DRONACHARYA
College of Engineering

LABORATORY MANUAL

B.Tech. Semester- IV

ANALOG CIRCUITS LAB
Subject code: LC-ECE-208G

Prepared by:	**Checked by:**	**Approved by:**
Mrs. Monika Thakur	Mrs. Dimple Saproo	Name : Prof. (Dr.) Isha Malhotra
Sign.: ……	**Sign.: ……**	**Sign.: ……**

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING
DRONACHARYA COLLEGE OF ENGINEERING
KHENTAWAS, FARRUKH NAGAR, GURUGRAM (HARYANA)

Table of Contents

Vision and Mission of the Institute

Vision:

To impart Quality Education, to give an enviable growth to seekers of learning, to groom them as World Class Engineers and Managers competent to match the expanding expectations of the Corporate World has been our ever enlarging vision extending to new horizons since the inception of Dronacharya College of Engineering.

Mission:

M1: To serve the society and improve the mode of life by imparting high quality education in the field of Engineering and Management catering to the explicit and implicit needs of the students, society, humanity and industry.

M2: To create an inspiring ambience that raises the motivation level for conducting quality research

M3: To provide an environment for acquiring ethical values and positive attitude.

Vision and Mission of the Department

Vision:

"To become a Centre of Excellence in teaching and research in Electrical and Electronics Engineering for producing skilled professionals having a zeal to serve society"

Mission:

M1: To create an environment where students can be equipped with strong fundamental concepts, analysis and problem-solving skills.

M2: To provide an exposure to emerging technologies by providing hands on experience for generating competent professionals.

M3: To promote Research and Development in the frontier areas of Electrical and Electronics Engineering and encourage students for pursuing higher education

M4: To inculcate in students ethics, professional values, team work and leadership skills.

Programme Educational Objectives (PEOs)

PEO1: To practice the profession of engineering using a systems perspective and analyze, design, develop, optimize & implement engineering solutions and work productively as engineers, including supportive and leadership roles on multidisciplinary teams

PEO2: To Continue their education in leading graduate programs in engineering & interdisciplinary areas to emerge as researchers, experts, educators & entrepreneurs and recognize the need for, an ability to engage in continuing professional development and life-long learning

PEO3: To Engineers, guided by the principles of sustainable development and global interconnectedness, will understand how engineering projects and affect society and the environment.

PEO4: To Promote Design, Research and implementation of products and services in the field of Engineering through strong Communication and Entrepreneurial skills.

PEO5: To Re-learn and innovate in ever-changing global economic and technological environments on the 21st century.

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 analyze 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 software tools including prediction and modeling 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 need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

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 give 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 a 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.

Programme Specific Outcomes (PSOs)

PSO1. Equip themselves to potentially rich & employable field of Engineering. Analyse and design electronic systems for signal processing, communications and other applications.

PSO2. Pursue higher studies in the contemporary Technologies and multidisciplinary fields with an inclination towards continuous learning. area of Electronics, Telecommunication ,VLSI or Instrumentation.

PSO3. Design, implement and evaluate processes, components and/or programs using modern techniques, skills and tools of core Information Technologies to effectively integrate effective communication-based solutions into using Electronic components.

PSO4. Develop impactful solutions by using research-based knowledge and methods in the fields of integration and implementation, alongside Meeting the requirements of the Industrial standard.

.

University Syllabus

LIST OF EXPERIMENTS:

1 To analyze and study frequency response of RC coupled amplifier.

2 To analyze and study different types of feedback topology.

3 To analyze and study RC phase shift oscillator.

4 To analyze and study wein bridge oscillator.

5 To analyze and study three terminal IC voltage regulator.

6 To draw characteristics of a transistor.

7 To analyze and study CE amplifier and calculate its gain.

8 To analyze and study 555 timer as a square wave generator.

9 To analyze and study SMPS power supply.

10 To analyze and study working of Push-Pull amplifier.

Course Outcomes (COs)

Upon successful completion of the course, the student will be able to:

CO1. Understand the characteristics and AC analysis of RC coupled amplifier.

CO2. Understand the operation and characteristics of different oscillators, regulators and timers.

CO3. Understand the operation of power supply.

These course outcomes aim to equip students with practical skills, hands-on experience, and a deeper understanding of analog circuits.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	1	1				1	2	1
CO2	3	1	2	1	1	3				3	2	2
CO3	3	2	2	2	1	2				2	2	3
Average												

CO-PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	1	2
CO2	2	2	3	2
CO3	1	2	2	3
Average				

Course Overview

The Analog Circuits Lab is a practical course designed to complement the theoretical knowledge gained in analog circuits or electronics courses. The lab provides students with hands-on experience in designing, building, and testing analog electronic circuits. It focuses on the application of fundamental principles and concepts in analog electronics, such as amplifiers, filters, oscillators, and signal conditioning circuits. Study the characteristics and applications of basic electronic components such as resistors, capacitors, inductors, and operational amplifiers. Understand how to use datasheets to select appropriate components for specific circuit requirements.

It helps in design and build common amplifier circuits, including voltage amplifiers, current amplifiers, and differential amplifiers. Analyze their frequency response, gain, and distortion characteristics. It gives information to design and analyze passive and active filters, such as low-pass, high-pass, band-pass, and band-reject filters. Understand their frequency response, attenuation characteristics, and phase shift. It also gives information about the design and construct oscillators using feedback circuits, such as RC oscillators, LC oscillators, and crystal oscillators. Study their frequency stability, waveform generation, and startup characteristics.

List of Experiments mapped with COs

S. No.	Name of the Experiments	Course Outcome
1	To analyze and study frequency response of RC coupled amplifier.	CO1,
2	To analyze and study different types of feedback topology.	CO1,CO2
3	To analyze and study RC phase shift oscillator.	CO2,
4	To analyze and study wein bridge oscillator.	CO2
5	To analyze and study three terminal IC voltage regulator.	CO3
6	To draw characteristics of a transistor.	CO1,CO2
7	To analyze and study CE amplifier and calculate its gain.	CO1, CO2
8	To analyze and study 555 timer as a square wave generator	CO2
9	To analyze and study SMPS power supply.	CO3
10	To analyze and study working of Push-Pull amplifier	CO1,CO2

Dos and DONT's

Dos

1. Students should carry notes and records completed in all aspects and get it verified by the teacher.
2. If an individual comes in contact with a live electrical conductor, do not touch the equipment, wire or person. Shut off power at the main switch or MCB.
3. Avoid contact with energized electrical circuit.
4. While handling any equipment, be sure that hands are dry and when possible wear non-conductive gloves and shoes with insulated soles.
5. If water or any chemical is spilled on to equipment, shut off power at the main switch or MCB and unplug the equipment.
6. Select proper range of meters and type (AC, DC) of the supply.
7. Be sure you understand the function and wiring of an instrument before using it in the circuit.
8. Students should carry notes and records completed in all aspects and get it verified by the teacher.
9. The connections done should be checked by the teacher in charge/ technical assistant before switching ON the supply.
10. All patch cords and stools should be put back to proper position after completion of the experiment.

11. After completion of the experiment, components must be submitted properly to the lab in-charge.
12. Always wear shoes without any conducting material.
13. Be punctual, maintain discipline & silence
14. After completion of Experiment, return the bread board, trainer kits, wires, CRO probes and other components to lab in-charge.
15. Note the working range of electronic equipment /measuring device

DON'Ts

1. Don't exceed the permissible values of Current, Voltages and /or speed of any circuits, apparatus, load etc.
2. Don't make circuit changes or perform any wiring when power is on.
3. Don't switch ON the supply without verifying by the Staff Member.
4. Don't leave the lab without the permission of the Lab In-Charge.
5. Don't use any experimental kit if there is a smoke, spark.

General Safety Precautions

Precautions (In case of Injury or Electric Shock)

1. To break the victim with live electric source, use an insulator such as fire wood or plastic to break the contact. Do not touch the victim with bare hands to avoid the risk of electrifying yourself.

2. Unplug the risk of faulty equipment. If main circuit breaker is accessible, turn the circuit off.

3. If the victim is unconscious, start resuscitation immediately, use your hands to press the chest in and out to continue breathing function. Use mouth-to-mouth resuscitation if necessary.

4. Immediately call medical emergency and security. Remember! Time is critical; be best.

Precautions (In case of Fire)

1. Turn the equipment off. If power switch is not immediately accessible, take plug off.

2. If fire continues, try to curb the fire, if possible, by using the fire extinguisher or by covering it with a heavy cloth if possible isolate the burning equipment from the other surrounding equipment.

3. Sound the fire alarm by activating the nearest alarm switch located in the hallway.

4. Call security and emergency department immediately:

Emergency: Reception

Security : Main Gate

Guidelines to students for report preparation

All students are required to maintain a record of the experiments conducted by them. Guidelines for its preparation are as follows: -

1) All files must contain a title page followed by an index page. **The files will not be signed by the faculty without an entry in the index page.**

2) Student's Name, Roll number and date of conduction of experiment must be written on all pages. 3) For each experiment, the record must contain the following

(i) Aim/Objective of the experiment

(ii) Apparatus required with specification and Name plate details

(iii) Circuit diagrams, procedures, observations and calculations

(v) Results/ output

Note:

1. Students must bring their lab record along with them whenever they come for the lab.

2. Students must ensure that their lab record is regularly evaluated.

Lab Assessment Criteria

An estimated 10 lab classes are conducted in a semester for each lab course. These lab classes are assessed continuously. Each lab experiment is evaluated based on 5 assessment criteria as shown in following table. Assessed performance in each experiment is used to compute CO attainment as well as internal marks in the lab course.

Grading Criteria	Exemplary (4)	Competent (3)	Needs Improvement (2)	Poor (1)
AC1: Technical Competence: (this may be assessed through viva)	Complete procedure with underlined concept is properly written	Underlined concept is written but procedure is incomplete	Not able to write concept and procedure	Underlined concept is not clearly understood
AC2: Data Collection and Analysis:	Circuit diagram must be neatly drawn and specification of instrument / equipment properly specified. Connection should be properly given	Circuit diagram drawn and connection given	Circuit diagram and connection to be given as per directions.	Circuit diagram is not proper. Unable to give connection as per circuit diagram.
AC3: Identification of problems in running the equipment and note down the reading	Able to identify the mistakes while running the machine and note down the reading accurately by varying all the related parameters	Able to identify the mistakes while running the machine and note down the reading by varying the parameters	Only few readings are taken and varying parameter is not proper	Unable to identify the mistakes
AC4: Final Demonstration and Execution	All variants of input /output are measured, experiment is well demonstrated and implemented concept is clearly explained	All variants of input /output are not measured, experiment is demonstrated and implemented concept is clearly explained	Only few variants are measured, experiment is demonstrated and implemented concept is not clearly explained	Not well demonstrated and not explained the concept
AC5: Practical file Record Assessment	All the readings are properly recorded and model calculations properly executed and performance analysis- results are plotted with graph (if necessary)	70 % calculations are done results and performance analysis are plotted with graph	Less than 70 % calculations are done results are plotted with graph if necessary	Not completed

LAB EXPERIMENTS

LAB EXPERIMENT 1

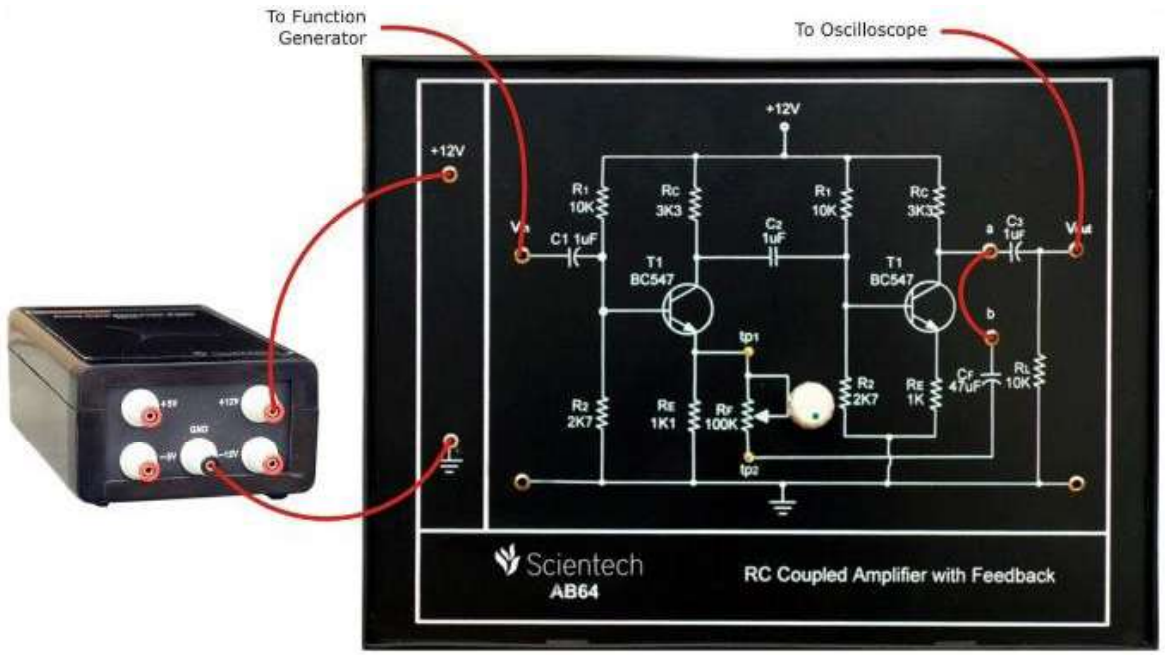
AIM:- To analyze and study frequency response of RC coupled amplifier.

APPARATUS REQUIRED:- RC coupled amplifier kit, DC power supply +12 V from external source, function generator, oscilloscope, 2 mm patch cords.

THEORY:-

RC coupled amplifier is a coupling of two emitter biased transistor circuit to form asingle cascade network. The output V_i of one stage is coupled to the input of the nextstage. A blocking capacitor is used to keep the DC component of the output voltage at V_{01}. The emitter resistor, R_C and resistor R1 and R2 are used for biasing. The bypass capacitor is used to present loss of Amplification due to negative feedback isC2 output is taken across capacitor C2.

CIRCUIT DIAGRAM:-



PROCEDURE:-

Step 1 Connect +12V variable DC Power Supply at their indicated position from external source.

Step 2 Switch 'On' the Power Supply.

Step 3 Connect 2 Vpp, 20Hz Sine wave signal at the input (between points V_{in} and ground) of amplifier of AB64 board and observe the same on Oscilloscope CH1.

Step 4 Observe the output waveform between points V_{OUT} and ground on Oscilloscope CH 2.

Step 5 Increase the input frequency from lowest value and observe the output waveform amplitude on Oscilloscope.

Step 6 Calculate gain in dB and plot a semi log graph between A_V (dB) and Frequency.

Step 7 Measure frequency range for which the output wave amplitude is 3dB down the maximum amplitude on graph (this will give two values of frequency f_L and f_H, the lower 3dB frequency and higher 3dB frequency respectively) as shown in figure.

Step 8 Calculate Bandwidth of RC-Coupled Amplifier without feedback using Equation 3.

Step 9 Keep the potentiometer RF at 60K and calculate feedback factor using Equation 1.

Step 10 Connect the patch chord between 'a' and 'b'.

Step 11 Follow procedure from step 3 to 7. This will give a plot between A_{VF} (dB)and Frequency.

Step 12 Calculate Bandwidth of RC-Coupled Amplifier with feedback usingEquation 3.

Step 13 Compare the frequency response and Bandwidth of RC-Coupled Amplifierwith & without feedback.

TABULATION:-

S. No.	Without feedback			With feedback □ = ……..		
	Freq (Hz)	Amp V_{out} (V_{pp})	A_V (dB) $20\log_{10}$ (V_{out}/V_{in})	Freq (Hz)	Amp V_{out} (V_{pp})	A_{VF} (dB) $20\log_{10}$ (V_{out}/V_{in})

RESULT:-

Without feedback:

f_L (lower 3dB frequency) = …….

f_H (higher 3dB frequency) = …….

Bandwidth (f_H-f_L) = …….

With feedback:

Feedback factor = …….

f_L (lower 3dB frequency) = …….

f_H (higher 3dB frequency) = …….

Bandwidth (f_H-f_L) = …….

With negative feedback gain decreases and bandwidth increases.

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supplyshould be switched off.
3. Ensure all connections should be tight before switching on the power supply.

QUIZ/ANSWERS:-

Q1.In RC coupled amplifier which component is responsible for reduction in voltage gain in the high frequency range?

A1. Shunt capacitance in the input circuit.

Q2.In RC coupled amplifier which component's value is responsible for low 3-dBfrequency?

A2. Increasing the value of coupling capacitor C_b.

Q3.In RC coupled amplifier which component's value is responsible for high 3-dBfrequency?

A3. By reducing the total effective shunt capacitance in the input circuit of hybridpi model.

Q4.In a single stage RC coupled amplifier, what is the phase shift introduced in thetrue middle frequency?

A3. 180

Q5.Which type of coupling capacitor is used in RC coupled amplifier?

A5. 0.05 μf paper capacitor.

Q6.What is the application of RC coupled amplifier?

A6. It is widely used as a voltage amplifier.

Q7.In single stage RC coupled amplifier, what is the phase shift at low 3-dBfrequency?

A7. 225

Q8. In single stage RC coupled amplifier, what is the phase shift at high 3-dBfrequency?

A8. 225

Q9. In RC coupled amplifier what is the effect of low 3-dB frequency by increasingthe value of coupling capacitor C_b?

A9. Decreasing.

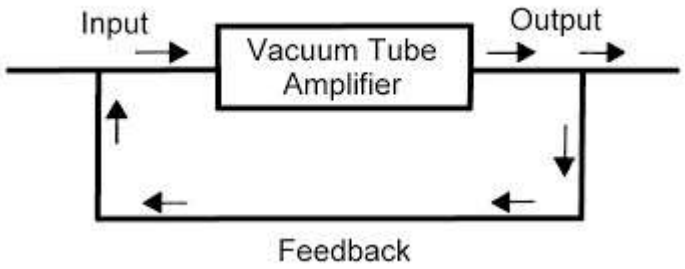
Q10.In RC coupled amplifier what is the effect of low 3-dB frequency by increasingthe value of total effective shunt capacitor?

A10. Decreasing.

LAB EXPERIMENT 2

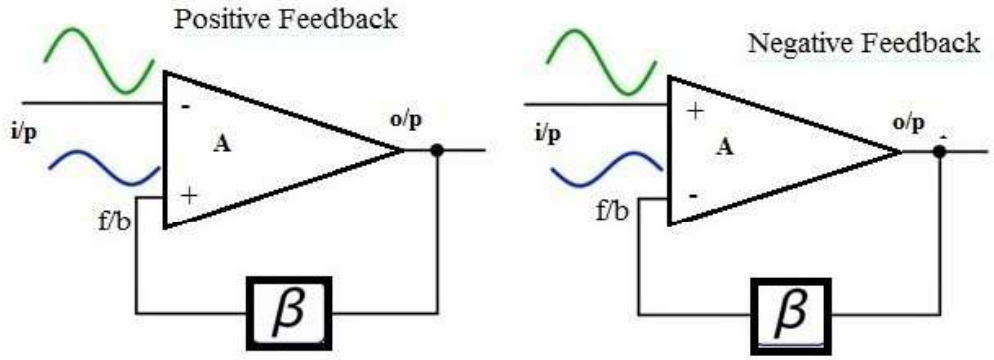
AIM: To analyze and study different types of feedback topology

THEORY:- The feedback-amplifier can be defined as an amplifier which has feedback lane that exists between o/p to input. In this type of amplifier, feedback is the limitation which calculates the sum of feedback given in the following amplifier. The feedback factor is the ratio of the feedback signal and the input signal.



TYPES OF FEEDBACK AMPLIFIER

The procedure of introducing some device's output energy fraction from back to the i/p is termed as Feedback. This is mainly used to reduce the noise as well as to make the operation of an amplifier is constant. This amplifier can be classified into two types based on the feedback signal helps such as positive & negative feedback amplifier.



1.) Positive Feedback Amplifier

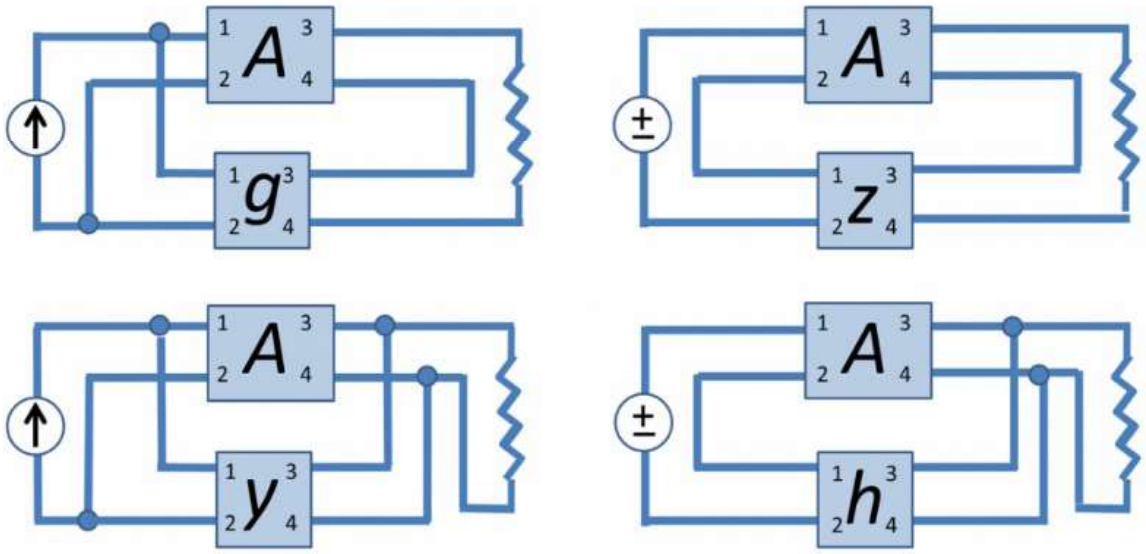
The positive feedback can be defined as when the feedback current otherwise voltage is applied for increasing the i/p voltage, then it is named as positive feedback. Direct feedback is another name of this positive feedback. Because positive feedback generates unnecessary distortion; it is not often used in amplifiers. But, it amplifies the original signal power and can be used in oscillator circuits.

2.) Negative Feedback Amplifier

The negative feedback can be defined as if the feedback current otherwise voltage can be applied for reducing the amplifier i/p, then it is called as negative feedback. Inverse feedback is another name of this negative feedback. This kind of feedback is regularly used in amplifier circuits.

FEEDBACK AMPLIFIER TOPOLOGIES

There are four basic **amplifier topologies** for connecting the feedback signal. Both the current as well as voltage can be feedback toward the input in series otherwise in parallel.



- Voltage Series Feedback Amplifier
- Voltage Shunt Feedback Amplifier
- Current Series Feedback Amplifier
- Current Shunt Feedback Amplifier

a.) Voltage Series Feedback Amplifier

In this type of circuit, a portion of the o/p voltage can be applied to the input voltage in series through the feedback circuit. The block diagram of the **voltage series feedback-amplifier** is shown below, by which it is apparent that the feedback circuit is located in shunt by means of the output although in series by means of the input.

When the **feedback circuit** is allied in shunt through the output, then the o/p impedance will be reduced and the i/p impedance is enlarged because of the series connection with the input.

b.) Voltage Shunt Feedback Amplifier

In this type of circuit, a portion of the o/p voltage can be applied to the input voltage in parallel with through the feedback circuit. The block diagram of the **voltage shunt feedback-amplifier** is shown below, by which it is apparent that the feedback circuit is located in shunt by means of the output as well as the input.

When the feedback circuit is allied in shunt through the o/p as well as the input, then both the o/p impedance & the i/p impedance will be decreased.

c.) Current Series Feedback Amplifier

In this type of circuit, a portion of the o/p voltage is applied to the i/p voltage in series through the feedback circuit. The block diagram of the **current series feedback-amplifier** is shown below, by which it is apparent that the feedback circuit is located in series by means of the output as well as the input.

When the feedback circuit is allied in series through the o/p as well as the input, then both the o/p impedance & the i/p impedance will be increased.

d.) Current Shunt Feedback Amplifier

In this type of circuit, a portion of the o/p voltage is applied to the i/p voltage in shunt through the feedback circuit. The block diagram of the **current shunt feedback-amplifier** is shown below, by which it is apparent that the feedback circuit is located in shunt by means of the output as well as the input.

When the feedback circuit is allied in series through the o/p however in parallel with the input, then the o/p impedance will be increased & because of the parallel connection with the i/p, the i/p impedance will be decreased.

Amplifier Characteristics

The **amplifier characteristics** which are affected by various negative feedback are listed in the following table.

Feedback Topology	**Input Resistance**	**Output Resistance**
Voltage Series	Increases Rif = Ri*(1+A*β)	Decreases Rof=Ro/(1+A*β)
Current Series	Increases Rif = Ri*(1+A*β)	Increases Rof = Ro*(1+A*β)
Current Shunt	Decreases Rif = Ri/(1+A*β)	Increases Rof = Ro*(1+A*β)

Voltage Shunt	Decreases Rif = Ri*(1+A*β)	Decreases Rof=Ro/(1+A*β)

RESULT: The four topologies are studied with their characteristics

QUIZ/ANSWERS:-

Q1: What is the purpose of using feedback in electronic circuits?

A1: The primary purpose of feedback in electronic circuits is to control and modify the behavior of the circuit or system. It involves deriving a portion of the output signal and feeding it back to the input, which can be used to regulate parameters such as gain, bandwidth, stability, distortion, and impedance.

Q2: How does voltage-series feedback differ from voltage-shunt feedback?

A2: Voltage-series feedback involves applying the feedback signal in series with the input signal, while voltage-shunt feedback applies the feedback signal in parallel with the input signal. Voltage-series feedback provides increased input impedance and improved linearity, while voltage-shunt feedback offers improved stability and reduced distortion.

Q3: What are the advantages of using current-series feedback?

A3: Current-series feedback provides increased input impedance and enhanced linearity in current amplifier circuits. It allows the input current to be accurately controlled and helps in minimizing the loading effect on the signal source.

Q4: Which feedback topology is commonly used for voltage-to-current conversion?

A4: Transconductance feedback is commonly used for voltage-to-current conversion. It involves deriving the feedback signal from the output voltage and applying it to the input as a current. This topology is particularly useful when a voltage needs to be converted into a proportional current.

Q5: In what type of applications is transresistance feedback beneficial?

A5: Transresistance feedback is useful in applications that require current-to-voltage conversion. It involves deriving the feedback signal from the output current and applying it to the input as a voltage. This topology is often employed in circuits utilizing field-effect transistors (FETs) or operational transconductance amplifiers (OTAs).

Q6: What are some common benefits of feedback in electronic circuits?

A6: Feedback in electronic circuits offers several advantages, including improved stability, increased linearity, reduced distortion, enhanced control over gain and bandwidth, and better impedance matching. It can also help in compensating for variations in components and external factors, thereby improving the overall performance of the circuit or system.

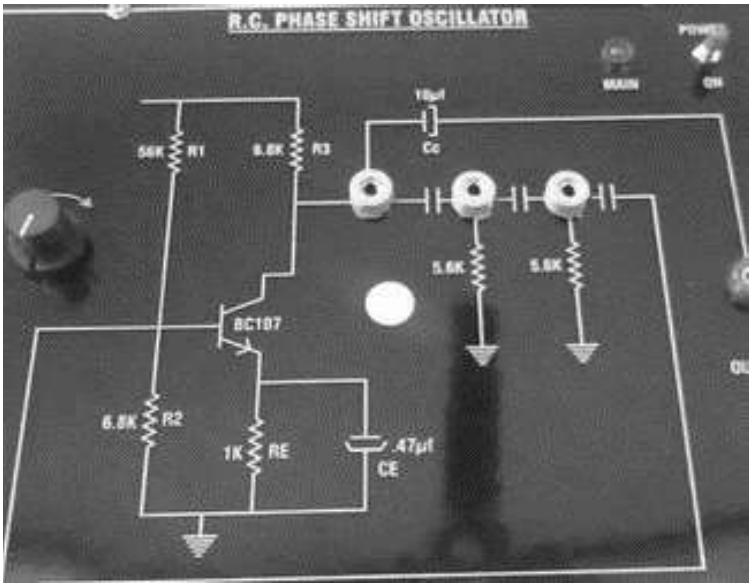
LAB EXPERIMENT No. 3

AIM:- To analyze and study RC phase shift oscillator.

APPARATUS REQUIRED:- RC phase shift oscillator kit, DC power supply +12 V from external source, oscilloscope, 2 mm patch cords.

THEORY:-

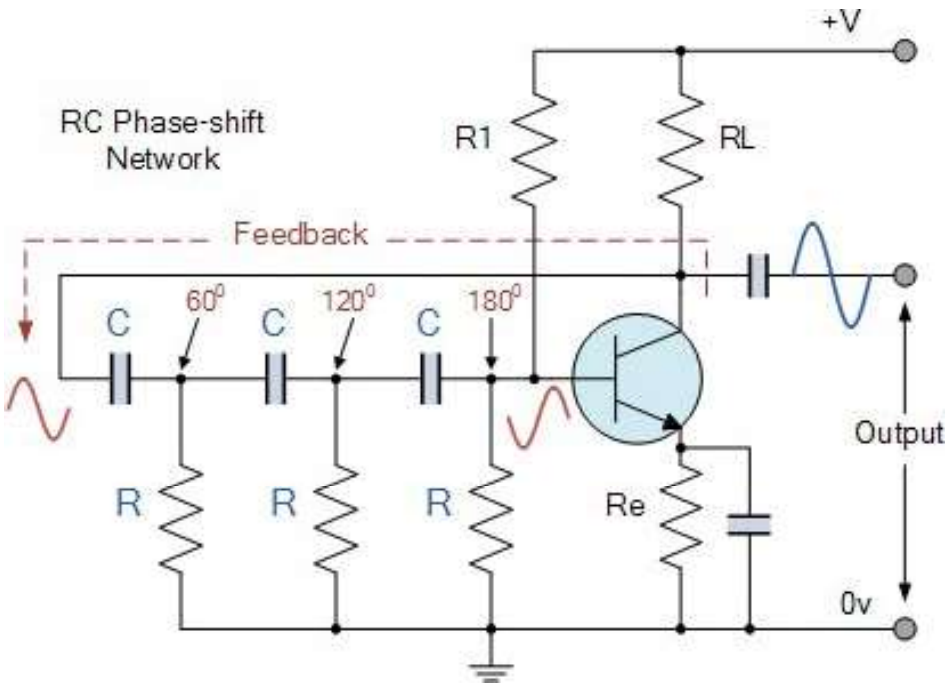
An oscillator is an electronic circuit for generating an AC signal voltage with a DC supply as the only input requirement. The frequency of the generated signal is



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 180º 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 60º.Thus The RC ladder network produces a total phase shift of 180º between its input and output voltage for the given frequency. Since CE Amplifier produces 180 º phases shift. Thetotal phase shift from the base of the transistor around the circuit and back to the base will be exactly 360º or 0º. 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. Theoretical frequency of the output signal obtained can be calculated by

$$f = \frac{1}{2\pi R_{C\sqrt{6}+\frac{4R_C}{R}}}$$

CIRCUIT DIAGRAM:-



PROCEDURE:-

Step 1 Connect the circuit diagram as shown in the figure.
Step 2 Switch on the power supply.

Step 3 Connect the O/P terminals to C.R.O.
Step 4 Observe the sinusoidal wave form on C.R.O.
Step 5 Determine the time period (T) of the wave form and frequency (1/T).
Step 6 Repeat the above procedure for different sets of Capacitors.
Step 7 Tabulate the readings and compare with theoretical values.

TABULATION:-

R (k□)	C (□F)	Theoretical f = 1/2 □RC√2N	Time Period T (Sec)	Practical f = 1/T (Hz)

RESULT:-

……

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supply should be switched off.
3. Ensure all connections should be tight before switching on the power supply.
4. Power supply should be switched off after completion of experiment.

QUIZ/ANSWERS:-

Q1:Why do we use RC phase shift oscillator?

Ans. RC Phase shift oscillator is used for low-frequency generation (Up to few Hundred of kHz). Typically it is used for the audio frequencies. In RC Phase Shift Oscillator, the transistor or op-amp in inverting mode is used for the amplification. So, it provides the 180 degrees of phase shift.

Q2What is the principle of phase shift oscillator?

Ans. The output voltage V1' across the resistor R leads the input voltage applied input V1 by some phase angle ϕ_o. If R were reduced to zero, V1' will lead the V1 by 90^o i.e., $\phi_o = 90^o$.

Q3 Where is oscillator used?

Ans. Oscillators convert direct current (DC) from a power supply to an alternating current (AC) signal. They are widely used in many electronic devices ranging from simplest clock generators to digital instruments (like calculators) and complex computers and peripherals etc.

Q4 How oscillations are produced in RC phase shift oscillator?

Ans. Phase shift oscillator is an RC type oscillator whose output is fed back to its input through a phase shift network consisting of resistors and capacitors in a ladder network. ... For sustained oscillations, phase shift of 0 degree or 360 degree and positive feedback it is necessary.

Q5 Why we need a phase shift between input and output signal?

Ans. To obtain the regenerative feedback in the phase-shift oscillator, we need a phase shift of 180 degrees between the output and the input signal. An RC network consists of three RC sections which provides the proper feedback and phase inversion to provide this regenerative feedback. Each section shifts the feedback signal 60 degrees in phase.

Q6 What does an RC circuit do?

Ans. It provide the phase-shift required by the feedback signal. They have excellent frequency stability and can yield a pure sine wave for a wide range of loads.

Q7 What is the total phase shift for the RC oscillator circuit?

Ans. 180^o

Q8 What is RC and LC oscillator?

Ans. The oscillation frequency is proportional to the inverse of the capacitance or resistance, whereas in an LC oscillator the frequency is proportional to inverse square root of the capacitance or inductance. So a much wider frequency rangecan be covered by a given variable capacitor in an RC oscillator.

Q9 What is the frequency of RC phase shift oscillator?

Ans. To find resonant frequency of an RC phase shift oscillator, use the following formula

$$F = 1/2\pi RC\sqrt{6}$$

Q10 Why RC oscillators cannot generate high frequency oscillations?

Ans. At high frequencies, resistors look like inductors or capacitors so the equations that govern oscillation in RC oscillators no longer apply. In other words, because of those parasitic components, it gets more and more difficult to makea stable RC oscillator as frequencies go up.

LAB EXPERIMENT No. 4

AIM:- To analyze and study Wien bridge oscillator.

APPARATUS REQUIRED:- Wien bridge oscillator kit, 2 mm patch cords.

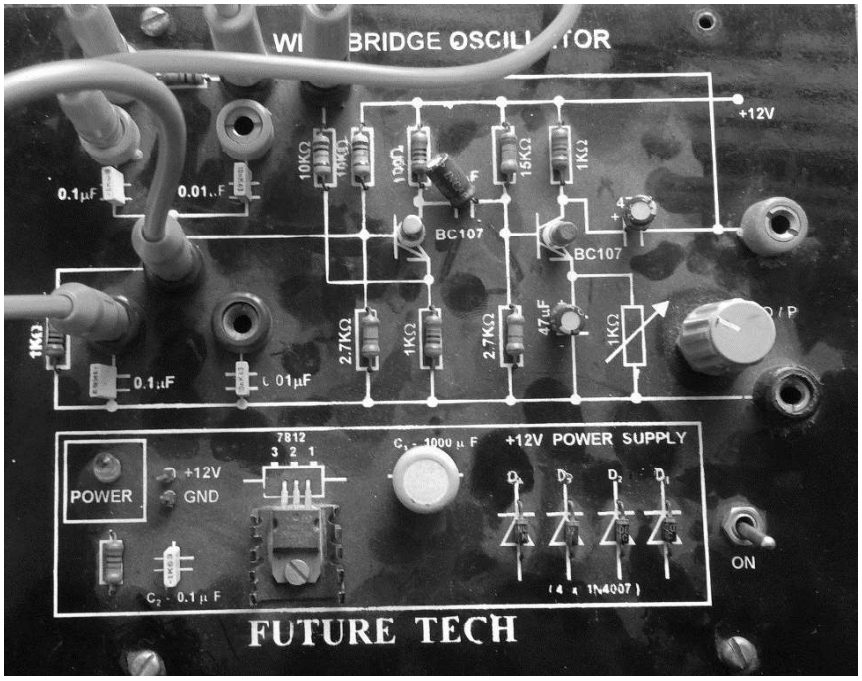
THEORY:-

Oscillators are circuits that produce periodic waveforms without input other than perhaps a trigger. They generally use some form of active device, lamp, or crystal, surrounded by passive devices such as Resistors, Capacitors, and Inductors, to generate the output.

An oscillator is a type of feedback amplifier in which part of the output is feed backto the input via a feedback circuit. If the signal fed back is of proper magnitude and phase, the circuit produces alternating currents or voltages. Two requirements for oscillation are:

- The magnitude of the loop gain AB must be at least 1.
- The total phase shift of the loop gain AB must be equal to 0° or 360°. If the amplifier causes a phase shift of 180°, the feedback circuit must provide an additional phase shift of 180° so that the total phase shift around the loop is 360°.

On the positive side, this circuit has only a few components and good frequency stability. Because of its simplicity and stability, it is the most commonly used audio-frequency oscillator. In the figure shown the Wien Bridge circuit is connected between the amplifier input terminals and the output terminal. The bridge has a seriesRC network in one arm and a parallel RC network in the adjoining arm. In the remaining two arms of the bridge, resistor R_1 and R_2 are connected, the phase angle



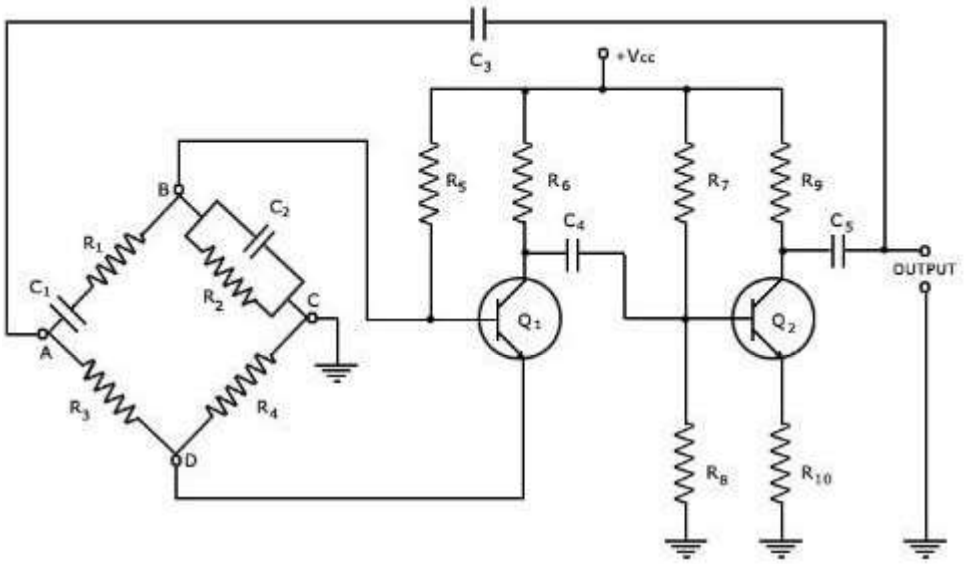
criterion for oscillation is that the total phase shift around the circuit must be 0°. This condition occurs only when the bridge is balanced, that is at resonance. The frequency of oscillation F_o is exactly the resonant frequency of the balanced Wien Bridge and is given by

$$F_o = 1/2 \pi RC = 0.159 / RC$$

Assuming that the resistors are equal in the value, and the capacitors are equal in the value in the reactive leg of the Wien Bridge. At this frequency the gain required for sustained oscillation is given by

$$A_v = 1/B = 3$$

CIRCUIT DIAGRAM:-



PROCEDURE:-

Step 1 Make the connections as per the circuit diagram.

Step 2 The two capacitances are varied by changing connection.

Step 3 The output wave is observed on the CRO.

Step 4 The time period of the wave for each value of capacitor is noted.

Step 5 The frequency of the wave is calculated from the time period using the formula $f = 1/T$

Step 6 Theoretical frequency is calculated by using the formula

$$f = 1/2 \pi \sqrt{R_1R_2C_1C_2}$$

Step 7 Compare the practical and theoretical values.

TABULATION:-

R1 = R2 (k□)	C		Theoretical f = 1/2 □√R1R2C1C2	Time Period T (Sec)	Practical f = 1/T (Hz)
	C1	C2			

RESULT:-

Sinusoidal signal is observed on oscilloscope.

As capacitance decreases, frequency increases.

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supplyshould be switched off.
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

QUIZ/ANSWERS:-

Q1 What is an oscillator?

Ans. An oscillator is a circuit which produces a continuous, repeated, alternating waveform without any input. Oscillators basically convert unidirectional current flow from a DC source into an alternating waveform which is of the desired frequency, as decided by its circuit components.

Q2 Mention the condition for oscillations in Wien bridge oscillator?

Ans. Two requirements for oscillation are:

- The magnitude of the loop gain AB must be at least 1.
- The total phase shift of the loop gain AB must be equal to 0° or 360°. If the amplifier causes a phase shift of 180°, the feedback circuit must provide an additional phase shift of 180° so that the total phase shift around the loop is 360°.

Q3 What type of feedback is used in oscillator?

Ans. A Wien-bridge oscillator has two paths for feedback. It uses both positive and negative feedbacks with one path each. The path for positive feedback form output is through the lead lag circuit and for negative feedback is through the voltage divide. Thus, a Wien-bridge oscillator uses both types of feedback.

Q4 What are the advantages of Wien bridge oscillator?

Ans. Good frequency stability, very low distortion and ease of tuning

Q5 Does an oscillator have input?

Ans. An oscillator does not require any external input signal to produce sinusoidal or other repetitive waveforms of desired magnitude and frequency at the output and even without use of any mechanical moving parts.

Q6 What are the different techniques for the stabilization of an oscillator?

Ans. By using LC as timing elements,the frequency stability improves relative to that of the RC oscillators as the inductors are relatively insensitive to temperature variations.

Q7 State Barkhausen criterion.

Ans. Barkhausen criterion states that one the total phase shift around a loop is a signal proceeds from input through the amplifier, feedback network back to the inputagain completing a loop should be 0 degree or 360 degree right.

Q8 What is resonant frequency?

Ans. Resonant frequency is the oscillation of a system at its natural or unforced resonance. Resonance occurs when a system is able to store and easily transfer energy between different storage modes, such as Kinetic energy or Potential energy as you would find with a simple pendulum.

Q9 What are the applications of Wien bridge oscillator?

Ans. The Wien bridge oscillator is used to find unknown values of components. In most of the cases this oscillator is used in the audios. The oscillators are designed simply, size is compressed and it has stable in frequency output.

Q10 What is the difference between amplifier and oscillator?

Ans. Amplifier is an electronic circuit which gives output as amplified form of input. The amplifier does not generate any periodic signal. Amplifier uses negative feedback. Amplifier operates as a multiplier. Amplifiers do nothing till input signal is fed to the input.

LAB EXPERIMENT No. 5

AIM:- To analyze and study three terminal IC voltage regulator.

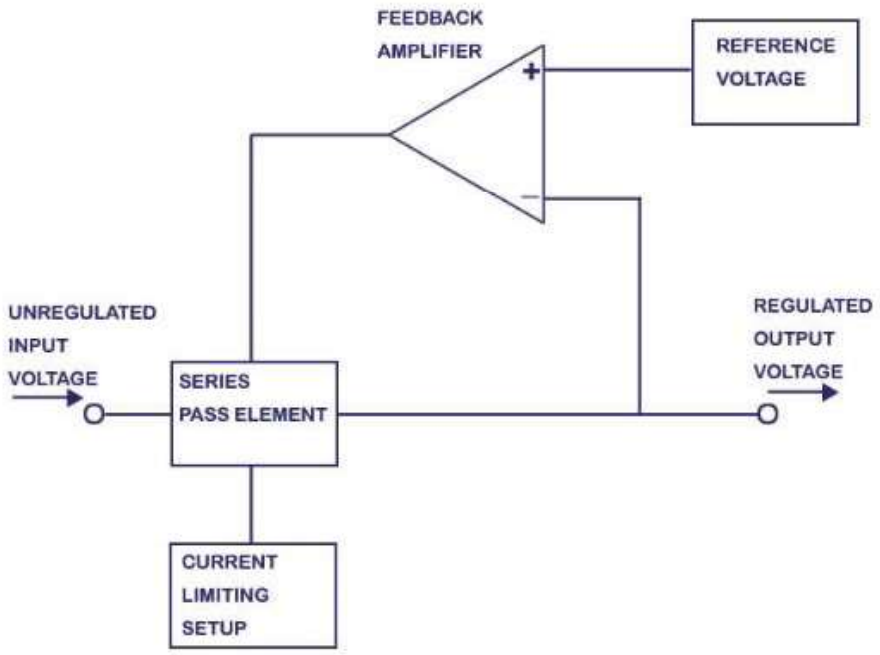
APPARATUS REQUIRED:- Bread board, ICs 7805, 7809, 7912 ICs - 1No. each,

RPS DRB / potentiometer 10KΩ ,Capacitors 1000μF, 22 μF , Voltmeter - 0-20V, Connecting wires.

THEORY:-

These regulators provide a constant output voltage. A popular example is the 7805 IC which provides a constant 5 volts output. A fixed voltage regulator can be a positive voltage regulator or a negative voltage regulator. A positive voltage regulator provides with constant positive output voltage. All those IC's in the 78XX series are fixed positive voltage regulators. In the IC nomenclature – 78XX ; the part XX denotes the regulated output voltage the IC is designed for. Examples:- 7805, 7806, 7809 etc.

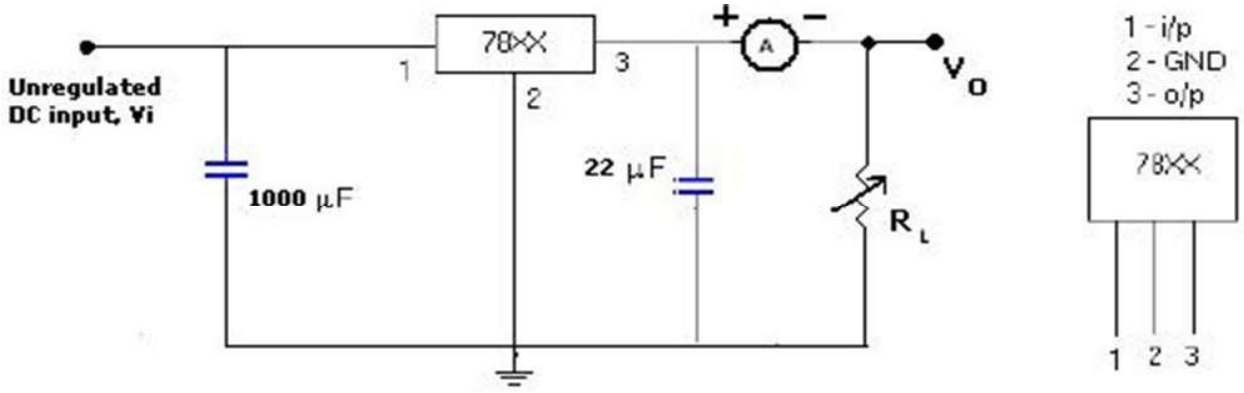
BLOCK DIAGRAM OF IC VOLTAGE REGULATOR



A negative fixed voltage regulator is same as the positive fixed voltage regulator in design, construction & operation. The only difference is in the polarity of output voltages. These IC's are designed to provide a negative output voltage. Example:- 7905, 7906 and all those IC's in the 79XX series.

A negative fixed voltage regulator is same as the positive fixed voltage regulator in design, construction & operation. The only difference is in the polarity of output voltages. These IC's are designed to provide a negative output voltage. Example:- 7905, 7906 and all those IC's in the 79XX series.

CIRCUIT DIAGRAM:-



PROCEDURE:-

Step 1 Connect the circuit diagram as shown in figure.1.

Step 2 Apply the unregulated voltage to the IC 7805 and note down the regulator output voltage. Vary input voltage from 7V to 20V and record the output voltages.

Step 3 Calculate the line regulation of the regulator using the formula.

$$\text{Line Regulation} = \Delta V_O / \Delta V_i.$$

Step 4 Now, fix the input voltage as 15V and vary the load resistance R_L, from 1K to10 K ohms. Note down the regulator output voltage.

Step 5 Calculate the Load regulation of the regulator using the formula.

$$\text{Load Regulation} = \Delta V_O / \Delta I_L.$$

Step 6 Repeat the above procedure for 7809.

RESULT:-

Thus, studied how voltage regulator is used.

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Ensure all connections should be tight before switching on the power supply.
3. Power supply should be switched off after completion of experiment.

QUIZ/ANSWERS:-

Q1. What is the function of a voltage regulator?

Ans. A voltage regulator is used to regulate voltage levels. When a steady, reliable voltage is needed, then the voltage regulator is the preferred device. It generatesa fixed output voltage that remains constant for any changes in an input voltageor load conditions.

Q2. What is IC and how it works?

Ans. An integrated circuit (IC), sometimes called a chip or microchip, is a semiconductor wafer on which thousands or millions of tiny resistors, capacitors, and transistors are fabricated.

Q3. What are IC regulators?

Ans. IC voltage regulators are three-terminal devices that provide a constant DC output voltage that is independent of the input voltage and output load current.

Q4. What is the use of regulator IC in power supply?

Ans. An external rectifier, inductor, and output capacitor produce the regulated dc output. The regulator IC compares a portion of the rectified dc output with a voltage reference (VREF) and varies the PWM duty cycle to maintain a constantdc output voltage.

Q5. What is the function of 7805 IC?

Ans. 7805 IC, a member of 78xx series of fixed linear voltage regulators used to maintain such fluctuations, is a popular voltage regulator integrated circuit (IC). The xx in 78xx indicates the output voltage it provides. 7805 IC provides +5 volts regulated power supply with provisions to add a heat sink

Q6. Which is a three terminal negative voltage regulator IC?

Ans. IC 79xx is a three pin negative voltage controller IC. It is a small integrated circuit used in a circuit to supply a constant negative input voltage. 'xx' can be replaced by the controlled output voltage provided by the regulator, for example, if it is 7905, then the output voltage of the IC is -5 V.

Q7. How does IC 7805 work?

Ans. IC 7805 is a 5V Voltage Regulator that restricts the output voltage to 5V output for various ranges of input voltage. It acts as an excellent component against input voltage fluctuations for circuits, and adds an additional safety.

Q8. What is positive voltage regulator?

Ans. Positive voltage regulation is the action of controlling positive supply voltage.
e.g. If you are trying to provide clean supply (I.e. No noise or ac content) to amicroprocessor that works on 5 V or 1.8 V, then this is positive regulation.

Q9. How do negative voltage regulators work?

Ans. Voltage regulators are very common in electronic circuits. They provide a constant output voltage for a varied input voltage. The name 7905 signifies twomeaning, “79” means that it is a negative voltage regulator and “05” means that it provides 5V as output. So our 7905 will provide a -5V output voltage.

Q10. Which type of regulator is considered more efficient?

Ans. The switching element dissipates negligible power in either on or off state. Therefore, the switching regulator is more efficient than the linear regulators.

LAB EXPERIMENT No. 6

AIM:- To draw characteristics of a transistor.

APPARATUS REQUIRED:- Analog Board, DC Power Supply + 12V external source, Function Generator, Oscilloscope, Digital Multimeters, 2 mm patchcords.

THEORY:- Any two-port network which is analogous to transistor configuration circuits can be analyzed using three types of characteristic curves. They are

- **Input Characteristics:** The curve describes the changes in the values of input current with respect to the values of input voltage, keeping the output voltage constant.
- **Output Characteristics:** The curve is obtained by plotting the output current against output voltage, keeping the input current constant.
- **Current Transfer Characteristics:** This characteristic curve describes the variation of output current in accordance with the input current, keeping the output voltage constant.

Configuration of Transistor

Any transistor circuit can be designed using three types of configuration. Three configurations of the transistor are based on the connection of the transistor terminal. The three types of transistor circuit configurations are:

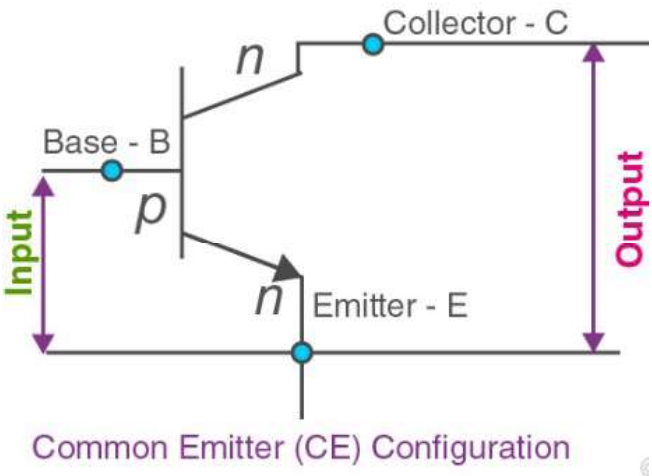
- Common Emitter Transistor
- Common Base Transistor
- Common Collector Transistor(emitter follower).

Each of these three circuit configurations has its own characteristics curve. Based on the requirement the type will be chosen for the circuit.

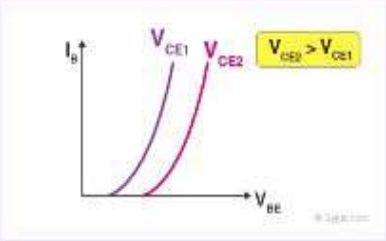
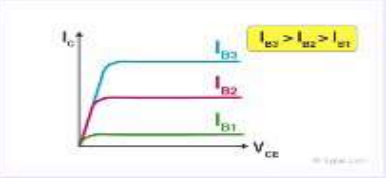
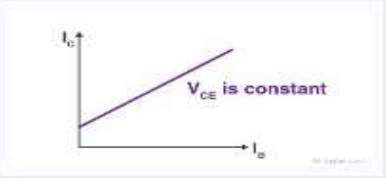
Common Emitter (CE) Configuration of Transistor

The configuration in which the emitter is connected between the collector and base is known as a common emitter configuration.

CIRCUIT DIAGRAM:

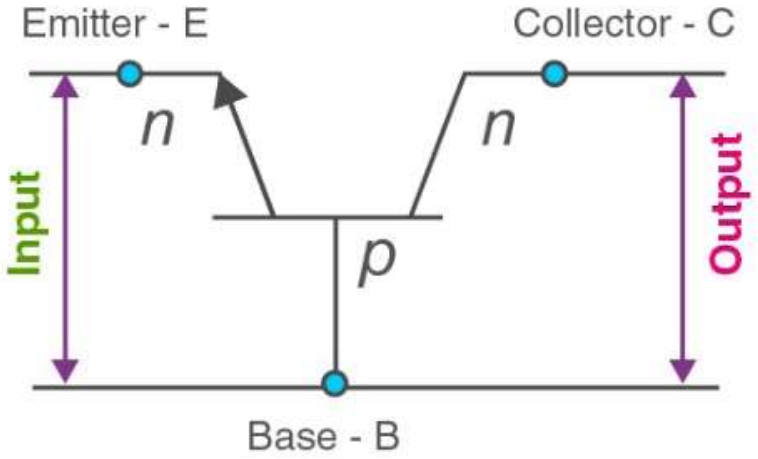


The transistor characteristic under Common Emitter configuration is as follows:

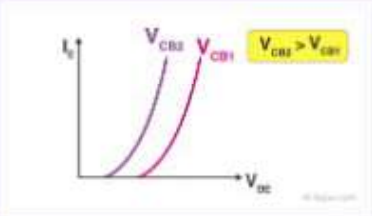
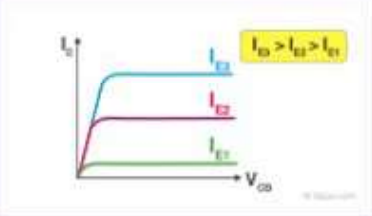
Transistor Characteristics	Definition	Formula/Expression	Characteristic Curve
Input Characteristics	The variation of emitter current(I_B) with Base-Emitter voltage(V_{BE}), keeping Collector Emitter voltage(V_{CE}) constant.	$R_{in} = \frac{\Delta V_{BE}}{\Delta I_B} \mid V_{CE} = Constant$	
Output Characteristics	The variation of collector current(I_C) with Collector-Emitter voltage(V_{CE}), keeping the base current(I_B) constant.	$R_{out} = \frac{\Delta V_{CE}}{\Delta I_C} \mid I_B = Constant$	
Current Transfer Characteristics	The variation of collector current(I_C) with the base current(I_B), keeping Collector-Emitter voltage(V_{CE}) constant. The resulting current gain has a value greater than 1.	$\alpha = \frac{\Delta I_C}{\Delta I_B} \mid V_{CB} = Constant$	

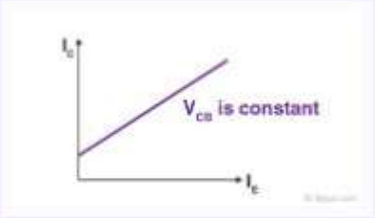
Common Base (CB) Configuration of Transistor

In CB Configuration, the base terminal of the transistor will be connected common between the output and the input terminals.



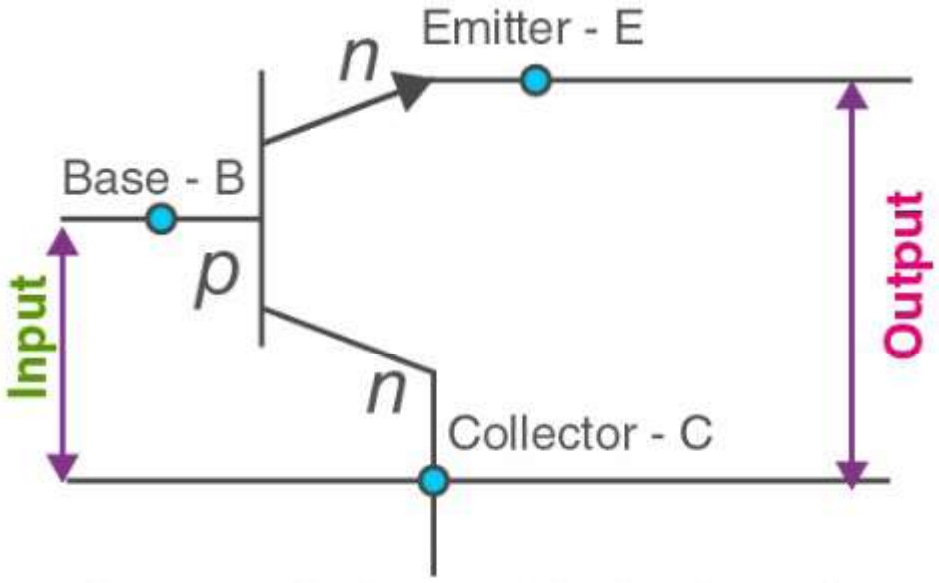
The transistor characteristic under Common Base configuration is as follows:

Transistor Characteristics	Definition	Formula/Expression	Characteristic Curve
Input Characteristics	The variation of emitter current(I_E) with Base-Emitter voltage(V_{BE}), keeping Collector Base voltage(V_{CB}) constant.	$R_{IN} = \frac{\Delta V_{BE}}{\Delta I_E} \mid V_{CB} = Constant$	
Output Characteristics	The variation of collector current(I_C) with Collector-Base voltage(V_{CB}), keeping the emitter current(I_E) constant.	$R_{OUT} = \frac{\Delta V_{CB}}{\Delta I_B} \mid I_E = Constant$	

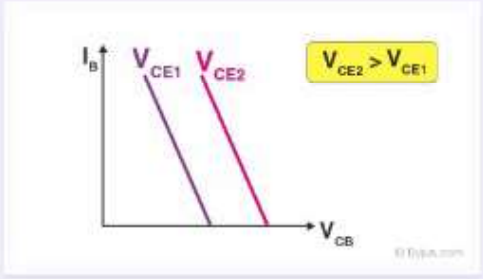
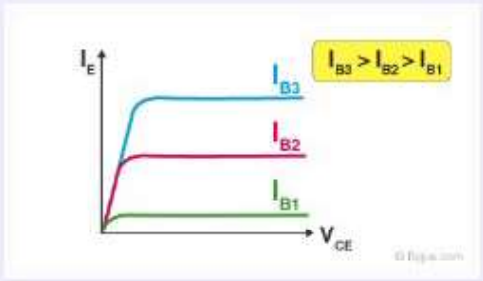
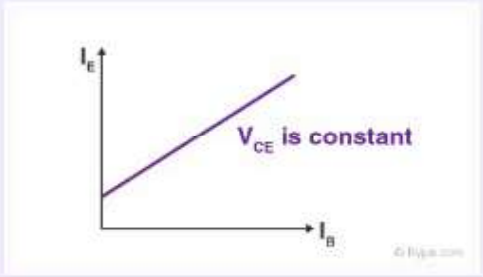
Current Transfer Characteristics	The variation of collector current(I_C) with the emitter current(I_E), keeping Collector Base voltage(V_{CB}) constant. The resulting current gain has a value less than 1.	$\alpha = \frac{\Delta I_C}{\Delta I_B} \mid V_{CB} = Constant$	

Common Collector (CC) Configuration of Transistor

In CE Configuration, the Collector terminal of the transistor will be connected common between the output and the input terminals.



The transistor characteristic under Common Collector configuration is as follows:

Transistor Characteristics	Definition	Characteristic Curve
Input Characteristics	The variation of emitter current(I_B) with Collector-Base voltage(V_{CB}), keeping Collector Base voltage(V_{CB}) constant.	
Output Characteristics	The variation of emitter current(I_E) with Collector-Emitter voltage(V_{CE}), keeping the base current(I_B) constant.	
Current Transfer Characteristics	The variation of Emitter current(I_E) with the base current(I_B), keeping Collector-Emitter voltage(V_{CE}) constant.	

RESULT: The input, output and current characteristics of three configurations has been drawn.

QUIZ/ANSWERES:

Q1: What is a CB transistor configuration?
A: CB stands for Common Base configuration. In this configuration, the base terminal is common between the input and output, while the emitter is the input terminal and the collector is the output terminal. The CB configuration offers high voltage gain, low current gain, and low input impedance.
Q2: What is a CE transistor configuration?
A: CE stands for Common Emitter configuration. In this configuration, the emitter terminal is common between the input and output, while the base is the input terminal and the collector is the output terminal. The CE configuration provides high current gain, medium voltage gain, and moderate input and output impedances.
Q3: What is a CC transistor configuration?
A: CC stands for Common Collector configuration, also known as an emitter follower configuration. In this configuration, the collector terminal is common between the input and output, while the emitter is the input terminal and the base is the output terminal. The CC configuration provides unity voltage gain (approximately), high current gain, and high input impedance.

Q4: What are the characteristics of a CB transistor configuration?

A: The CB configuration has the following characteristics:

- High voltage gain
- Low current gain
- Low input impedance
- Input and output signals are out of phase by 180 degrees
- Commonly used in RF amplifiers and frequency mixers

Q5: What are the characteristics of a CE transistor configuration?

A: The CE configuration has the following characteristics:

- High current gain
- Medium voltage gain
- Moderate input and output impedances
- Input and output signals are in phase
- Commonly used in amplifiers and switching applications

Q6: What are the characteristics of a CC transistor configuration?

A: The CC configuration has the following characteristics:

- Unity (approximately) voltage gain
- High current gain
- High input impedance
- Input and output signals are in phase
- Commonly used as a buffer stage or impedance matching stage between different circuits

LAB EXPERIMENT No. 7

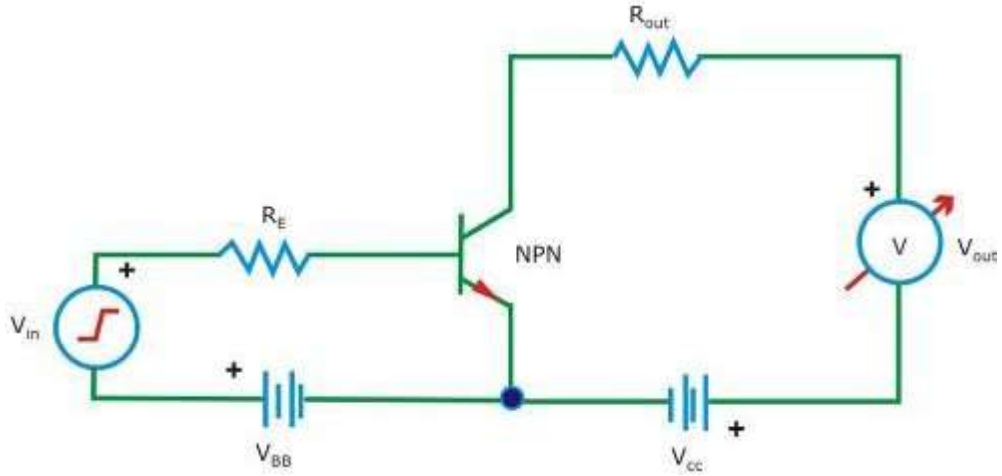
AIM:- To analyze and study CE Amplifier and calculate its gain.

APPARATUS REQUIRED:- Analog Board, DC Power Supply + 12V external source, Function Generator, Oscilloscope, Digital Multimeters, 2 mm patchcords.

THEORY:-

In CE configuration, the input signal is applied between base and emitter and the output is taken from the collector to emitter shown in the figure. The conditions for which transistor works as an amplifier are:

- Emitter Base junction is always forward biased.
- Collector Base junction is always reverse biased.



To achieve this, a DC voltage Vßß is applied in the input circuit in addition to signal shown in figure. This voltage is known as bias voltage and its magnitude is such that it always keeps the input circuit forward biased regardless the polarity of signal.

Input circuit has low resistance, therefore a small change in signal voltage causes an appreciable change in emitter current, this causes almost same change in collector current due to transistor action. The collector current is flowing through high load resistance RC produces a large voltage across it, thus a weak signal applied in the input circuit appears in the amplified form in collector circuit.

Current relations in CE configurations:

$$I_E = I_C + I_B \; I_C$$
$$= \square I_E + I_{CEO}$$
$$I_C = \square I_B$$

Coupling Capacitors: They are used to pass AC input signal and block the DC voltage from the preceding circuit. This prevents DC in the circuitry on the left of coupling capacitor from affecting the bias on transistor. The coupling capacitor also blocks the bias of transistor from reaching the input signal source. It is also called Blocking Capacitor.

Bypass Capacitors: It bypasses all the AC current from the emitter to the ground. Ifthe capacitor C_E is not put in the circuit, the AC voltage developed across R_E will affect the input AC voltage, such a feedback is reduced by putting the capacitor.

Load Resistance: It represents the load resistance is connected at the output. The input to the amplifier is a sine wave that varies a few millivolts. It is introduced intothe circuit by the coupling capacitor and is applied between the base and emitter with proper biasing circuit. As the input signal goes positive, the voltage across the emitter-base junction becomes more positive. This in effect increases forward bias, which causes base current to increase at the same rate as that of the input sine wave.Emitter and Collector currents also increase but much more than the base current. With an increase in collector current, more voltage is developed across R.

Voltage Gain: It is the ratio of output voltage (V_{out}) obtained to input voltage (V_{in}).

$$A_v = V_{out} / V_{in}$$

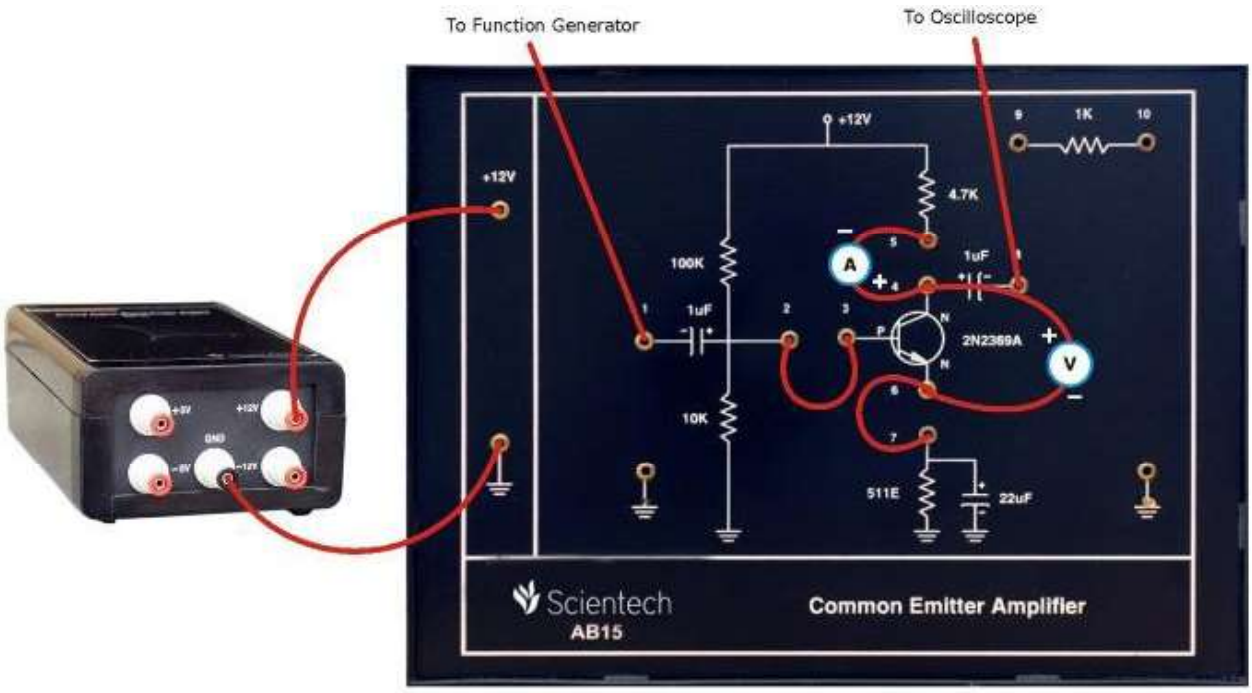
Current Gain: It is the ratio of Output current (I_o) to Input current (I_i).

$$A_i = I_o / I_i$$

The Current gain could be calculated using the equation

$$A_i = A_v \times Z_{in}/R_L$$

CIRCUIT DIAGRAM:-



PROCEDURE:-

Step 1 Connect Test point 2 and Test point 3, Test point 4 and Test point 5, Test point6 and Test point 7, using 2mm patch cords.

Step 2 Connect +12V DC Power Supply at their indicated position from external source.

Step 3 Switch 'On' the Power Supply.

Step 4 For the measurement of Quiescent Point measure the VCE by connecting Voltmeter between Test point 4 and Test point 6. Measure Collector current (I_c) by connecting Ammeter between Test point 4 and Test point 5.

Step 5 Connect a sinusoidal signal of lOmVpp at 25 KHz frequency at the Test point1 (Input of amplifier) from external source.

Step 6 Observe the amplified output on Oscilloscope by connecting Test point 8 (output of amplifier) to Oscilloscope.

Step 7 Calculate Voltage gain of amplifier. Connect Load resistor of 1K ohms at theoutput and find the voltage gain of amplifier with load resistor.

Step 8 Calculate input impedance, output impedance, and current gain of amplifier using the mentioned formulas with resistance 1K Ohm.

RESULT:-

Operating Point of the Common emitter amplifierCollector Current
I_C = 0.57 mA
Collector to Emitter voltage V_{CE} = 8.4 V
Voltage gain of the amplifier A_v= 90 Input
impedance of amplifier Z_{in} = 1K□
Output Impedance of amplifier Z_{out} = 4K□
Current gain of amplifier A_i = 96
Voltage gain reduces as load resistance is connected to circuit.

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supply should be switched off.
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

QUIZ/ANSWERS:-

Q1.The base current amplification factor β is given by_____

Ans. I_C/I_B

Q2. In I_{CEO}, what does the subscript 'CEO' mean?

Ans. The subscript 'CEO' means that it is collector to emitter base open. It is called as the leakage current. It occurs in a reverse bias in PNP transistor. The total current can be calculated by $I_C=\beta I_B+I_C$.

The range of β is _____

Ans. 20 to 500

Q3. Which amplifier is called as voltage follower?

Ans. The common collector transistor amplifier configuration is called as voltage follower. Since it has unity voltage gain and because of its very high input impedance.

Q4. Why biasing of transistor is necessary in amplifier circuit?

Ans. To Fix the value of current amplification

Q5.The configuration in which current gain of transistor amplifier is lowest is

Ans. Common base

Q6.The configuration in which voltage gain of transistor amplifier is lowest is

Ans. Common collector

In the symbols of P-N-P transistors and N-P-N transistor the arrow on the emitter shows the direction of flow of _____

Ans. Holes, holes

A transistor, when connected in CE mode, has_____

Ans. Medium input resistance and high output resistance

The emitter current in a junction with normal bias is_____

Ans. Equal to the sum of I_B and I_C

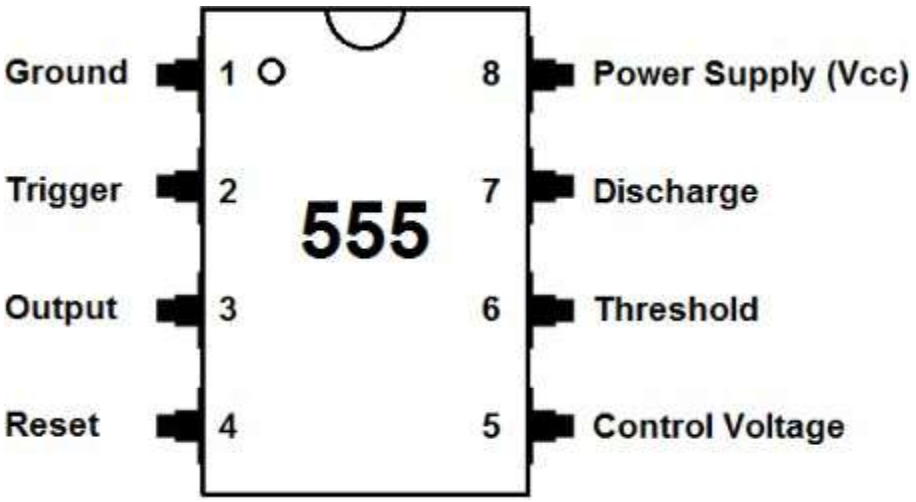
LAB EXPERIMENT No. 8

AIM:- To analyze and study 555 timer as a square wave generator.

APPARATUS REQUIRED:- 555 timer square wave generator kit, connectingwires, CRO 20 MHZ, CRO probes.

THEORY:-

The 555 Timer IC can be connected either in its Monostable mode thereby producing a precision timer of a fixed time duration, or in its Bistable mode to produce a flip- flop type switching action. The 555 Oscillator is another type of relaxation oscillator for generating stabilized square wave output waveforms of either a fixed frequency of up to 500 kHz or of varying duty cycles from 50 to 100%.



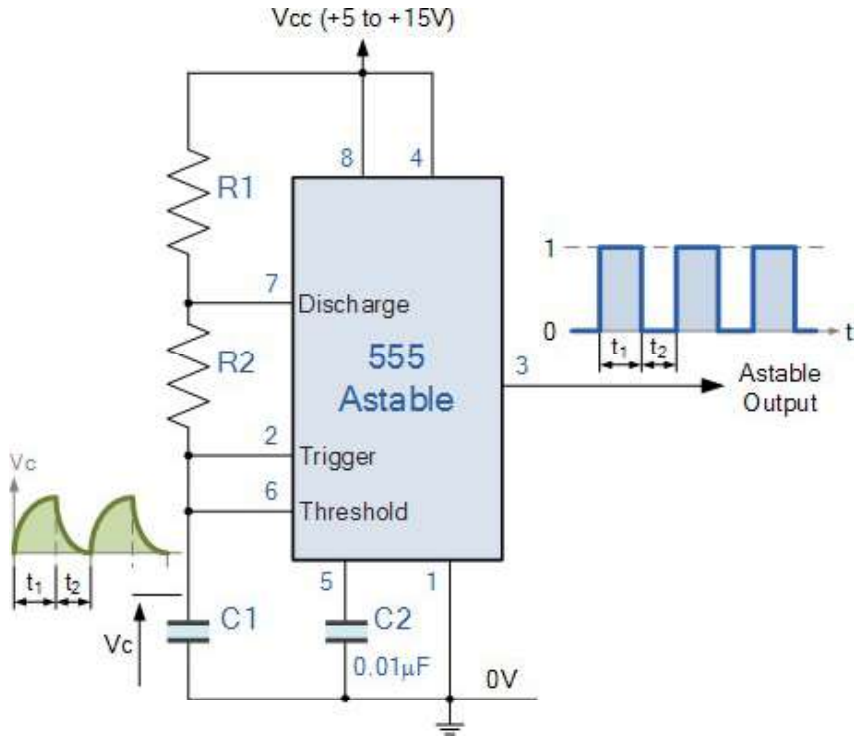
Pin 2 and pin 6 are connected together allowing the circuit to re-trigger itself on each and every cycle allowing it to operate as a free running oscillator. During each cyclecapacitor, C charges up through both timing resistors, R1 and R2 but discharges itselfonly through resistor, R2 as the other side of R2 is connected to the discharge terminal, pin 7. Then the capacitor charges up to 2/3Vcc (the upper comparator limit) which is determined by the 0.693(R1+R2).C combination and discharges itself down to 1/3Vcc (the lower comparator limit) determined by the 0.693(R2*C) combination. This results in an output waveform whose voltage level is approximately equal to Vcc – 1.5V and whose output "ON" and "OFF" time periods are determined by the capacitor and resistors combinations. The individual times required to complete onecharge and discharge cycle of the output is therefore given as:

$$t_1 = 0.693(R_1 + R_2).\ Ct_2 =$$

$$0.693 \times R_2 \times C$$

$$f = \frac{1.44}{(R_1 + 2R_2).C}$$

CIRCUIT DIAGRAM:-



PROCEDURE:-

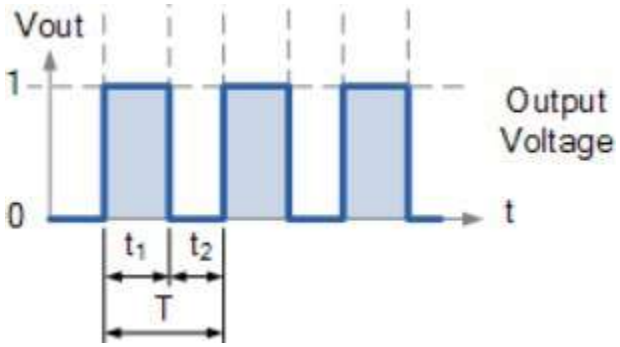
Step 1 Check the components/ Equipment for their working condition.

Step 2 Connections are made as shown in the circuit diagram.

Step 3 Switch on the power supply and observe the output waveforms on CRO andmeasure Td value and verify with the designed value.

Step 4 Observe the waveforms at different points as shown in the waveforms.

WAVE FORMS OBSERVED:-



RESULT:-

Thus Square Wave is obtained on CRO.

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Ensure all connections should be tight before switching on the power supply.
3. Take the reading carefully.
4. Power supply should be switched off after completion of experiment.

QUIZ/ANSWERS:-

What is the comparator?

Ans. Comparator compares two input signal i.e. known voltage with a reference.

How fast can a 555 timer go?

Ans. It can source or sink a maximum output current of 200mA.

What is duty cycle of 555 timer?

Ans. The 555 oscillator now produces a 50-100% duty cycle as the timing capacitor,C1 is now charging and discharging through the same resistor.

How does a 555 timer work in astable mode?

Ans. Astable mode works as a oscillator circuit, in which output oscillate at a particular frequency and generate pulses in rectangular wave form.

How do you make a square wave with a 555 timer?

Ans. It can easily create square waves when in astable mode of operation. This circuit utilizes that principle, that 555 timers can easily generate square wave signals. The potentiometers allow us to vary the frequency of the output signal as well as the amplitude.

What does multivibrator mean?

Ans. A multivibrator is an electronic circuit used to implement a variety of simple two-state devices such as relaxation oscillators, timers and flip-flops.

How do I reset my 555 timer?

Ans. Pin 4 is the reset pin, which can be used to restart the 555's timing operation.

What is the unit of duty cycle?

Ans. Duty cycle is the proportion of time during which a component, device, orsystem is operated. The duty cycle can be expressed as a ratio or as a percentage.

What is a 555 timer used for?

Ans. Pulse generation, to provide time delays, as an oscillator, and as a flip-flopelement.

What is IC 555 threshold?

Ans. Detects when the voltage on the timing capacitor rises above 0.66 Vcc and resets the output when this happens.

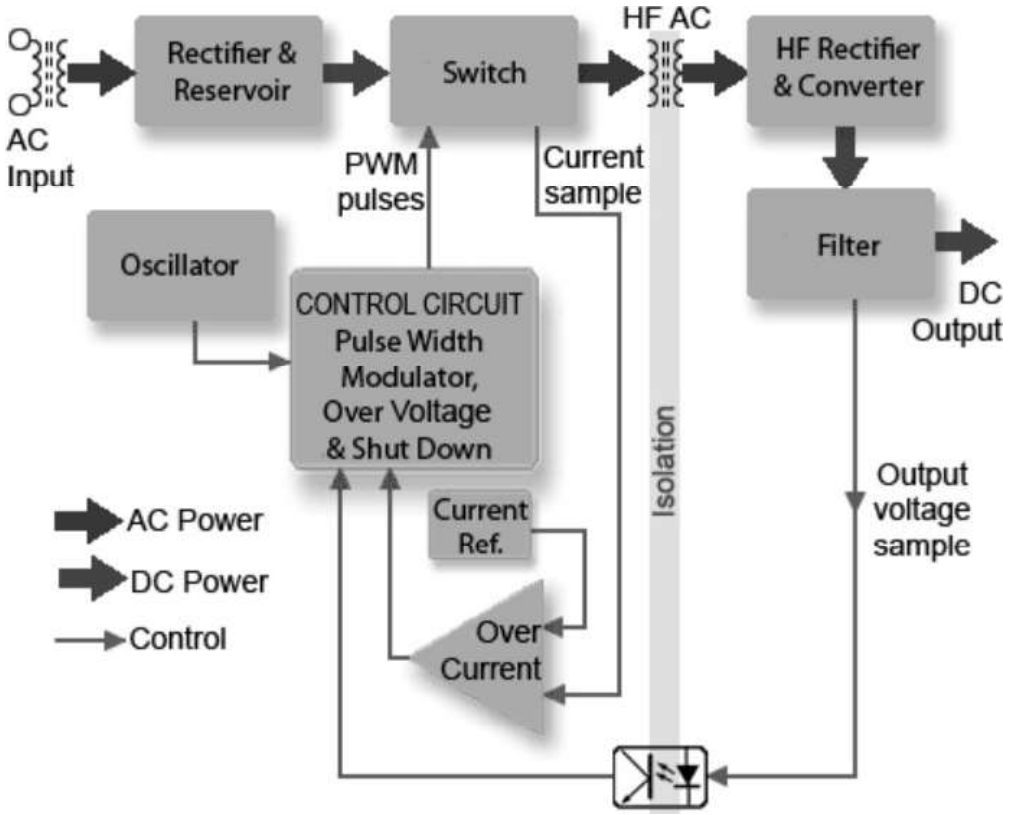
LAB EXPERIMENT No. 9

AIM:- To analyze and study SMPS power supply.

APPARATUS REQUIRED:- SMPS kit, connecting wires.

THEORY:-

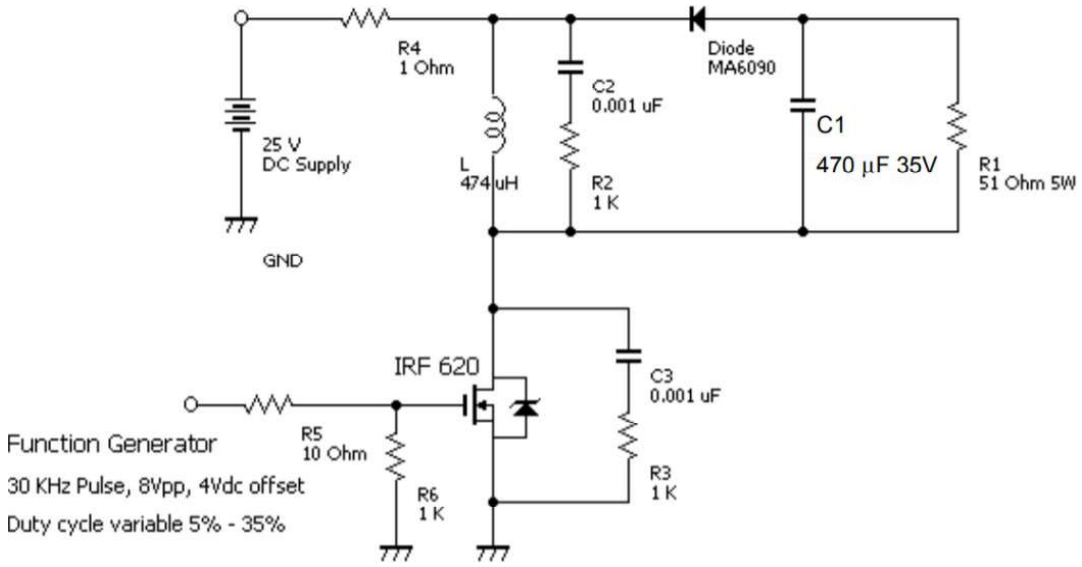
A power supply is an essential part of almost every electronic device and the current trend is towards the miniaturization of these devices. It is thus desirable to also attempt to reduce the size of the power supply and it is possible to achieve this objective by increasing the power density which is attainable by decreasing the sizeof the passive/energy storage components such as the inductors, capacitors and the transformer. The size of these components can also be decreased by increasing the switching frequencies. Basically, it is a device in which energy conversion and regulation is provided by power semiconductors that are continuously switching "on" and "off" with high frequency.



The switching regulator is also called as switched mode regulator. In this case, the pass transistor is used as a controlled switch and is operated at either cutoff or saturated state. Hence the power transmitted across the pass device is in discrete pulses rather than as a steady current flow. Greater efficiency is achieved since the pass device is operated as a low impedance switch. When the pass device is at cutoff,there is no current and dissipated power. Again when the pass device is in saturation,a negligible voltage drop appears across it and thus dissipates only a small amount

of average power, providing maximum current to the load. The efficiency is switchedmode power supply is in the range of 70-90%. A switching power supply is shown in figure. The bridge rectifier and capacitor filters are connected directly to the ac line to give unregulated dc input. The reference regulator is a series pass regulator. Its output serves as a power supply voltage for all other circuits. The transistors Q1,Q2 are alternatively switched 'on' &; off, these transistors are either fully 'on' or 'cut-off, so they dissipate very little power. These transistors drive the primary of the main transformer. The secondary is centre tapped and full wave rectification is achieved by diodes D1 and D2.

CIRCUIT DIAGRAM:-



PROCEDURE:-

Step 1 Make connection as per circuit diagram.

Step 2 Connect positive supply to the circuit.

Step 3 Increase the voltage step by step & note down the corresponding currentvalues.

RESULT:-

Thus the control of SMPS IC SG3524 had been studied.

PRECAUTIONS:-

1. Ensure all connections should be tight before switching on the power supply.
2. Take the reading carefully.
3. Power supply should be switched off after completion of experiment.

QUIZ/ANSWERS:-

Q 1.What are the 3 types of power supply?

Ans. Unregulated, linear regulated, and switching.

Q 2. What is SMPS?

Ans. A switched-mode power supply (SMPS) is an electronic circuit that converts power using switching devices that are turned on and off at high frequencies, and storage components such as inductors or capacitors to supply power when the switching device is in its non-conduction state.

Q 3. Why SMPS is used?

Ans. SMPS provide improved efficiency & space saving over traditional linear supplies.

Q 4. What is linear power supply?

Ans. Power supply is regulated to provide the correct voltage at the output. Sometimes the sensing of the voltage may be accomplished at the output terminals, or on some occasions it may be achieved directly at the load.

.Q 5 What is the working principle of SMPS?

Ans. A series switching element switches the current supply to a smoothing capacitor turn ON and OFF. The voltage on the smoothing capacitor controls the time when the series element is switched.

Q 6. What is the difference between linear power supply and SMPS?

Ans. Linear power supply converts the high voltage of AC into low voltage AC first then the rectification procedure takes place. On the contrary, the SMPS converts the AC signal into DC signal first then the stepping down of voltage signal takesplace.

Q 7. What is the uses of SMPS?

Ans. Short for Switched-Mode Power Supply, SMPS is a power supply that uses a switching regulator to control and stabilize the output voltage by switching the load current on and off. These power supplies offer a greater power conversionand reduce the overall power loss.

Q 8. What are types of SMPS?

Ans. AC-DC converter, DC-DC converter, Forward Converter and Flyback converter.

Q 9. How is AC converted to DC?

Ans. A rectifier is an electrical device that converts alternating current (AC), which periodically reverses direction, to direct current (DC), which flows in only one direction. The process is known as rectification.

Q 10. What are the symptoms of SMPS failure?

Ans. Any power-on or system startup failures or lockups, spontaneous rebooting or intermittent lockups during normal operation, intermittent parity check or othermemory-type errors.

LAB EXPERIMENT No. 10

AIM:- To analyze and study working of Push-Pull amplifier.

APPARATUS REQUIRED:- Analog Board, AB22, Variable DC Power Supply

+12V from external source, Function Generator, Oscilloscope, Digital Multimeter, 2mm patch cords.

THEORY:-

The power amplifiers are the amplifiers which deliver maximum undistorted symmetrical output voltage swing to the low impedance load. Generally any system (like a Stereo, Radio or Television) consists of several stages of amplification. When the signal passes through these stages, the power level of signal rises so much that the later stages require high power handling circuit elements such as power transistors. Also as the load impedance of these later stages is very small (of the orderof 8 ohm for stereo amplifier speakers), heavy collector current flows. To handle this,transistors Raving power rating of 1W or more are used in power amplifiers.

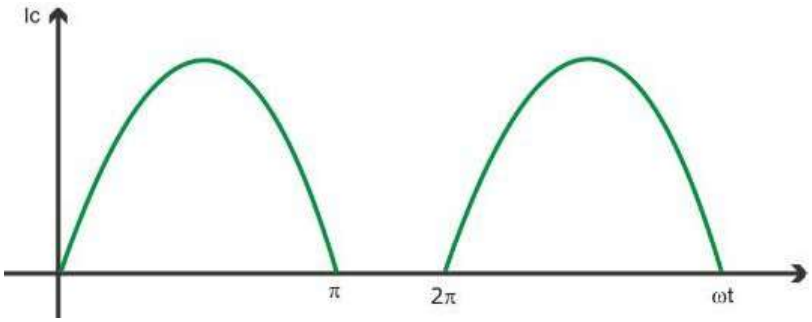
Power amplifiers are broadly classified as:

- Class A (Voltage Amplifier)
- Class B (Push-Pull Emitter Follower)
- Class C

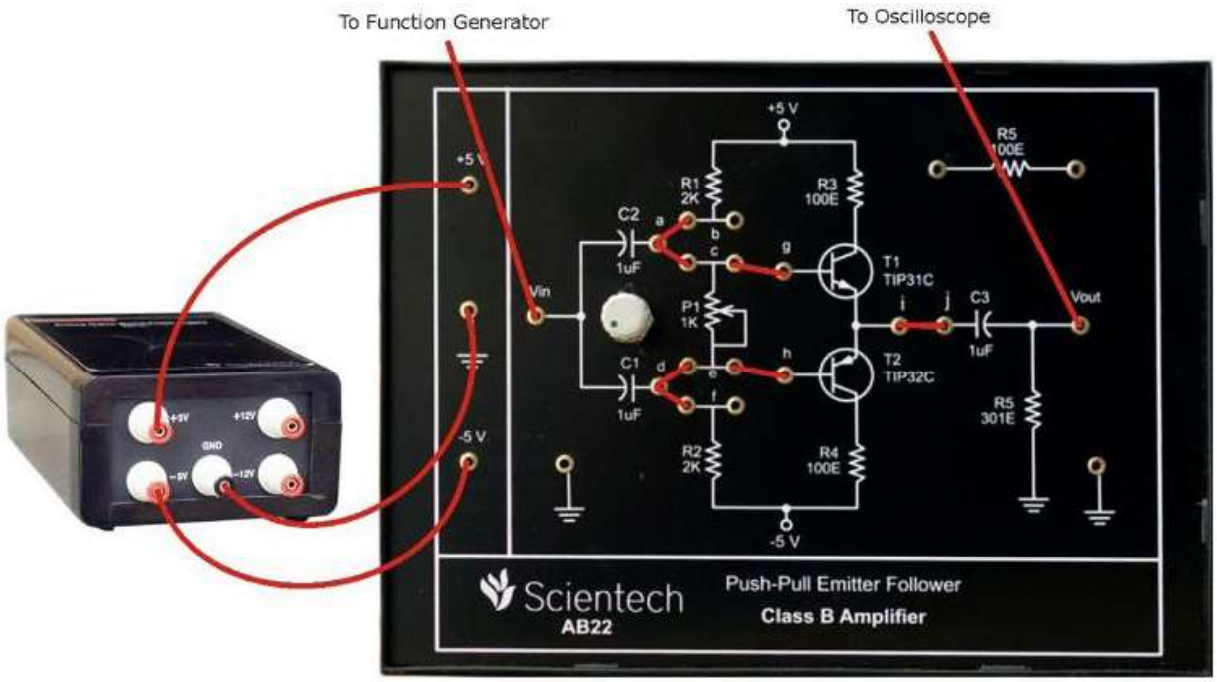
Class B Amplifier:

Class B amplifier is a circuit in which transistor conducts (Collector Current Flows)for only 1800 of input AC signal. When a signal is applied, one half cycle will forward bias the base-emitter junction and I will flow. The other half cycle will reverse bias the base-emitter junction and I will be cut off.

For class B amplifiers the Q point is located near the cutoff point of the AC load line. Thus, to amplify entire input AC signal a combination of two Class – B amplifiers are used. One of which amplifies positive half cycle of input AC signal and the otheramplifies negative half cycle of input AC signal. This amplifier configuration is known as push-pull or complementary symmetry. In the push pull configuration it is important to match the two transistors carefully for the proper amplification of boththe halves.



CIRCUIT DIAGRAM:-



PROCEDURE:-

Step 1 Connect +5V and -5V DC Power Supply at their indicated position from external source.

Step 2 Connect AC signal (1 KHz) at the V,. input of the AB22.

Step 3 Connect Patch Cord between (a and b), (a and c), (c and g), (d and e), (d and f), (e and h) and (I and j).

Step 4 Put the potentiometer P1 to its minimum position i.e. rotate it fully anticlockwise. (This is the condition when no bias voltage is applied to the emitterdiodes of both the transistors).

Step 5 Connect Oscilloscope at the output terminals of AB22 and observe the outputwaveform. The crossover distortion can be clearly observed on the Oscilloscope. **Step 6** Gradually increase the bias voltage by increasing bias resistance (i.e. rotate thepotentiometer in clockwise direction) up to the value when the crossover distortion is completely removed and maximum amplification of the input signal is obtained.

Step 7 Connect the input AC signal to the Class B amplifier through 100 ohms seriesresistance.

RESULT:-

Input AC Voltage Amplitude (V_{in}) = 2 V_{P-P}

Input Impedance (Z_{in}) = V_{in} / I_i = R_S / [A_V / A_V -1] = 800 □

Input Current (I_i): 2.5 □A

Output AC Voltage Amplitude (V_{OUT}): 1.8 V_{P-P}

Output Impedance (Z_{OUT}) = V_{OUT} / I_O = [A_V /A_V -1] * R_S = 112.5 □

Output Current (I_O): 14 □A Power

Gain (A_P): 2.16 approx

PRECAUTIONS:-

1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supply should be switched off.
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

QUIZ/ANSWERS:-

Why push pull amplifier is called so?

Ans. A Push-Pull Amplifier combines two signals to form a third signal The circuit is called a Push-Pull because one transistor pushes in one direction whilethe other pulls in another direction. Both transistors are NPN types in this case.A common small signal BJT is the 2N2222 NPN Transistor [low power].

How do you calculate conversion efficiency?

Ans. Efficiency is measured simply by dividing the output power in watts by the input power in watts and is expressed as a percentage. In power electronics, the Greek letter eta (η) is used to represent efficiency.

Which power amplifier has maximum efficiency?

Ans. Class C Amplifier – is the most efficient amplifier class but distortion is very high as only a small portion of the input signal is amplified therefore the output signal bears very little resemblance to the input signal.

What is complementary push pull amplifier?

Ans. Push-pull amplifiers use two "complementary" or matching transistors, one being an NPN-type and the other being a PNP-type with both power transistors receiving the same input signal together that is equal in magnitude, but in opposite phase to each other.

What is Class C amplifier?

Ans. Class C power amplifier is a type of amplifier where the active element(transistor) conduct for less than one half cycle of the input signal. Less than one half cycle means the conduction angle is less than 180° and its typical valueis 80° to 120°. Theoretical maximum efficiency of a Class C amplifier is around90%.

What are the advantages of push pull amplifier?

Ans. Advantages of push pull amplifier are low distortion, absence of magnetic saturation in the coupling transformer core, and cancellation of power supply ripples which results in the absence of hum.

What are the disadvantages of push pull amplifier?

Ans. The disadvantages are the need of two identical transistors and the requirement of bulky and costly coupling.

What is crossover distortion and how it is eliminated?

Ans. By applying a small base bias voltage either by using a resistive potential divider circuit or diode biasing this crossover distortion can be greatly reducedor even eliminated completely by bringing the transistors to the point of being just switched "ON".

What is the efficiency of Class B amplifier?

Ans. That means the conduction angle is 180° for a Class B amplifier. Since the active device is switched off for half the input cycle, the active device dissipates less power and hence the efficiency is improved. Theoretical maximum efficiency of Class B power amplifier is 78.5%

What is meant by harmonic distortion?

Ans. Harmonic distortion is defined as the ratio of harmonics to fundamental when a (theoretically) pure sinewave is reconstructed, and is the most common specifications

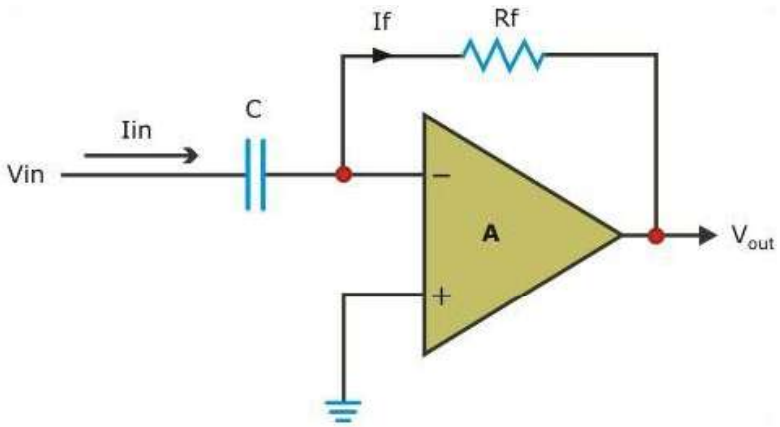
LAB EXPERIMENT No. 11.(BEYOND THE SYLLABUS)

AIM:- To observe Op amp as Differentiator and Integrator.

APPARATUS REQUIRED:- Scientech 2322 TechBook with Power Supply cord,Oscilloscope, 2 mm patch cords.

THEORY:-

Differentiator: As its name implies, the circuit performs the mathematical operation of differentiator; that is the output waveform is the derivative of the input waveform.Figure shows the differentiator or differentiation Amplifier. The differentiator may be constructed from a basic inverting Amplifier if an input resistor R1 is replaced bya capacitor Cl.



The expression for the output voltage is given by:

$$I_{IN} = I_F \text{ and } I_F = -\frac{V_{out}}{R_F}$$

The Charge on the Capacitor = Capacitance x Voltage across the Capacitor

$$Q = C \text{ X } V_{IN}$$

The rate of change of this charge is

$$\frac{dQ}{dt} = C\,\frac{dV_{IN}}{dt}$$

But dQ/dt is the capacitor current i

$$i_{IN} = C\,\frac{dV_{IN}}{dt} = I_F$$

Therefore,

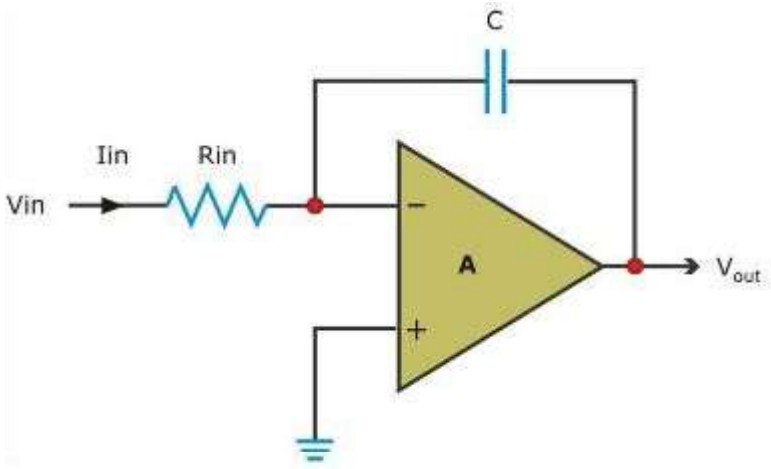
$$-\frac{V_{out}}{R_F} = C\,\frac{dV_{IN}}{dt}$$

From which we have an ideal voltage output for the Differentiator Amplifier is givenas:

$$V_{OUT} = -R_F C \frac{dV_{IN}}{dt}$$

Thus the output V_0 is equal to the R_F C_1 times the negative instantaneous rate of change of the input voltage V_{IN} with time.

Integrator: A circuit in which the output voltage waveform is the integral of the input voltage waveform is the integrator or the integration Amplifier. Such a circuit is obtained by using a basic inverting Amplifier configuration if the feedback resistor RF is replaced by a capacitor CF as shown in figure.



The expression for the output voltage V_{OUT} is given by:

$$\upsilon_o = -\frac{1}{R_1 C_F}\int_0^t \upsilon_{in}\, dt + C$$

PROCEDURE:-

Differentiator:

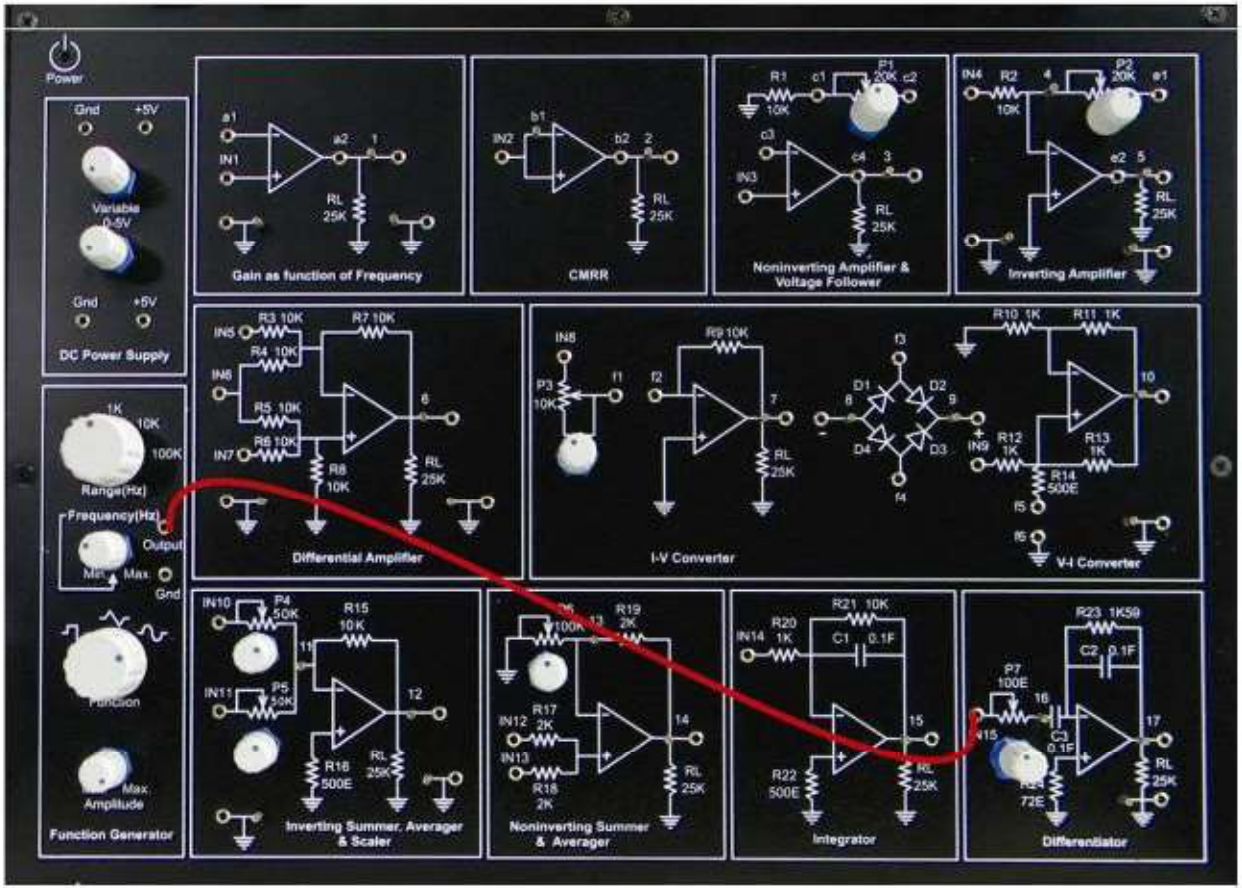
Step 1 Set the Potentiometer P7 at 82□.

Step 2 Connect the on board Function Generator probe at socket 'IN 15'.

Step 3 Set the 1V, 1 KHz input sinusoidal signal of Function Generator and observethe input at Oscilloscope CH II.

Step 4 Observe the output waveform between sockets '16' and ground, onOscilloscope CH I.

Step 5 Observe the output signal's amplitude, wave shape and its phase differencewith the input signal.



Step 6 Verify that the output is cosine wave with 1800 phase shift between input and output.

Step 7 Set the 1V, 1 KHz input triangle signal of Function Generator and observe theinput at Oscilloscope CH II.

Step 8 Observe the output signal's amplitude, wave shape and its phase differencewith the input signal.

Step 9 Verify that the output is square wave with 180° phase shift between input andoutput.

Step 10 Set the 1V, 1 KHz input square signal of Function Generator and observe theinput at Oscilloscope CH II.

Step 11 Observe the output signal's amplitude, wave shape and its phase differencewith the input signal.

Step 12 Verify that the output is spikes.

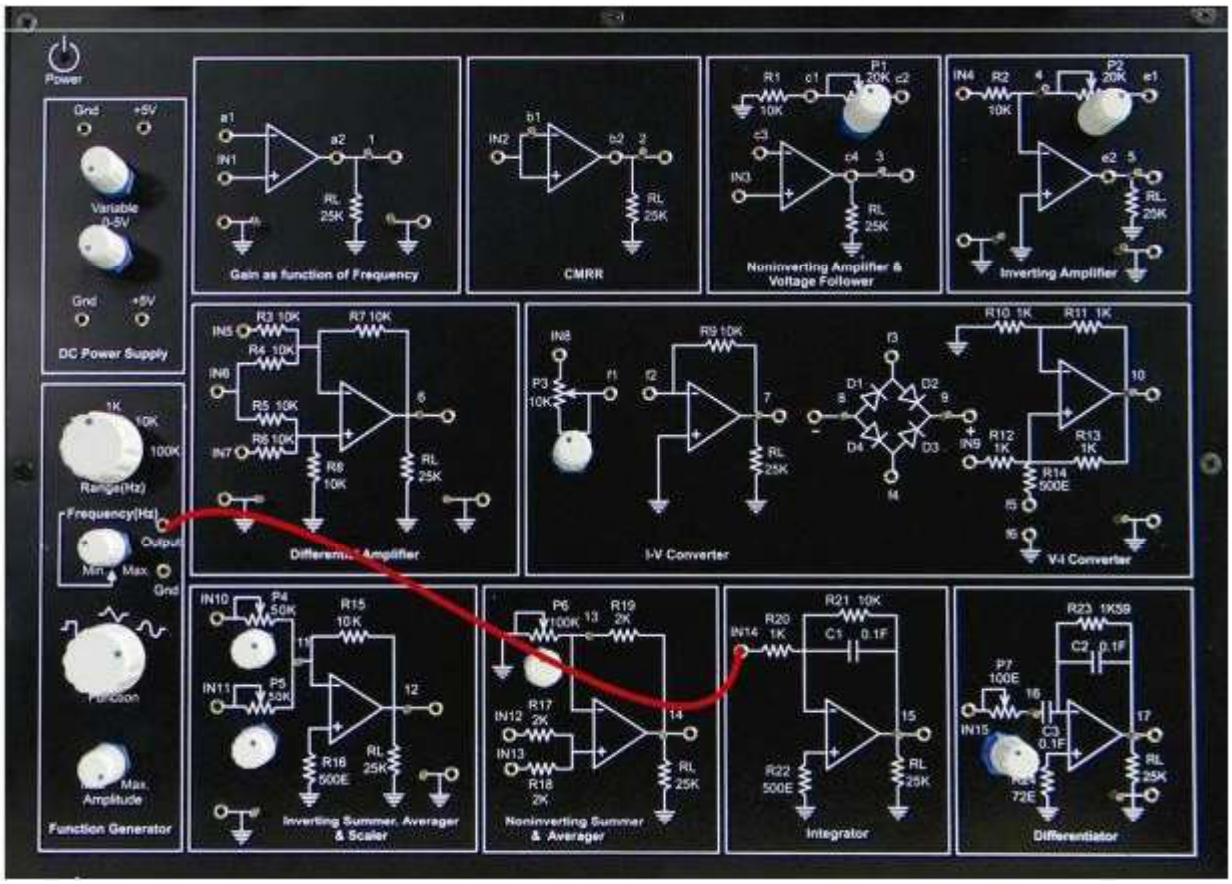
Integrator:

Step 1 To observe the working of integrator.

Step 2 Connect the on board Function Generator probe at socket 'IN 14'.

Step 3 Set the 1V, 1 KHz input sinusoidal signal of Function Generator and observethe input at Oscilloscope CH II.

Step 4 Observe the output waveform between sockets '15' and ground, onOscilloscope CH I.



Step 5 Observe the output signal's amplitude, wave shape and its phase differencewith the input signal.

Step 6 Verify that the output is cosine wave with 180□ phase shift between input andoutput.

Step 7 Set the 1V, 1 KHz input triangle signal of Function Generator and observe theinput at Oscilloscope CH II.

Step 8 Observe the output signal's amplitude, wave shape and its phase differencewith the input signal.

Step 9 Verify that the output is sine wave with 180□ phase shift between input andoutput.

RESULT:-

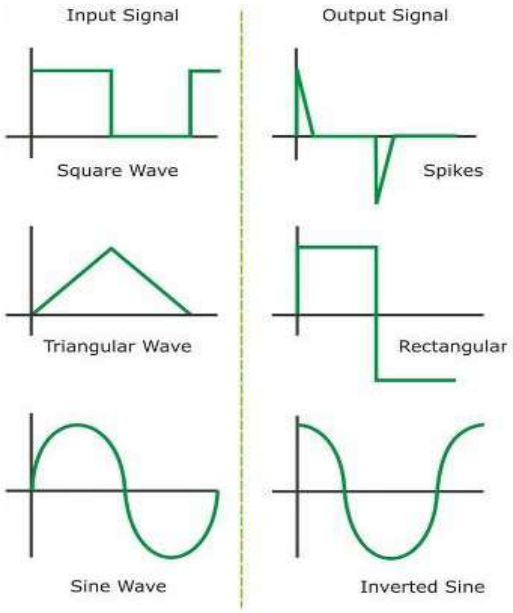
The input and output signal are in accordance of observation diagram.

PRECAUTIONS:-

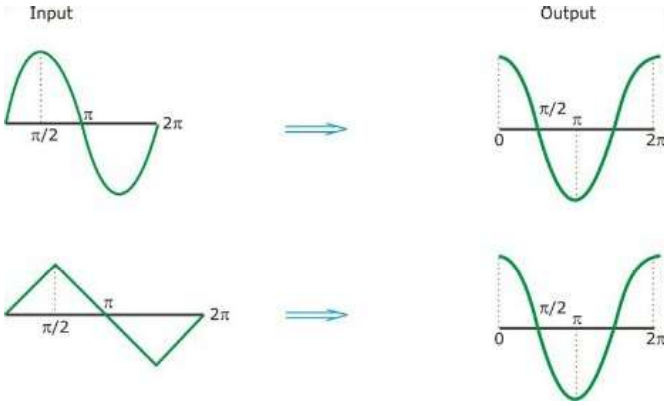
1. Do not use open ended wires for connecting to 230 V power supply.
2. Before connecting the power supply plug into socket, ensure power supply should be switched off.
3. Ensure all connections should be tight before switching on the power supply.
4. Take the reading carefully.
5. Power supply should be switched off after completion of experiment.

WAVE FORMS OBSERVED:-

Differentiator: If we apply a constantly changing signal such as a Square-wave, Triangular or Sine-wave type signal to the input of a differentiator Amplifier circuitthe resultant output signal will be changed and whose final shape is dependent upon the RC time constant of the Resistor/Capacitor combination.



Integrator:



QUIZ/ANSWERS:-

What are the stages required for constructing an operational Amplifier?

Ans. The Op amp is constructed from several transistor stages, which commonly include a differential-input stage, an intermediate-gain stage and a push-pull output stage.

What is operational Amplifier?

Ans. The Op amp is basically a differential Amplifier having a large voltage gain, very high input impedance and low output impedance. The Op amp has an "inverting" or (-) input and "non-inverting" or (+) input and a single output.

What are the operating voltages required for operational Amplifier?

Ans. The Op amp is usually powered by a dual polarity Power Supply in the range of ±5 volts to ±15 volts.

Define Maximum Output Voltage Swing?

Ans. The maximum output voltage, ±VOM, is defined as the maximum positive or negative peak output voltage that can be obtained without wave form clipping, when quiescent DC output voltage is zero.

Define CMRR and what should be its ideal value?

Ans. Common-mode rejection ratio, CMRR, is defined as the ratio of the differential voltage amplification to the common-mode voltage amplification, CMRR = A_D/A_{CM}. Ideally this ratio would be infinite with common mode voltages beingtotally rejected.

What is differentiator?

Ans. The differentiator may be constructed from a basic inverting Amplifier if an input resistor R_1 is replaced by a capacitor C_1.

What are the steps of designing a differentiator?

Ans. A workable differentiator can be designed by implementing the following steps:

i. Select F_a equals to the highest frequency of the input signals to be differentiated. Then, assuming a value of $C_1 < 1$ □, calculate the value of R_F.
ii. Choose Fb = 10 Fb and calculate the value of R_1 and C_F so that $R_1C_1 = R_FC_F$.

What is non inverting Amplifier?

Ans. The Non-inverting Amplifier is an Amplifier in which the output signal is in phase with input signal with some amplification.

What is the function of feed-back resistance in non-inverting Amplifier?

Ans. The function of RF is to protect the inverting input from an over voltage to limit the current through the input ESD (electro-static discharge) structure (typically
< 1 mA), and it can have almost any value (20 k is often used). RF can never beleft out of the circuit in a current feedback Amplifier design because RF determines stability in current feedback Amplifiers.

What is integrator?

Ans. A circuit in which the output voltage waveform is the integral of the input voltage waveform is the integrator or the integration Amplifier.

This lab manual has been updated by

Er. Monika Rani

monika.rani@ggnindia.dronacharya.info

Cross checked by

HOD / EEE & ECE