1+\beta) Ico$

When temperature increases Ico increases. Thus Ic increases & therefore operating point shifts upwards.

Procedure :-

1. Connect the circuit as shown in the figure.
2. Connect Voltmeter & Ammeter in required position.
3. First calculate the theoretical value and that after measure practical value.

Observations :-

Selected resistance value		
	Theoretical	Practical
$V_{BE}=V_B$		
I_C		
I_B		
V_{CE}		

Calculations:-

$I_B = (V_{CC}-V_{BE}) / R_B$
$I_C = \beta I_B$
$V_{CE}=V_{CC} - I_C*R_C$
$V_{CE}=V_C-V_E$
$V_{BE}=V_B$

Result:

The Fixed Bias circuit has been studied and theoretical & practical value are nearly same.

Viva Questions:-

1. What type of bias is used where only moderate changes in ambient temperature are expected?
2. What is thermal instability & thermal resistance?

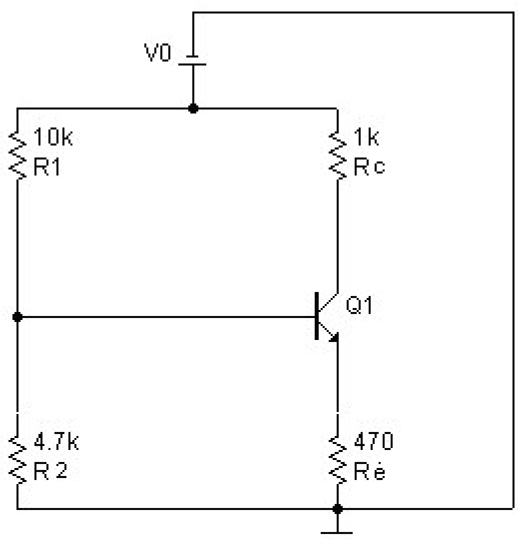
Experiment No. 8(b)

Aim:- To Study Self Bias circuit of transistor.

Apparatus:-

Resistor – 10 K Ohm , 470 Ohm, 1 K Ohm
Transistor - SL 100,
Multimeter.

Circuit Diagram:-



Theory :-

A better method of biasing is obtained by inserting the bias resistor directly between the base and collector, as shown in figure By tying the collector to the base in this manner, feedback voltage can be fed from the collector to the base to develop forward bias. This arrangement is called SELF-BIAS. Now, if an increase of temperature causes an increase in collector current, the collector voltage (V_C) will fall because of the increase of voltage produced across the load resistor (R_2). This drop in V_C will be fed back to the base and will result in a decrease in the base current. The decrease in base current will oppose the original increase in collector current and tend to stabilize it. The exact opposite effect is produced when the collector current decreases. This circuit uses an emitter resistor to provide negative feedback along with a voltage divider to provide a nearly constant V_B. The current to the base of the transistor is supplied by the voltage divider.

Procedure :-

1. Connect the circuit as shown in the figure.
2. Connect Voltmeter & Ammeter in required position.
3. First calculate the theoretical value and that after measure practical value.

Observations:-

Selected resistance value		
	Theoretical	Practical
V_B		
V_E		
I_E		
V_{RC}		
V_C		
V_{CE}		

Calculations:-

Base voltage $V_B = V_{CC} * R_2 / (R_1+R_2)$
Emitter Voltage $V_E = V_B - V_{BE}$
Emitter Current $I_E = V_E/R_E$
Voltage across Collector Resistor (R_C) $V_{RC} = I_C * R_C$
Collector Voltage $V_C = V_{CC} - V_{RC}$
Collector Emitter Voltage $V_{CE} = V_{CC} – I_E (R_C+R_E)$

Result:

The voltage divider Bias circuit has been studied and theoretical & practical value are nearly same.

Viva Questions:-

1) What is the most widely used combination-bias system?
2) When is degeneration tolerable in an amplifier?

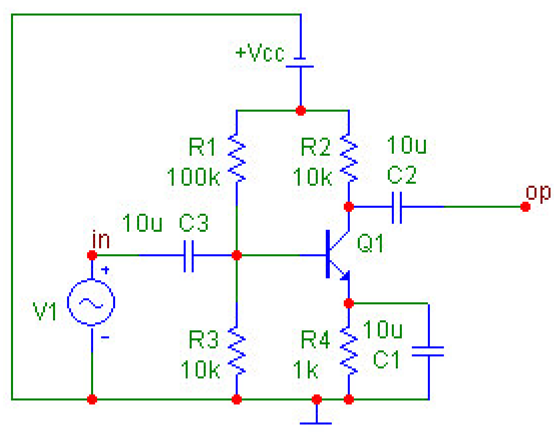
Experiment No. 9

Aim: - To Study single stage RC coupled Amplifier & to perform simulation on Micro-cap Software.

Apparatus:-

DC power supply
Transistor-SL 100
Resistor-47K, 15K, 4.7K, 1.8K
Capacitors- 47uf (2 nos.)
CRO
Function generator

Circuit diagram:-



Theory:-

Direct coupling provides a good frequency response since no frequency-sensitive components (inductors and capacitors) are used. The frequency response of a circuit using direct coupling is affected only by the amplifying device itself. Direct coupling has several disadvantages, however. The major problem is the power supply requirements for direct-coupled amplifiers. Each succeeding stage requires a higher voltage. The load and voltage divider resistors use a large amount of power and the biasing can become very complicated. In addition, it is difficult to match the impedance from stage to stage with direct coupling. (Impedance matching is covered a little later in this chapter.) The direct-coupled amplifier is not very efficient and the losses increase as the number of stages increase. Because of the disadvantages, direct coupling is not used very often.

In the network of R1, R2, and C1, R1 acts as a load resistor for Q1 (the first stage) and develops the output signal of that stage. The capacitor, C1, "blocks" the dc of Q1's collector, but "passes" the ac output signal. R2 develops this passed, or coupled, signal as the input signal to Q2 (the second stage). This arrangement allows the coupling of the signal while it isolates the biasing of each stage. This solves many of the problems associated with direct coupling. $X_L=1/2\pi fC$

As frequency decreases, X_c increases. This causes more of the signal to be "lost" in the capacitor... So, when a capacitor is used as a coupling element, the capacitance should be relatively high so that it will couple the entire signal well and not reduce or distort the signal.

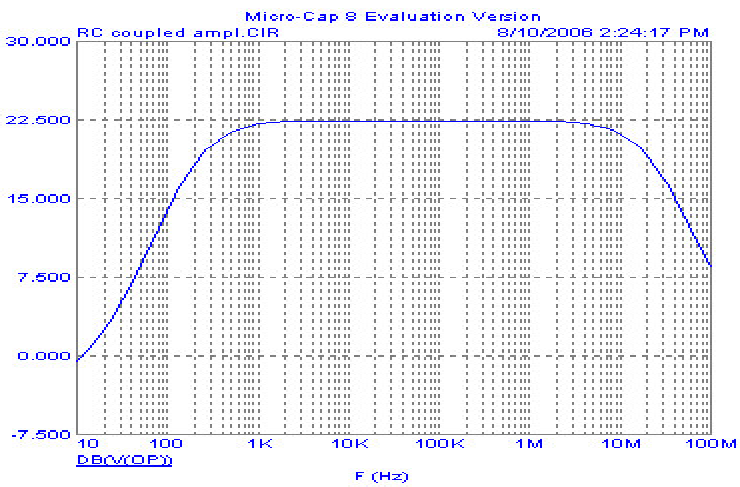
Procedure:-

1. Assemble the circuit.
2. Apply input signal of Vm=18 mV to 25 mV at base.
3. At different input frequencies observe output at collector using CRO and note Vm.
4. Plot graph of frequency vs. gain in decibel on semilog graph paper.

Observations: **Vin=_________**

Sr. No.	**Frequency (Hz)**	**Output voltage (V_0) volts**	**Gain (Af=Vo/Vin)**
	100 Hz		
	..		
	..		
	300KHz		

Simulation Result:-



Result:-

The bandwidth is found to be __________KHz.

Viva Questions:-

1. Define current gain and voltage gain?
2. Comment on the behavior of frequency plot.