Experiment No: 1

Aim: Observe and draw V-I Characteristics of PN Diode & LED Diode.

Equipment: Breadboard, PN junction diode, LED Diode, power supply, multimeter, connecting wires etc**.**

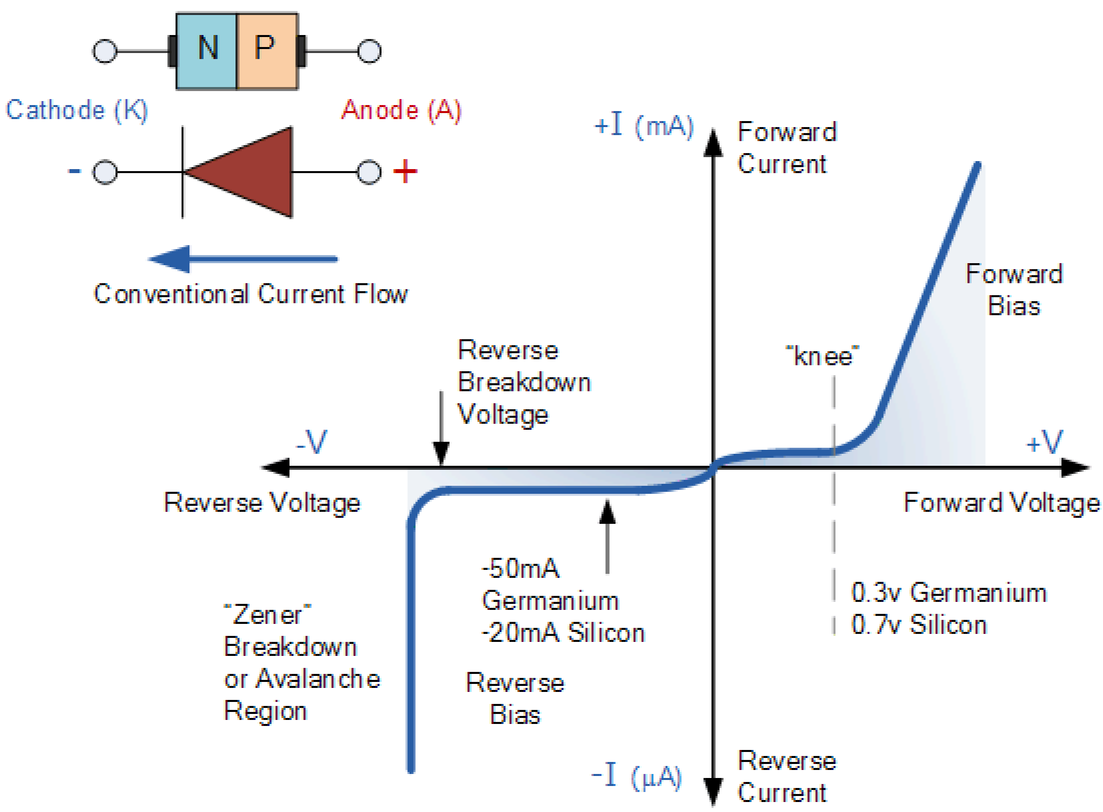
Theory:

A) PN Junction Diode

A PN-junction diode is formed when a p-type semiconductor is fused to an n-type semiconductor creating a potential barrier voltage across the diode junction.

Forward Bias – The voltage potential is connected positive, (+ve) to the P-type material and negative, (-ve) to the N-type material across the diode which has the effect of Decreasing the PN junction diodes width.

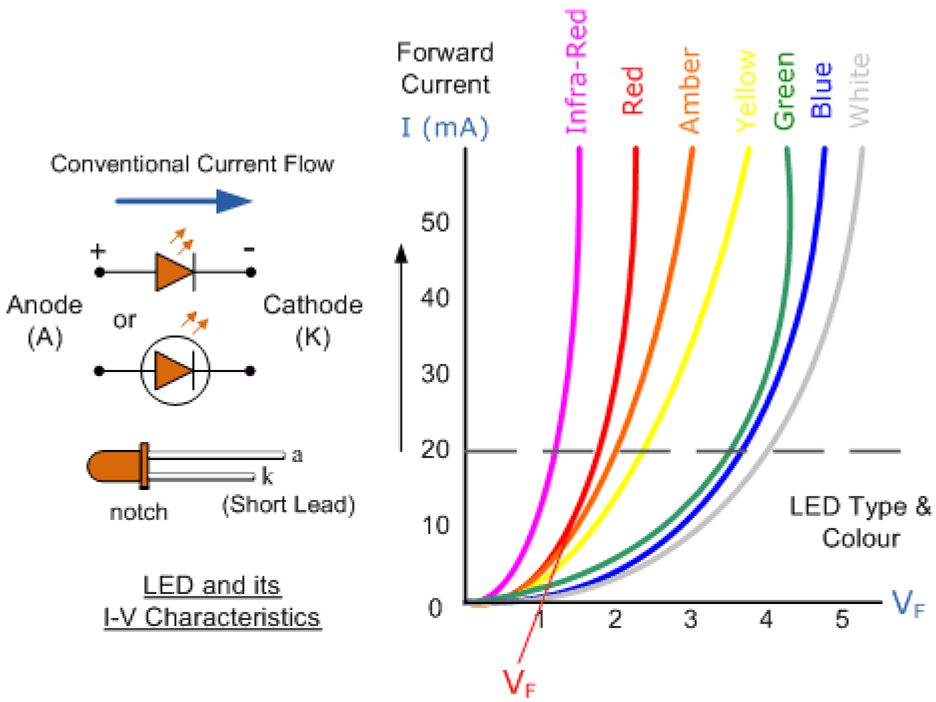
Reverse Bias – The voltage potential is connected negative, (-ve) to the P-type material and positive, (+ve) to the N-type material across the diode which has the effect of Increasing the PN junction diode's width.



B) LED Diode:

The “Light Emitting Diode” or LED as it is more commonly called, is basically just a specialised type of diode as they have very similar electrical characteristics to a PN junction diode. This means that an LED will pass current in its forward direction but block the flow of current in the reverse direction.

Light emitting diodes are made from a very thin layer of fairly heavily doped semiconductor material and depending on the semiconductor material used and the amount of doping, when forward biased an LED will emit a coloured light at a particular spectral wavelength.



Procedure:

1) Design the circuit as per the diagram on bread board.
2) Connect the power supply as per the circuit diagram.
3) Measure the values of current and voltage through the circuit.
4) Draw the output graph.

Observation:

Sr No	Voltage	Current

Conclusion:

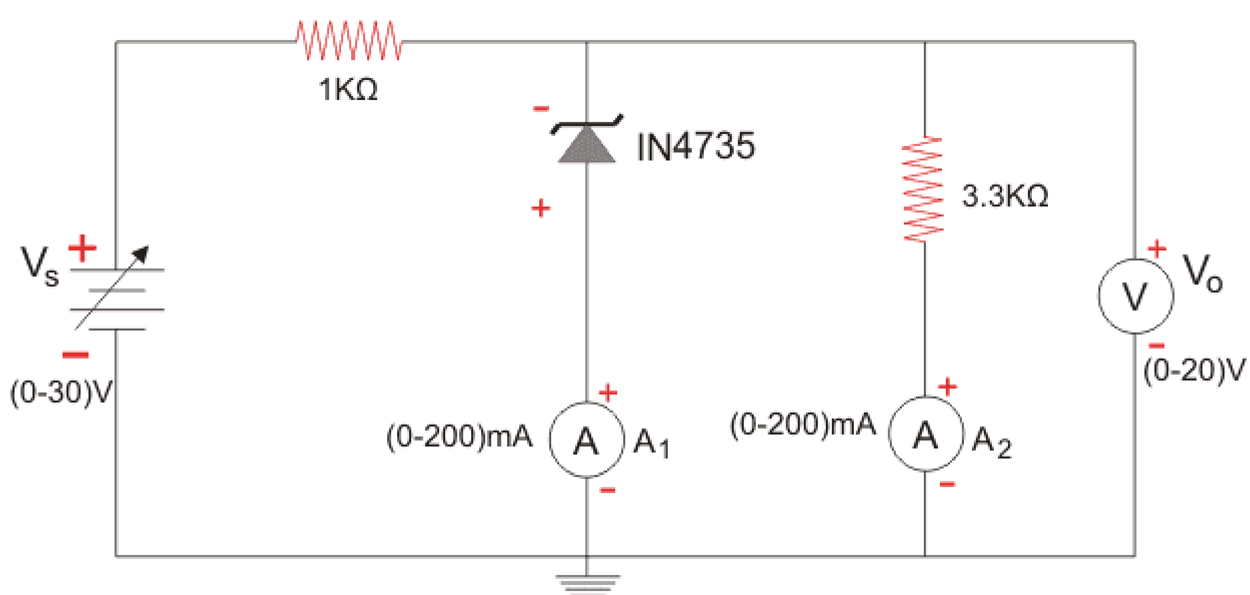
Experiment No: 2

Aim:_ Observe and draw the V-I characteristics and Regulation characteristics of a Zener diode.

Equipment: Breadboard, Zener diode, power supply, multimeter, connecting wires etc**.**

<u>Theory:</u>

The Zener diode mainly operates in reverse biased condition. We use Zener diodes for voltage regulation and voltage stabilisation. They provide a low-cost and no frill method for voltage regulation. The critical parameter of this type of diodes is the Zener breakdown voltage. The Zener breakdown voltage is the minimum reverse biased voltage below which the diode blocks the reverse current through it and above which it causes a significant amount of reverse bias current to flow through it. Once the reverse voltage reaches the Zener breakdown voltage, the voltage across the device remains constant at that level. Hence we can use Zener diode for voltage regulation.



Procedure:

1) Design the circuit as per the diagram on bread board.
2) Connect the power supply as per the circuit diagram.
3) Measure the values of current and voltage through the circuit.
4) Draw the output graph.

Observation:

Sr No	Voltage	Current

Conclusion:

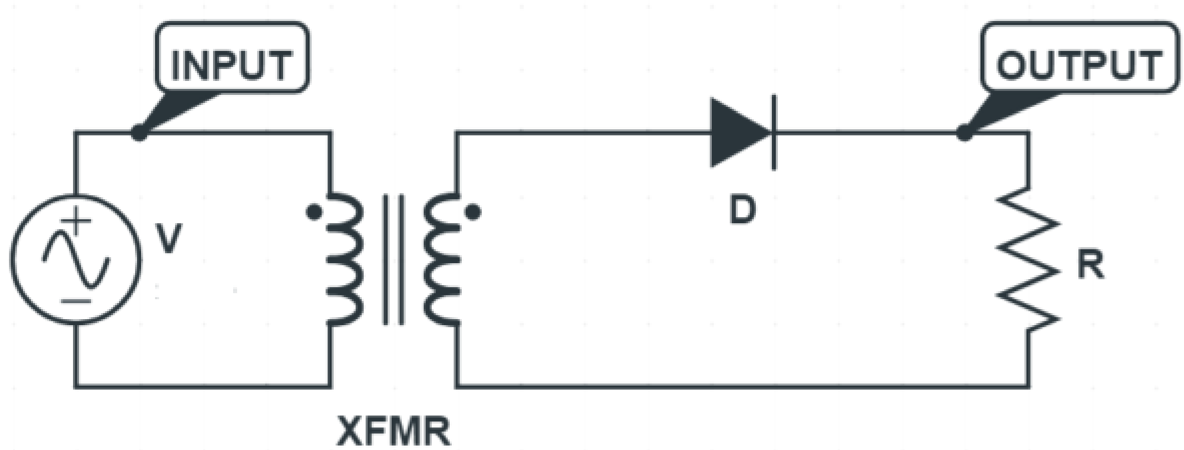
Experiment No: 3

Aim:_ Obtain ripple factor of Half Wave Rectifier circuit with & without filter

Equipment: Breadboard, PN junction diode, LED Diode, power supply, multimeter, connecting wires etc

Theory:

The diode will be forward biased for the positive half cycle of the supply whereas it will be reverse biased for the negative half cycle. Thus the diode will conduct only for the positive half cycle and will not conduct for the negative half cycle. Therefore, current output will only be conducting and allowing the current to flow just for the positive half cycle of the supply. This is the reason; it is called single phase half wave rectifier.
The circuit diagram of single phase half wave rectifier is shown below.



$$Ripple\ Factor, \gamma = \frac{\sqrt{(Irms)^2 - (Idc)^2}}{Idc}$$

$$= \frac{\sqrt{(Vrms)^2 - (Vdc)^2}}{Vdc}$$

Proceure:

1) Design the circuit as per the diagram on bread board.
2) Connect the power supply as per the circuit diagram.
3) Measure the values of current and voltage through the circuit.
4) Draw the output graph.

Observation:

Sr No	Vrms	Irms

Conclusion:

Experiment No: 4

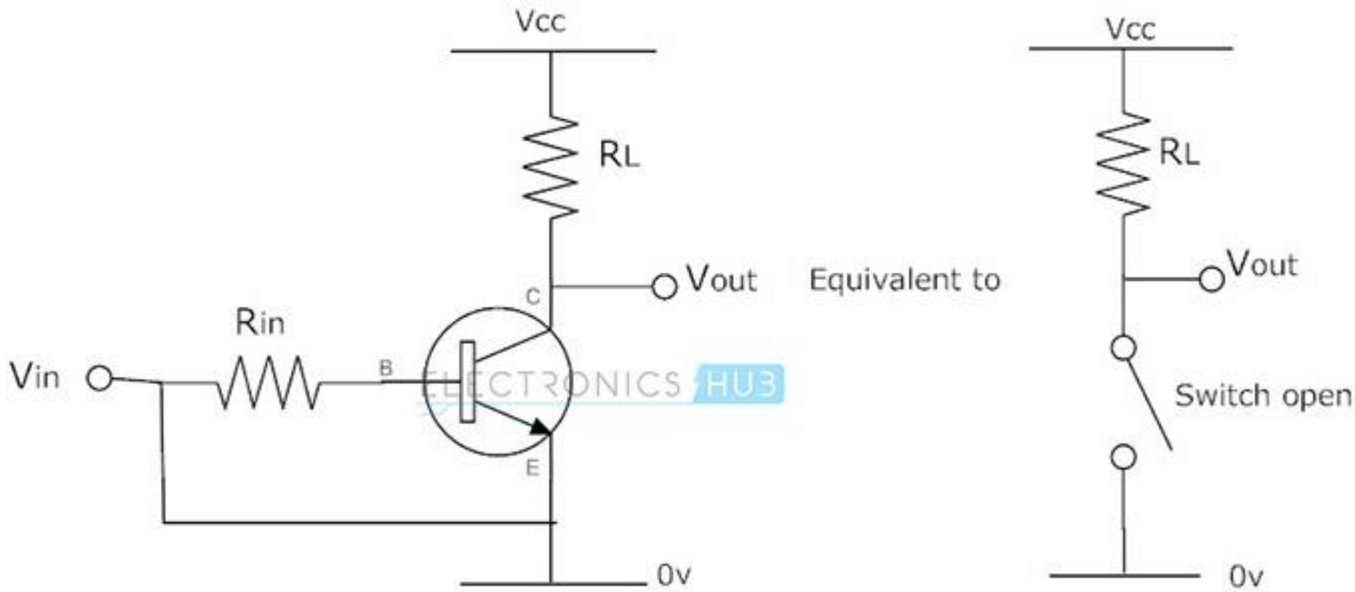
Aim:_ Design bipolar junction transistor as a switch

.**Equipment:** Breadboard, NPN transistor, power supply, multimeter, connecting wires etc

Theory:

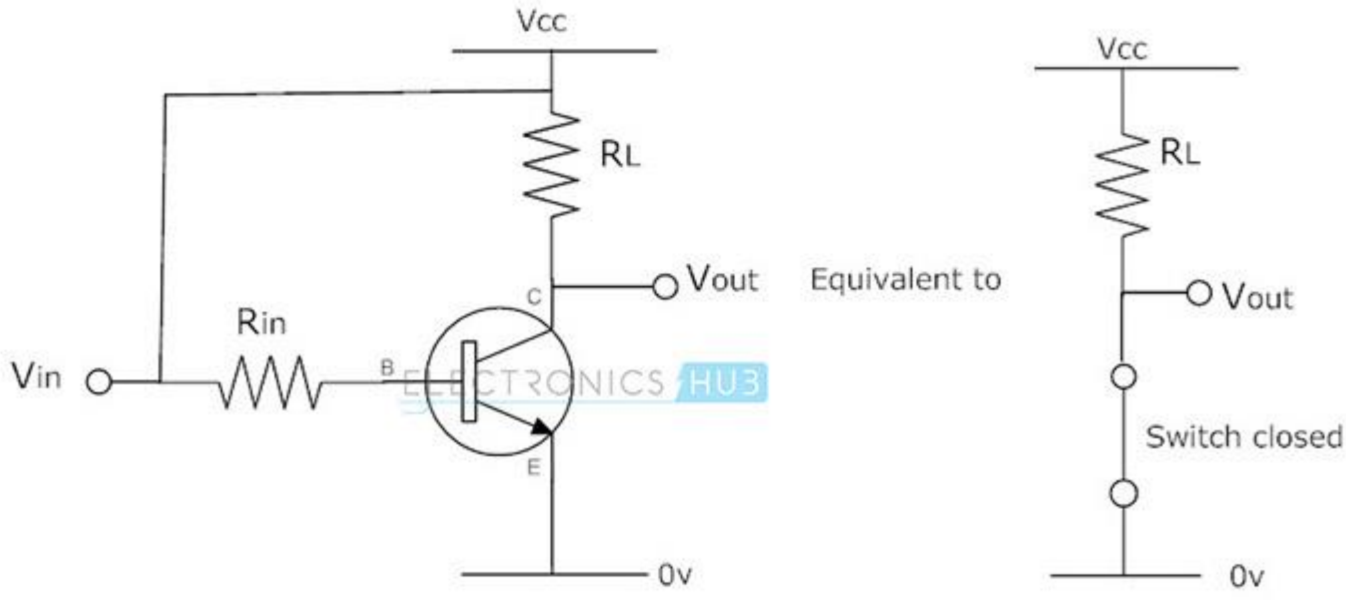
Cutoff Mode

In this mode, both collector base junction and emitter base junction are reverse biased. This in turn not allows the current to flow from collector to emitter when the base-emitter voltage is low. In this mode device is completely switched off as the result the current flowing through the device is zero.



Saturation Mode

In this mode of operation, both the emitter base and collector base junctions are forward biased. Current flows freely from collector to emitter when the base-emitter voltage is high. In this mode device is fully switched ON.



The below figure shows the output characteristics of a BJT Transistor. In the below figure cutoff region has the operating conditions as zero collector output current, zero base input current and maximum collector voltage. These parameters causes a large depletion layer which further doesn't allow current to flow through the transistor. Therefore, the transistor is completely in OFF condition.

Procedure:

1) Design the circuit as per the diagram on bread board.
2) Connect the power supply as per the circuit diagram.
3) Measure the values of current and voltage through the circuit.
4) Draw the output graph.

Observation:

Sr No	Vrms	Irms

Conclusion:

Experiment No: 5

Aim: Design bipolar junction transistor (BJT) as a switch.

Equipment: BJT, Power Supply,CRO, LED, Resistor, Breadboard, Connecting wires.

Theory:

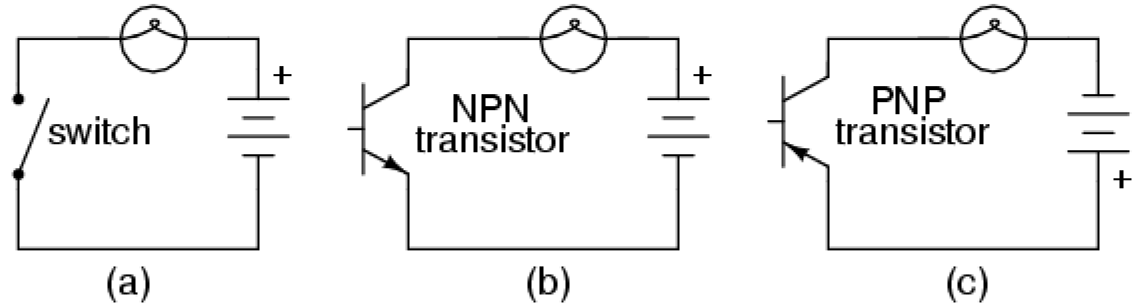
Bipolar junction transistors (BJTs) can be used as an amplifier, filter, rectifier, oscillator, or even a switch. The transistor will operate as an amplifier or other linear circuit if the transistor is biased into the linear region. The transistor can be used as a switch if biased in the saturation and cut-off regions. This allows current to flow (or not) in other parts of a circuit.

Because a transistor's collector current is proportionally limited by its base current, it can be used as a sort of current-controlled switch. A relatively small flow of electrons sent through the base of the transistor has the ability to exert control over a much larger flow of electrons through the collector.

Suppose we had a lamp that we wanted to turn on and off with a switch. Such a circuit would be extremely simple, as in the figure below (a).

For the sake of illustration, let's insert a transistor in place of the switch to show how it can control the flow of electrons through the lamp. Remember that the controlled current through a transistor must go between collector and emitter.

Since it is the current through the lamp that we want to control, we must position the collector and emitter of our transistor where the two contacts of the switch were. We must also make sure that the lamp's current will move *against* the direction of the emitter arrow symbol to ensure that the transistor's junction bias will be correct as in the figure below (b).

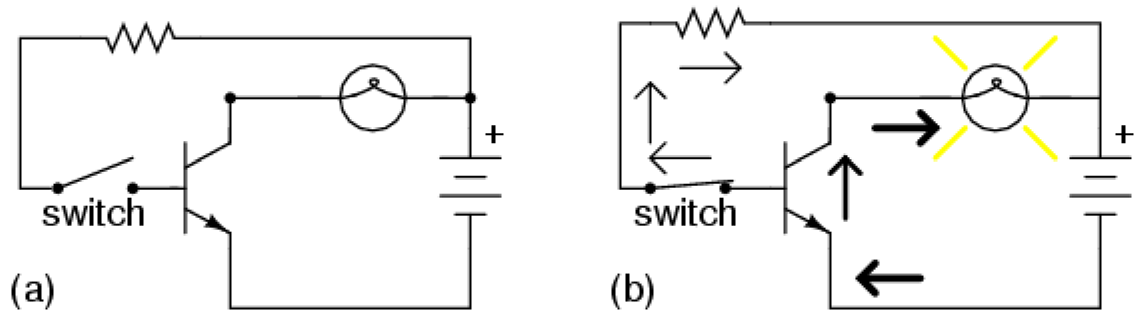


(a) mechanical switch, (b) NPN transistor switch, (c) PNP transistor switch.

A PNP transistor could also have been chosen for the job. Its application is shown in the figure above (c).

The choice between NPN and PNP is really arbitrary. All that matters is that the proper current directions are maintained for the sake of correct junction biasing (electron flow going *against* the transistor symbol's arrow).

In the above figures, the base of either BJT is not connected to a suitable voltage, and no current is flowing through the base. Consequently, the transistor cannot turn on. Perhaps, the simplest thing to do would be to connect a switch between the base and collector wires of the transistor as in figure (a) below.



Transistor: (a) cutoff, lamp off; (b) saturated, lamp on.

Cutoff vs Saturated Transistors

If the switch is open as in figure (a), the base wire of the transistor will be left "floating" (not connected to anything) and there will be no current through it. In this state, the transistor is said to be ***cutoff***.

If the switch is closed as in figure (b), current will be able to flow from the base to the emitter of the transistor through the switch. This base current will enable a much larger current flow from the collector to the emitter, thus lighting up the lamp. In this state of maximum circuit current, the transistor is said to be ***saturated***.

Result and Conclusion:

Experiment No: 6

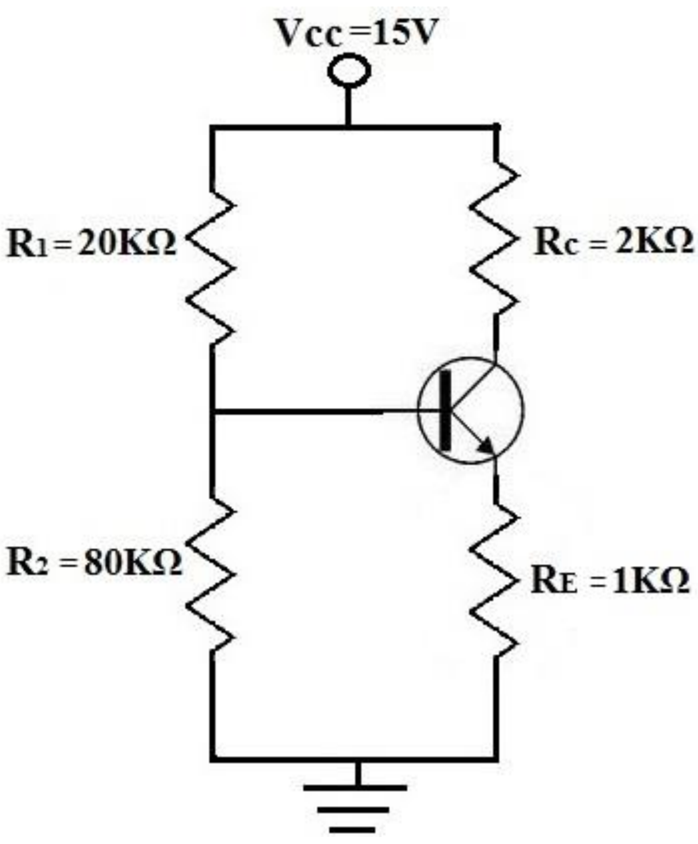
Aim: Design of Voltage Divider Bias for BJT.

Equipment: BJT, Power Supply, CRO, Resistors, Breadboard.

Theory:

One way to bias a BJT transistor is a method called voltage divider bias.

Voltage divider bias is the most popular and used way to bias a transistor. It uses a few resistors to make sure that voltage is divided and distributed into the transistor at correct levels. One resistor, the emitter resistor, RE also helps provide stability against variations in β that may exist from transistor to transistor.
Below is a typical BJT receiving voltage divider bias:



For the circuit above, we're going to assume that β=100 for the transistor.

The base supply voltage, VBB, is calculated by:

We calculate RB below, which we will use the next calculation for IE.

Then, we calculate for the emitter current using the following formula:

$$R_B = R_1 \parallel R_2$$

$$=10K\Omega \frac{(20K\Omega)}{(100K\Omega)} = 16K\Omega$$

$$I_{EQ} = \frac{V_{BB} - V_{BE}}{\frac{R_B}{(\beta+1)} + R_E} = \frac{12V - 0.7V}{\frac{16K\Omega}{100} + 1K\Omega} = 9.74ma$$

The collector current IC is approximately equal to the emitter current.
IC≈ IE

Result and Conclusion:

Experiment No: 7

Aim: Design Audio oscillator using BJT

Equipment: BJT, Power Supply, CRO, Resistors, Capacitors, Breadboard.

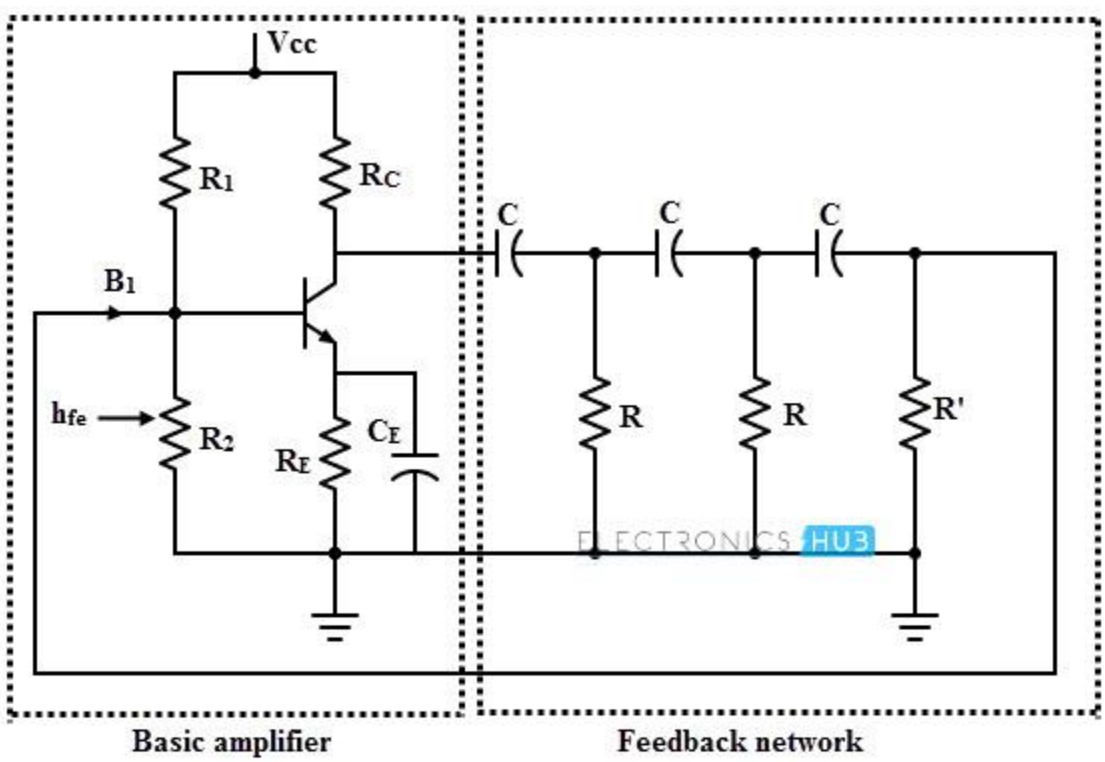
Theory:

Here Audio oscillator is nothing but a RC oscillator, so we will design a RC oscillator.

In this transistorized oscillator, a transistor is used as active element of the amplifier stage. The figure below shows the RC oscillator circuit with transistor as active element. The DC operating point in active region of the transistor is established by the resistors R1, R2, RC and RE and the supply voltage Vcc.

The capacitor CE is a bypass capacitor. The three RC sections are taken to be identical and the resistance in the last section is R' = R – hie. The input resistance hie of the transistor is added to R', thus the net resistance given by the circuit is R.

The biasing resistors R1 and R2 are larger and hence no effect on AC operation of the circuit. Also due to negligible impedance offered by the RE – CE combination, it is also no effect on AC operation.



When the power is given to the circuit, noise voltage (which is generated by the electrical components) start the oscillations in the circuit. A small base current at the transistor amplifier produces a current which is phase shifted by 180 degrees.

When this signal is feedback to the input of the amplifier, it will be again phase shifted by 180 degrees. If the loop gain is equal to unity then sustained oscillations will be produced.

By simplifying the circuit with equivalent AC circuit, we get

The frequency of oscillations,

$f = 1/ (2 \pi R C \sqrt{((4Rc / R) + 6)})$

If $Rc/R << 1$, then

$f= 1/ (2 \pi R C \sqrt{6})$

The condition of sustained oscillations,

$hfe\ (min) = (4\ Rc/ R) + 23 + (29\ R/Rc)$

For a phase shift oscillator with R = Rc, hfe should be 56 for sustained oscillations.

From the above equations it is clear that, for changing the frequency of oscillations, R and C values have to be changed.

But for satisfying oscillating conditions, these values of the three sections must be changed simultaneously. So this is not possible in practice, therefore a phase shift oscillator is used as a fixed frequency oscillator for all practical purposes.

Calculations:

Consider: $Rc = 10 \times 10^3 Hz$

$R = 8 \times 10^3 Hz$

$f = 2 \times 10^3 Hz$

To Calculate: Capacitor C and hfe.

In phase shift oscillator, the frequency of oscillations is given by

$f = 1/ (2 \pi R C \sqrt{((4Rc / R) + 6)})$

$2 \times 10^3 = 1/ (2 \pi \times 8 \times 10^3 C \sqrt{((4 \times 10 \times 10^3 / 8 \times 10^3) + 6)})$

$C = 3.0 \times 10^{-9}$ F or 0.003 µ F

The value of the transistor gain is given by

$hfe \geq (4 Rc/ R) + 23 + (29 R/Rc)$

$hfe \geq (4 \times 10 \times 10^3/ 8 \times 10^3) + 23 + (29 \times 8 \times 10^3 / 10 \times 10^3)$

$hfe \geq 51.2$

Hence the capacitor value is C = 3.0 × 10-9 F and hfe = 51.2.

Result and Conclusion:

Experiment No: 8

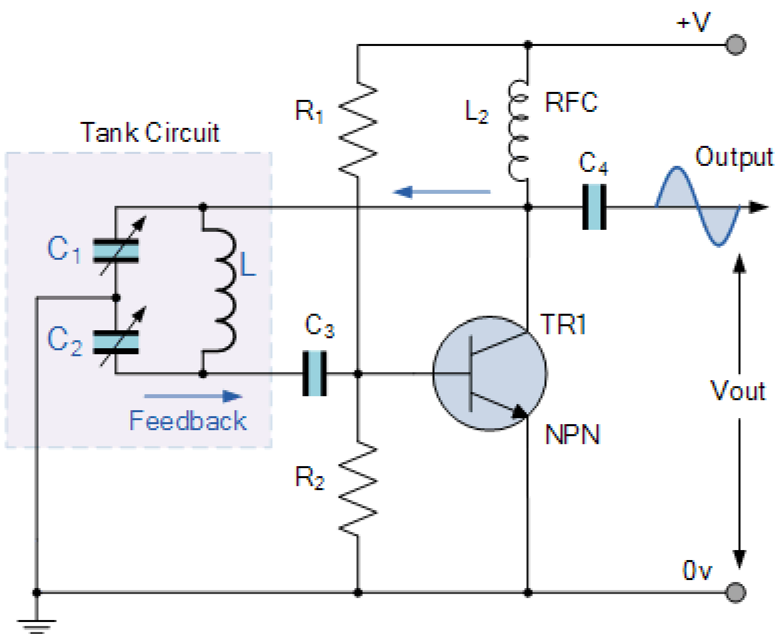
Aim: Design Radio oscillator using BJT

Equipment: BJT, Power Supply, CRO, Resistors, Capacitors, Inductance, Breadboard.

Theory:

Here Radio oscillator is nothing but a Colpitt's oscillator, so we will design a Colpitt's oscillator.

Basic Colpitts Oscillator Circuit



The emitter terminal of the transistor is effectively connected to the junction of the two capacitors, C1 and C2 which are connected in series and act as a simple voltage divider. When the power supply is firstly applied, capacitors C1 and C2 charge up and then discharge through the coil L. The oscillations across the capacitors are applied to the base-emitter junction and appear in the amplified at the collector output.

Resistors, R1 and R2 provide the usual stabilizing DC bias for the transistor in the normal manner while the additional capacitors act as a DC-blocking bypass capacitors. A radio-frequency choke (RFC) is used in the collector circuit to provide a high reactance (ideally open circuit) at the frequency of oscillation, (fr) and a low resistance at DC to help start the oscillations.

The required external phase shift is obtained in a similar manner to that in the Hartley oscillator circuit with the required positive feedback obtained for sustained undamped oscillations. The amount of feedback is determined by the ratio of C1 and C2. These two capacitances are generally "ganged" together to provide a constant amount of feedback so that as one is adjusted the other automatically follows.

The frequency of oscillations for a Colpitts oscillator is determined by the resonant frequency of the LC tank circuit and is given as:

$$f_r = \frac{1}{2\pi\sqrt{L\,C_T}}$$

where C_T is the capacitance of C1 and C2 connected in series and is given as:

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} \quad \text{or} \quad C_T = \frac{C_1 \times C_2}{C_1 + C_2}$$

The configuration of the transistor amplifier is of a *Common Emitter Amplifier* with the output signal 180^o out of phase with regards to the input signal. The additional 180^o phase shift require for oscillation is achieved by the fact that the two capacitors are connected together in series but in parallel with the inductive coil resulting in overall phase shift of the circuit being zero or 360^o.

The amount of feedback depends on the values of C1 and C2. We can see that the voltage across C1 is the the same as the oscillators output voltage, Vout and that the voltage across C2 is the oscillators feedback voltage. Then the voltage across C1 will be much greater than that across C2.

Therefore, by changing the values of capacitors, C1 and C2 we can adjust the amount of feedback voltage returned to the tank circuit. However, large amounts of feedback may cause the output sine wave to become distorted, while small amounts of feedback may not allow the circuit to oscillate.

Then the amount of feedback developed by the Colpitts oscillator is based on the capacitance ratio of C1 and C2 and is what governs the the excitation of the oscillator. This ratio is called the "feedback fraction" and is given simply as:

$$\text{Feedback Fraction} = \frac{C_1}{C_2}\,\%$$

Calculations:

Consider: C1: 24nF; C2: 240nF; L1: 10mH

To calculate: Frequency of oscillation circuit, Feedback fraction to draw the circuit.

The oscillation frequency for a Colpitts Oscillator is given as:

$$f_r = \frac{1}{2\pi\sqrt{LC_T}}$$

As the colpitts circuit consists of two capacitors in series, the total capacitance is therefore:

$$C_T = \frac{24nF \times 240nF}{24nF + 240nF} = 21.82nF$$

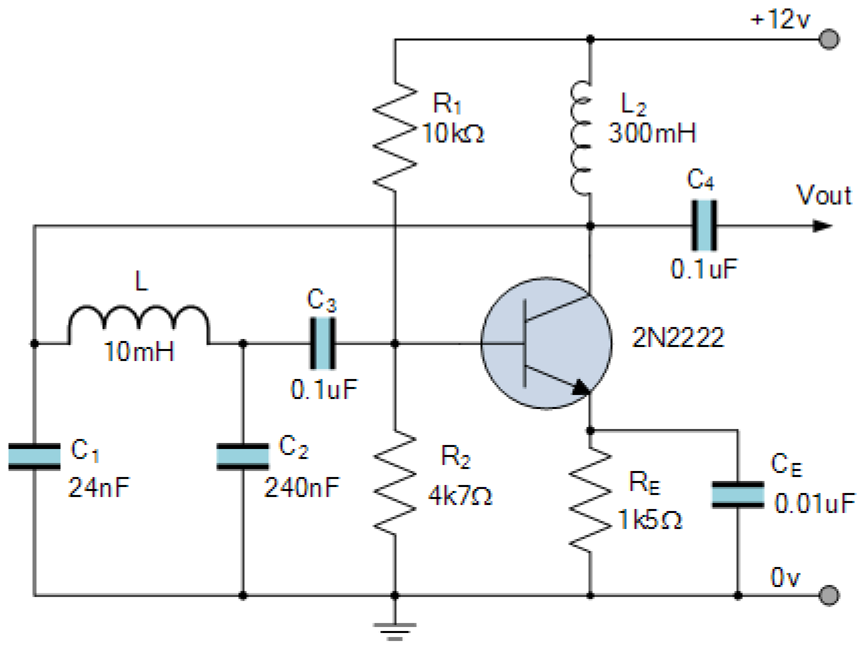
The inductance of the inductor is given as 10mH, then the frequency of oscillation is:

$$f_r = \frac{1}{2\pi\sqrt{LC_T}} = \frac{1}{6.283\sqrt{0.01 \times 21.82 \times 10^{-9}}} = 10.8kHz$$

The frequency of oscillations for the Colpitts Oscillator is therefore 10.8kHz with the feedback fraction given as:

$$F_F = \frac{C_1}{C_2} = \frac{24nF}{240nF} = 10\%$$

Colpitts Oscillator Circuit



Calculation & Observation