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DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Academic Year 2024-25

Lab Manual

Name of Subject: Electronics Device Circuit Lab

Class: SY **Semester: III**

Name of Subject In charge: Mr. Patel J.H

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EXPERIMENT 01: TO STUDY COMMON EMITTER CONFIGURATIONS OF BJT

Aim: To study Common Emitter Configuration of BJT

APPARATUS:

1. DC power supply (0-30V)
2. Breadboard.
3. Connecting Wires

COMPONENTS REQUIRED:

1.Resistor (1KΩ,)

2.Transistor : BJT (BC547/ BC 157)

3. Multimeter

THEORY:

Bipolar Junction Transistor – BJT

BJT or Bipolar Junction Transistor is a type of transistor that is bipolar and has a junction. Bipolar means that it uses both types of charge carriers i.e. electrons and holes.

While the junction refers to the boundary between two different semiconductor materials usually known as PN junction.

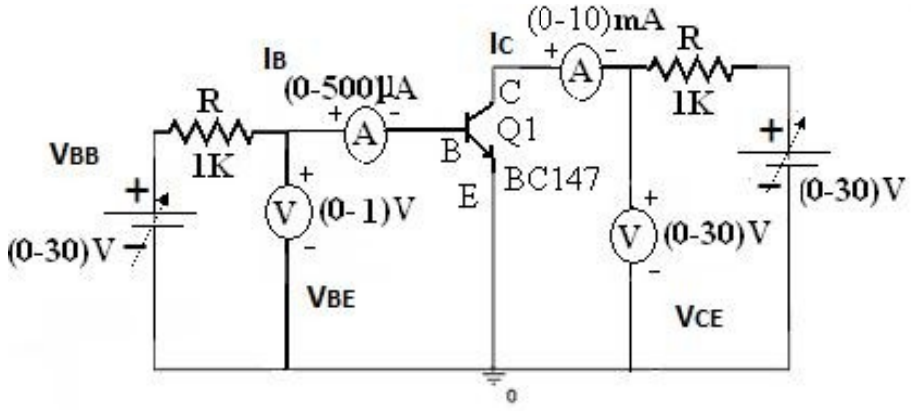
Bipolar junction transistor (BJT) is a 3 terminal (emitter, base, collector) semiconductor device. There are two types of transistors namely NPN and PNP. It consists of two P-N junctions namely emitter junction and collector junction.

In Common Emitter configuration the input is applied between base and emitter and the output is taken from collector and emitter. Here emitter is common to both input and output and hence the name common emitter configuration.

Input characteristics are obtained between the input current and input voltage taking output voltage as parameter. It is plotted between VBE and IB at constant VCE in CE configuration.

Output characteristics are obtained between the output voltage and output current taking input current as parameter. It is plotted between VCE and IC at constant IB in CE configuration.

Circuit Diagram:



Precautions:

1. While doing the experiment do not exceed the ratings of the transistor. This maylead to damage the transistor.
2. Connect voltmeter and Ammeter in correct polarities as shown in the

circuitdiagram.

3. Do not switch **ON** the power supply unless you have checked the circuit connections as per the circuit diagram.
4. Make sure while selecting the emitter, base and collector terminals of the transistor

Procedure:

Input Characteristics

1. Connect the transistor in CE configuration as per circuit diagram
2. Keep output voltage V_{CE} = 0V by varying V_{CC}.
3. Varying V_{BB} gradually, note down both base current I_B and base - emittervoltage (V_{BE}).
4. Repeat above procedure (step 3) for various values of V_{CE}

Output Characteristics

1. Make the connections as per circuit diagram.
2. By varying V_{BB} keep the base current I_B = 20µA.
3. Varying V_{CC} gradually, note down the readings of collector-current (I_C) andcollector- emitter voltage (V_{CE}).
4. Repeat above procedure (step 3) for different values of I_E

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Input Characteristics:

V_{CE} = 0 V		V_{CE} = 5V	
V_{BE} (volts)	I_B (mA)	V_{BE} (volts)	I_B (mA)

Output Characteristics:

I_B = 30 µA		I_B = 60 µA	
V_{CE} (volts)	Ic (mA)	V_{CE} (volts)	Ic (mA)

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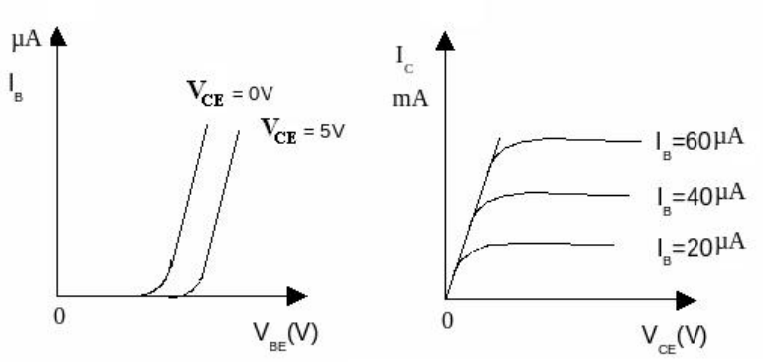
Model Graph:



Input characteristics **Output characteristics**

Result

Thus the input and output characteristics of BJT in CE configuration was verified and the graph was plotted.

a) Impedance (hie) = ΔVBE / ΔIB, VCE constant. =

b) Output admittance (hoe)= ΔIc / Δ VEC , IB constant =

Questions

1) Draw NPN ,PNP Transistor Symbol
2) Explain BJT: construction, working, characteristics
3) Draw & Explain transistor as amplifier

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EXPERIMENT 02: TRANSISTOR AS A SWITCH

AIM: To Study Transistor as Switch

APPARATUS:

1. DC power supply (0-30V)

2.Breadboard.

COMPONENTS REQUIRED:

1.Resistor (1KΩ, 100KΩ)

2.Transistor : BJT (BC547)

3. LED

THEORY:

If the circuit uses the **Bipolar Transistor as a Switch**, then the biasing of the transistor, either NPN or PNP is arranged to operate the transistor at both sides of the " I-V " characteristics curves

The areas of operation for a transistor switch are known as the **Saturation Region** and the **Cut-off Region**.

In **Saturation Region** Base to Emitter and Base to Collector Junction are Forward bias.

In **Cut-off Region** Base to Emitter and Base to Collector Junction are Reversed bias.

This means then that we can ignore the operating Q-point biasing and voltage divider circuitry required for amplification, and use the transistor as a switch by driving it back and forth between its "fully-OFF" (cut-off) and "fully-ON" (saturation) regions as shown below.

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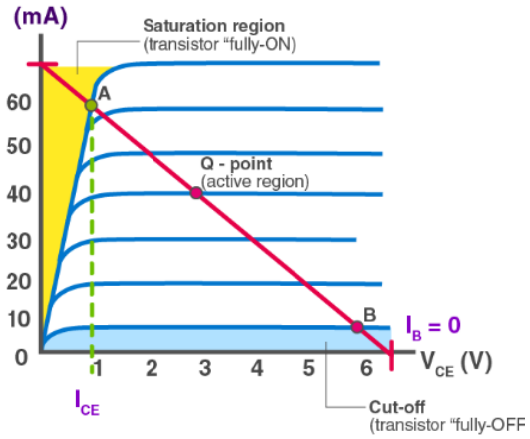
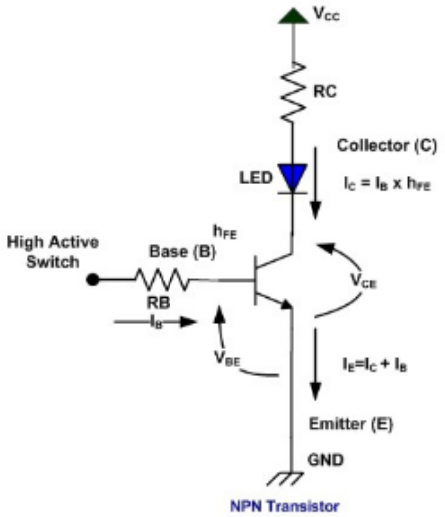


Circuit Diagram:



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First of all, find that given transistor is PNP or NPN in the sense of polarity.

- I have determined that transistor is NPN type.
- I have make a circuit on the bread board in which Collector junction is connected to 5V supply, Emitter is connected to negative terminal of load (LED operated at 3V) and base junction is opened.
- When base junction is connected to the 5v supply, then circuit completes and LED switched 'ON'.
- When we cut off the supply of Base junction, then current does not follow and LED is not working.
- The following circuit shows the whole working procedure

OBSERVATION:

1. When input is less than V_T LED is off.
2. When input is more than V_T LED is on.

CONCLUSION: We have checked working of BJT as switch

Questions:

1) State the mode of Transistor operation and explain it
2) Draw and Explain Transistor as Switch
3) Draw CB, CC and CE amplifier diagram

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EXPERIMENT 03: TWO STAGE RC COUPLED AMPLIFIER

AIM: To obtain the Voltage gain for two stage RC coupled Amplifier and also to observe the Frequency Response

APPARATUS:

1. DC power supply (0-30V)
2. 2.Breadboard.
3. Cathode Ray Oscilloscope
4. Function Generator
5. connecting wires

COMPONENTS REQUIRED:

1.Resistor (15kΩ, 10kΩ, 1kΩ, 3.3kΩ, 220Ω)

2.Transistor : BJT (BC547)

3. Capacitors-10µf

THEORY:

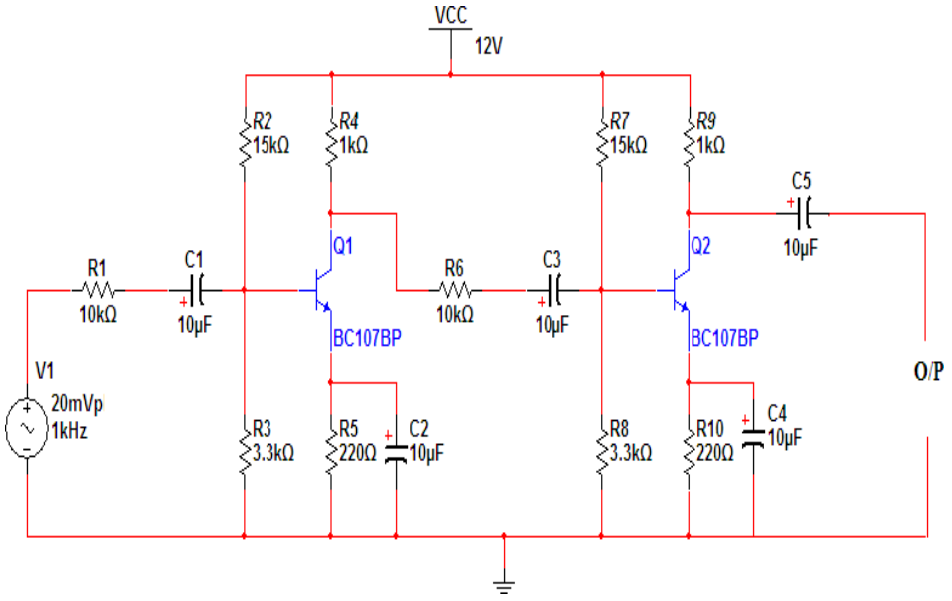
Whenever large amplification with very good impedance matching is required using an active device such as a transistor or a field effect transistor a single active device and its associated circuitry will not be able to cater to the needs. In such a case single stage amplifier is not sufficient and one requires more stages of amplification i.e., output of one stage is connected to the input of second stage of amplification circuit and the chain continues until the required characteristics of amplifier is achieved such an amplifier is called as multistage amplifier. IN multistage amplifier, the output signal preceding stage is to be

coupled to the input circuit of succeeding stage. For this interstage coupling different types of coupling can be employed. They are

1. RC coupling
2. Transformer coupling
3. Direct coupling

RC coupling is most popularly used type of coupling because it is cheap and provides excellent fidelity over a wide range of frequency .it is usually employed for voltage.

Circuit Diagram:



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PROCEDURE:

1) Connect the circuit as shown in the figure.

2) Apply 1KHz frequency and 20mv Vp-p Sine wave from function generator..

3) Observe input and output Waveforms simultaneously on C.R.O

4) Change the frequency of input signal from 10HZ to 1MHZ in steps and note amplitudes of input and output Waveforms(input signal should be maintained constant).

5) Calculate Voltage gain (A) for each (in db) verses frequency.

S.No	Frequency (Hz)	Input Voltage	Output Voltage	Gain=(V_0/V_i)	Gain in db= $20 \times \log_{10}(V_0/V_i)$

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PRECAUTIONS:

1. Check connections before switching ON power supply.
2. Don't apply over voltage
3. When you are not using the equipment switch them Off

CALCULATIONS:

Maximum gain of the amp:

Upper cutoff frequency F2:

Lower cutoff frequency F1:

Band width=F2-F1

Questions:

1) Draw and explain RC coupled CE Amplifier. What are Effects of bypass and cou-pling capacitors
2) Draw and explain TWO stage RC Coupled Amplifier with construction , operation and frequency response
3) Draw Direct coupled Amplifier with frequency response
4) Draw Transformer Coupled Amplifier with frequency response

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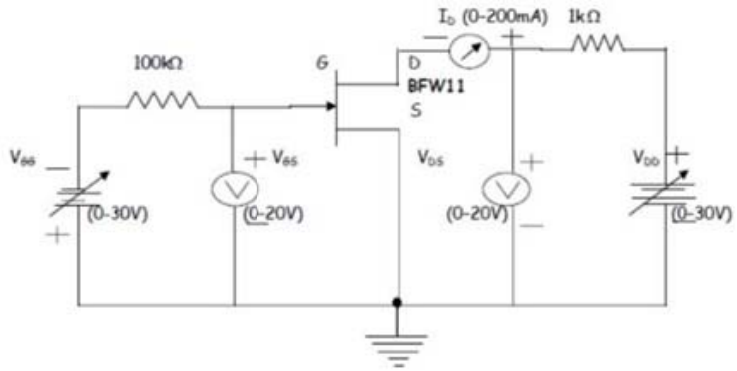
EXPERIMENT 04: N-CHANNEL JFET CHARACTERISTICS

AIM: To study transfer and output characteristics of a n-channel Junction field effect Transistor (JFET) in Common-source configuration.

APPARATUS:

1. JFET (BFW10)
2. Resistor (1KΩ, 100KΩ)
3. Ammeters (0-10mA, 0-100µ A)
4. Connecting wires
5. DC power supply (0-30V)
6. Multi- meter
7. Breadboard

CIRCUIT DIAGRAM:



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PROCEDURE:

OUTPUT CHARACTERISTICS:

1. Connect the circuit as per given diagram properly.

2. Keep VGS = 0V by varying VGG

3. Vary VDS in step of 1V up to 10 volts and measure the drain current ID. Tabulate all the readings.

4. Repeat the above procedure for VGS as -0.5, -1V, -1.5V, -2V, -2.5V, -3V, -3.5V etc

TRANSFER CHARACTERISTICS:

1. Connect the circuit as per given diagram properly.

2. Set the voltage VDS constant at 10 V.

3. Vary VGS by varying VGG in the step of 0.5 up to 3.5V and note down value of drain current ID.

Tabulate all the readings.

4. Plot the output characteristics VDS vs ID and transfer characteristics VGS vs ID.

5. Calculate IDSS, VP, from the graphs.

OBSERVATION TABLE:

OUTPUT CHARACTERISTICS:

V_{GS}=0V		V_{GS}=-1V		V_{GS}=-1.5V		V_{GS}=-2V	
V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)
0		0		0		0	

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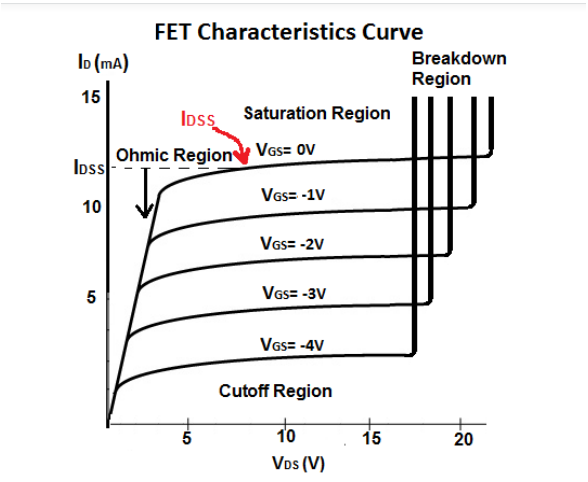
TRANSFER CHARACTERISTICS:

V_{DS}=10V	
V_{GS} (V)	I_D(mA)
0	



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CALCULATION:

1. **Drain saturation current I_{DSS}:** Maximum current flowing through JFET when gate to source voltage is zero.
2. **Pinch-off voltage V_P:** Gate to source voltage at which, drain current becomes zero.

RESULTS:

1. **I_{DSS} : _____**
2. **V_P : _____**

Conclusion: We have seen output and transfer characteristics of JFET and calculated various parameters of JFET**.**

Questions:

1) Compare between BJT and JFET
2) Explain working of N-Channel JFET
3) Explain FFT as a Voltage Variable Resistor
4) Explain JFET as Amplifier and Switch

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EXPERIMENT 05: STATIC CHARACTERISTICS OF MOSFET

AIM: To plot the Transfer and Drain characteristics of MOSFET

APPARATUS:

1. MOSFET IRF 740
2. Resistor (560Ω, 100KΩ)
3. Ammeters (0-10mA, 0-100μ A)
4. Connecting wires
5. DC power supply (0-30V)
6. Multi- meter
7. Breadboard

THEORY:

A MOSFET (Metal oxide semiconductor field effect transistor) has three terminals called Drain, Source and Gate. MOSFET is a voltage controlled device. It has very high input impedance and works at high switching frequency.

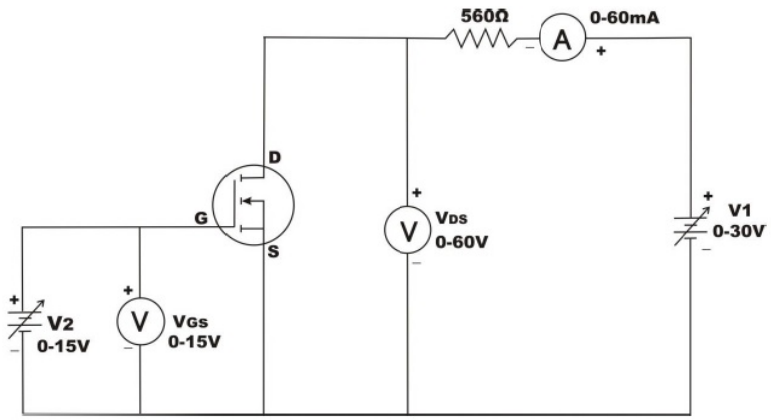
MOSFET's are of two types 1) Enhancement type 2) Depletion type

1) **Enhancement Type**
   - Enhancement mode means, that whenever the voltage toward the gate terminal of this MOSFET increases, then the current flow will be increased more from drain to source.
   - Enhancement type MOSFETS are normally off which means when an enhancement-type MOSFET is connected, there will be no flow of current from the terminal drain (D) to the source (S).
   - This MOSFET is a three-terminal voltage-controlled device where the terminals are a source, gate, and drain.
   - The enhancement MOSFET are both P-channel & N-channel.

2) Depletion type

- Depletion mode means, that whenever the voltage toward the gate terminal of this MOSFET increases, then the current flow will be decreased from drain to source.
- Depletion t type MOSFETS are normally ON which means when an Depletion -type MOSFET is connected, there will be flow of current from the terminal drain (D) to the source (S).
- This MOSFET is a three-terminal voltage-controlled device where the terminals are a source, gate, and drain.
- The Depletion MOSFET are both P-channel & N-channel.

CIRCUIT DIAGRAM:



PROCEDURE:

A) Transfer Characteristics:

1. Make the connections as per the circuit diagram.

2. Initially keep V1 and V2 at 0 V.

3. Switch ON the regulated power supplies. By varying V1, set VDS to some constant voltage say 5V.

4. Vary V2 in steps of 0.5V, and at each step note down the corresponding values of VGS and ID. (Note: note down the value of VGS at which ID starts increasing as the threshold voltage).

5. Reduce V1 and V2 to zero.

6. By varying V1, set VDS to some other value say 10V.

7. Repeat step 4.

8. Plot a graph of VGS versus ID for different values of VDS.

B) Drain or Output Characteristics:

1. Make the connections as per the circuit diagram.

2. Initially keep V1 and V2 at zero volts.

3. By varying V2, set VGS to some constant voltage (must be more than Threshold voltage).

4. By gradually increasing V1, note down the corresponding value of VDS and ID.

(Note: Till the MOSFET jumps to conducting state, the voltmeter which is connected across device as VDS reads approximately zero voltage. Further increase in voltage by V1 source cannot be read by VDS, so connect multimeter to measure the voltage and tabulate the readings in the tabular column).

5. Set VGS to some other value (more than threshold voltage) and repeat step 4.

6. Plot a graph of VDS versus ID for different values of VGS.

Note: If VDS is lower than VP (pinch-off voltage) the device works in the constant resistance region that is linear region. If VDS is more than VP, a constant ID flows from the device and this operating region is called constant current region.

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OBSERVATION TABLE:

A) TRANSFER CHARACTERISTICS:

VDS=VDS1= ____VoltsV		VDS=VDS2= ____VoltsV	
VGS (V)	I_D(mA)	VGS (V)	I_D(mA)

B) OUTPUT CHARACTERISTICS:

V_{GS1}=5V		V_{GS2}=7V		V_{GS3}=10V		V_{GS4}=15V	
V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)	V_{DS}(V)	I_D(mA)

PIN CONFIGURATION:

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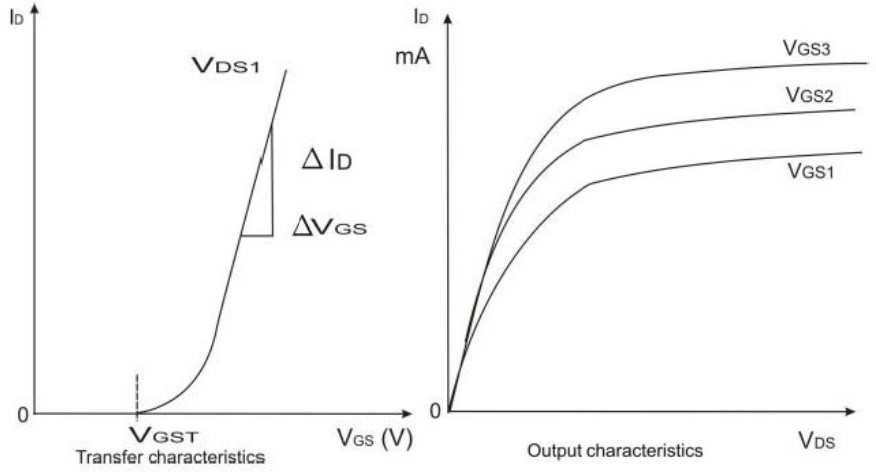
GRAPH:



CONCLUSION: We have seen output and Transfer characteristics & Output characteristics of MOSFETS**.**

Questions:

1) Explain VI characteristics of MOSFET
2) Explain construction and working E-MOSFET
3) Explain construction and working of D-MOSFET
4) Draw N-Channel ,P-Channel MOSFET symbol

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EXPERIMENT 06: CLASS A POWER AMPLIFIER

AIM: To design and test the class A power amplifier

APPARATUS:

1. DC power supply (0-30V)
2. Breadboard.
3. Cathode Ray Oscilloscope
4. Function Generator
5. BNC Probes and connecting wires

COMPONENTS REQUIRED:

1.Resistor (33kΩ, 4.7kΩ, 1kΩ, 8.2kΩ, 2.2kΩ)

2.Transistor : BJT (CL 100)

3. Capacitors-10µf 3 Qty

THEORY:

The amplifier is said to be class A power amplifier if the Q point and the input signal are selected such that the output signal is obtained for a full input cycle. For this class the position of Q point is approximately y at the midpoint of the load line. For all the values of input signal the transistor remains in the active region and never entire into the cutoff or saturation region. The collector current flows for 360^0 (life cycle) of the input signal in other words the angle of the collector current flow is 360^0 the class a amplifiers or furthers classified as directly coupled and transformer coupled and transformer coupled amplifiers in directly coupled type .The load is directly connected in the collector circuit while in the transformer coupled type, the load is coupled to the collector using the transformer

Yashoda Shikshan Prasarak Mandal's

Yashoda Technical Campus, Satara

(Approved by AICTE, Delhi/Approved by Govt of Maharashtra DTE) Email: principalengg_ytc@yes.edu.in
Web : www.yes.edu.in NH-4, Wadhe, Satara, Tele Fax-02162-271238/39/9172220775

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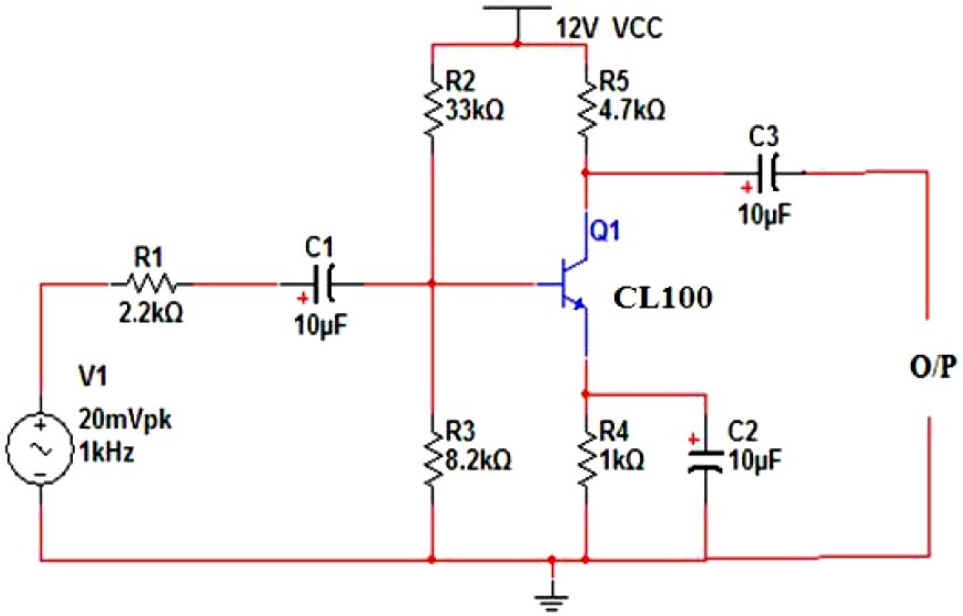
CIRCUIT DIAGRAM:



PROCEDURE:

Build the RC Phase Shift Oscillator circuit as per circuit diagram

1. Set Input signal (1 Vpp), at 50 Hz using signal generator.
2. By keeping the input voltage constant, vary the frequency from 50 to 1MHz in regular steps .
3. Note down the corresponding output voltage from CRO
4. Calculate the DC input power using the formula Pdc= Vcc * IcQ (Take IcQ = 15mA)
5. Calculate the AC output power using the formula Pac = $Vpp^2/8RL$
6. Calculate the efficiency η = Pac /Pdc
7. Plot the graph between Gain (db) and frequency.
8. Calculate bandwidth from the graph.

CALCULATIONS:

Input power: $P_{dc} = V_{cc} I_{cQ} =$

Outpower: $P_{ac} = V_{PP}^2/8R_L =$

η = Efficiency=output power/input power*100 = Pac / Pdc*100 =

CONCLUSION: We have calculate efficiency of Class A Amplifier and observed that efficiency is less than 25 %**.**

Questions:

1) Compare Class A, Class B, Class C, Class AB amplifiers
2) Draw and explain operation of transformer coupled Class A amplifier
3) Calculate the efficiency of coupled Class A amplifier
4) Derive Expression for Maximum Efficiency of Class B Power Amplifier

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EXPERIMENT 07: CLASS B COMPLEMENTARY SYMMETRY AMPLIFIER

AIM: To observe the input and output waveforms and to calculate the efficiency of Class B Complimentary symmetry power amplifier.

APPARATUS:

1. DC power supply (0-30V)
2. Breadboard.
3. Cathode Ray Oscilloscope
4. Function Generator
5. BNC Probes and connecting wires

COMPONENTS REQUIRED:

1.Resistor (2.2kΩ Qty – 2 , 1kΩ, 220Ω Qty-2)

2.Transistor : BJT (2N3904 , 2N3906)

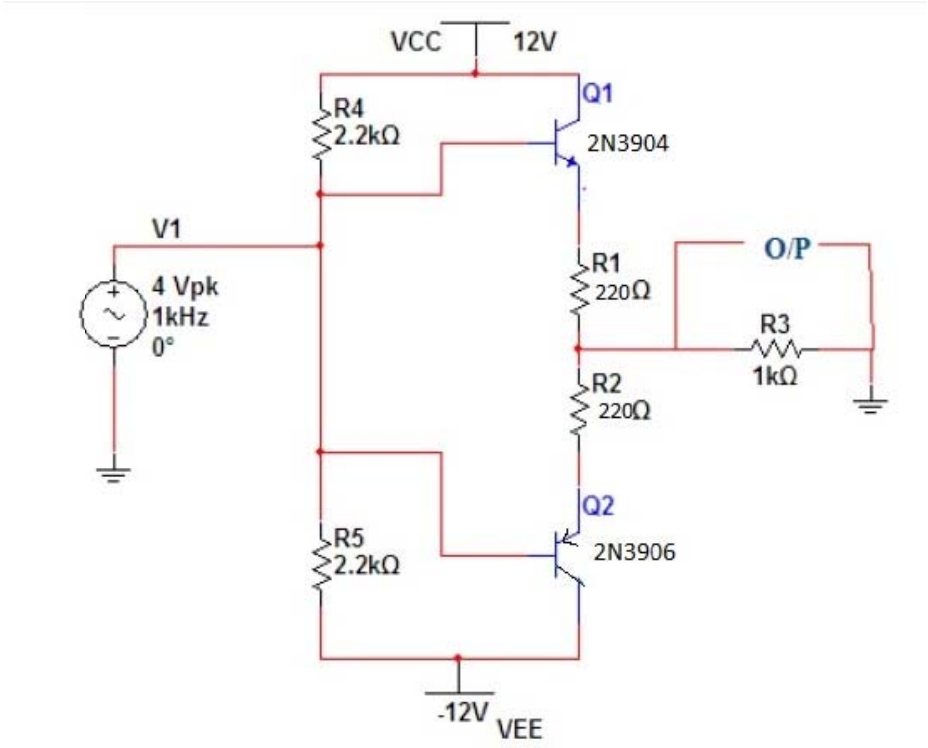
THEORY:

An amplifying system consists of several stages in cascade. The input and the intermediate stages amplify small signal excitations to a value large enough to drive the final device .The out put stage feeds the final device .The output stage feeds a transducer such as a CRO,loudspeaker or servomotor. Thus the final stage must be capable of delivering a large voltage or current or appreciable amount of power. This requires an amplifier which is referred as a power amplifier.
In Complementary symmetry class B amplifier which uses a NPN transistor and a PNP transistor is connected in push pull configuration.
One of the main disadvantages of the Class B push pull amplifier circuit is that it uses balanced center-tapped transformers in its design, making it expensive to construct.

When the input signal is applied, during the positive half cycle of the input signal, the NPN transistor conducts and the PNP transistor cuts off. During the negative half cycle, the NPN transistor cuts off and the PNP transistor conducts.

In this way, the NPN transistor amplifies during positive half cycle of the input, while PNP transistor amplifies during negative half cycle of the input. As the transistors are both complement to each other name is Complementary symmetry class B amplifier

CIRCUIT DIAGRAM:



Vision

To be an excellent technological hub in the field of Electronics and Telecommunication Engineering ensuring state of the art knowledge transfer through teaching and research activities to meet educational, societal, ethical need of the nation.

Mission

To Provide cutting edge platform to explore innovative, creative and entrepreneurial leadership qualities among the students.
To be hungry for academic excellence through innovative procedure.
To inculcate leadership quality and ethical values.
To accept/ face technological challenges through the continuous efforts in collaboration with industry

PROCEDURE:

Build the circuit as per circuit diagram

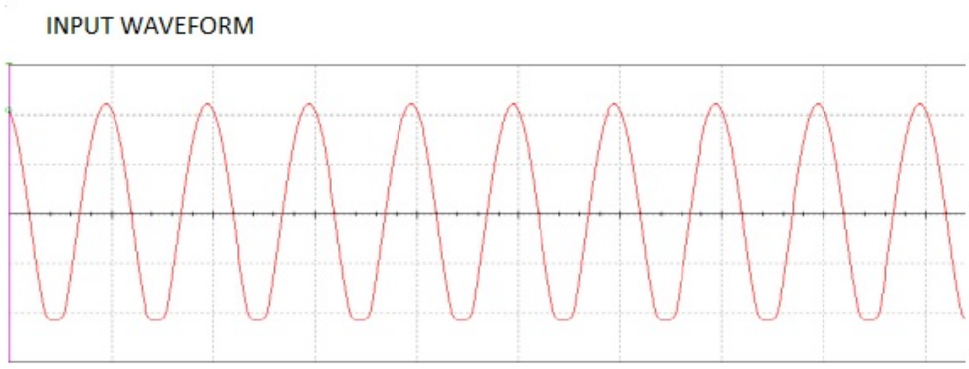
1) Apply 4VPP with 1KHZ frequency using function generator
2) Observe the output in CRO & note the cross over distortion in output.(outputVp-p)
3) Remove the collector connection and put ammeter.
4) Note the Idc value in the ammeter.
5) Using Pdc and Pac formulas find the efficiency

CALCULATIONS:

1) **Pac**=$Vm^2/2RL$

2) Pdc=Vcc*Idc

WAVEFORM:



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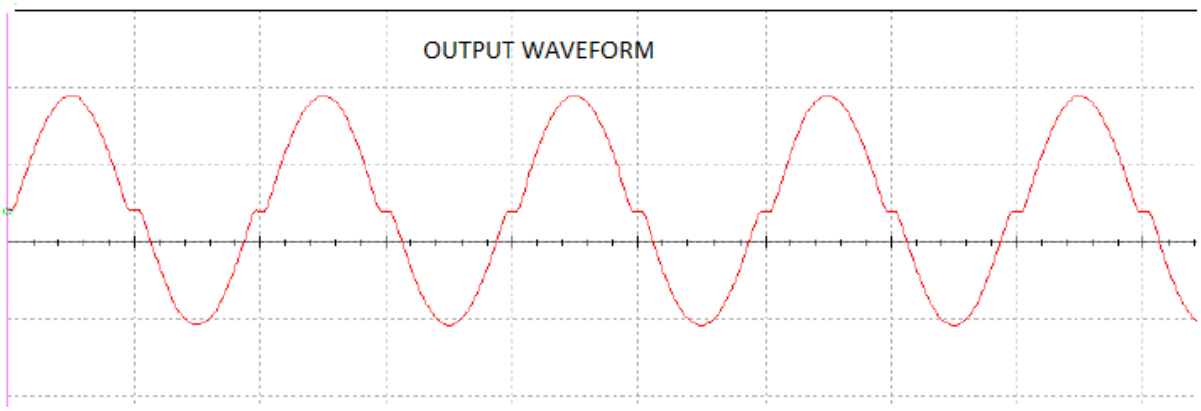

CONCLUSION:

Thus the Class B Push Pull amplifier using BJT was obtained and measure efficiency.

Questions:

1) What is cross over distortion
2) Explain working of class AB Power Amplifier
3) What is used of Heat Sink
4) Draw Class C Power Amplifier

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EXPERIMENT 08: RC Phase Shift Oscillator

AIM: To design and test the RC Phase Shift Oscillator

APPARATUS:

1. DC power supply (0-30V)
2. Breadboard.
3. Cathode Ray Oscilloscope
4. BNC Probes and connecting wires

COMPONENTS REQUIRED:

1.Resistor (68kΩ, 12kΩ, 1kΩ, 3.9kΩ, 10 kΩ- 3 Qty)

2.Transistor : BJT (BC 547)

3. Capacitors-0.1µf 3 Qty , 100 µf

THEORY:

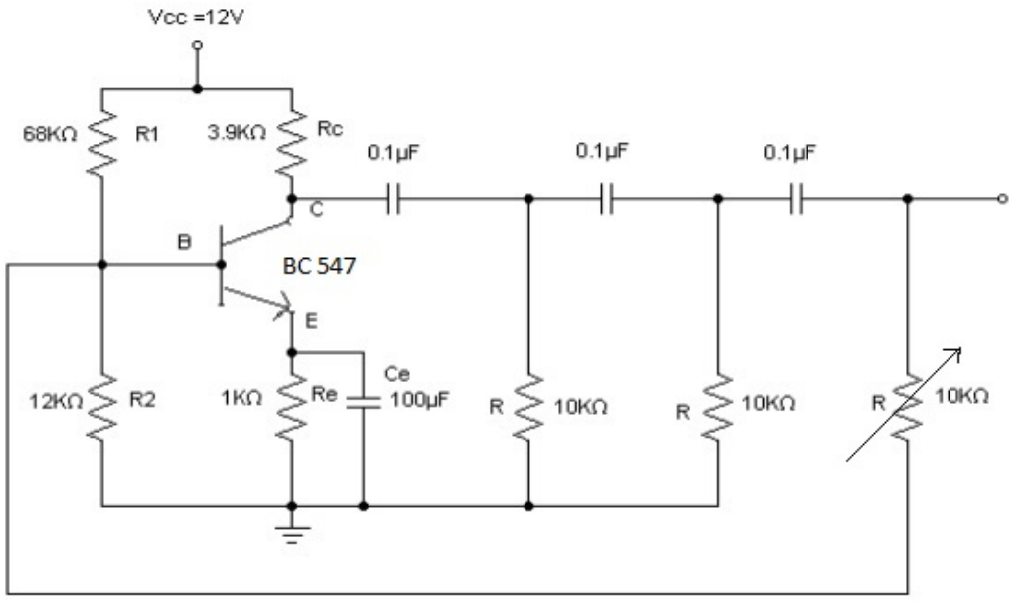
An oscillator is an electronic circuit for generating an AC signal voltage with a DC supply as the only input requirement. The frequency of the generated signal is decided by the circuit elements used. An oscillator requires an amplifier, a frequency selective network and a positive feedback from the output to the input.

The Barkhausen criterion for sustained oscillation is Aβ = 1 where A is the gain of the amplifier and β is the feedback factor (gain).The unity gain means signal is in phase. (If the signal is 180^0 out of phase and gain will be -1).

RC-Phase shift Oscillator has a CE amplifier followed by three sections of RC phase shift feed-back Networks. The output of the last stage is return to the input of the amplifier. The values of R and C are chosen such that the phase shift of each RC section is 60^0.Thus The RC ladder network produces a total phase shift of 180^0 between its input and output voltage for the given frequency. Since CE

Amplifier produces 180^0phases shift. The total phase shift from the base of the transistor around the circuit and back to the base will be exactly 360^0 or 0^0.
This satisfies the Barkhausen condition for sustaining oscillations and total loop gain of this circuit is greater than or equal to 1, this condition used to generate the sinusoidal oscillations.

CIRCUIT DIAGRAM:



PROCEDURE:

1) Identify the pin details of BC547 Transistor test it using a millimeter.
2) Set up the circuit on breadboard as shown in figure.
3) A 12V Supply Voltage is given by using Regulated power supply and output is taken from collector of the Transistor.
4) By using CRO the measure output time period and calculated practical frequency.

CALCULATIONS:

1) Theoretical calculated frequency is

$$f = \frac{1}{2\pi . RC . \sqrt{6}} \; Hz$$

Where,
R = resistor in phase shift network in ohms
C = capacitor in phase shift network in Farad

2) Practically calculated frequency is

CONCLUSION:

Thus the RC phase shift oscillator using BJT was obtained and measure the Theoretical frequency & Practically calculated frequency

Questions:

1) State Barkhausen criterion for sustained oscillation
2) Differentiate oscillator from amplifier
3) In the phase shift oscillator , R1 = R2 = R3 = 1MΩ and C1 = C2 = C3 = 68 pF. At what frequency does the circuit oscillate.
4) In the Wien bridge oscillator, R1 = R2 = 220 kΩ and C1 = C2 = 250 pF. Determine the frequency of oscillations.