ANALOG CIRCUITS
LABORATORY MANUAL
(R-19/R20)
B. Tech
(II YEAR – II SEM)
(2020-2021)

Prepared by

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Department of Electronics and Communication Engineering

BAPATLA WOMEN'S ENGINEERING COLLEGE

(Affiliated to Acharya Nagarjuna University)

BAPATLA - 522101, AP, INDIA

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

VISION

To produce highly professional and socially responsible women engineers through world class quality technical education and research to meet industry and Society needs in the field of Electronics and Communication Engineering.

MISSION

M1- To inculcate quality education for women through innovative learning practices with the use of modern tools.

M2- To impart professional ethics and moral values through co-curricular and extra-curricular activities as individual and team member.

M3- Empowering graduates through industrial trainings/on-job training in collaboration with industries with-a-view to life-long learning.

Department Programme Educational Objectives (PEOs)

PEO1: To develop and implementation of Electronics and Communication systems by imparting technical knowledge, professional leadership and communication skills as an individual and team in a multi-disciplinary stream.

PEO2: To train Graduates in solving complex problems, analyzing, designing and imparting research-based knowledge by using modern scientific tools to develop least cost-effective and innovative products.

PEO3: To produce women graduates through life-long learning, who ensure ethical and moral behaviour.

The Programme Specific Objectives (PSO'S)

PSO1: To understand and analyze basic concepts of electronics and communication in various areas like signal processing, VLSI, embedded systems, communications, digital and analog devices.

PSO2: Ability to design and develop computing systems using concepts of mathematics, electronics engineering and other related inter disciplines to asses and resolve societal, environmental, health safety and cultural issues with professional ethics.

Department Programme Outcomes (POs)

- **PO1: Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- **PO2: Problem analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO3: Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **PO4: Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO5: Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools prediction and modelling to complex engineering activities with an understanding of the limitations.
- **PO6: The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
- **PO7: Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable development.
- **PO8: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering prac tice.
- **PO9: Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10: Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and receive clear instructions.
- **PO11: Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in team, to manage projects and in multidisciplinary environments.
- **PO12: Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

ACHARYA NAGARJUNA UNIVERSITY
NAGARJUNA NAGAR, GUNTUR

COURSE STRUCTURE

Course Details			**Scheme of Instruction**			**Scheme of Examination**			
Course	Code/ Regulation	Subject	L	T	P	Maxi Internal Marks	Maxi External Marks	Total Marks	Credits
II/IV B.Tech ECE	**EC261/ R19**	**Analog Circuits Lab**	**0**	**0**	**3**	**40**	**60**	**100**	**1.5**

EC 261 ANALOG CIRCUITS LAB

1. Study of Full Wave Rectifier with and without Filters.
2. Frequency Response of Common Emitter Amplifier.
3. Frequency Response of Common Source Amplifier.
4. Measurement of Parameters of Emitter Follower; RI, AV, AI & RO.
5. Measurement of Parameters of Source Follower; RI, AV, AI & RO.
6. Two Stage RC-Coupled Amplifier.
7. Study of Cascode Amplifier.
8. Current series feedback topology
9. Class-A Power Amplifier
10. RC Phase Shift Oscillator
11. Hartley Oscillator
12. Colpitts Oscillator

List of Experiment(s) Beyond the Syllabus

1. Transistor as a Switch

NOTE: A minimum of 10(Ten) experiments have to be performed and recorded by the candidate to attain eligibility for University Practical Examination

Laboratory Rules & Regulations

General Rules to follow in Laboratories:

1. You are expected to arrive on time and not depart before the end of a Your laboratory.
2. You must not enter a lab unless you have permission from a technician or lecturer.
3. You are expected to comply with instructions, written or oral, that the laboratory Instructor gives you during the laboratory session.
4. You should behave in an orderly fashion always in the lab.
5. You must not stand on the stools or benches in the laboratory.
6. Keep the workbench tidy and do not place coats and bags on the benches.
7. You must ensure that at the end of the laboratory session all equipment used is stored away where you found it.
8. You must put all rubbish such as paper outside in the corridor bins. Broken components should be returned to the lab technician for safe disposal.
9. You must not remove test equipment, test leads or power cables from any lab without permission.
10. Eating and drinking in the laboratories are forbidden.
11. The use of mobile phones during laboratory sessions is forbidden.

Specific Safety Rules for Laboratories:

1. You must not damage or tamper with the equipment or leads.
2. You should inspect laboratory equipment for visible damage before using it. If there is a problem with a piece of equipment, report the technician or lecturer. DONOT return it to equipment to a storage area.
3. You should not work on circuits where the supply voltage exceeds 40 volts without very specific approval from your lab supervisor. If you need to work on such circuits, you should contact your supervisor for approval and instruction on how to do this safely before commencing the work.
4. Always use an appropriate stand for holding your soldering iron.
5. Turn off your soldering iron if it is unlikely to be used for more than 10 Minutes.
6. Never leave a hot soldering iron unattended.
7. Never touch a soldering iron element or bit unless the iron has been disconnected from the mains and has had adequate time to cool down.

8. Never strip insulation from a wire with your teeth or a knife, always use an appropriate wire stripping tool.
9. Shield wire with your hands when cutting it with a pliers to prevent bits of wire flying about the bench.

Course Objectives:

The objectives of this course:

1. To understand the analysis and design of single stage and multi stage amplifiers.
2. To construct feedback amplifiers, oscillators, power amplifiers, Tuned Amplifiers and Multivibrators.
3. To simulate various analog electronic circuits and to determine their characteristics.

Course Outcomes:

On successful completion of the course, students will be able to

CO.No.	Course Outcome Statement	Bloom's Taxonomy Level
C352.1	Acquire Knowledge in Different Electronic Circuits using transistor amplifier	**Understand**
C352.2	Analyze and design of amplifiers and feedback amplifiers	**Analyze**
C352.3	Determine the important parameters of various amplifiers.	**Apply**
C352.4	Calculate frequency of different types of oscillator circuits.	**Apply**

Mapping of CO's with PO's and PSO's:-

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS0 1	PSO 2
C252.1	2	2	2	2	-	-	-	-	-	-	-	2	2	2
C252.2	3	3	3	3	-	-	-	-	3	3	-	3	2	2
C252.3	2	2	2	2	-	-	-	-	-	-	-	2	2	2
C252.4	3	3	3	3	-	-	-	-	3	3	-	3	2	2
AVG	**2.5**	**2.5**	**2.5**	**2.5**	**-**	**-**	**-**	**-**	**1.25**	**1.5**	**1.25**	**2.5**	**2**	**2**

LIST OF EXPERIMENTS

S.No.	Name of the Experiment	Page No.
1.	Study of Full Wave Rectifier with and without Filters.	1-5
2.	Frequency Response of Common Emitter Amplifier.	6-9
3.	Frequency Response of Common Source Amplifier.	10-13
4.	Measurement of Parameters of Emitter Follower; RI, AV, AI & RO.	14-16
5.	Measurement of Parameters of Source Follower; RI, AV, AI & RO.	17-19
6.	Two Stage RC-Coupled Amplifier.	20-23
7.	Study of Cascode Amplifier.	24-17
8.	Current series feedback topology	28-31
9.	Class-A Power Amplifier	32-35
10.	RC Phase Shift Oscillator	36-38
11.	Hartley Oscillator	39-41
12.	Colpitts Oscillator	42-45
S.No.	**List of Experiment(s) Beyond the Syllabus**	**Page No.**
1.	Transistor as a Switch	46-48

1.STUDY OF FULL WAVE RECTIFIER WITH AND WITHOUT FILTER

AIM: To Examine the input and output waveforms of Full wave Rectifier and also calculate Calculate its load regulation and ripple factor

1.With Filter

2. Without Filter

APPARATUS:

S.No.	Name	Quantity(No's)
1.	Bread Boad	1
2.	Diode(1N4007)	2
3.	Resister(1KΩ)	1
4.	Capacitor(1000μF)	1
5.	Transformer with center tapped	1
6.	Digital Multimeter	1
7.	CRO and CRO Probes	1 &2
8.	Connecting wires	Single Strand

THEORY:

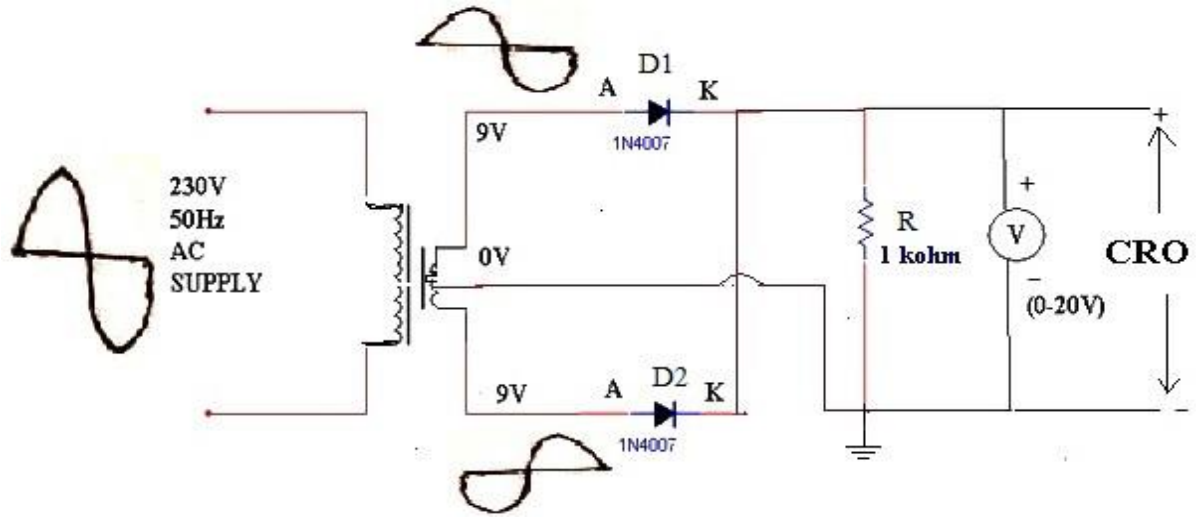
The circuit of a center-tapped full wave rectifier uses two diodes D1&D2. During positive half cycle of secondary voltage (input voltage), the diode D1 is forward biased and D2 is reverse biased. So, the diode D1 conducts and current flows through load resistor RL.

During negative half cycle, diode D2 becomes forward biased and D1 reverse biased. Now, D2 conducts and current flows through the load resistor RL in the same direction. There is a continuous current flow through the load resistor RL, during both the half cycles and will get unidirectional current as show in the model graph. The difference between full wave and half wave rectification is that a full wave rectifier allows unidirectional (one way) current to the load during

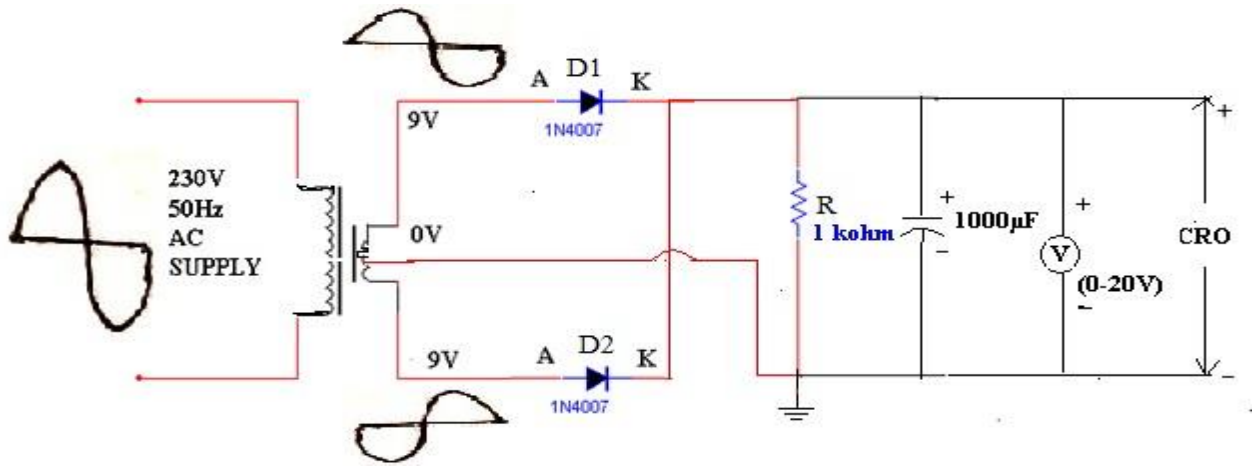
the entire 360 degrees of the input signal and half-wave rectifier allows this only during one half cycle (180 degree).

Circuit Diagram:

Full Wave Rectifier (without Filter):



Full Wave Rectifier (with Filter):



Procedure:

1. Connect the circuit as shown in the circuit diagram.
2. Connect the primary side of the transformer to AC mains and the secondary side to rectifier input.
3. Using a CRO, measure the maximum voltage V_m of the AC input voltage of the rectifier and AC voltage at the output of the rectifier.
4. Using a DC voltmeter, measure the DC voltage at the load resistance.
5. Observe the Waveforms at the secondary windings of transformer and across load resistance for a load of 1KΩ.
6. Calculate the ripple factor (γ), percentage of Regulation and efficiency(η) as per the below given formula.

Observations:

1. Peak Voltage, V_m = (From CRO for HWR with and without filter)
2. DC Voltage, $V_{DC\ (full\ load)}$ = (From Voltmeter/ Multimeter for HWR with and without filter)
3. No Load DC Voltage, $V_{DC\ (No\ load)}$ = (From Voltmeter/ Multimeter for HWR with and without filter)
4. Ripple Voltage, V_r = (From CRO for HWR with filter)

Calculations:

Without filter:

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

$$V_{ac} = \sqrt{(V_{rms}^2 - V_{dc}^2)}$$

$$V_{dc} = \frac{2V_m}{\pi}$$

Ripple factor (Theoretical) = $\sqrt{(\frac{V_{rms}}{V_{dc}})^2 - 1} = 0.48$

Ripple Factor (Practical) $\gamma = \frac{V_{ac}}{V_{dc}}$

With filter:

Ripple factor (Theoretical) $\gamma = \frac{1}{4\sqrt{3}fCR}$

Where f = 50Hz, R =1KΩ, C = 1000μF.

$$V_{ac} = \frac{V_{r(p-p)}}{2\sqrt{3}}$$

$$V_{dc} = V_m - \frac{V_{r(p-p)}}{2}$$

Ripple Factor $\gamma = \frac{V_{ac}}{V_{dc}}$

Percentage Regulation = $(\frac{V_{NL} - V_{FL}}{V_{FL}}) * 100\ \%$

V_{NL} = DC voltage at the load without connecting the load (Minimum current).

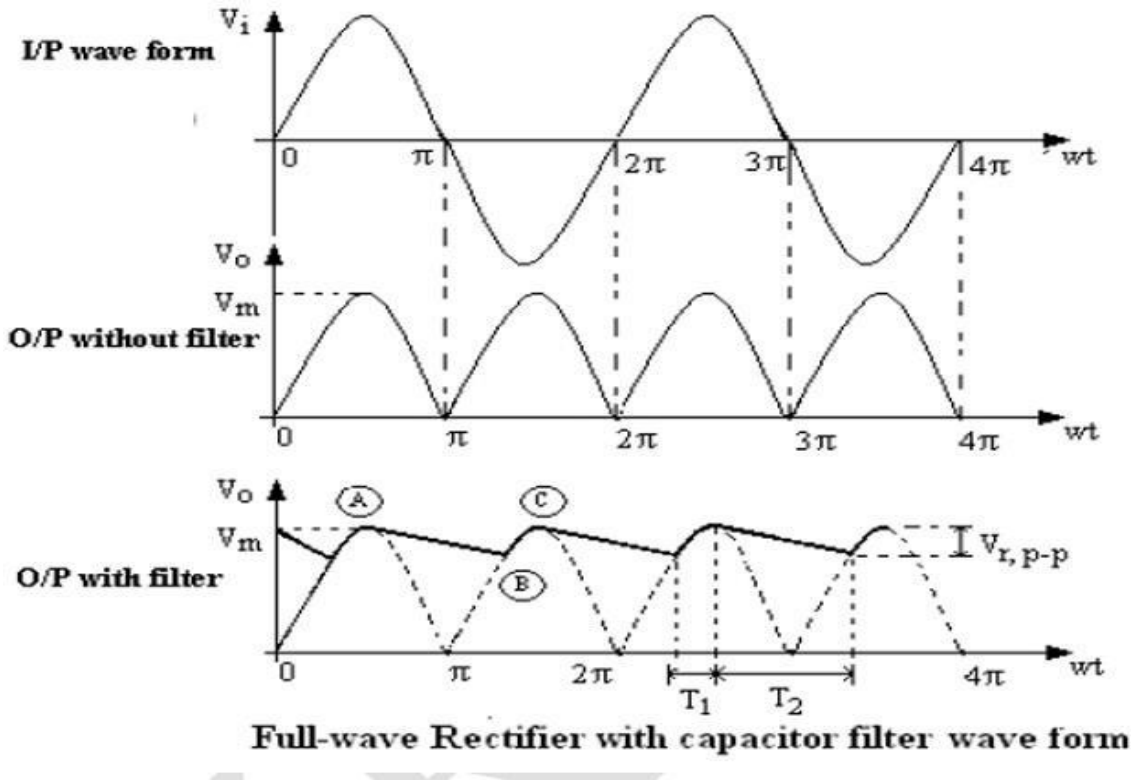
V_{FL} = DC voltage at the load with load connected.

Efficiency $\eta = \frac{P_{DC}}{P_{AC}}$%u200B

$P_{AC} = V^2_{rms} / R_L$

$P_{DC} = V_{dc} / R_L$

Expected waveforms:



Full-wave Rectifier with capacitor filter wave form

Precautions:

1. Wires should be checked for good continuity.
2. Carefully note down the readings without any errors.

Result:

Viva-Voce Questions:

1. Define regulation of the full wave rectifier?
2. Define peak inverse voltage (PIV)? And write its value for Full-wave rectifier?
3. If one of the diodes is changed in its polarities, what wave form would you get?
4. Does the process of rectification alter the frequency of the waveform?
5. What is ripple factor of the Full-wave rectifier?
6. What is the necessity of the transformer in the rectifier circuit?
7. What are the applications of a rectifier?
8. What is meant by ripple and define Ripple factor?

2.FREQUENCY RESPONSE OF COMMON EMITTER AMPLIFIER

Aim:

1.To Measure the voltage gain of a CE amplifier.

2. To draw the frequency response curve of the CE amplifier.

Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	Transistor (BC 107)	1
3.	Resister (1KΩ)	2
4.	Resistors (100 KΩ,10 KΩ,4.7 KΩ)	1
5.	Capacitors (10μF)	1
6.	Signal Generator (0-1MHZ)	1
7.	CRO and CRO Probes	1 &2
8.	Bread Board and connecting wires	1 set

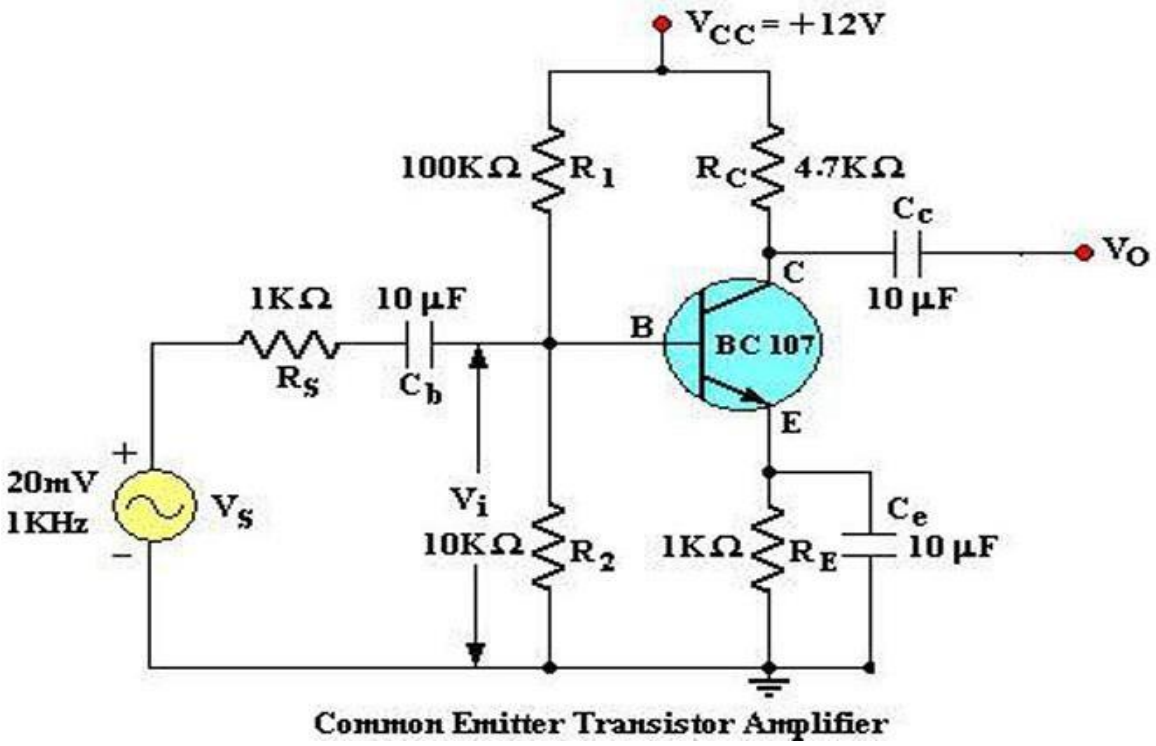
Theory:

The CE amplifier provides high gain & wide frequency response. The emitter lead is common to both input & output circuits and is grounded. The emitter-base circuit is forward biased. The collector current is controlled by the base current rather than emitter current. When a transistor is biased in active region it acts like an amplifier.

The input signal is applied to base terminal of the transistor and amplifier output is taken across collector terminal. A very small change in base current produces a much larger change in collector current. When positive half-cycle is fed to the input circuit, it opposes the forward bias of the circuit which causes the collector current to decrease; it decreases the voltage more negative. Thus when input cycle varies through a negative half-cycle, increases the forward bias of the circuit, which causes the collector current to increases thus the output signal is common emitter amplifier is in out of phase with the input signal. An amplified output signal is obtained when this

fluctuating collector current flows through a collector resistor Rc. The capacitor across the collector resistor Rc will act as a bypass capacitor. This will improve high frequency response of amplifier.

Circuit diagram:



Common Emitter Transistor Amplifier

Procedure:

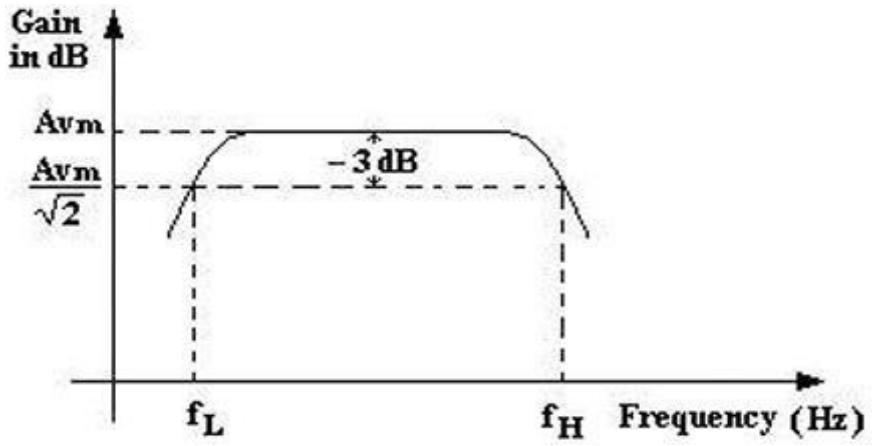
1. Connect the circuit as shown in the circuit diagram.
2. Connect the signal generator output to input terminals of the circuit and CH-I of dual trace CRO.
3. Connect the output terminal of the circuit CH-II of the dual trace CRO.
4. Set the power supply voltage to 9V and connect to the circuit.
5. Set the signal generator output sine wave of 100 Hz at 10 mV constant.
6. Vary the function generator frequency from 100 Hz to 500 kHz (as per in the given tabular form) and note the corresponding output voltage.
7. Calculation the gain AV =Vo/Vi .
8. Set the graph frequency verses gain (dB) on a semi log sheet.

Tabular form:

Input voltage Vin =10mv

S.No.	Frequency (Hz)	Output voltage(v)	Gain Av=Vo/Vi	Gain in db 20log (Av)

Model graph:



Observations:

1. Maximum gain (Av) = ----------dB

2. Lower cut-off frequency (Fl) =----------Hz

3. Upper cut-off frequency (FH) =----------MHz

4. Band width (B.W) = (FH – FL) =----------kHz

Precautions:

1.All the connections should be tight.

2.Transistor terminals must be identified properly

Result:

Viva-Voce Questions:

1. What are the advantages and disadvantages of single-stage amplifiers?
2. Why gain falls at HF and LF?
3. Why the gain remains constant at MF?
4. Explain the function of emitter bypass capacitor, Ce?
5. How the band width will effect as more number of stages are cascaded?
6. Define frequency response?
7. What is the phase difference between input and output waveforms of a CE amplifier?
8. What is Early effect?
9. What is meant by Bandwidth of an amplifier?

3. FREQUENCY RESPONSE OF COMMON SOURCE AMPLIFIER

Aim:

1. To obtain the frequency response of the common source FET Amplifier
2. To find the Bandwidth

Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	FET	1
3.	Resistors (6.8 KΩ,1 MΩ,1.5 KΩ)	1
4.	Capacitors (0.1µF ,47µF)	2 ,1
5.	Signal Generator (0-1MHZ)	1
6.	CRO and CRO Probes	1 &2
7.	Bread Board and connecting wires	1 set

Theory:

A field-effect transistor (FET) is a type of transistor commonly used for weak-signal amplification (for example, for amplifying wireless (signals). The device can amplify analog or digital signals. It can also switch DC or function as an oscillator. In the FET, current flows along a semiconductor path called the channel. At one end of the channel, there is an electrode called the source. At the other end of the channel, there is an electrode called the drain. The physical diameter of the channel is fixed, but its effective electrical diameter can be varied by the application of a voltage to a control electrode called the gate.

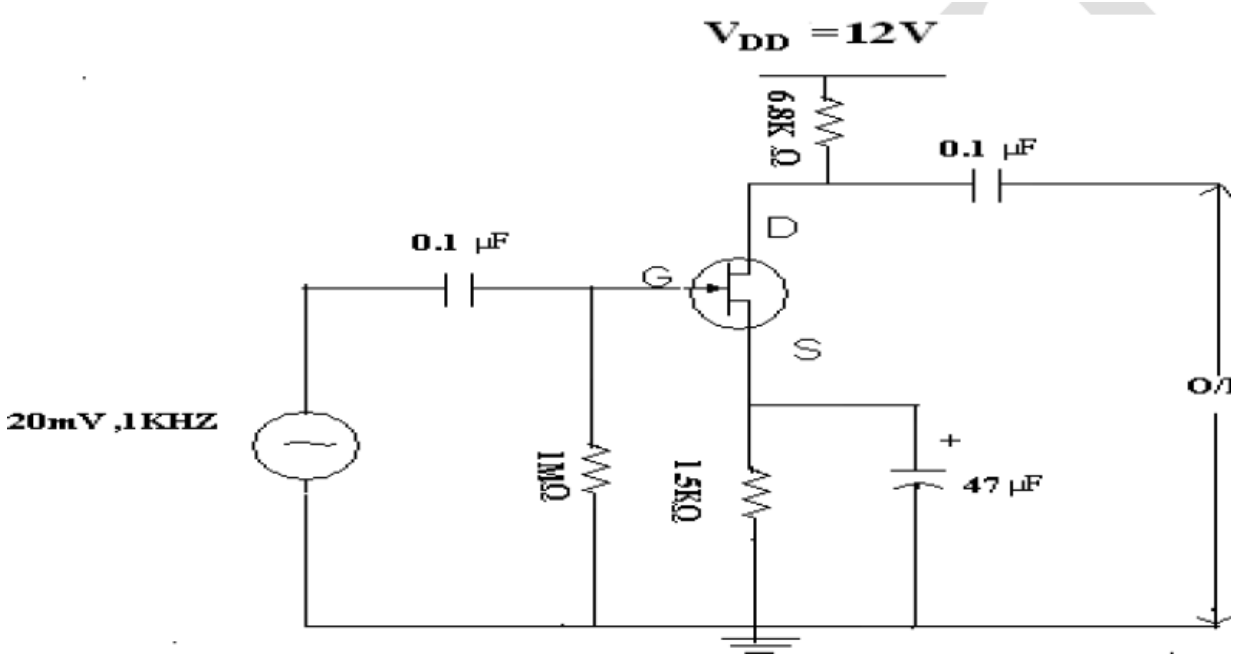
Field-effect transistors exist in two major classifications. These are known as the junction FET (JFET) and the metal-oxide- semiconductor FET (MOSFET). The junction FET has a channel consisting of N-type semiconductor (N-channel) or P-type semiconductor (P-channel) material; the gate is made of the opposite semiconductor type. In P-type material, electric charges are carried mainly in the form of electron deficiencies called holes. In N-type material, the charge carriers are primarily electrons.

In a JFET, the junction is the boundary between the channel and the gate. Normally, this P-N junction is reverse-biased (a DC voltage is applied to it) so that no current flows between the channel and the gate. However, under some conditions there is a small current through the junction during part of the input signal cycle. The FET has some advantages and some disadvantages relative to the bipolar transistor. Field-effect transistors are preferred for weak-signal work, for example in wireless, communications and broadcast receivers. They are also preferred in circuits and systems requiring high impedance. The FET is not, in general, used for high-power amplification, such as is required in large wireless communications and broadcast transmitters.

Field-effect transistors are fabricated onto silicon integrated circuit (IC) chips. A single IC can contain many thousands of FETs, along with other components such as resistors, capacitors, and diodes.

A common source amplifier FET amplifier has high input impedance and a moderate voltage gain. Also, the input and output voltages are 180 degrees out of Phase.

Circuit diagram:



Procedure

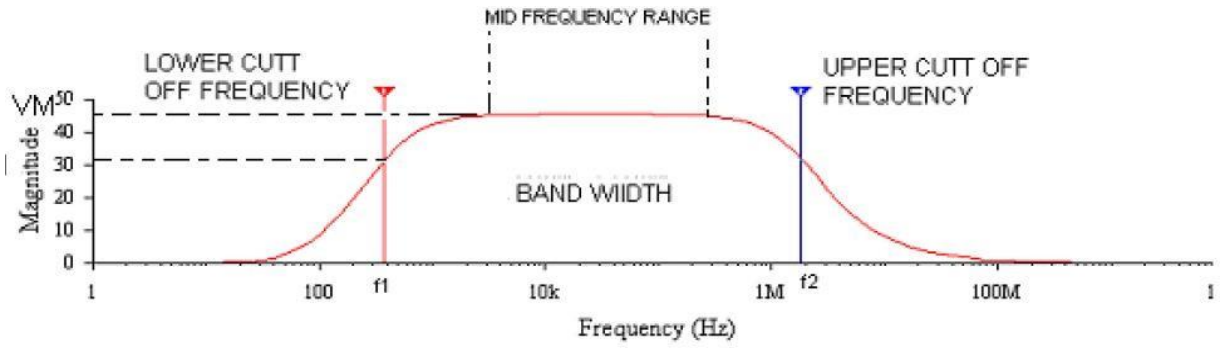
1. Connect the circuit as shown in the circuit diagram.
2. Connect the signal generator output to input terminals of the circuit and CH-I of dual trace CRO.
3. Connect the output terminal of the circuit CH-II of the dual trace CRO.
4. Set the power supply voltage to 9V and connect to the circuit.
5. Set the signal generator output sine wave of 100 Hz at 10 mV constant.
6. Vary the function generator frequency from 100 Hz to 500 kHz (as per in the given tabular form) and note the corresponding output voltage.
7. Calculation the gain AV =Vo/Vi .
8. Set the graph frequency verses gain (dB) on a semi log sheet.

Tabular form:

Input voltage Vin =10mv

S.No.	Frequency (Hz)	Output voltage(v)	Gain Av=Vo/Vi	Gain in db. 20log (Av)

Model graph:



Observations:

1. Maximum gain (Av) = ----------dB

2. Lower cut-off frequency (Fl) =----------Hz

3. Upper cut-off frequency (FH) =----------MHz

4. Band width (B.W) = (FH – FL) =----------kHz

Precautions:

1. All the connections should be tight.
2. Transistor terminals must be identified properly

Result:

Viva-Voce Questions:

1. What is the difference between FET and BJT?
2. FET is unipolar or bipolar?
3. Draw the symbol of FET?
4. What are the applications of FET?
5. FET is voltage controlled or current controlled?
6. Draw the equivalent circuit of common source FET amplifier?
7. What is the voltage gain of the FET amplifier?
8. What is the input impedance of FET amplifier?
9. What is the output impedance of FET amplifier?
10. What are the FET parameters?
11. What are the FET applications?

4.MEASURMENT OF PARAMETERS OF EMITTER FOLLOWER

Aim: To calculate the Voltage gain, Current gain, input resistance and output resistance of Emitter follower.

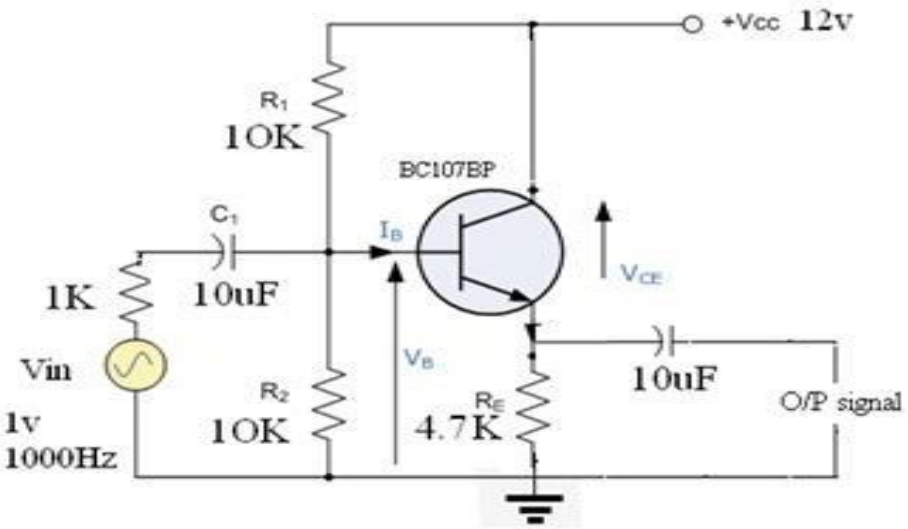
Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT	1
3.	Resistors (10 KΩ,10KΩ,1 KΩ,4.7KΩ)	1
4.	Capacitors (10μF)	2
5.	Signal Generator (0-1MHZ)	1
6.	CRO and CRO Probes	1 & 2
7.	Bread Board and connecting wires	1 set

Theory:

The common collector circuit is also known as emitter follower. The ac output voltage from a CC circuit is essentially the same as the input voltage; there is no voltage gain or phase shift. Thus, the CC circuit can be said to have a voltage gain of 1. The fact that the CC output voltage follows the changes in signal voltage gives the circuit its other name emitter follower. The input impedance of a CC amplifier is high. Output impedance is low and the Voltage gain is almost unity. Because of these Characteristics the CC circuit is normally used as a buffer amplifier, placed between a high impedance signal source and a low impedance load.

Circuit diagram:



Procedure:

1. Connect the circuit as per the circuit diagram.
2. Apply 1 KHZ signal from the signal generator.
3. Observe corresponding output from the CRO and then calculate voltage gain using the formula Av=Vo/Vi.
4. Measure voltage across ab terminals and then calculate input current by using the formula Iin=V_{ab}/R_{ab}.
5. Measure current flowing through resistor at emitter terminal and note down it as Iout.
6. Calculate current gain using the formula Ai=Iin/Iout.
7. Calculate input resistance using the formula Rin=Vin/Iin.
8. To calculate the output resistance, connect the slot at the output and vary the resistance of the pot up to half of the output with RL is equal to infinity. The resistance of pot is the output resistance.

PRECAUTIONS:

1. Wires should be checked for good continuity.
2. BJT terminals must be identified and connected carefully.

RESULT:

Viva-Voce Questions:

1. What type of amplifier is an emitter follower amplifier?
2. How is the input impedance of an emitter follower amplifier?
3. How is the output impedance of an emitter follower amplifier?
4. How is the current gain of an emitter follower amplifier?
5. How is the power gain of an emitter follower amplifier?
6. What is the application of an emitter follower amplifier?

4. MEASURMENT OF PARAMETERS OF SOURCE FOLLOWER

Aim: To calculate the Voltage gain, Current gain, input resistance and output resistance of source follower.

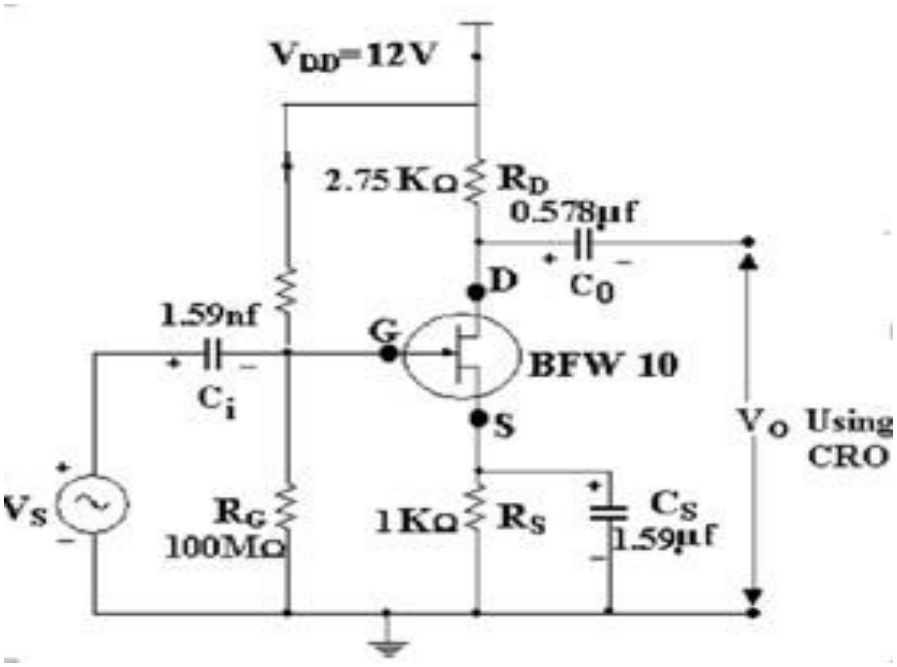
Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	FET	1
3.	Resistors (2.75 KΩ,100MΩ,1 KΩ)	1
4.	Capacitors (1.59nF,0.578μF)	2
5.	Signal Generator (0-1MHZ)	1
6.	CRO and CRO Probes	1 & 2
7.	Bread Board and connecting wires	1 set

Theory:

The FET common drain circuit has the output voltage developed across the source resistor Rs. Here the ac output voltage is closely equal to the ac input voltage, and the circuit can be said to have unity gain. Because the output voltage at the source terminal follows the signal voltage at the gate, the common drain circuit is also known as a source follower. A common drain circuit has a voltage gain approximately equal to 1, no phase shift between input and output, very high input impedance and low output impedance. Because of its high zi, low zo and unity gain the common drain circuit is used as a buffer amplifier between a high impedance signal source and a low impedance load.

Circuit Diagram:



Procedure:

1. Connect the circuit as per the circuit diagram.
2. Apply 1 KHZ signal from the signal generator.
3. Observe corresponding output from the CRO and then calculate voltage gain using the formula Av=Vo/Vi.
4. Measure voltage across ab terminals and then calculate input current by using the formula $Iin=V_{ab}/R_{ab}$.
5. Measure current flowing through resistor at source terminal and note down it as Iout.
6. Calculate current gain using the formula Ai=Iin/Iout.
7. Calculate input resistance using the formula Rin=Vin/Iin.
8. To calculate the output resistance, connect the slot at the output and vary the resistance of the pot up to half of the output with RL is equal to infinity. The resistance of pot is the output resistance.

Precautions:

1. Wires should be checked for good continuity.
2. FET terminals must be identified and connected carefully.

RESULT:

Viva-Voce Questions:

1. What type of amplifier is a Source follower amplifier?
2. How is the input impedance of a Source follower amplifier?
3. How is the output impedance of a Source follower amplifier?
4. How is the current gain of a Source follower amplifier?
5. How is the power gain of a Source follower amplifier?
6. What is the application of a Source follower amplifier?

6.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:

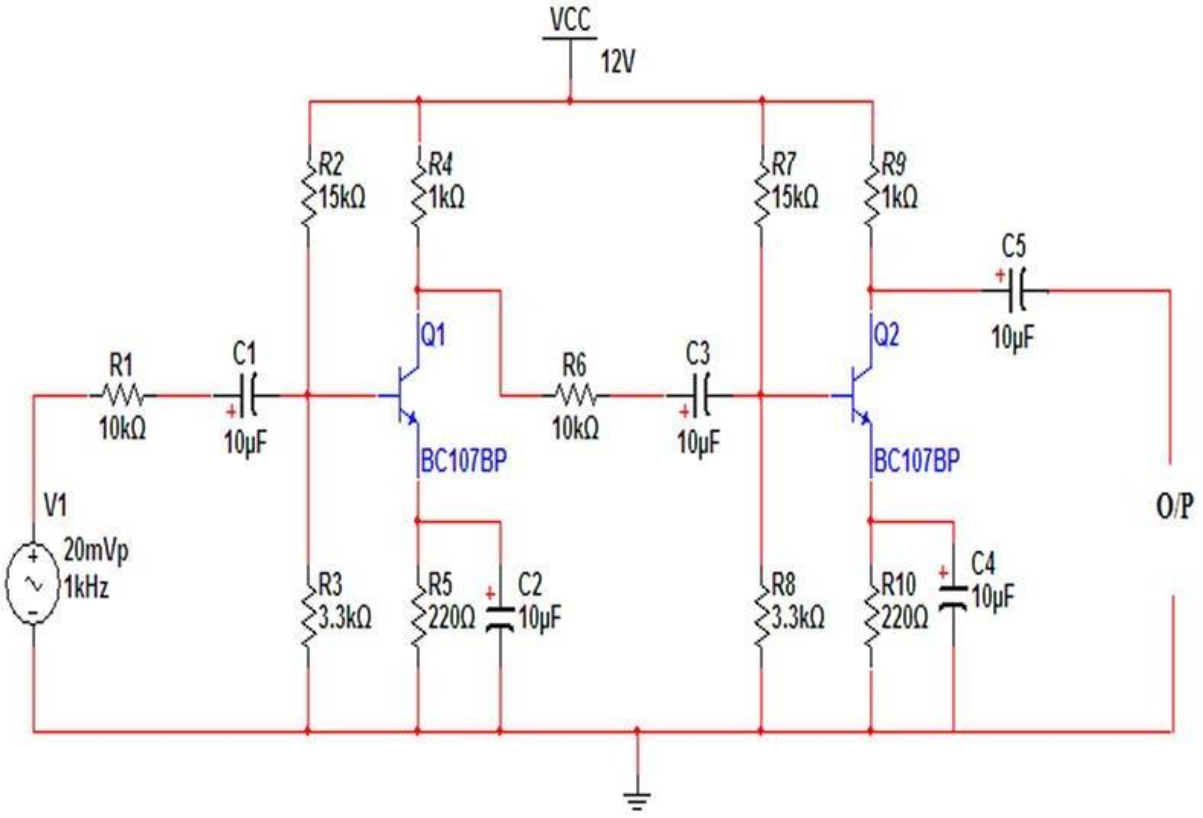
S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT (BC 107)	2
3.	Resistors (15KΩ,1 KΩ,3.3KΩ,220Ω)	2
4.	Resistors(1KΩ)	3
4.	Capacitors (10μF)	5
5.	Signal Generator (0-1MHZ)	1
6.	CRO and CRO Probes	1 & 2
7.	Bread Board and connecting wires	1 set

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:



Procedure:

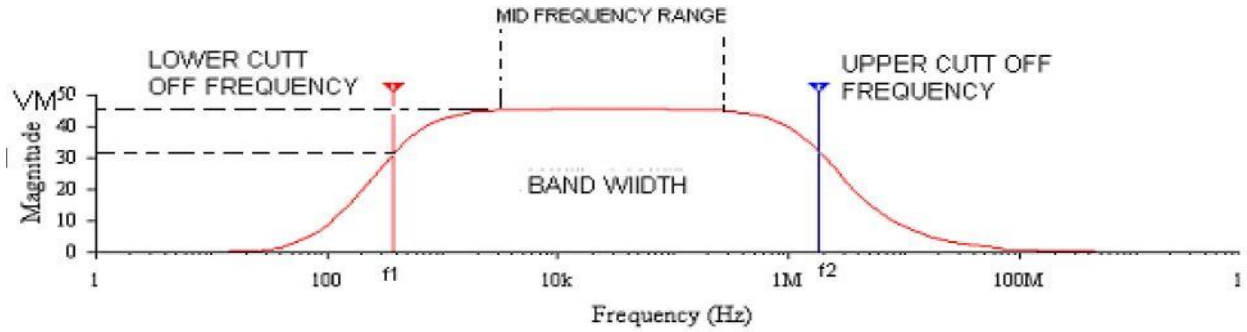
1. Connect the circuit as shown in the figure.
2. Apply 1Khz frequency and 20mv Vp-p Sine wave from function generator
3. Observe input and output Waveforms simultaneously on C.R.O
4. Change the frequency of input signal from 10HZ to 1MHZ in steps and note amplitudes of input and output Waveforms (input signal should be maintained constant).
5. Calculate Voltage gain (A) for each (in db) verses frequency.

Tabular form:

Input voltage Vin =20mv

S.No.	Frequency (Hz)	Output voltage(v)	Gain Av=Vo/Vi	Gain in db. 20log (Av)

Model graph:



Observations:

1. Maximum gain (Av) = ----------dB

2. Lower cut-off frequency (Fl) =----------Hz

3. Upper cut-off frequency (FH) =----------MHz

4. Band width (B.W) = (FH – FL) =----------kHz

Precautions:

1. All the connections should be tight.
2. Transistor terminals must be identified properly

Result:

Viva-Voce Questions:

1. What is an amplifier?
2. What are the coupling elements on this amplifier?
3. What are the applications of this amplifier?
4. Why this type of amplifier will be used in AF amplifiers?
5. which type of biasing issued in this amplifier?
6. whatis the range of bandwidth in this amplifier?

6. STUDY OF CASCODE AMPLIFIER

Aim: To obtain the Voltage gain for two stage RC coupled Amplifier and also to observe the frequency Response.

Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT (BC 107)	2
3.	Resistors (6.8 KΩ,4.7KΩ,1.1 KΩ,5.6KΩ,1.8KΩ)	2
4.	Capacitors (10μF,5 μF,5 μF,20 μF)	1
5.	Signal Generator (0-1MHZ)	1
6.	CRO and CRO Probes	1 & 2
7.	Bread Board and connecting wires	1 set

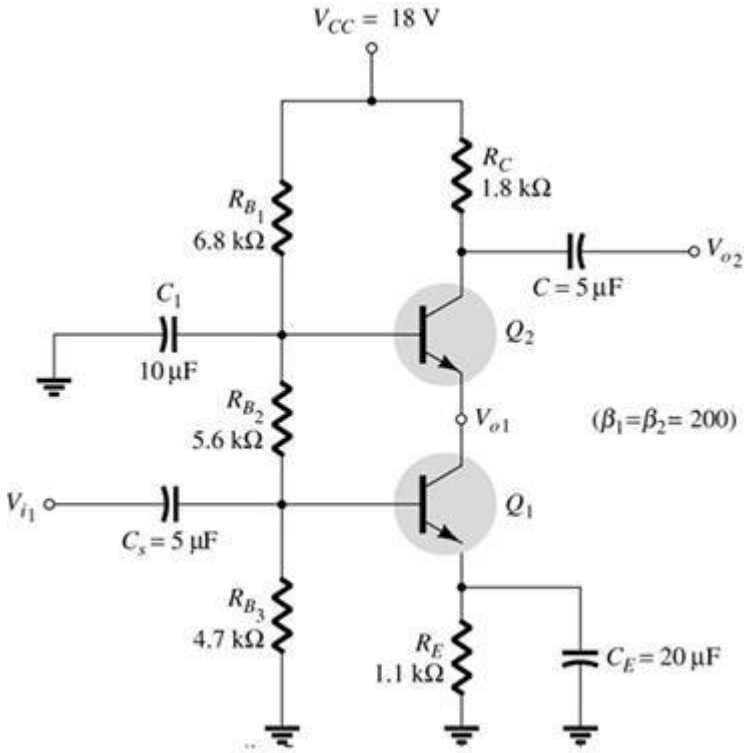
Theory:

A Cascode amplifier consists of a CE amplifier followed by a CB amplifier. The CE amplifier is directly coupled to the CB amplifier. Hence a Cascode amplifier is defined as a direct coupled CE-CB amplifier. The CE amplifier drives a CB amplifier for both DC and AC inputs. A practical Cascode amplifier circuit consists of resistors R4 and R5 forming a voltage divider biasing network for the FET Q2. R3 is the drain resistor for Q2 and it limits the drain current. R2 is the source resistor of Q1 and C1 is its by-pass capacitor. R1 ensures zero voltage at the gate of Q1 during zero signal condition.

The Cascode connection is especially useful in wideband amplifier design as well as the design of high-frequency tuned amplifier stages. The improvement in high frequency performance is due to the impedance mismatch between the output of the common emitter stage and the input of the common base stage. Another important characteristic of the Cascode connection is the higher

isolation between its input and output than for a single common emitter stage, because the reverse transmission across the compound device stage is much smaller than for the common emitter stage.

Circuit Diagram:



Procedure

1. Connect the circuit as shown in the circuit diagram.
2. Connect the signal generator output to input terminals of the circuit and CH-I of dual trace CRO.
3. Connect the output terminal of the circuit CH-II of the dual trace CRO.
4. Set the power supply voltage to 9V and connect to the circuit.
5. Set the signal generator output sine wave of 100 Hz at 10 mV constant.
6. Vary the function generator frequency from 100 Hz to 500 kHz (as per in the given tabular form) and note the corresponding output voltage.

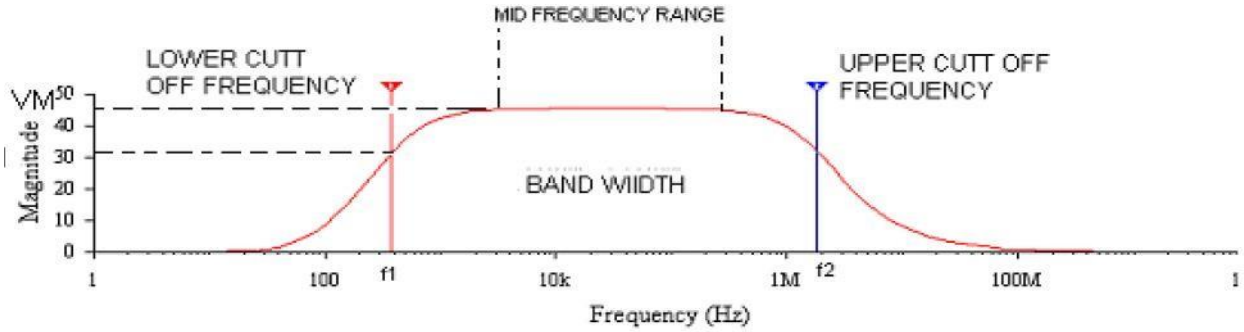
7. Calculation the gain AV =Vo/Vi .
8. Set the graph frequency verses gain (dB) on a semi log sheet.

Tabular form:

Input voltage Vin =10mv

S.No.	Frequency (Hz)	Output voltage(v)	Gain Av=Vo/Vi	Gain in db. 20log (Av)

Model graph:



Observations:

1. Maximum gain (Av) = ----------dB

2. Lower cut-off frequency (Fl) =----------Hz

3. Upper cut-off frequency (FH) =----------MHz

4. Band width (B.W) = (FH – FL) =----------kHz

Precautions:

1. All the connections should be tight.
2. Transistor terminals must be identified properly

Result:

Viva-Voce Questions:

1. What is the Cascode Amplifier?
2. Why is it called Cascode?
3. What are the applications of Cascode Amplifier?

9. CURRENT SERIES FEED BACK TOPOLOGY

Aim:

To calculate the input impedance, output impedance and voltage gain of current series feedback amplifier with and without feedback

Apparatus:

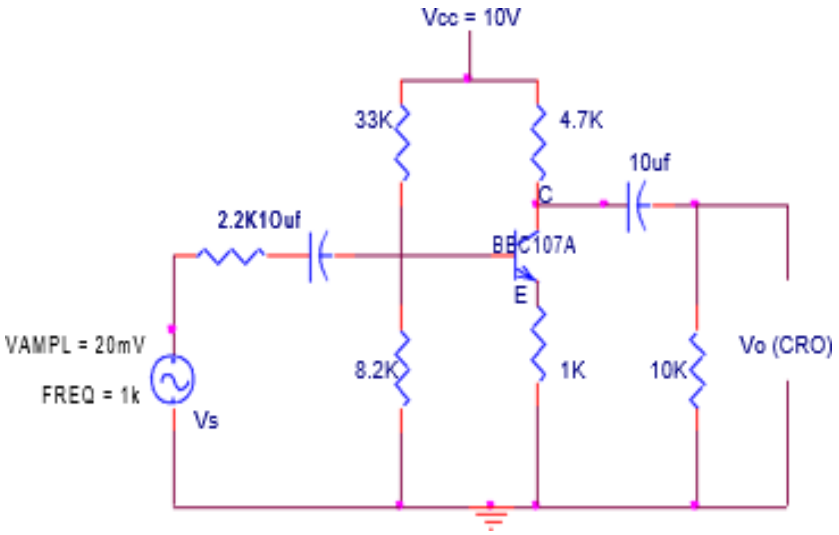
S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT (BC 107)	1
3.	Resistors(10KΩ,8.2KΩ,1KΩ,33KΩ,22KΩ,4.7KΩ)	1
4.	Capacitors (10μF)	3
5.	Signal Generator (0-1MHZ)	1
6.	CRO and CRO Probes	1 & 2
7.	Bread Board and connecting wires	1 set

Theory:

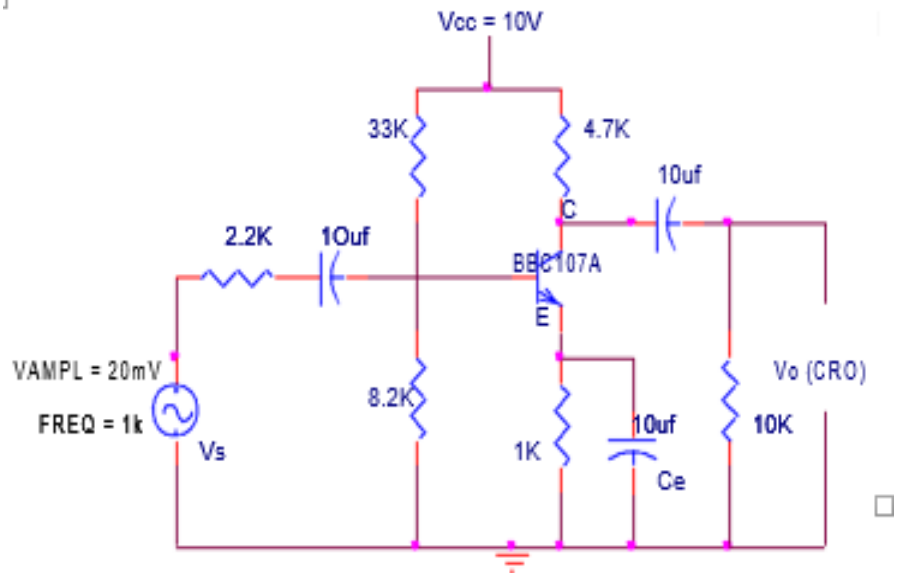
In the current series feedback circuit, a fraction of the output voltage is applied in series with the input voltage through the feedback circuit. This is also known as series-driven series-fed feedback i.e., a series-series circuit. Current series feedback amplifier is also called as series fed amplifier or transconductance amplifier. In this circuit, current sampling and series mixers are used. When the part of the output current is sampled and given to the feedback circuit, where the fraction of current is converted into a proportional voltage and then given as input signal. By this technique, the input resistance and bandwidth increase but the output gain decrease.

Circuit Diagram:

Current Series Amplifier with Feedback:



Current Series Amplifier without Feedback:



Procedure:

1. Connections are made as per the circuit diagram. Without input source, Ce and load i.e in DC bias.
2. A 10V DC supply is given to the circuit for biasing
3. Calculate emitter voltage across Re and find emitter current Ie
4. Circuit is connected as per circuit diagram without feedback i.e., without Ce.
5. certain amplitude of input signal (say 20mV) is kept constant using the function at a constant frequency of 1KHz.
6. Note down the Vin, VL, VNL using CRO
7. Now the Circuit is connected as per circuit diagram with feedback i.e keeping Ce.
8. Note down the Vin, VL, VNL using CRO
9. Calculate input impedance Zin output impedance ZO ,and voltage gain Av and compare with theoretical values.

Calculations:

Calculation of hie= hfe * re

hfe= using multimeter calculate hfe value for the given transistor

re= 26mV/IE

IE=VE/RE (calculate drop across RE using multimeter for DC bias circuit)

Input impedance without Feedback:

$Z\text{in} = R1 /\!/ R2 /\!/ hie$

Output impedance without Feedback:

$Z\text{o} = RC /\!/ RL$

Voltage gain without feedback:

$Av = -h(Z\text{o} / Z\text{in})$

Input impedance with Feedback:

$Z\text{in} = R1 /\!/ R2 /\!/ (hie + (1+hfe)\, Re)$

Output impedance with Feedback:

$Z\text{o} = RC /\!/ RL$

Voltage gain with feedback:

$AV = -hfe\ (Z\text{o}\ / Z\text{in})$

Observations (with and without feedback):

VIN =_____V (using CRO)

Zin = Rs [Vin/ Vs−Vin]

VL=____V (using CRO)

VNL=____V (using CRO)

Zo = R_L (VNL – VL/VL)

Av = VL/Vin

Precautions:

1. Avoid loose and wrong connections.
2. Avoid parallax error while taking readings.

Result:

Viva-Voce Questions:

1. What is the relationship between the transfer gain with feedback Af and that without feedback?
2. What are the advantages of negative feedback.?
3. How is the i/p impedance and o/p impedance of a voltage shunt feedback amplifier?
4. What are the types of feedback amplifier

9.CLASS-A POWER AMPLIFIER

Aim: To design and test the class A power amplifier.

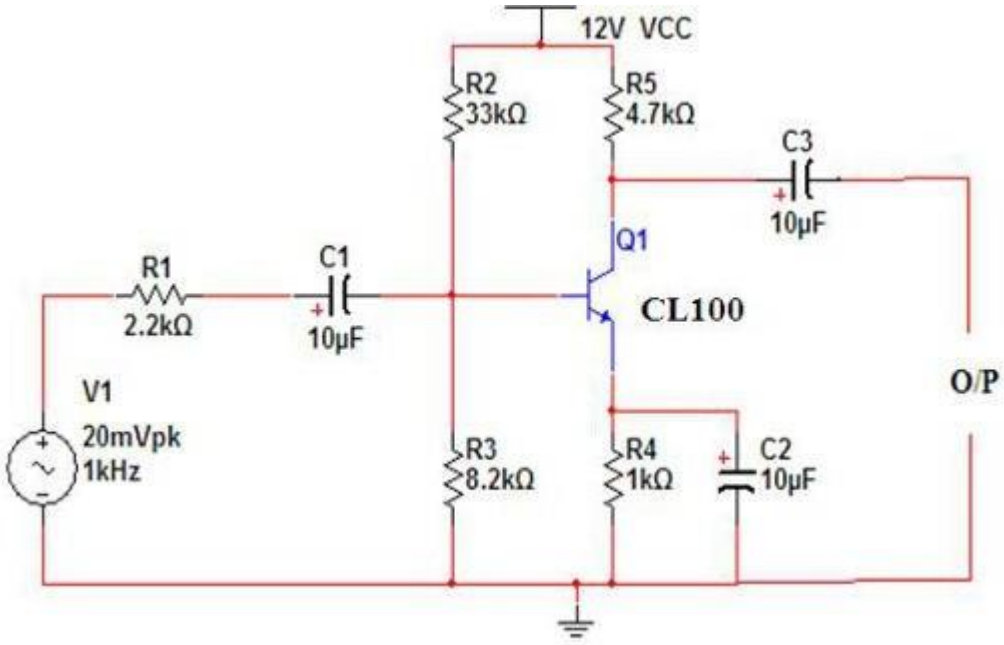
Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT (BC 107)	2
3.	Resistors (4.7KΩ,1 KΩ,33KΩ,2.2KΩ,8.2KΩ)	1
4.	Capacitors (10μF)	3
5.	Signal Generator (0-1MHZ)	1
6.	CRO and CRO Probes	1 & 2
7.	Bread Board and connecting wires	1 set

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 cut off or saturation region. The collector current flows for 3600 (life cycle) of the input signal in other words the angle of the collector current flow is 3600 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.

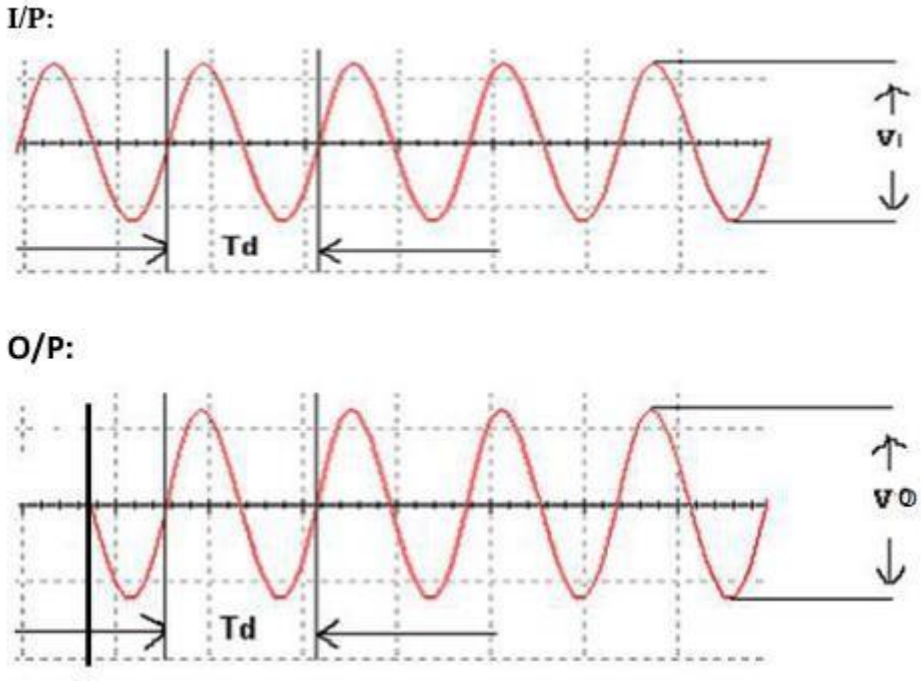
Circuit Diagram:



Procedure:

1. Connect the circuit as per the circuit diagram.
2. Set Vin (say 250 to 300 mV), at 10 KHz using signal generator.
3. By keeping the input voltage constant, vary the frequency from 0 to 1MHz in regular steps
4. Note down the corresponding output voltage from CRO
5. Calculate the DC input power using the formula Pdc = VccIc
6. Calculate the AC output power using the formula Pac = Vo2/8RL
7. Calculate the efficiency η = Pac /Pdc
8. Plot the graph between Gain (db) and frequency.
9. Calculate bandwidth from the graph.

Model Graph:



Calculations:

- **Input power**: Pdc= VccIc =
- **Outpower**: Pac = VPP2/8RL =
- **η = Efficiency=output power/input power*100** = Pac /Pdc*100 =

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.
4. Handle all equipment carefully.

Result:

Viva-Voce Questions:

1. On which criteria based the power amplifiers are classified?
2. what is the operating point of class-A power amplifier?
3. what is meant by efficiency?
4. howmuch efficiency will be obtained in class-A power amplifier?
5. what are the applications of power amplifier?

10. RC PHASE SHIFT OSCILLATOR

Aim: To determine the frequency of oscillations of a given RC phase shift Oscillator.

Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT (BC 107)	1
3.	Resistors (47 KΩ,1 KΩ,560Ω)	1
4.	Resistor (4.7 KΩ)	4
5.	Capacitors (0.1µF,0.01 µF,0.001 µF)	3
6.	Capacitors (100µF,0.047 µF)	1
7.	CRO and CRO Probes	1 & 2
8.	Bread Board and connecting wires	1 set

Theory:

The oscillator circuit that produces a sine wave using a phase-shift network is called as a Phase-shift oscillator circuit. The phase-shift oscillator circuit consists of a single transistor amplifier section and a RC phase-shift network. The phase shift network in this circuit, consists of three RC sections. At the resonant frequency f_o, the phase shift in each RC section is 60^o so that the total phase shift produced by RC network is 180^o.

The frequency of oscillations is given by

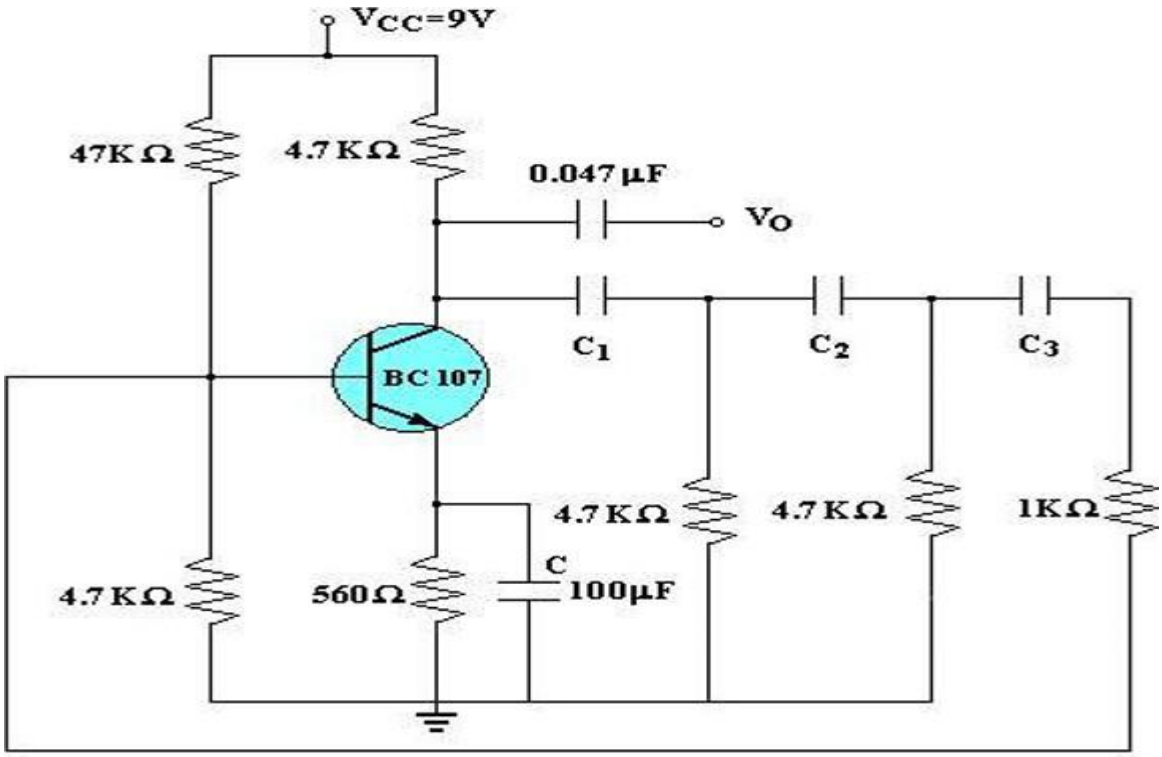
$$f_o = \frac{1}{2\pi RC\sqrt{6}}$$

were

R1=R2=R3=R

C1=C2=C3=C

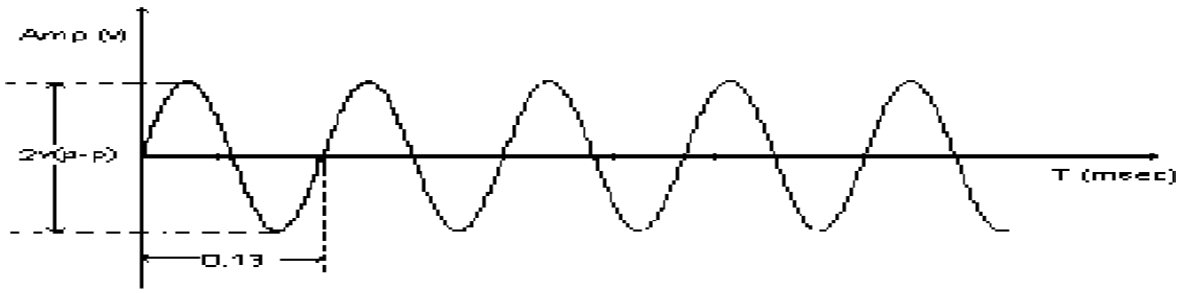
Circuit Diagram:



Procedure:

1. Connect the circuit diagram as shown in the figure.
2. Switch on the power supply.
3. Connect the O/P terminals to C.R.O.
4. Observe the sinusoidal wave form on C.R.O.
5. Determine the time period (T) of the wave form and frequency (1/T).
6. Repeat the above procedure for different sets of Capacitors.
7. Tabulate the readings and compare with theoretical values.

Model Graph:



Tabular Form:

S.No	Resistance (kΩ)	Capacitance(μF)	Theoretical Freq (HZ)	Practical Freq (HZ)
1.	**4.7**	**0.1**		
2.	**4.7**	**0.01**		
3.	**4.7**	**0.001**		

Calculations:

$$f(\text{practical}) = 1/T \text{ Hz.}$$

$$f_o = \frac{1}{2\pi RC\sqrt{6+4K}} \quad \text{(Theoretical)}$$

Where $K = R_C / R = 1.$

$$R_1 = R_2 = R_3 = R.$$
$$C_1 = C_2 = C_3 = C.$$

Result:

Viva-Voce Questions:

1. Which type of feedback is incorporated in RC phase shift oscillator?
2. Can we have built up an RC phase shift oscillator using two stages of RC network of each 90 degrees phase shift?
3. State Barkhausen criterian?
4. What is the condition imposed on A and β to get sustained oscillations?

11.Hartley Oscillator

Aim: To Determine the frequency of oscillations of a Hartley Oscillator and compare it with the theoretical values.

Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT (BC 107)	1
3.	Resistors (10 KΩ,1KΩ,47 KΩ)	1
4.	Capacitors (0.22μF)	2
5.	Decade Capacitance Box	1
6.	Decade Inductance Box	2
7.	CRO and CRO Probes	1 & 2
8.	Bread Board and connecting wires	1 set

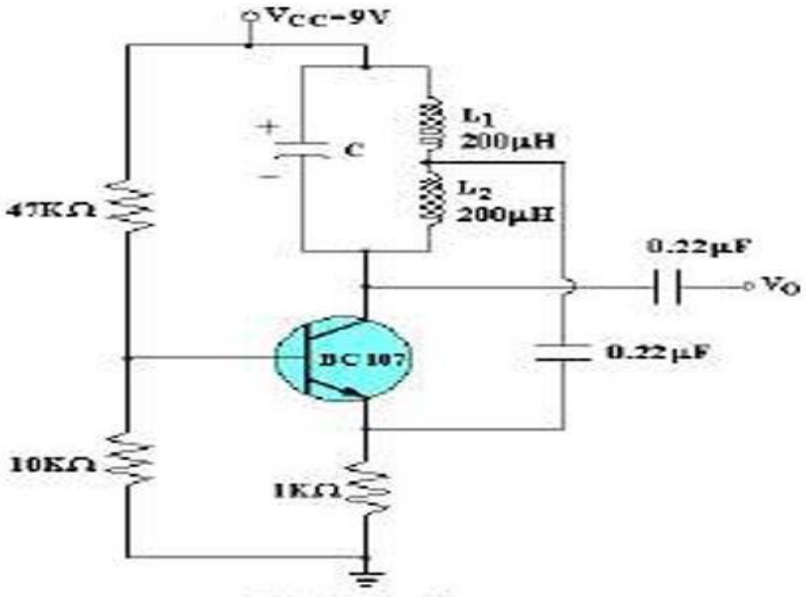
Theory:

In the Colpitts oscillator shown in figure, Z1, and Z2 are inductor and Z3 is a capacitor. The resistors R and R2 and RE provide the necessary DC bias to the transistor. CE is a bypass capacitor CC1 and CC2 are coupling capacitors. The feedback network consisting of capacitors C, inductor L1 and L2 determine the frequency of the oscillator. When the supply voltage +VCC is switched ON, a transient current is produced in the tank circuit, and consequently damped harmonic oscillations are setup in the circuit. The current in tank circuit produces AC voltages across L1 and L2. As terminal 3 is earthed, it will be at zero potential.If terminal is at positive potential with respect to 3 at any instant, then terminal 2 will be at negative potential with respect to 3 at the same instant. Thus, the phase difference between the terminals 1 and 2 is always 1800. In the CE mode, the transistor provides the phase difference of 1800 between the input and output. Therefore, the total phase shift is 360 degrees.

The frequency of oscillations is

$$f_0 = \frac{1}{2\pi\sqrt{L_{eq}C}}$$

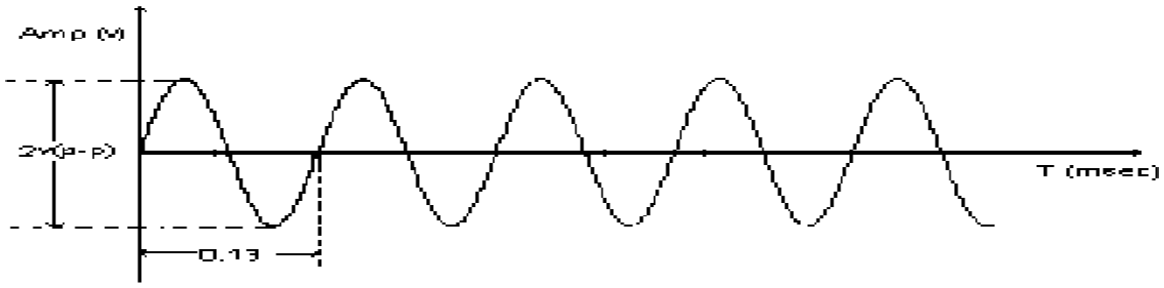
Circuit Diagram:



Procedure:

1. Connect the circuit as shown in the figure.
2. Connect the O / P of the oscillator to the C.R.O.
3. Adjust the Capacitance and Inductance Boxes until a sinusoidal signal is observed in the CRO.
4. Determine the frequency of the wave form.
5. Vary the Capacitance in convenient steps and determine the frequency each time
6. Tabulate the readings and compare the readings with the theoretical values.

Model Graph:



Tabular Form:

S.No.	Capacitance c(μF)	Inductance(mH)		Practical Freq (HZ)	Theoretical Freq (HZ)
		L1	L2		
1.					
2.					

Calculations:

Theoretical Frequency $f_0 = \frac{1}{2\pi\sqrt{L_{eq}C}}$

Practical Frequency F: $\frac{1}{T}$

Results:

Viva-Voce Questions:

1. Why RC network oscillator cannot be used at Radio frequencies?
2. Why LC network oscillators are preferred at high frequencies?
3. Why a buffer amplifier is required in between an oscillator and a load?
4. What is meant by ringing in an amplifier?
5. Why the crystal oscillator is highly stable?
6. Draw the electrical equivalent circuit of a crystal oscillator?

12. COLPITT'S OSCILLATOR

Aim: To determine the frequency of oscillations of a given Colpitt's Oscillator.

Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT (BC 107)	1
3.	Resistors(560Ω,47KΩ,4.7KΩ,4.7KΩ)	1
4.	Capacitors (100μF, 0.047μF)	1
5.	Decade Inductance Box	1
6.	Decade Capacitance Box	2
7.	CRO and CRO Probes	1 & 2
8.	Bread Board and connecting wires	1 set

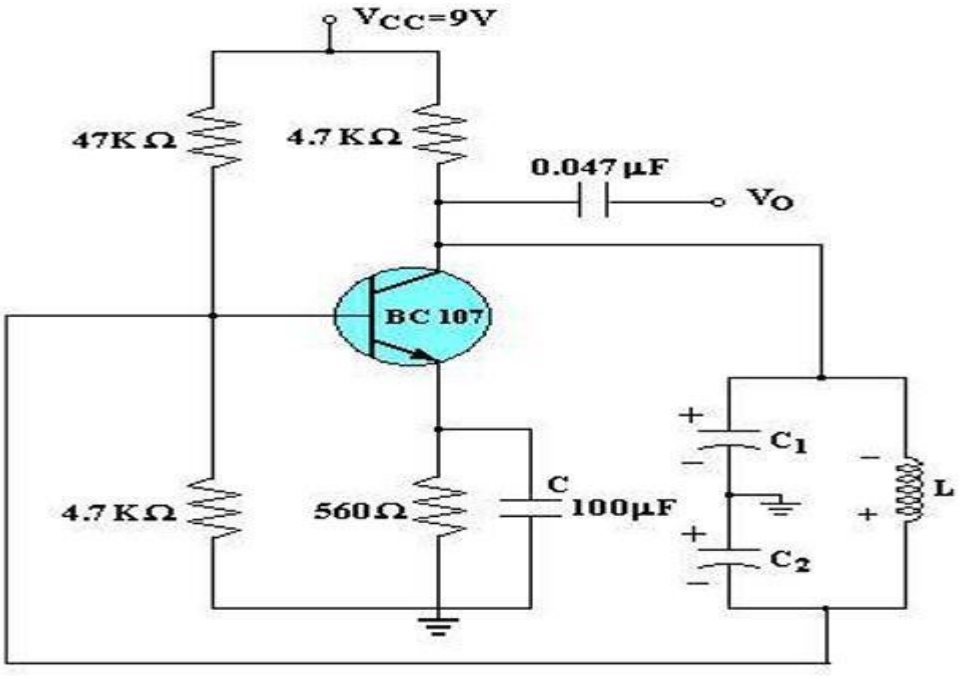
Theory:

The Colpitts circuit, like other LC oscillators, consists of a gain device (such as a bipolar junction transistor, field effect transistor, operational amplifier, or vacuum tube) with its output connected to its input in a feedback loop containing a parallel LC circuit (tuned circuit) which functions as a bandpass filter to set the frequency of oscillation. Colpitts oscillator is the electrical dual of a Hartley oscillator, where the feedback signal is taken from an "inductive" voltage divider consisting of two coils in series (or a tapped coil). Fig. 1 shows the common-base Colpitts circuit. L and the series combination of C1 and C2 form the parallel resonant tank circuit which determines the frequency of the oscillator. The voltage across C2 is applied to the base-emitter junction of the transistor, as feedback to create oscillations. Here the voltage across C1 provides feedback. The frequency of oscillation is approximately the resonant frequency of the LC circuit, which is the series combination of the two capacitors in parallel with the inductor.

$$f_0 = \frac{1}{2\pi\sqrt{L\left(\frac{C_1 C_2}{C_1+C_2}\right)}}$$

The actual frequency of oscillation will be slightly lower due to junction capacitances and resistive loading of the transistor. As with any oscillator, the amplification of the active component should be marginally larger than the attenuation of the capacitive voltage divider, to obtain stable operation. Thus, a Colpitts oscillator used as a variable frequency oscillator (VFO) performs best when a variable inductance is used for tuning, as opposed to tuning one of the two capacitors. If tuning by variable capacitor is needed, it should be done via a third capacitor connected in parallel to the inductor (or in series as in the Clapp oscillator).

Circuit Diagram:

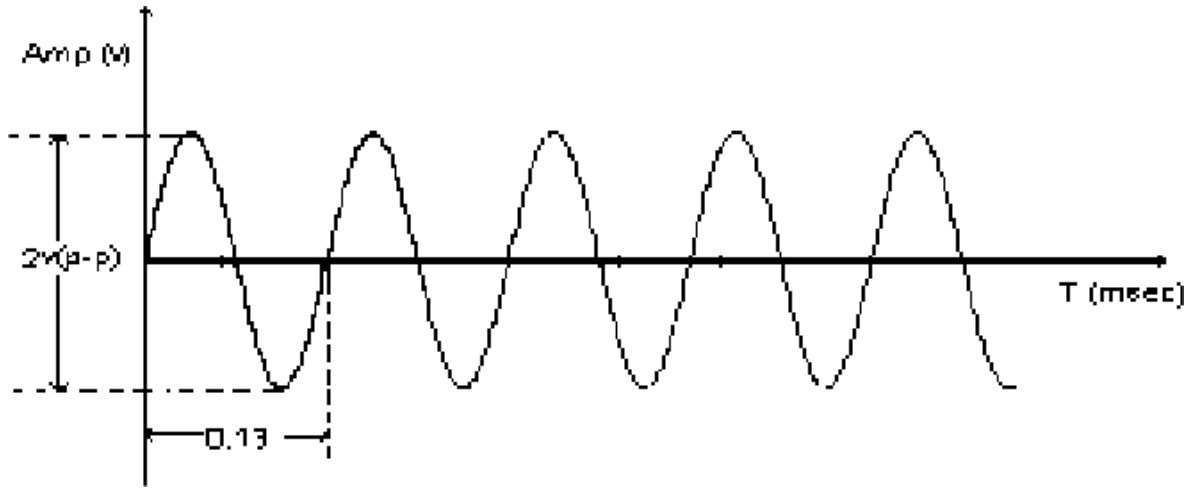


Procedure:

1. Connect the circuit as per the circuit diagram.
2. Connect the output of the Colpitts Oscillator kit to the CRO.

3. Observe the sinusoidal signal as an output and note down the time period of the oscillation.
4. Compare the practical frequency with the theoretical frequency.

Model Graph:



Tabular Form:

S.No.	Inductance L(mH)	Capacitance C (µF)		Practical Freq (HZ)	Theoretical Freq (HZ)
		C1	C2		
1.					
2.					

Calculations:

f_0 (practical) $= 1/T$ Hz.

f_0 (theoretical) $f_0 = \frac{1}{2\pi\sqrt{LC_{eq}}}$. [Where $C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$]

Result:

Viva-Voce Questions:

1. Define oscillator?
2. Which type of Feedback is employed in oscillator?
3. What are the applications of Colpitts oscillator?
4. What is meant by resonant Circuit Oscillators?
5. Define gain and phase Margin?
6. What is a beat frequency oscillator?
7. What is damped Oscillation?
8. Write the expression for frequency of oscillations for Colpitts and Hartley oscillators?
9. Classify the different types of Oscillators?
10. What are the factors that determine the stability of an oscillator?

LAB EXPERIMENT BEYOND THE SYLLABUS

TRANSISTOR AS A SWITCH

Aim: To Design Transistor to act as a Switch and Verify the Operation. Choose Vcc= 10V, Ic_{max} =10 mA, Vce_{sat} = 0.2, Vin =4Vp-p, Vbe_{sat} =0.6V.

Apparatus:

S.No.	Name	Quantity (No's)
1.	Regulated D.C Power supply (0-30V)	1
2.	BJT (BC 107)	1
3.	Resistors(1KΩ,8.2KΩ)	1
4.	CRO and CRO Probes	1 & 2
5.	Bread Board and connecting wires	1 set
6.	Function Generator	1

Theory:

When the I/P voltage Vi is negative or Zero , transistor is cut-off and no current flows through Rc. Hence Vo= Vcc when I/P voltage Vi jumps to positive Voltage , transistor will be driven into saturation. Then

$$V0 = Vcc - IcRc = Vce_{sat.}$$

Design Procedure: let us take hfe=50

When Q is ON

$$Rc = (Vcc - Vce_{sat)} / Ic_{max.}$$

$$= (10-0.2) / 10$$

$$= 10 \text{ K ohms.}$$

$$I_B >= 10mA/50$$

$$I_B >= 0.2mA$$

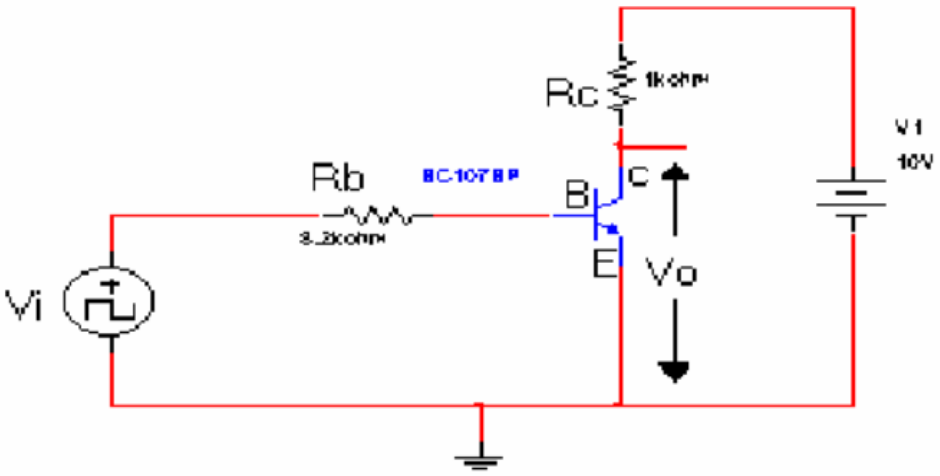
To Keep the transistor is in ON , I_B should be Greater than $I_{B(sat)}$.

$Vin = I_B R_B + Vbe_{sat}$

$2v = 0.2\ mA\ R_B + 0.6V$

$R_B =$ 7K ohms (Choose Practical Value 8.2 K ohms).

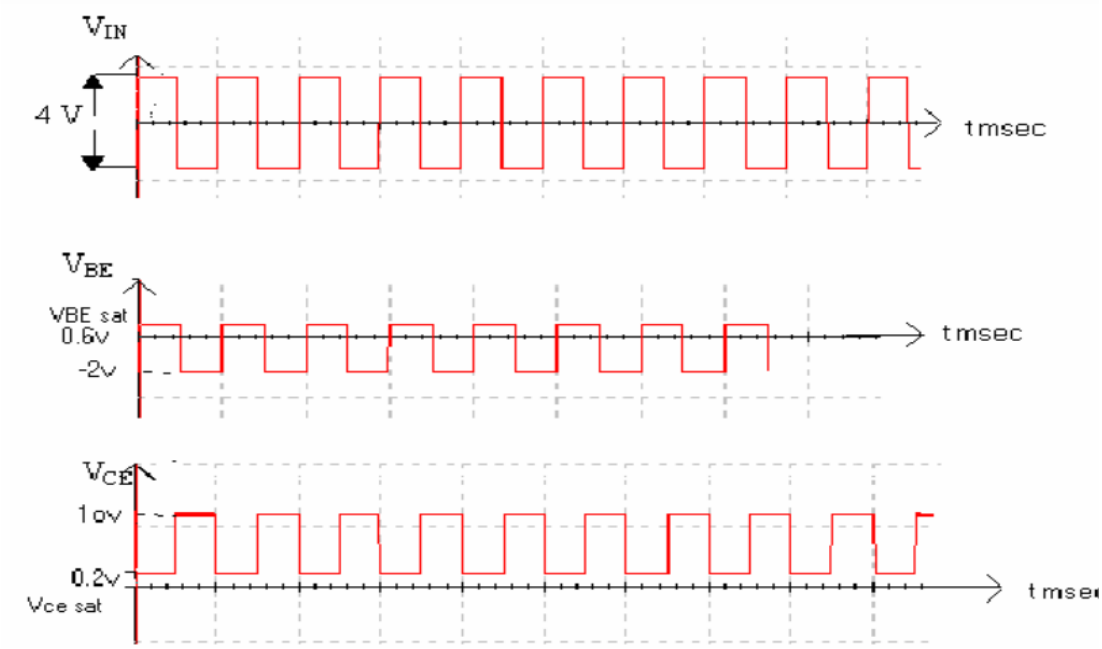
Circuit Diagram:



Procedure:

1. Connect the Circuit as Shown in Figure .
2. Apply the square wave 4Vp-p frequency of 1KHZ.
3. Observe the waveform at collector and and Base and Plot it.

Model Graph:



Precautions:

1. When you are measuring O/P waveform at collector and Base , Keep the CRO in DC mode.
2. When you are measuring V_{besat} , V_{cesat} Keep Volts/div switch at either 0.2 or 0.5 Position.
3. When you are applying the square wave see that there is no DC voltage in that . this can be checked by CRO in either AC or DC mode. There should not be any Jumps/ Distortion in waveform on the screen.

Result:

Viva-Voce Questions:

1. Differentiate between diode and transistor as a switch?
2. Mention typical values of $V_{BE\ sat}$,V_{CEsat} for both Si, Ge transistor?
3. Define ON time , OFF time of The Transistor?
4. IN which region transistor acts as a switch?
5. Define Rise time & fall Time of a Transistor switch?