

ELECTRONIC CIRCUIT ANALYSIS-II

LABORATORY MANUAL

(II/IV ECE 2nd Semester)



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Mission

The Department aims to bring out competent young Electronics & Communication Engineers by achieving excellence in imparting technical skills, soft skills and the right attitude for continuous learning.



Course Objective

1. To Analyze and verify the characteristics and frequency response of feedback amplifiers and sinusoidal oscillators.
2. To understand and analyze different power amplifier circuits
3. To design tuned voltage amplifiers for different applications
4. To verify different applications of op-amp
5. To verify the operation of a MOSFET

Course Outcomes

After successful completion of the course, the students shall be able to –

- C01.** Design and identify the applications of feedback amplifiers and sinusoidal oscillators in different electronic circuits.
- C02.** Design and implement different power amplifiers and tuned voltage amplifiers.
- C03.** Calculate the parameters of BJT differential amplifier
- C04.** Apply op-amps fundamentals in design and analysis of op-amps applications.
- C05.** Apply the MOSFET inverter in different electronic circuits

CO-PO Mapping

CO	PO1	PO2	PO3	PO4	PO10	PS01	PS02	PS03
C01	2	2	2	2	2	2	-	2
C02	2	2	2	2	2	2	-	2
C03	1	2	2	1	2	2	-	2
C04	2	2	3	2	2	2	-	2
C05	2	1	2	2	2	2	-	2

Correlation levels 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Scheme of Evaluation
(ECA-I and ECA-II Labs)

Total marks for each student to evaluate in lab: 100 marks

Out of 100 marks:

- External exam Evaluation: 50 marks
 - Internal Evaluation: 50 marks
- Internal exam: 25 marks
Assessing a student in each lab: 25 marks

EXTERNAL EXAMS (50 Marks)			
S.No.	Lab exam assessment		Marks allotted
1.	Write Up-Aim, apparatus, Circuit diagram		05
2.	Procedure		05
3.	Tabular columns , Theoretical calculations(if any),Formulas		05
4.	Model graphs & precautions		05
5.	Performance		10
6.	Results & graph		10
7.	Viva		10
TOTAL MARKS			50
INTERNAL EVALUATION (50 Marks)			
1.	Internal Exam at the end of semester(Marks division same as above)		25
2.	Evaluation in lab		
	Observation(write up for every experiment)	5	25
	Viva (viva in every lab)	5	
	Record Aim & apparatus-1mark Circuit diagram and procedure-3 marks Theory-3 marks Calculations and tables-2 marks Result-1marks	10	
	Attendance >90% - 5 marks >80% - 90% - 4 marks >75% - 80% - 3 marks >=66% - 75% -2 marks <66% - No Marks	5	
	Total marks:		

Physical lab Incharge:

Dr.V.Rajya Lakshmi

Ms.Ch.Anoosha

HOD,ECE

MAJOR EQUIPMENT IN EDC-I LABORATORY

S.NO	DESCRIPTION	MAKE	QUANTITY
1.	20 MHz, 25MHz&30MHz DUAL TRACE OSCILLOSCOPE	SCIENTECH/SCIENTIFIC/ CADDO/FALCON	38
2.	1 MHz FUNCTION GENERATOR WITH DIGITAL DISPLAY	SCIENTECH/SCIENTIFIC/ SYSTRONICS/FUTURE TECH/METRAVI/APLAB	38
3.	TRPS 0-30V, 2A DUAL CHANNEL	ITL HYD/FALCON	20
4.	TRPS 0-30V, 2A SINGLE CHANNEL	ITL HYD	10
5.	AC MICRO VOLTMETER	SYSTRONICS	10
6.	DC MICRO VOLTMETER	SYSTRONICS	10
7.	BENCH TOP DIGITAL MULTIMETER	METRAVI/APLAB	13
8.	31/2 DIGITAL MULTIMETER	CIE	16

TOTAL EXPENDITURE OF LABORATORY : Rs. 14,89,992.29

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1. CURRENT SERIES FEEDBACK AMPLIFIER

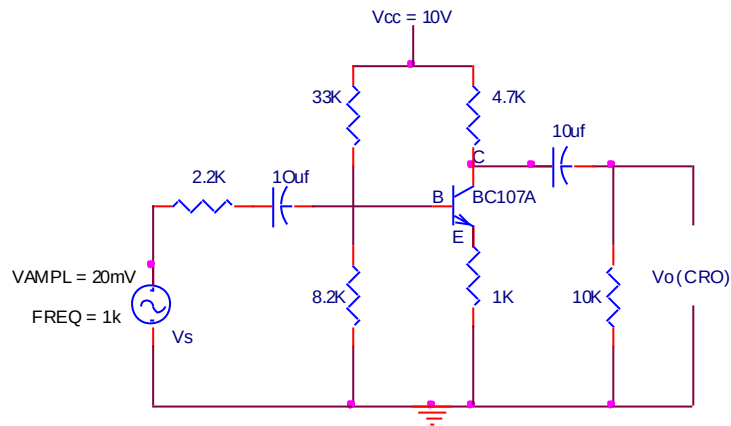
AIM:

To obtain the frequency response characteristics of a Current Series amplifier with and without feedback and Obtain the bandwidth.

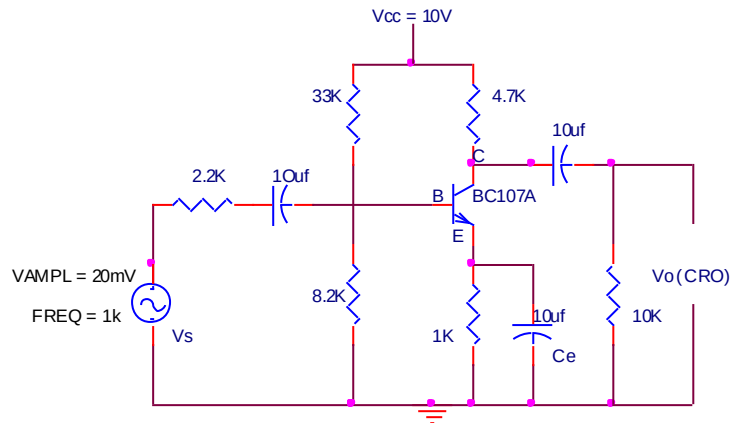
APPARATUS :

Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No
Resistors	1k Ω ,4.7k,8.2k	1 No
Resistors	2.2k,33k,10K	1 No
Capacitors	10 μ F	3 No ,
Transistors	BC107	1 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAMS :-



CURRENT SERIES AMPLIFIER WITH FEEDBACK



CURRENT SERIES AMPLIFIER WITHOUT FEEDBACK

PROCEDURE :

1. Connections are made as per the circuit diagram.
2. A 10V supply is given to the circuit.
3. The circuit is connected for with feedback, i.e., without bypass capacitor.
4. A certain amplitude of input signal is kept constant using signal generator and for different frequencies, the output voltage from CRO are noted.
5. Now, the circuit is connected for without feedback i.e., with bypass capacitor C_E and R_E in the circuit.
6. By keeping the input signal constant, the output voltage for different frequencies are noted.
7. Gain for with and without feedback is calculated using

$$\text{Gain} = 20 \log V_o / V_i \text{ (dB)}$$

Where V_o is output voltage, V_i is input voltage.

TABULAR FORM : WITH FEEDBACK $V_i =$

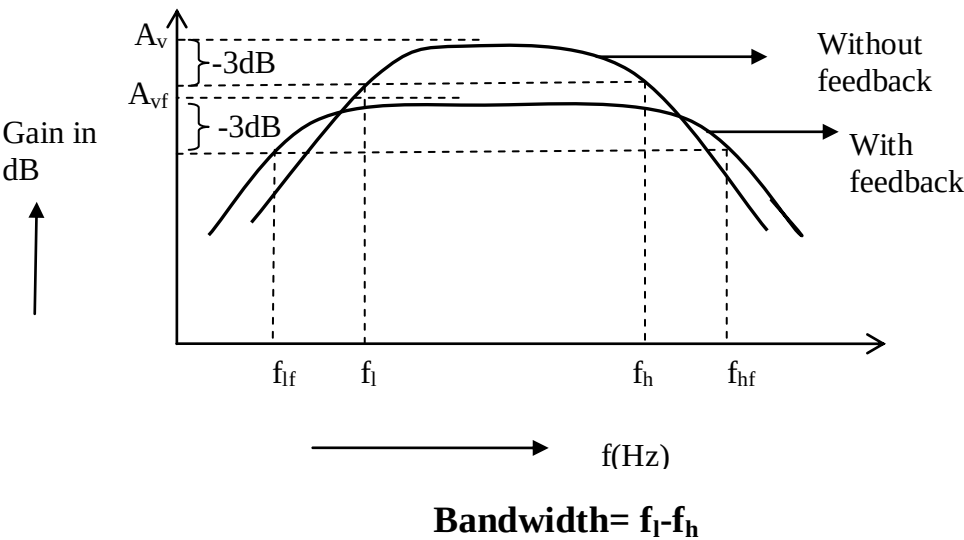
INPUT FREQUENCY (Hz)	O/P Voltage(V_o) (V)	Voltage gain $AV = V_o/V_i$	Gain in dB = $20 \log AV$
100			
200			
300			
500			
700			
1k			
2k			
3k			
5k			
7k			
10k			
20k			
30k			
50k			
70k			
100k			
200k			
300k			
500k			
700k			
1M			

WITHOUT FEEDBACK:

$V_i =$

INPUT FREQUENCY (Hz)	O/P VOLTAGE (Vo)	Voltage gain $A_V=V_o/V_i$	Gain in dB = $20 \log A_V$
100			
200			
300			
500			
700			
1k			
2k			
3k			
5k			
7k			
10k			
20k			
30k			
50k			
70k			
100k			
200k			
300k			
500k			
700k			
1M			

MODEL GRAPH :



GRAPH:

A graph is plotted between gain (dB) and frequency (Hz) for both with and without feedback.

PRECAUTIONS:

1. Connections must be made with proper polarity.
2. Avoid loose and wrong connections.

QUESTIONS:

1. What is the relationship between the transfer gain with feedback A_f and that without feedback A .
A. $A_f = A / (1 + A\beta)$
2. Define negative feedback.
A. The amount of feedback applied is subtracted from the input to get negative feedback.
3. What are the advantages of negative feedback.
A. High BW, less noise, less distortion, gain stability
4. How is the i/p impedance and o/p impedance of a current shunt feedback amplifier
A. $R_{if} = R_i / (1 + A\beta)$, $R_{of} = R_o (1 + A\beta)$

RESULT:

The frequency response characteristics of current series amplifier with & without feedback and bandwidth are obtained.

2. PARAMETERS CALCULATION OF A CURRENT SERIES FEEDBACK AMPLIFIER

AIM:

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

APPARATUS :

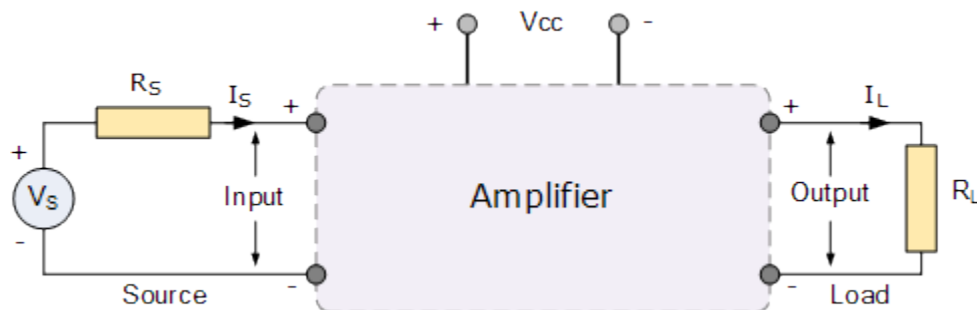
Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No
Resistors	1k Ω ,4.7k,8.2k	1 No
Resistors	2.2k,33k,10K	1 No
Capacitors	10 μ F	3 No ,
Transistors	BC107	1 No
Bread board		
CRO Probes		

Theory:

An amplifiers impedance value is particularly important for analysis especially when cascading individual amplifier stages together one after another to minimise distortion of the signal.

The *input impedance of an amplifier* is the input impedance “seen” by the source driving the input of the amplifier. If it is too low, it can have an adverse loading effect on the previous stage and possibly affecting the frequency response and output signal level of that stage. But in most applications, common emitter and common collector amplifier circuits generally have high input impedances.

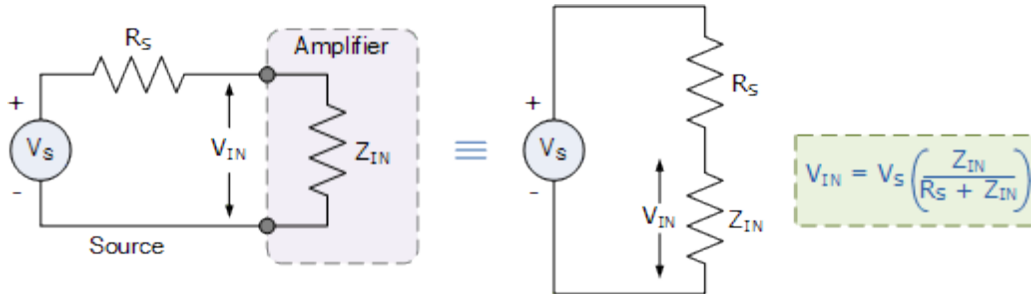
Output and Input Impedance Model



Where, V_s is the signal voltage, R_s is the internal resistance of the signal source, and R_L is the load resistance connected across the output. We can expand this idea further by looking at how the amplifier is connected to the source and load.

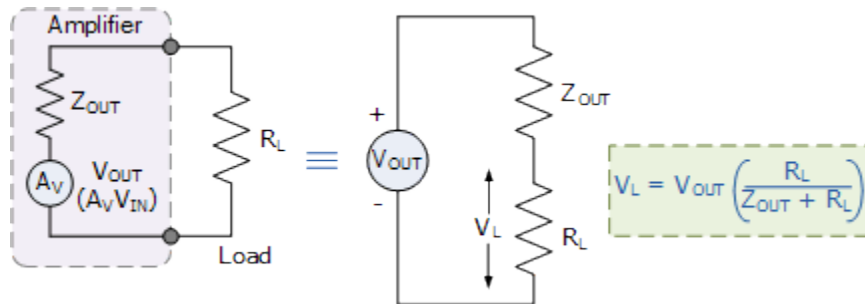
When an amplifier is connected to a signal source, the source “sees” the input impedance, Z_{in} of the amplifier as a load. Likewise, the input voltage, V_{in} is what the amplifier sees across the input impedance, Z_{in} . Then the amplifiers input can be modelled as a simple voltage divider circuit as shown.

Amplifier Input Circuit Model



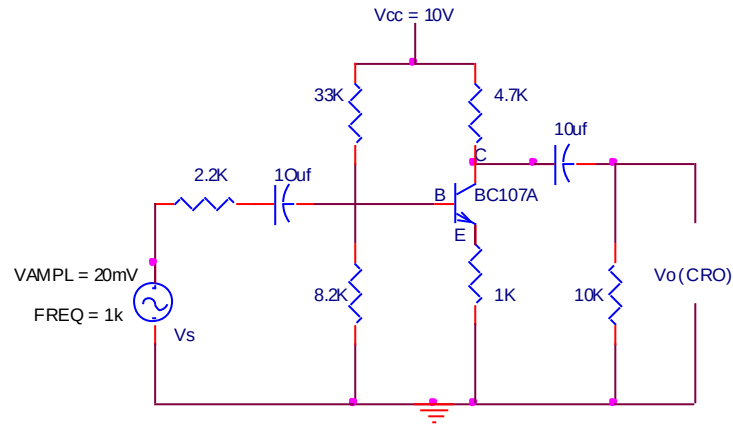
The same idea applies for the output impedance of the amplifier. When a load resistance, R_L is connected to the output of the amplifier, the amplifier becomes the source feeding the load. Therefore, the output voltage and impedance automatically becomes the source voltage and source impedance for the load as shown.

Amplifier Output Circuit Model

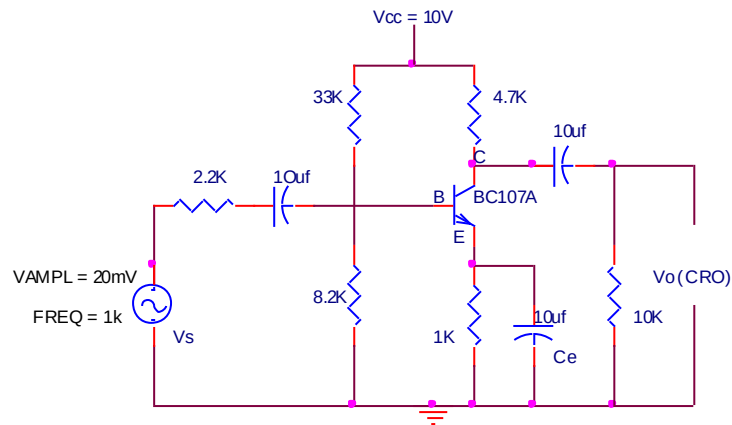


Then we can see that the input and output characteristics of an amplifier can both be modelled as a simple voltage divider network. The amplifier itself can be connected in *Common Emitter* (emitter grounded), *Common Collector* (emitter follower) or in *Common Base* configurations. In this tutorial we will look at the bipolar transistor connected in a common emitter configuration seen previously.

CIRCUIT DIAGRAMS :-



CURRENT SERIES AMPLIFIER WITH FEEDBACK



CURRENT SERIES AMPLIFIER WITHOUT FEEDBACK

Theoretical Calculations:

Calculation of $h_{ie} = h_{fe} \times r_e$

h_{fe} = using multimeter calculate hfe value for the given transistor

$$r_e = 26\text{mV}/I_E$$

$I_E = V_E/R_E$ (calculate drop across R_E using multimeter for DC bias circuit)

Input impedance without Feedback:

$$Z_{IN} = R_1 // R_2 // h_{ie}$$

Output impedance without Feedback:

$$Z_O = R_C // R_L$$

Voltage gain without feedback:

$$A_V = -hfe \frac{Z_O}{Z_{IN}}$$

Input impedance with Feedback:

$$Z_{IN} = R_1 // R_2 // (h_{ie} + (1 + hfe)R_e)$$

Output impedance with Feedback:

$$Z_O = R_C // R_L$$

Voltage gain with feedback:

$$A_V = -hfe \frac{Z_O}{Z_{IN}}$$

Practical Observations(with and without feedback):

$$V_{IN} = \text{___ V (using CRO)}$$

$$Z_{IN} = R_S \left[\frac{V_{IN}}{V_S - V_{IN}} \right]$$

$$V_L = \text{___ V (using CRO)}$$

$$V_{NL} = \text{___ V (using CRO)}$$

$$Z_O = R_L \left[\frac{V_{NL} - V_L}{V_L} \right]$$

$$A_V = \frac{V_L}{V_{IN}}$$

PROCEDURE:

1. Connections are made as per the circuit diagram. With out 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. A certain amplitude of input signal (say 20mV) is kept constant using the function at a constant frequency of 1KHz

6. Note down the V_{IN} , V_L , V_{NL} using CRO
7. Now the Circuit is connected as per circuit diagram with feedback i.e keeping C_e
8. Note down the V_{IN} , V_L , V_{NL} using CRO
9. Calculate input impedance Z_{IN} , output impedance Z_O , and voltage gain A_V and compare with theoretical values.

PRECAUTIONS :

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

VIVA QUESTIONS:

1. What is the relationship between the transfer gain with feedback A_f and that without feedback A .
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 amplifiers.

RESULT:

The input impedance Z_{IN} , output impedance Z_O , and voltage gain A_V with & with out feedback are calculated and compared theoretically.

3. VOLTAGE SHUNT FEEDBACK AMPLIFIER

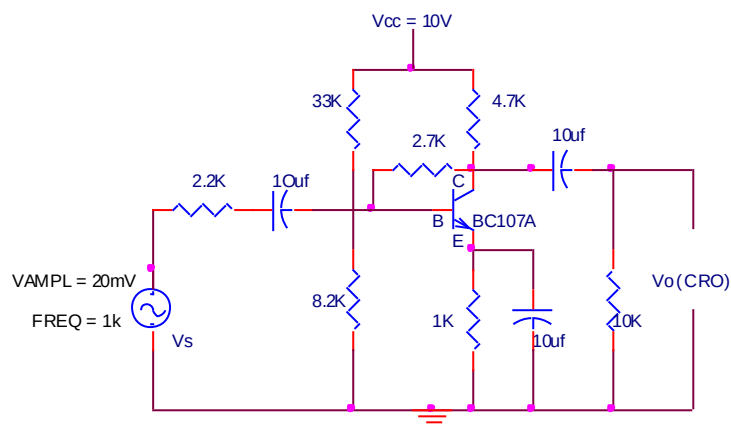
AIM:

To obtain the frequency response of a voltage shunt feedback(with and without) amplifier and obtain the bandwidth

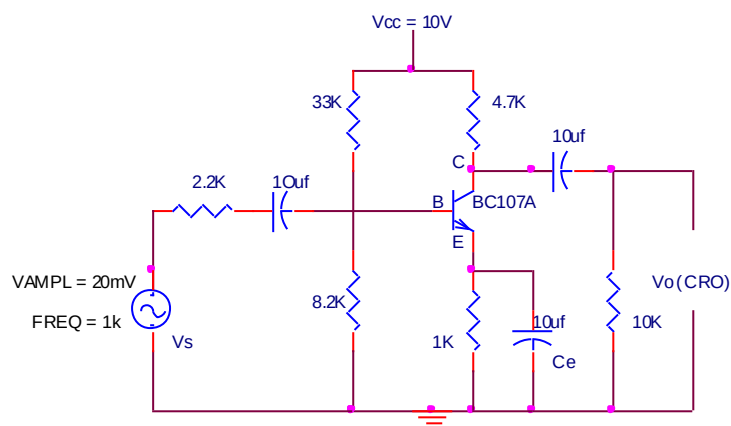
APPARATUS :

Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No
Resistors	1k Ω ,4.7k,8.2k	1 No
Resistors	2.2k,33k,10K,2.7K	1 No
Capacitors	10 μ F	3 No ,
Transistors	BC107	1 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAMS :



VOLTAGE SHUNT AMPLIFIER WITH FEEDBACK



VOLTAGE SHUNT AMPLIFIER WITHOUT FEEDBACK

PROCEDURE:

1. Connections are made as per the circuit diagram.
2. A 10V DC supply is given to the circuit for biasing.
3. The circuit is connected without feedback i.e., without R_F
4. A certain amplitude of input signal (say 20mV) is kept constant using the function generator and for different frequencies the output voltage from CRO are noted.
5. Now, the circuit is connected with feedback i.e., with R_F .
6. By keeping the input signal constant the output voltages for different frequencies are noted from CRO.
7. Gain with and without feedback is calculated from the formula

$$\text{Gain} = 20 \log V_o / V_i \text{ (dB)}$$

Where V_o is output voltage, V_i is input voltage.

TABULAR FORM :
WITH FEEDBACK:

I/P VOLTAGE V_i =

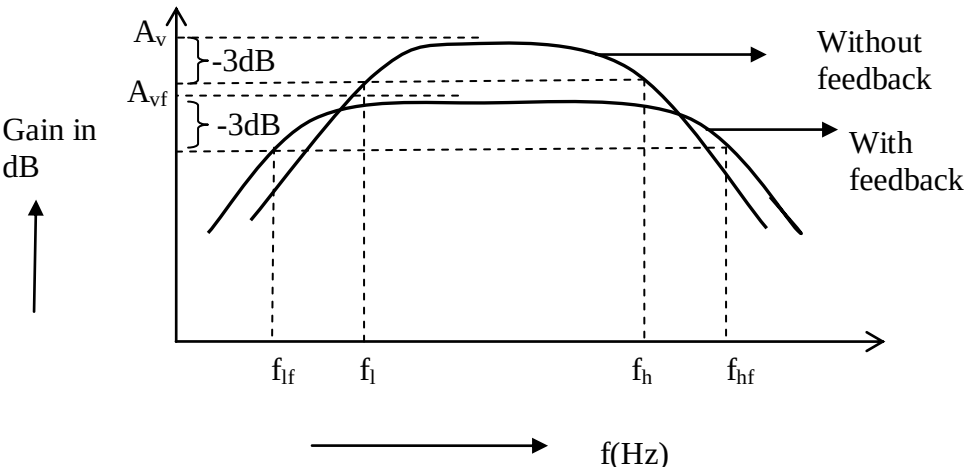
FREQUENCY (Hz)	O/P VOLTAGE (V_o)	Gain in dB = $20 \log V_o / V_i$
100		
200		
300		
500		
700		
1k		
2k		
3k		
5k		
7k		
10k		
20k		
30k		
50k		
70k		
100k		
200k		
300k		
500k		
700k		
1M		

WITHOUT FEEDBACK:

I/P VOLTAGE $V_i =$

FREQUENCY (Hz)	O/P VOLTAGE (V_o)	Gain in dB = $20 \log V_o / V_i$
100		
200		
300		
500		
700		
1k		
2k		
3k		
5k		
7k		
10k		
20k		
30k		
50k		
70k		
100k		
200k		
300k		
500k		
700k		
1M		

MODEL GRAPH :



Bandwidth= $f_h - f_L$

GRAPH : A graph is plotted between gain (dB) and frequency(Hz) which is frequency response of voltage shunt feedback amplifier for without feedback and with feedback.

PRECAUTIONS :

3. Avoid loose and wrong connections.
4. Avoid parallax error while taking readings.

QUESTIONS:

1. What is the relationship between the transfer gain with feedback A_f and that without feedback A .
A. $A_f = A/(1+A\beta)$
2. What are the advantages of negative feedback.
A. High BW, less noise, less distortion, gain stability
3. How is the i/p impedance and o/p impedance of a voltage shunt feedback amplifier
A. $R_{if} = R_i/(1+A\beta)$, $R_{of} = R_o/(1+A\beta)$
4. What are the types of feedback amplifiers.
A. Voltage shunt, current shunt, current series, voltage series feedback amplifiers.

RESULT:

The frequency response of the given voltage shunt amplifier with & with out feedback are obtained .

4. COLPITTS OSCILATOR

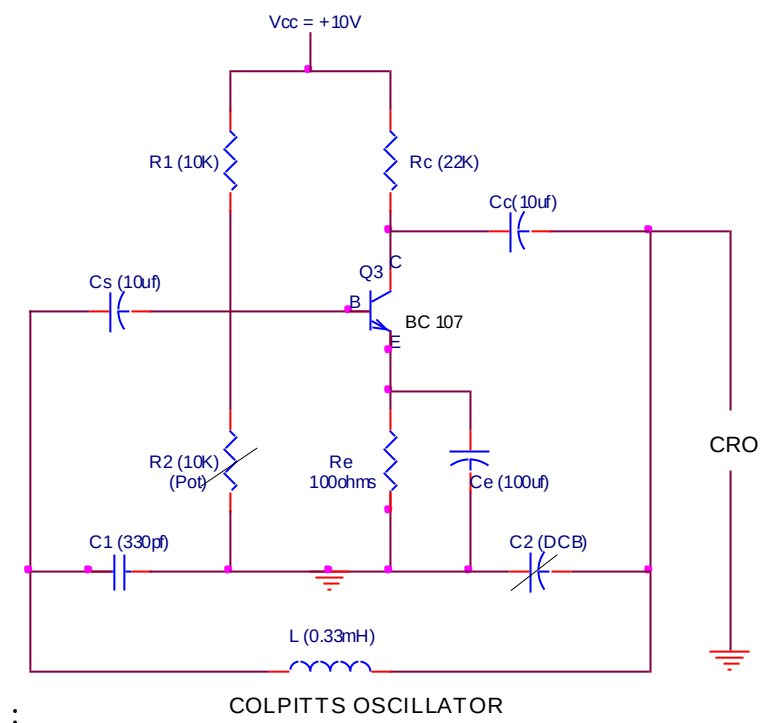
AIM:

To determine the frequency of oscillations of the Colpitts Oscillator.

APPARATUS

Power supply	0-30V	1No.
CRO	20MHz	1No.
Inductor	0.33mH	1 No
Resistors	10k Ω , 22k Ω , 100k Ω	1 No
Capacitors	100 μ F, 330pF	1 No
Capacitors	10 μ F	2 No,
Transistors	BC107	1 No.
Potentiometer	10K	1 No
DCB		1 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAM:



PROCEDURE :

1. The circuit is connected as shown in figure.
2. The capacitor C_1 is kept constant and C_2 is up to some value.
3. The resistor R_2 is adjusted until sinusoidal waveform is observed on the CRO.
4. Then the time period and hence the frequency are Calculated which is nearly equal to the theoretical frequency.
5. The theoretical and practical values of frequency are verified using the formula.

$$f_o = 1 / 2\pi \sqrt{LC_{eq}} \text{ where } C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$

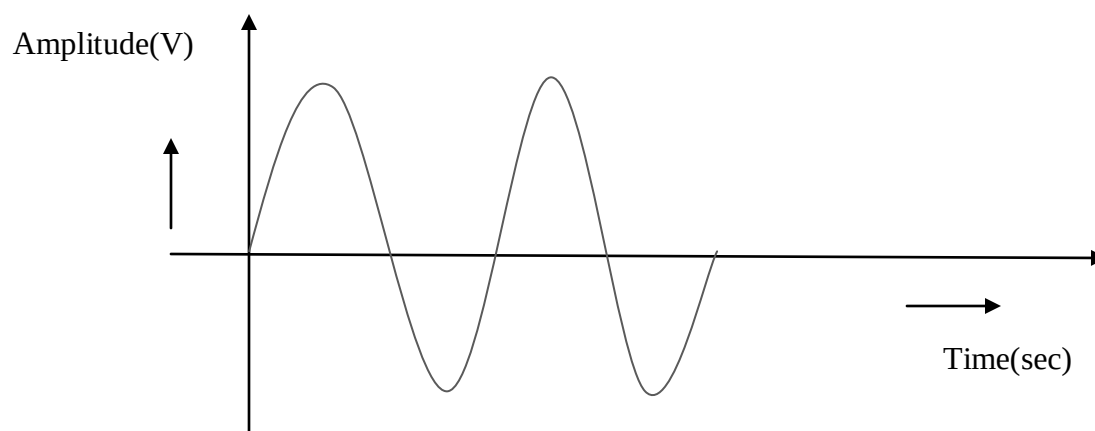
$$f_o \text{ practical} = 1 / T \text{ (Hz) } T = \text{Time period.}$$

6. The experiment is repeated for different values of C_2 and each time the time period is noted.

TABULARFORM :

S.NO.	INDUCTANCE (L)	CAPACITANCE			Theoretical $f_o = 1/2\pi \sqrt{LC_{eq}}$ (kHz)	T (Sec)	f=1/T (Hz)	Amplitude (V)
		C_1	C_2	C_{eq}				
1.	0.33mH	330pf	330pf					
2.	0.33mH	330pf	470pf					
3.	0.33mH	330pf	570pf					

MODEL GRAPH :



PRECAUTIONS :

1. Avoid loose and wrong connections.
2. The sinusoidal waveform obtained must be distortion.
3. Readings should be taken without parallax error.

QUESTIONS:

1. What type of feedback is used in oscillators.
A. Positive feedback
2. Define tank circuit.
A. It is the circuit which generates oscillations in the oscillator using tank circuit components.
3. What is barkhausen condition.
A. i. loop gain $|A\beta|=1$ ii. Total phase shift = 360° or 0°
4. Why LC oscillators cannot be used as a audio frequency oscillators.
A. At audio frequency range 1.e at low frequency the inductor size becomes bulky.

RESULT: The frequency of the oscillations of colpitts oscillator is determined .

5. HARTLEY OSCILLATOR

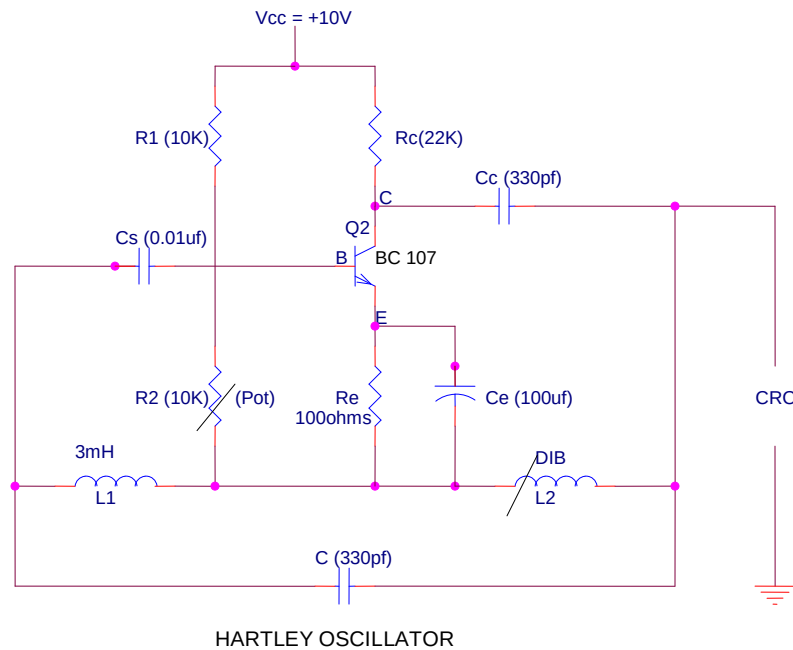
AIM:

To determine the frequency of oscillations of Hartley oscillator.

APPARATUS:

Power supply	0-30V	1No.
CRO	20MHz	1No.
Inductor	100 μ H	1 No
Resistors	10k Ω , 22k Ω , 100k Ω	1 No
Capacitors	100 μ F, 0.01 μ F	1 No
Capacitors	330pF	2 No,
Transistors	BC107	1 No.
Potentiometer	10K	1 No
DIB		2 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAM :



PROCEDURE:

1. Connections are made as shown in circuit diagram.
2. The inductor 'L₂' is up to some value, keeping inductor 'L₁' constant
3. The potentiometer 'R₂' is adjusted until sinusoidal waveform is observed on CRO.
4. The time period and hence the frequency are calculated for the wave obtained which is nearly equal to the theoretical frequency.
5. The theoretical and practical values of frequency are verified using the formula.

$$f_0 = 1 / 2\pi \sqrt{L_{eq}C} \text{ where } L_{eq} = L_1 + L_2$$

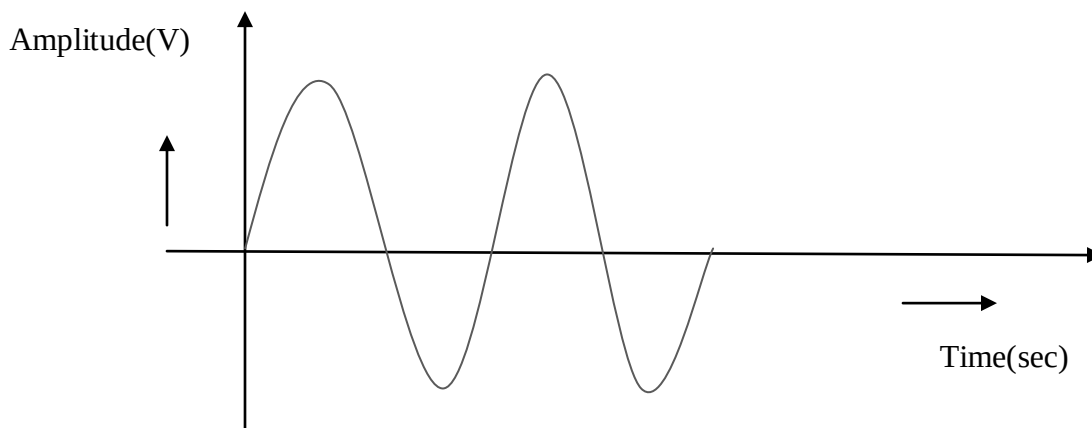
$$f_0 \text{ practical} = 1 / T \text{ (Hz)} \quad T = \text{Time period}$$

6. The experiment is repeated for different values of 'L₂' and each time the time period is noted.

TABULAR FORM :

C	Inductance			Theoretical $f = 1 / 2\pi \sqrt{L_{eq}C}$	Time T (Sec)	PRACTICAL $f = 1 / T \text{ (Hz)}$	Amplitude (V)
	L ₁	L ₂	L _{eq} = L ₁ + L ₂				
470pf	3mH	3mH					
470pf	3mH	4mH					
470pf	3mH	5mH					

MODEL GRAPH:



GRAPH :

A graph is plotted between time period on x-axis and amplitude on y-axis to obtained a sinusoidal waveform at a particular value of L₂.

PRECAUTIONS :

1. Avoid loose contacts.
2. Avoid wrong connections.

QUESTIONS:

1. What type of feedback is used in oscillators.
A. Positive feedback
2. What are the types of oscillator.
A. Sinusoidal oscillators and relaxation oscillators
3. What is barkhausen condition.
A. i. loop gain $|A\beta|=1$ ii. Total phase shift = 360° or 0°
4. Why LC oscillators cannot be used as a audio frequency oscillators.
A. At audio frequency range 1.e at low frequency the inductor size becomes bulky.
5. What is the other name for LC and RC oscillators and its ranges of frequency.
A. LC are also called as Radio frequency oscillators(range= 20KHz to 100MHz)
RC are also called as audio frequency oscillators (range=20Hz to 20 KHz)

RESULT:

The frequency of oscillations of Hartley oscillator is determined.

6. RC PHASE SHIFT OSCILLATOR

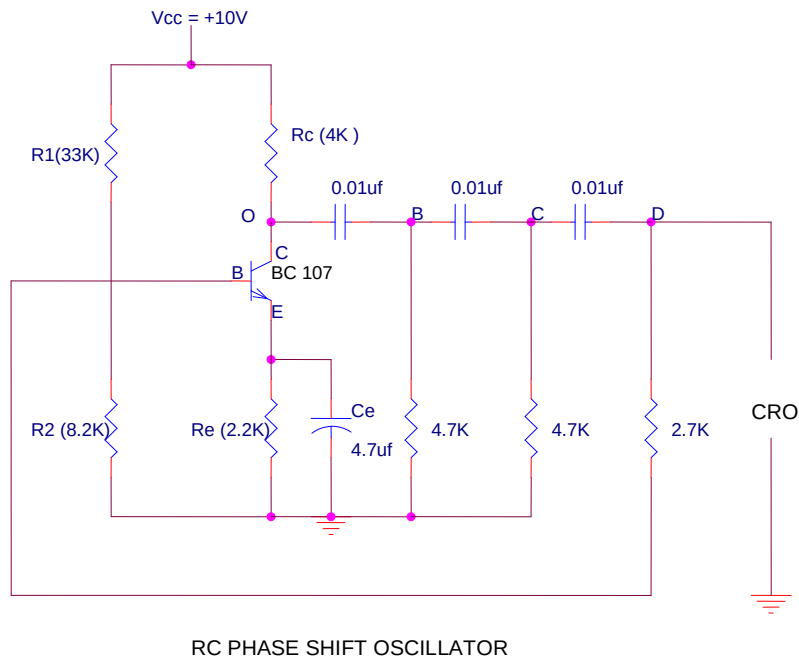
AIM:

To find the frequency of oscillations of the RC phase shift oscillator and to measure the phase shift of each section of the RC network.

APPARATUS:

Power supply	0-30V	1No.
CRO	20MHz	1No.
Resistors	33k Ω , 8.2k Ω , 4k Ω	1 No
Resistors	2.2k Ω , 2.7k Ω , 10K Ω	1 No
Resistors	4.7k Ω	2 No
Capacitors	0.01 μ F	3 No
Capacitors	4.7 μ F	1 No
Transistors	BC107	1 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAM :



PROCEDURE:

1. Connections are made as per the circuit diagram.
2. observe the output waveform at '0' on CRO which is sinusoidal.
3. Now, the CRO probe is changed to position 'B' such that the output waveform at B is observed on CRO, which is shifted by 60° w.r.t. '0'
4. The output waveform at 'C' is observed on CRO, which is shifted by 120° w.r.t. '0'.
5. The output waveform at 'D' is observed on CRO, which is shifted by 180° w.r.t. '0'.
6. Theoretically the frequency of oscillations is calculated by the formula,
$$f = \frac{1}{2\pi RC\sqrt{6+4K}}, \quad K = R_C / R$$

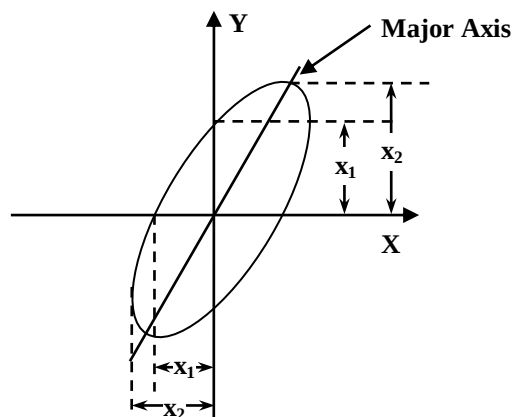
Practically the time period 'T' on CRO is noted and frequency $f = 1/T$ is calculated.

7. A graph is plot for phase and amplitude locating the phase shift observed on CRO at different positions of (B,C,D).

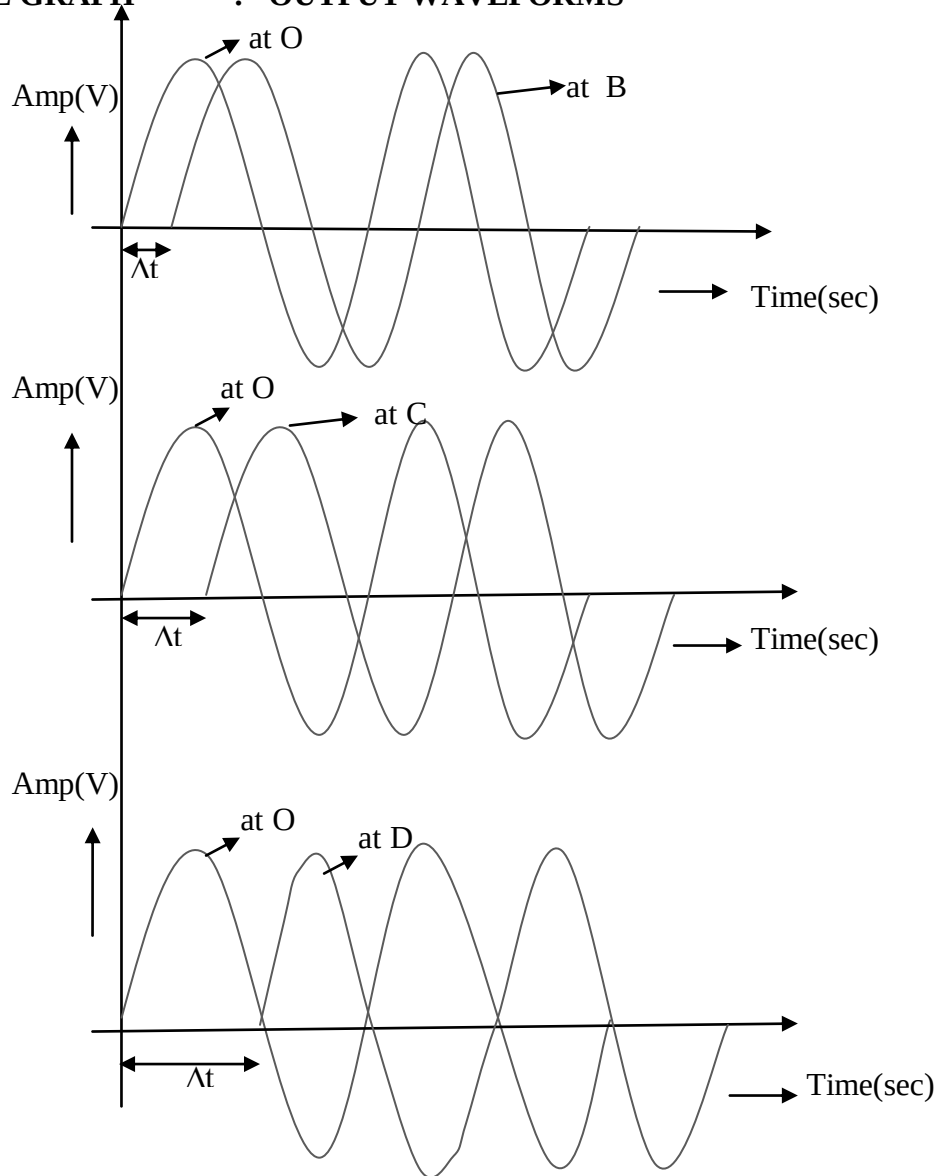
TABULAR FORM :

R_C ($K\Omega$)	Position w.r.t Collector	Lissajous Pattern	x_1	x_2	$\theta = \sin^{-1}$ (x_1 / x_2)	T (Sec)	f_0 (Hz) Theoretical	Amplitude (V)	Δt (sec)
4K	B								
	C								
	D								

LISSAZEIOUS PATTERN:



MODEL GRAPH : OUTPUT WAVEFORMS



PRECAUTIONS :

1. The readings are to be noted down without parallax error.
2. Wrong connections should be avoided.

QUESTIONS:

1. How the Barkhausen Criteria is satisfied in the RC phase-shift oscillator?
A. To satisfy total phase shift 360° , each RC section gives 60° i.e $60^\circ \times 3 = 360^\circ$
2. How do you vary the frequency of the RC phase-shift oscillator?
A. By changing R and C components and again designing the circuit with changed components to get the new frequency.
3. What is the maximum phase-shift that can be obtained by a single RC section?
A. 60°
4. What is the frequency range that can be obtained by the RC phase shift oscillator?
A. Audio range = 20Hz to 20KHz
5. What is the need of Lissajous pattern.
A. To find the phase angle of each RC section

RESULT: The frequency of oscillations of a phase shift oscillator is found and phase shift of each section of the RC network(in Lissajous pattern) is measured.

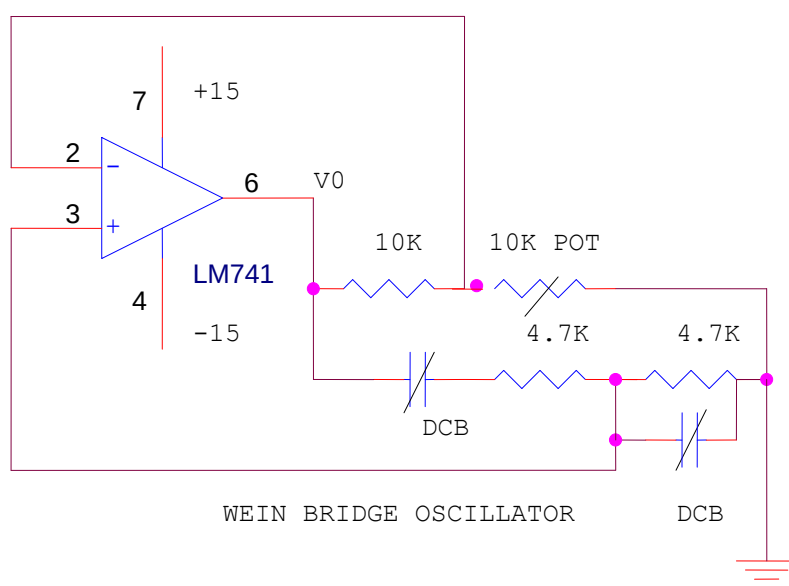
7. WEIN BRIDGE OSCILLATOR

AIM: To obtain the frequency of oscillations of a Wein Bridge oscillator.

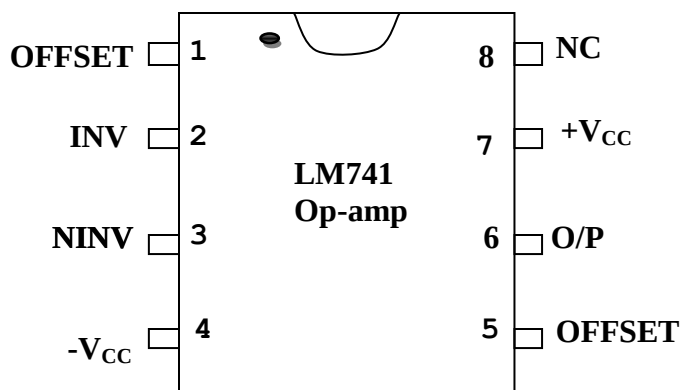
APPARATUS:

Power supply(2 channel)	0-30V	1No.
CRO	20MHz	1No.
Resistors	10K Ω	1 No
Resistors	4.7k Ω	2 No
DCB		2 No
potentiometer	10K Ω	1 No
Op-amp	LM 741 IC	1 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAM :



PIN DIAGRAM :



PROCEDURE :

1. Connections are made as per the circuit diagram.
2. The two capacitances are varied by using variable capacitance box.
3. The output wave is observed on the CRO.
4. The time period of the wave for each value of capacitor is noted.
5. The frequency of the wave is calculated from the time period using the formula $f = 1/T$
6. Theoretical frequency is calculated by using the formula

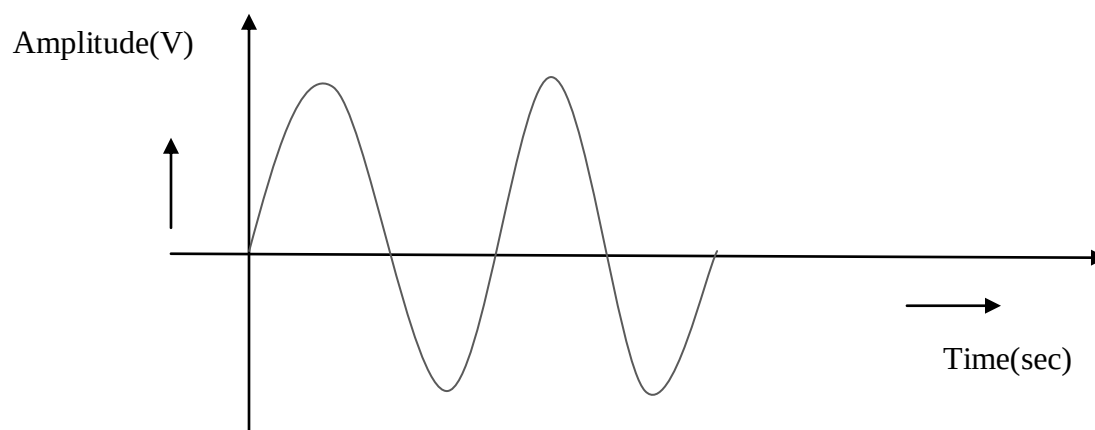
$$f = 1/\sqrt{2\pi R_1 R_2 C_1 C_2}$$

7. Compare the practical and theoretical values.

TABULAR FORM :

$R_1 = R_2$ (Ω)	C		Theoretical(Hz) $f = 1/\sqrt{2\pi R_1 R_2 C_1 C_2}$	Output voltage(v)	Time Period T (Sec)	Practical $f = 1/T$ (Hz)	Amplitude (V)
	C_1	C_2					
4.7K	3nf	3nf					
4.7K	4nf	4nf					
4.7K	5nf	5nf					

MODEL GRAPH:



PRECAUTIONS :

1. Avoid loose and wrong connections.
2. Connections should be made properly and the output should be a proper sine wave, such that the time period and amplitude may be obtained accurately.

QUESTIONS:

1. What determines the frequency of oscillations?
 - A. The R and C components of the bridge circuit.
2. What is the frequency range of oscillations?
 - A. Audio range=20Hz to 20KHz
3. When frequency of oscillations occur in oscillator.
 - A. When bridge is balanced.

RESULT

The frequency of oscillations of Wein bridge oscillator is Determined.

8. EFFICIENCY OF CLASS A POWER AMPLIFIER

AIM: To calculate the efficiency of a Class-A power amplifier and compare with theoretical value.

APPARATUS:

Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No
voltmeter		1 No
Transistors	CL-100	1 No
Bread board		
CRO Probes		

THEORY:

The power into amplifier is provided by supply. Without input signal the dc current drawn is the collector bias I_{CQ} . Then the input power drawn from supply is:

$$P_i(dc) = V_{cc} * I_{CQ}$$

The output power (ac power) is given by :

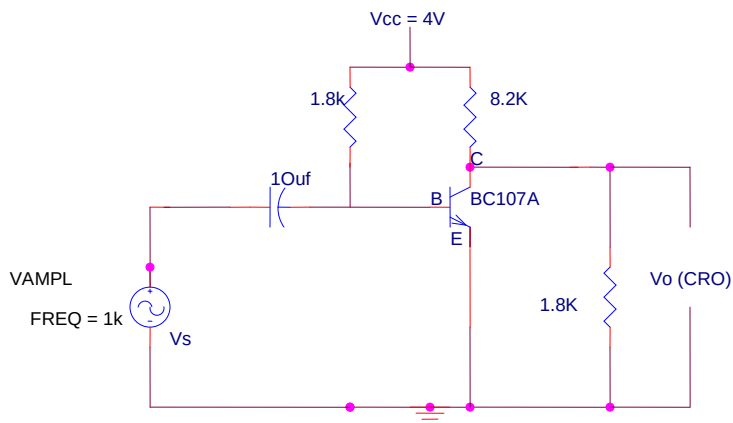
$$P_o(ac) = V_{CE} (rms) * I_c(rms) \quad P_o(ac) = I_c^2(rms) * R_c \quad P_o(ac) = V_{CE}^2 (rms) /$$

The efficiency is:

$$\% \eta = \frac{P_o(ac)}{P_i(dc)} \times 100\%$$

The maximum efficiency is equal to 25%

CIRCUIT DIAGRAM :



THEORITICAL CALCULATIONS:

$$\% \eta = \frac{P_{AC}}{P_{DC}} \times 100 = 25\%$$

PRACTICAL CALCULATIONS:

$$P_{DC} = V_{CC} \times I_{DC}$$

$$P_{AC} = V_{rms} \times I_{rms} = \frac{V_{pp} I_{pp}}{8} \left(\because V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{V_{pp}}{2\sqrt{2}}, I_{rms} = \frac{I_m}{\sqrt{2}} = \frac{I_{pp}}{2\sqrt{2}} \right)$$

$$P_{AC} = \frac{V_{pp}^2}{8R_L} \text{ or } \frac{I_{pp}^2 R_L}{8}$$

PROCEDURE:

1. The circuit is connected as shown in figure
2. An input voltage of 1V and a frequency of 1KHz is applied with the help of signal generator
3. Observe the output undistorted waveform
4. Note the Vpp value
5. Using multimeter calculate the voltage across Rc and calculate the current Ic in RL
6. Now calculate the practical efficiency using formula given
7. Compare the practical efficiency and theriotical efficiency.

PRECAUTIONS:

1. Loose and wrong connections must be avoided.
2. Readings must be taken without parallax error.

QUESTIONS:

1. In what way the design features of power transistors different from small signal transistors?
2. What is the basis for the classification of power amplifiers? Mention different types of power amplifiers?
3. What reasons will you assign for higher conversion efficiency of Class B amplifier as compared to Class A amplifier?

RESULT: Calculated the efficiency of a Class-A power amplifier and compared with theoretical value.

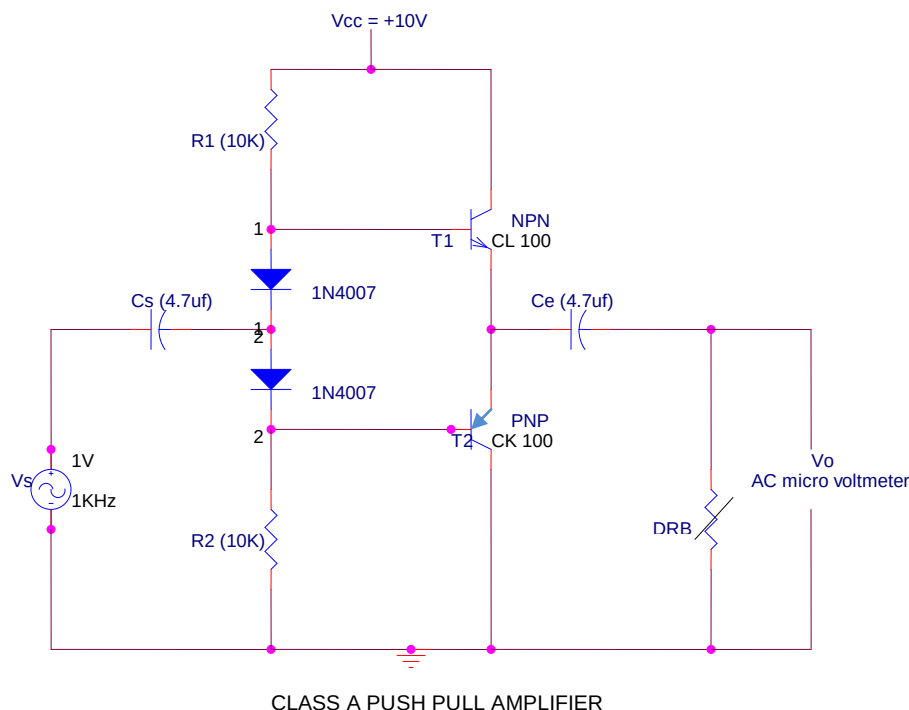
9. LOAD CHARACTERISTICS OF CLASS – B PUSH PULL AMPLIFIER

AIM: To obtain the Load and power Characteristics of a Class-B push pull amplifier.

APPARATUS:

Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No
AC micro voltmeter		1 No
Resistors	10k Ω	2 No
DRB		1 No
Capacitors	4.7 μ F	2 No
diodes	1N4007	2 No.
Transistors	CK-100,CL-100	1 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAM :



PROCEDURE :

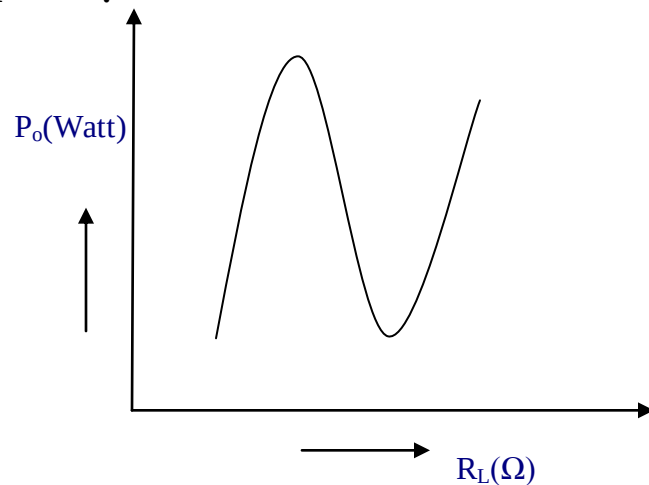
1. The circuit is connected as shown in figure.
2. An input voltage of 20V and a frequency of 1KHz is applied with the help of signal generator
3. The load R_L is varied from 10K to 10 Ω with the help of decade resistance box and each time the output voltage is noted from AC micro voltmeter.
4. The power, $P_o = V_o^2 / R_L$ is calculated in each case and a graph is plot between P_o and R_L is drawn.

TABULARFORM :

I/P VOLTAGE, $V_i = 20V, 1KHz$

$R_L (\Omega)$	V_O (Volts)	$P_o = V_o^2 / R_L$ (Watts)
10K Ω To 10 Ω		

MODEL GRAPH :



PRECAUTIONS :

1. Loose and wrong connections must be avoided.
2. Readings must be taken without parallax error.

QUESTIONS:

1. Define class-B amplifier
 - A. The output current flows only for the half of the input signal
2. What are the advantages of class B over class A amplifier.
 - A. Efficiency of class B(50%) is more than class A(25%)
3. What is cross over distortion.
 - A. Crossover distortion is the term given to a type of distortion that occurs in push-pull class AB or class B amplifiers. It happens during the time that one side of the output stage shuts off, and the other turns on.
4. What is complementary symmetry amplifier.
 - A. A complimentary-symmetry amplifier is a power output stage using two transistors. One is an NPN and the other is PNP

RESULT:

Hence the load Characteristics of the given class-B Push pull amplifier.

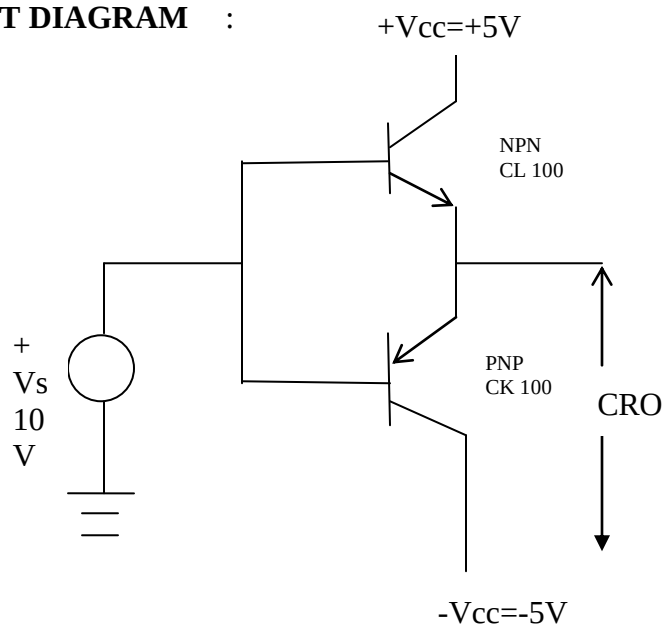
9. EFFICIENCY OF CLASS – B PUSH PULL AMPLIFIER

AIM: To calculate the efficiency of a Class-B push pull amplifier and compare with theoretical value.

APPARATUS:

Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No
voltmeter		1 No
Transistors	CK-100,CL-100	1 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAM :



Theoretical calculations:

$$\eta_{th} = \left(\frac{V_p}{V_{CC}} \right) \times \left(\frac{\pi}{4} \right) \times 100$$

Practical calculations:

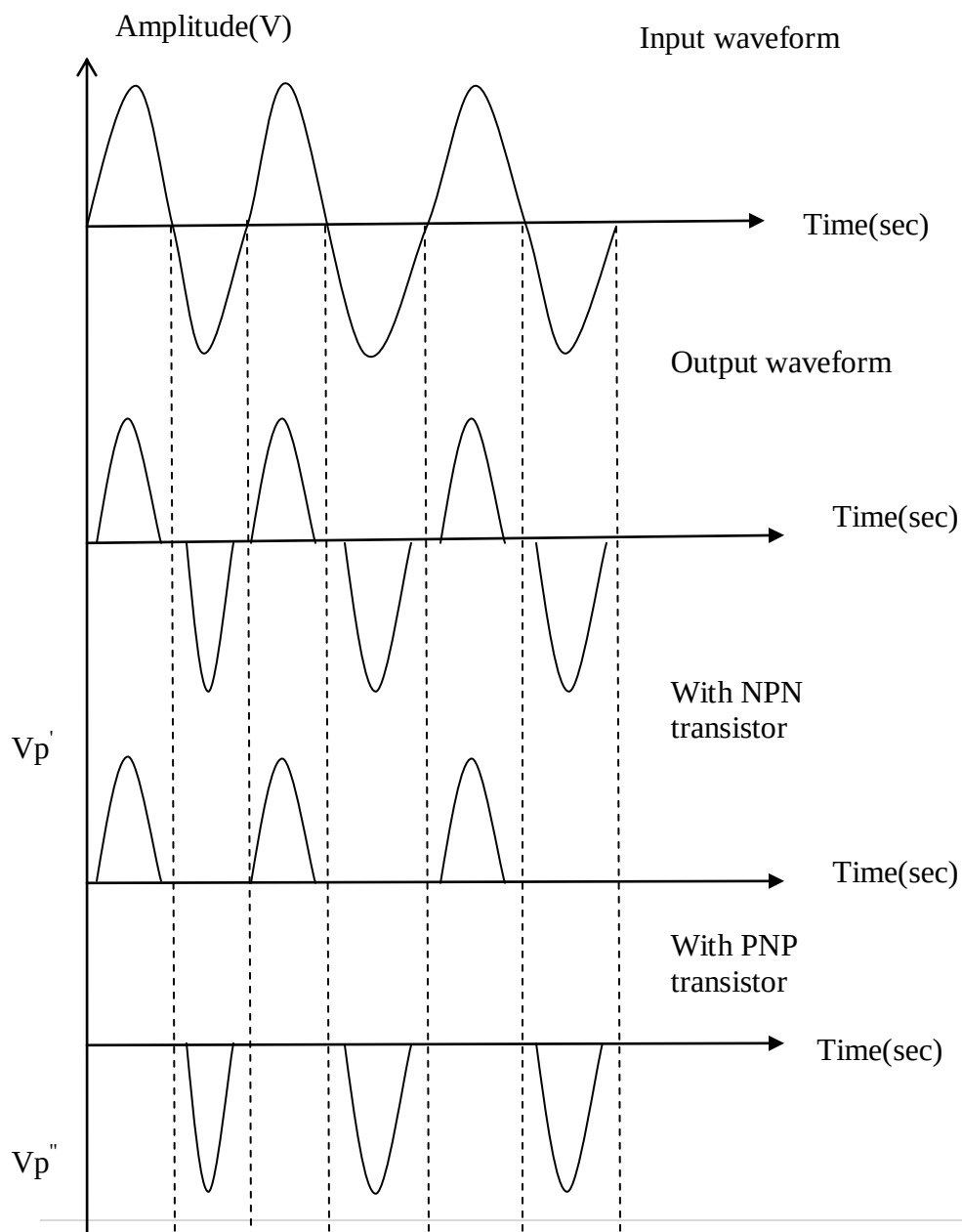
$$\eta_{PR} = \left(\frac{P1}{P2} \right) \times 100 ;$$

$$P1 = \left(\frac{V_{pp}}{2\sqrt{2}} \right) \times \frac{1}{R_L} , \quad P2 = V_{CC} \left(\frac{V'_{op}}{\pi R_L} + \frac{V''_{OP}}{\pi R_L} \right)$$

PROCEDURE:

1. The circuit is connected as shown in figure
2. An input voltage of 2V and a frequency of 1KHz is applied with the help of signal generator
3. Observe the output waveform with cross over distortion and note the required values for graph and V_{pp} voltage
4. Open the pnp transistor and observe the o/p waveform and note down the peak voltage V_p'
5. Open the NPN transistor and observe the o/p waveform and note down the peak voltage V_p''
6. Calculate the efficiency and compared with theoretical value

MODEL GRAPHS:



PRECAUTIONS :

1. Loose and wrong connections must be avoided.
2. Readings must be taken without parallax error.

QUESTIONS:

1. Define class-B amplifier
The output current flows only for the half of the input signal
2. What are the advantages of class B over class A amplifier.
Efficiency of class B(50%) is more than class A(25%)
3. What is cross over distortion.
Crossover distortion is the term given to a type of distortion that occurs in push-pull class AB or class B amplifiers. It happens during the time that one side of the output stage shuts off, and the other turns on.
4. What is complementary symmetry amplifier.
A complimentary-symmetry amplifier is a power output stage using two transistors. One is an NPN and the other is PNP

RESULT:

The efficiency of class-B Push pull amplifier is calculated and compared with theoretical value

10. TUNED VOLTAGE AMPLIFIER

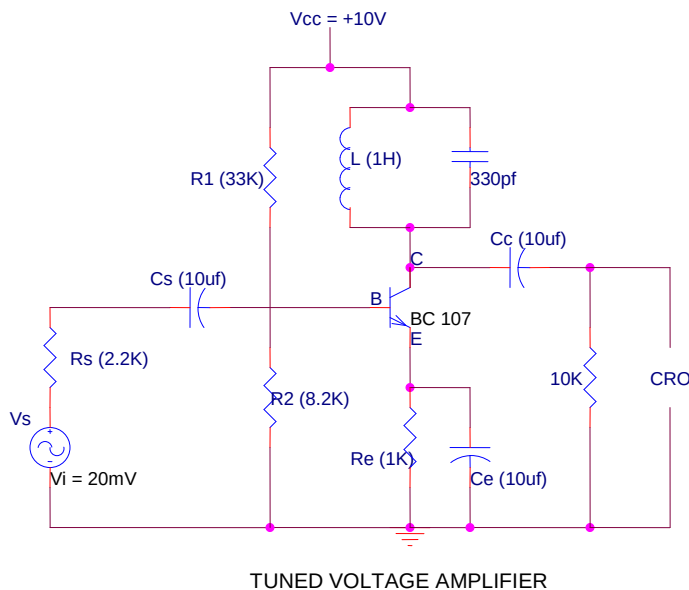
AIM:

To obtain the frequency response of tuned voltage amplifier and find the resonant Frequency and verify it with practical frequency.

APPARATUS:

Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No.
Capacitors	10 μ F	3 No.
Capacitor or DCB	330pF	1 No.
Transistors	BC107	1 No.
Resistor	33K Ω , 8.2K Ω	1 No.
Resistor	2.2K Ω , 1K Ω , 10K Ω	1.No.
Inductor or DIB	1H	1 No
Bread board and connecting wires		

CIRCUIT DIAGRAM:



PROCEDURE:

1. The circuit is connected as shown in the figure.
2. A 10V DC supply is given to the circuit for biasing.
3. An input signal of (say 20mV to 30mV) is given from the output of the signal generator.
4. The output voltage V_o is noted for different values of the frequencies.
5. In each case the gain is calculated using the formulae

$$A_V = 20 \log_{10} V_o/V_i \text{ (dB)}.$$

6. It is observed that at certain frequency the gain obtained is maximum. The frequency is known as the resonant frequency at which $X_L = X_C$ and it approximately

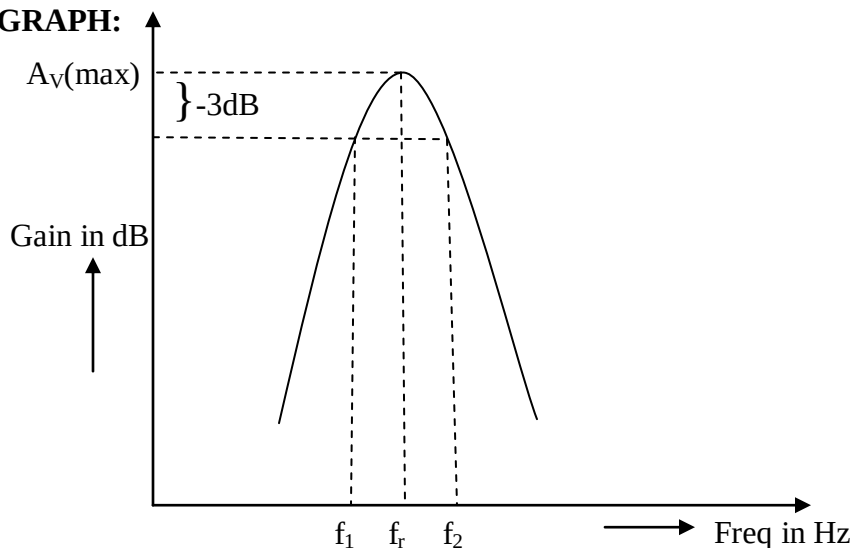
$$f_r (\text{theoretical}) = 1 / 2\pi\sqrt{LC}$$

TABULAR FORM :

I/P Voltage, V_i =

Frequency (Hz)	O/P Voltage, V_o (V)	Gain $A_v = 20 \log_{10} V_o/V_i$ (dB)
100		
200		
300		
500		
700		
1k		
2k		
3k		
5k		
7k		
10k		
20k		
30k		
50k		
70k		
100k		
200k		
300k		
500k		
700k		
1M		

MODEL GRAPH:



PRECAUTIONS:

1. Avoid loose and wrong connections.
2. The amplitude of the input voltage must be maintained constant through out the experiment.
3. Waveforms must be obtained without any distortion.

QUESTIONS:

1. What is resonant frequency.
 - A. Resonance is the tendency of a system to oscillate at maximum amplitude at certain frequencies, known as the resonance frequencies
2. State the conditions which exist during resonance.
 - A. The impedance of inductor is equal to the impedance of capacitor.
3. Define Quality factor
 - A. The quality factor or Q factor is a dimensionless parameter that describes how under-damped an oscillator or resonator is, or equivalently, characterizes a resonator's bandwidth relative to its center frequency.
4. Give the relation between Quality factor and bandwidth.
 - A. $Q = f_r / BW$
5. What are the applications of tuned voltage amplifier.
 - A. Radio and TV amplifiers employ tuned amplifiers to select one broadcast channel from among the many concurrently induced

RESULT:

The frequency response and band width of a tuned Voltage amplifier are obtained .

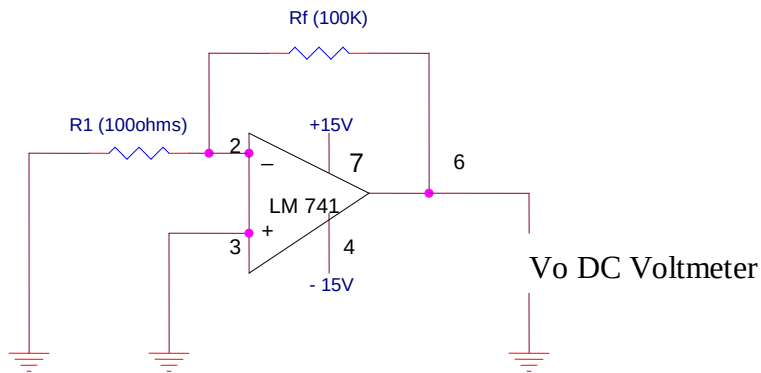
11. MEASUREMENT OF OP – AMP PARAMETERS

AIM : To determine the parameters of operational amplifier.

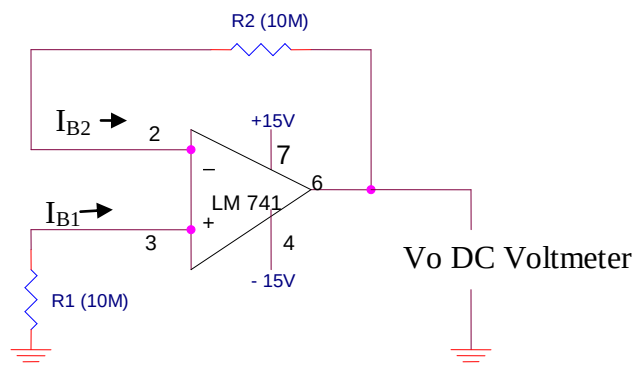
APPARATUS :

Power supply (2-Channel)	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No.
Op-amp	LM 741IC	1 No.
Digital micro voltmeter		1 No.
Resistor	100K Ω , 100 Ω , 10M Ω	2 No.
Resistor	10K Ω	1No.
CRO Probes		2 No.
Bread board and connecting wires		

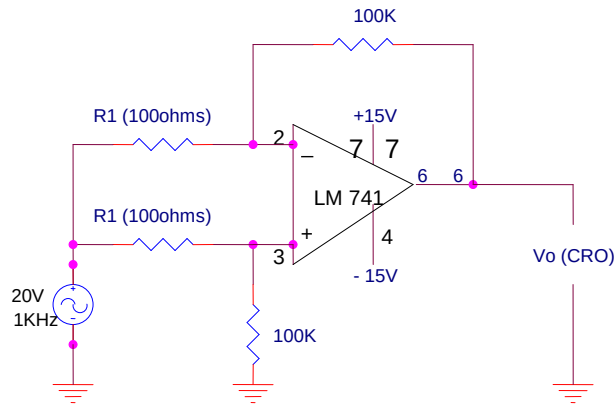
CIRCUIT DIAGRAM :



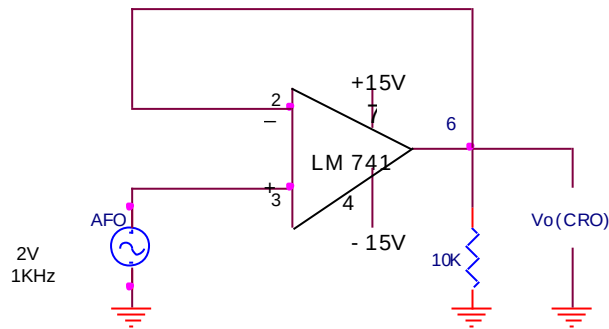
INPUT OFFSET VOLTAGE



INPUT OFFSET CURRENT



CALCULATION OF CMRR



SLEW RATE

PROCEDURE:

INPUT OFFSET VOLTAGE :

1. connect the circuit as shown in diagram (1).
2. A DC voltage of 15V is given.
3. The output voltage V_o is calculated
4. input offset voltage is calculated from the formula,

$$V_{io} = \frac{V_o}{1+(R_F / R_1)}$$

INPUT OFFSET CURRENT and INPUT BIAS CURRENT :

1. Connections are made as shown in circuit diagram(2).
2. The input bias current and input offset current is calculated by obtaining bias currents, I_{B1} & I_{B2} .
3. I_{B1} is obtained by shorting R_2 resistor and the output voltage V_o is measured by a Dc micro voltmeter.
4. I_{B1} is obtained by substituting in the formulae

$$I_{B1} = V_o / R_1$$
5. I_{B2} is obtained by shorting R_1 resistor and the output voltage V_o is measured by a Dc micro voltmeter.
6. I_{B2} is obtained by substituting in the formulae.

$$I_{B2} = V_o / R_2$$

$$\text{Bias current } I_B = \frac{(I_{B1}) + (I_{B2})}{2}$$

$$\text{Input offset current, } I_{io} = I_{B1} \sim I_{B2}$$

COMMON MODE REJECTION RATIO:

1. Connections are made as shown in circuit diagram (3).
2. A DC supply of 15V is given.
3. An input signal of 20V at 1KHz is given from the signal generator.
4. The output voltage V_o is measured from the CRO is calculated by the formula,

$$\text{CMRR} = (1 + R_F/R_1) (V_s/V_o)$$

$$\text{CMRR(dB)} = 20 \log_{10}(\text{CMRR})$$

SLEW RATE

:

1. Connections are made as shown in circuit Diagram (4).
2. A Dc dual supply of 15V is given from the TRPS.
3. An input signal of 2V at 1KHz is given from the signal generator.
4. The frequency is increased gradually and the voltage ($2V_m$) at which square wave transforms into triangular wave is noted. The value of frequency is also noted.
5. The slew rate is calculated by the formula.,

$$\text{Slew Rate(SR)} = 2\pi f_m V_m / 10^6 \text{ (V/}\mu\text{. Sec)}$$

PRECAUTIONS

:

1. Loose and wrong connections should be avoided.
2. Readings are to be taken without parallax error.
3. The power should be turned off before making and breaking circuit connections

QUESTIONS:

1. Define Operational amplifier.
 - A. An operational amplifier ("op-amp") is a direct coupled high gain amplifier with a differential input and, usually, a single-ended output
2. What is virtual ground
 - A. Virtual ground (or virtual earth) is a node of the circuit that is maintained at a steady reference potential, without being connected directly to the reference potential.
3. What are the ideal characteristics of op-amp.
 - A. $A=\infty, R_i=\infty, R_o=0, BW=\infty, V_{io}=0V$.

RESULT

: The parameters of the given op-amp are determined.

12. FREQUENCY RESPONSE OF OP – AMP

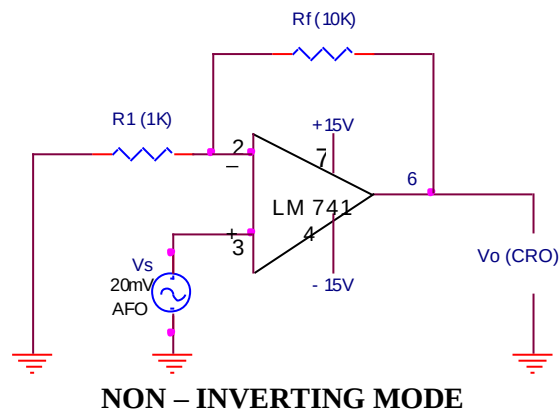
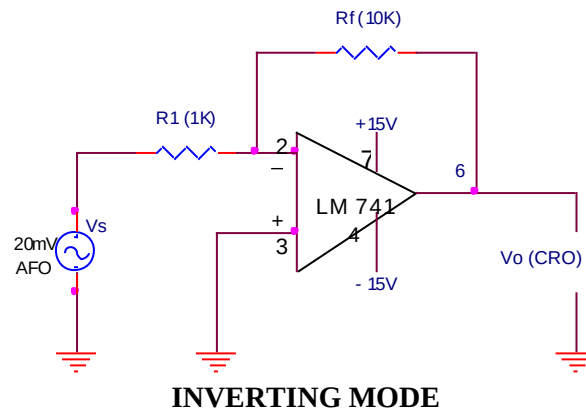
AIM:

To plot the frequency response characteristics for both inverting and non inverting modes of the given OP – AMP and to obtain its bandwidth.

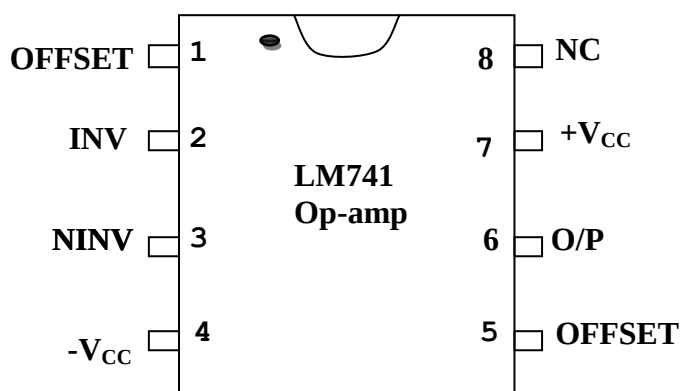
APPARATUS:

Power supply (2-Channel)	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No.
Op-amp	LM 741	1 No.
Resistor	10K Ω , 1K Ω	2 No.
CRO Probes		2 No.
Bread board and connecting wires		

CIRCUIT DIAGRAM:



PIN DIAGRAM:



PROCEDURE :

1. The circuit is connected as shown in circuit diagram (1) in inverting mode.
2. A 15V dual supply is given to the op amp from TRPS
3. Now an input voltage of (Say 20mV to 30mV) is given from the signal generator.
4. By varying the frequency, the output voltage V_o is noted from the CRO for different values of frequencies up to 1MHz.
5. For each value, the gain is calculated by the formula,
$$A_V = 20 \log V_o / V_i \text{ dB.}$$
6. Now the circuit diagram (2) is connected in non-inverting mode and the above procedure is repeated.
7. It is observed that the gain (A_V) of an op amp is greater in non inverting mode compared to that in inverting mode.

THEORETICAL CALCULATIONS:

For Inverting mode:

$$A_V = -R_f/R_1$$

$$A_{V(\text{db})} = 20 \log_{10}(A_V)$$

For Non-Inverting mode:

$$A_V = (1 + (R_f/R_1))$$

$$A_{V(\text{db})} = 20 \log_{10}(A_V)$$

TABULAR FORM :

INVERTING MODE : $V_i =$

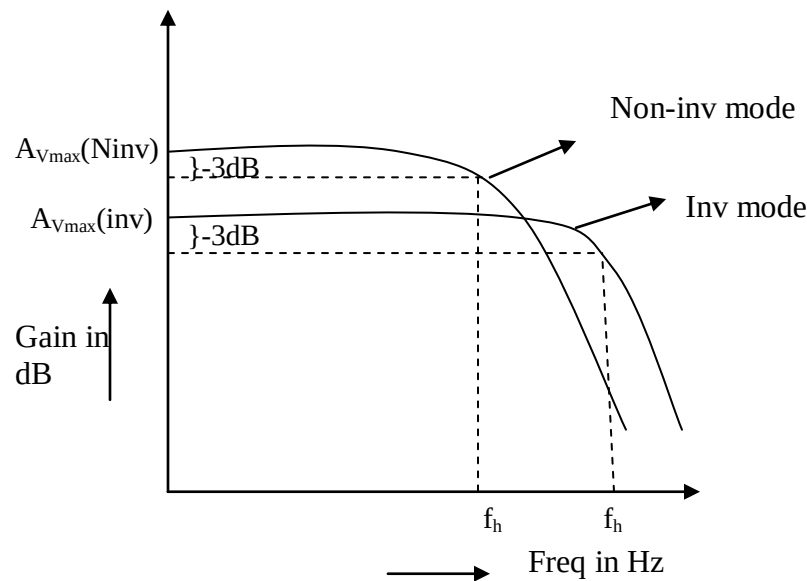
FREQUENCY (Hz)	O/P VOLTAGE V_o (V)	GAIN $A_v = 20 \log V_o / V_i$ (dB)
100		
200		
300		
500		
700		
1k		
2k		
3k		
5k		
7k		
10k		
20k		
30k		
50k		
70k		
100k		
200k		
300k		
500k		
700k		
1M		

NON INVERTING MODE : $V_i =$

FREQUENCY (Hz)	O/P VOLTAGE V_o (V)	GAIN $A_v = 20 \log V_o / V_i$ (dB)
100		
200		
300		
500		
700		
1k		
2k		
3k		
5k		
7k		
10k		
20k		
30k		
50k		

70k		
100k		
200k		
300k		
500k		
700k		
1M		

MODEL GRAPH :



Bandwidth $\approx f_h$

GRAPH:

A graph is plotted between voltage gain (dB) and frequency (Hz) both for inverting and non inverting amplifiers.

PRECAUTION:

1. Avoid loose and wrong connections.
2. The output signal should be free from distortions.
3. Avoid parallax error while taking readings from CRO.

QUESTIONS:

1. Why response of Op-amp starts from constant.
A. As Op-Amp is a direct coupled amplifier there is no coupling capacitor
2. What are the types of packages for op-amp.
A. Flay pack, metal can pack etc.
3. What are the applications of op-amp
A. Summer, scaling, log amplifier etc.

RESULT :

The frequency response characteristics of the given Op-amp in both inverting & non inverting modes are Obtained.

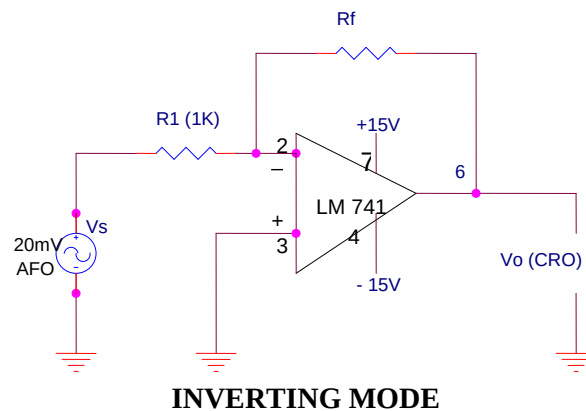
13. GAIN BANDWIDTH PRODUCT OF OP – AMP

AIM: To find bandwidth without plotting frequency response graph and to prove the gain BW product is constant in inverting modes of the given OP – AMP

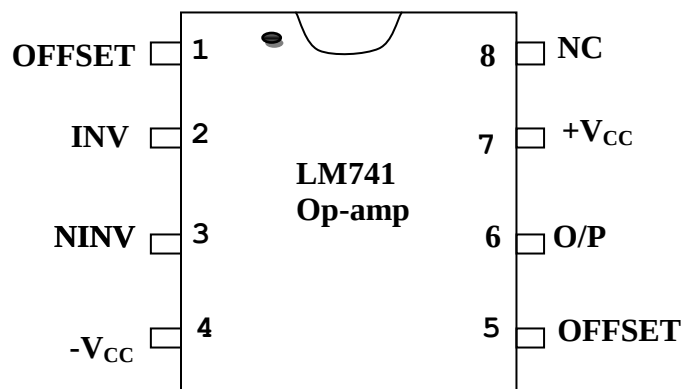
APPARATUS:

Power supply (2-Channel)	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No.
Op-amp	LM 741	1 No.
Resistor	10K Ω , 1K Ω	2 No.
CRO Probes		2 No.
Bread board and connecting wires		

CIRCUIT DIAGRAM:



PIN DIAGRAM:



PROCEDURE :

1. The circuit is connected as shown in circuit diagram (1) in inverting mode.
2. A 15V dual supply is given to the op amp from TRPS
3. Now an input voltage of (Say 20mV to 30mV) is given from the signal generator and a frequency of 1KHz
4. For any value of R_f , the output voltage V_o is noted from the CRO and calculate the gain and compare with theoretical values
5. For each value, the gain is calculated by the formula,

$$A_v = 20 \log V_o / V_i \text{ dB.}$$
6. Find the $V_o/\sqrt{2}$ value and observe/set this value in CRO by increasing the frequency in function generator. Then note the corresponding frequency which is BW
7. Calculate the GBW product
8. Repeat steps 4 to 7 for different values of R_f
9. It is observed that the gain bandwidth product is constant for any value of R_f .

TABULAR FORM :

$R_f(\Omega)$	O/P Voltage(V_o)	$V_o/\sqrt{2}$ value	$A_v=V_o/V_{in}$	$A_v(\text{dB})= 20 \log V_o / V_i$	Bandwidth	GBW product
10K						
22K						
30K						

PRECAUTION:

1. Avoid loose and wrong connections.
2. The output signal should be free from distortions.
3. Avoid parallax error while taking readings from CRO.

QUESTIONS:

4. Why response of Op-amp starts from constant.
B. As Op-Amp is a direct coupled amplifier there is no coupling capacitor
5. What are the types of packages for op-amp.
B. Flay pack, metal can pack etc.
6. What are the applications of op-amp
B. Summer, scaling, log amplifier etc.

RESULT :

The BW is calculated for different values of R_f and proved that GBW product is constant.

14. BJT Differential Amplifier

AIM: To determine the gain and CMRR of a BJT differential amplifier and to prove that CMRR improves with the increase in R_E .

APPARATUS :

Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No
Resistors	47k Ω ,	3 No
Resistors	50k Ω ,100k Ω	1 No
Transistors	BC107	2 No
Bread board		
CRO Probes		

THEORY:

The differential amplifier, or differential pair, is an essential building block in all integrated amplifiers. In general, the input stage of any analog integrated circuit with more than one input consists of a differential pair or differential amplifier. The basic differential pair circuit consists of two matched transistors Q_1 and Q_2 , whose emitters are joined together and biased a constant current source I as shown in Figure 1. The operation mode of the differential amplifier is defined according to the type of the input signal, for example large or small input signal, polarity of the input signals. Three important characteristics of the differential input stage are: the common-mode rejection ratio $CMRR$, the input differential resistance $i_d R$, and the differential-mode gain A_d

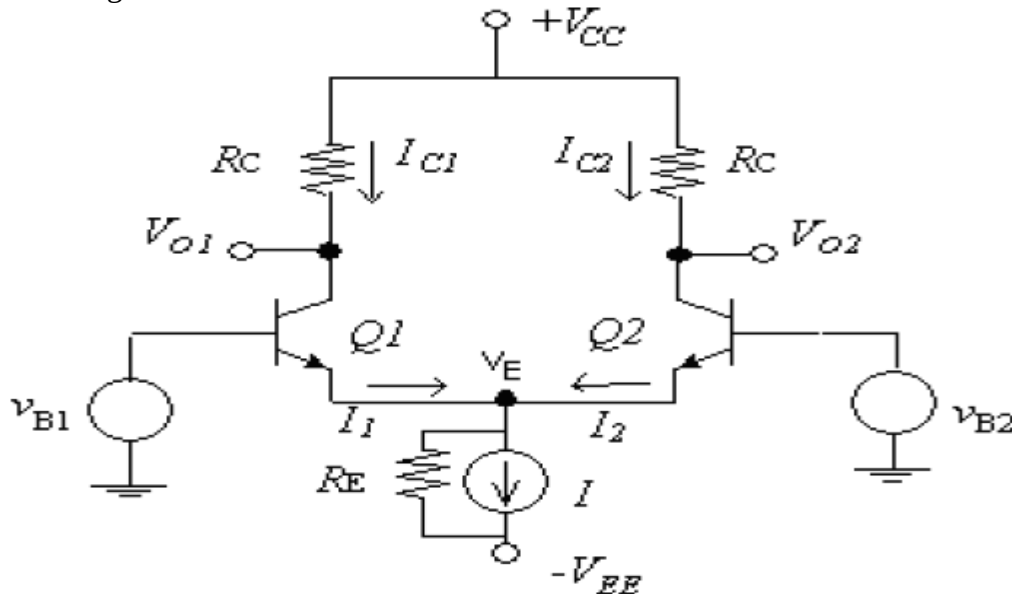


Figure 1

THE DIFFERENTIAL –MODE GAIN

Let $v_{B1} - v_{B2} = v_{id}$, then $v_{O1} = -A_d v_{id}$ and $v_{O2} = A_d v_{id}$. For perfectly matched transistors pair, the differential gain is given by

$$A_d = \frac{v_{O2}}{v_{id}} = \frac{1}{2} g_m R_C$$

Note that the above equation is obtained using half-circuit concept that is one half of the circuit was used to conduct the small-signal analysis. The trans-conductance of either transistor is $g_m = \frac{|I_C|}{V_T}$ where is the thermal voltage $V_T \cong 25mV$.

THE COMMON –MODE REJECTION RATIO

Let $v_{B1} = v_{B2} = v_{cm}$ in Figure 1 where the voltage v_{cm} is called common-mode voltage. Assume that the two transistors Q_1, Q_2 are perfectly matched. It follows that the current I is divided equally between the two transistors and remain so as long as the transistors are in active region. The voltage at each collector will be $V_{CC} - 0.5\alpha I R_C$, and the difference $V_{O1} - V_{O2} = 0$. Any change in v_{cm} will not affect the balance of the emitter current in both transistors and the collector voltages remain the same this means that the differential pair rejects common-mode input signal. The common-mode gain is given by

$$A_{CM} = \frac{v_{O2}}{v_{cm}} \approx -\frac{R_C}{2R_E}$$

Basically the differential amplifier is designed to amplify differential signal, this requires $A_d \gg A_{cm}$. The ideal differential amplifier has $A_d \approx \infty$, and $A_{cm} \approx 0$. The Common-Mode Rejection Ratio $CMRR$ is used as a measure of the differential amplifier performance. It is defined as

$$CMRR = \frac{A_d}{A_{cm}}$$

Substitute the values of the differential and common gains in the above equation

$$CMRR = -g_m R_E$$

As we can see from the above equation increasing the value of R_E , the $CMRR$ will increase, in other words the performance of the differential amplifier can be improved by simply increasing the emitter resistance. **A common practice is to use a current source to replace R_E , the results will be high $CMRR$.** To avoid dealing with large numbers the $CMRR$ is expressed in dB as given below

$$(CMRR)_{dB} = 20 \log \left| \frac{A_d}{A_{cm}} \right|$$

PRACTICAL INPUT- OUTPUT SIGNALS

So far we have assumed that the input signal is present in either common-mode or differential-mode. In practice the input signals can be decomposed into common-mode and differential-mode components.

The output signal will be given in general by

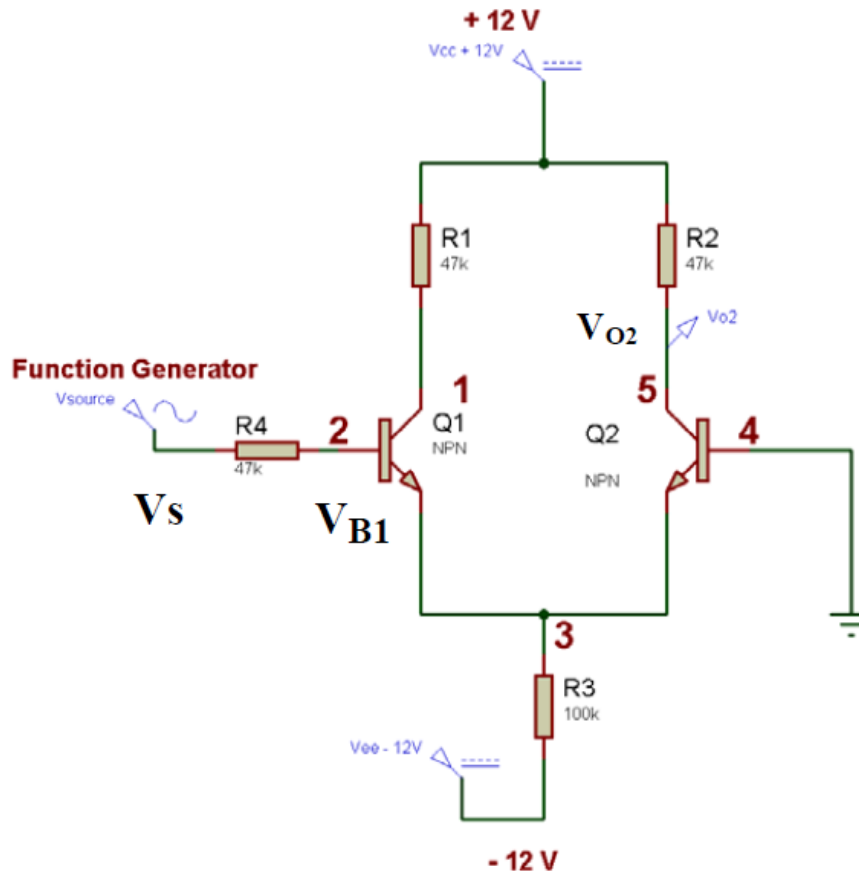
$$v_{O2} = A_d v_{id} + A_{cm} v_{cm} = A_d (v_{B1} - v_{B2}) + A_{cm} \left(\frac{v_{B1} + v_{B2}}{2} \right)$$

DIFFERENTIAL-MODE INPUT- OUTPUT RESISTANCE

Looking into the collector of either transistor, assume that the transistor load is a passive load as shown in Figure 1. The differential-mode output resistance is simply the output resistance of common-emitter stage and equals R_C . **If R_C is replaced by an active load (current mirror), the output resistance will be r_o as explained in Experiment 1.**

The differential-mode input resistance R_{id} is the resistance seen by the differential signal v_{id} (i.e. looking into the base of the BJT) and is given by $R_{id} = 2r_\pi$, where $r_\pi = \frac{V_T}{I_B}$.

CIRCUIT DAIGRAM:



PROCEDURE:

1. Build the differential amplifier shown in Figure with $R_E=50k\Omega$
2. Before applying **Function Generator** input, make sure that you have the minimum voltage under **-40 dB** attenuation with **1 kHz** frequency!! (First press **-20 dB ATT** button, and also pull **-20 dB** knob located on the right hand side.)
3. Now apply a input of 100mv at any one input V_{B1} or V_{B2} This configuration is called as Differential mode input signal
4. **3.** By connecting Ch1 to the output of the amplifier V_{O2} (Collector Voltage) Measure the peak-to-peak values and Calculate the differential gain $A_d = V_{O2}/V_s$

5. Modify the circuit connections as follows: disconnect the ground connection at point **VB2** and connect this point to VB1. This circuit configuration is known as differential amplifier with a **common-mode** input signal.
6. By connecting Ch1 to the output of the amplifier V_{o2} (Collector Voltage) Measure the peak-to-peak values and Calculate the
Common mode gain $A_c = V_{o2}/V_c$
7. Calculate $CMRR = A_d/A_c$ and in dB $CMRR_{dB} = 20 \log_{10}(A_d/A_c)$
8. Repeat the steps 3 to 6 for different value of $R_E = 100k\Omega$ and find CMRR
9. Observe that with increasing R_E value CMRR improves.

TABULAR FORM:

Input condition	Vs1	Vs2	Vo2	V02=Vc	$A_d = V_{o2}/V_s$	$A_c = V_{o2}/V_c$	CMRR = A_d/A_c	$CMRR_{dB} = 20 \log_{10}(A_d/A_c)$
Differential mode	100mV	--		--		--		
Common mode	100mV	100mV	--		--			

PRECAUTIONS :

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

QUESTIONS:

1. Define Common Mode Rejection Ratio.
2. Features of differential amplifier.
3. List the configuration of differential amplifiers
4. Methods of improving CMRR
5. What are the other methods to improve CMRR without R_E
6. List the advantage of current mirror circuit?

RESULT: The gain and CMRR of a BJT differential amplifier are determined and it was proved that CMRR improves with the increase in R_E .

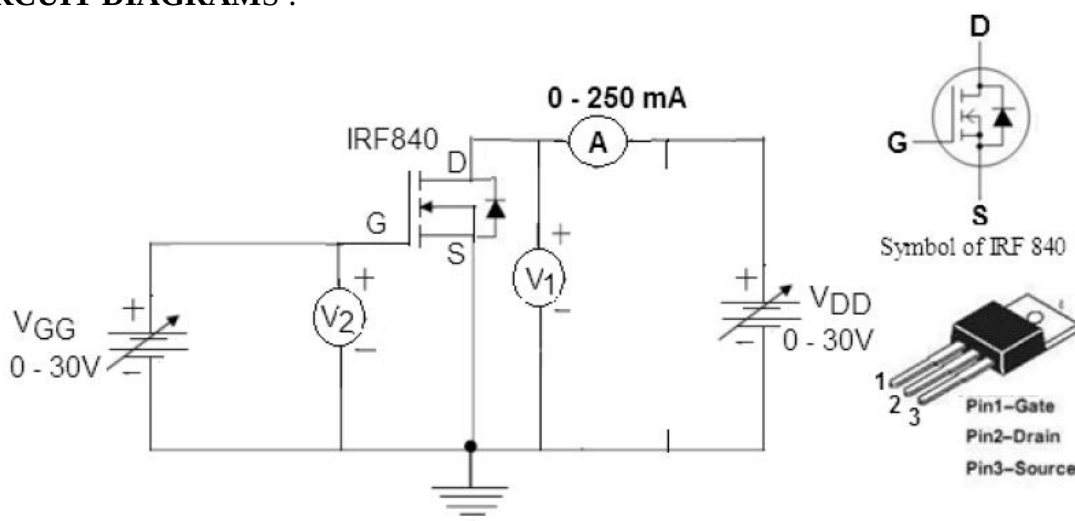
15. N-CHANNEL MOSFET CHARACTERISTICS

AIM: Plot the transfer and drain characteristics of n-channel MOSFET and calculate its parameters drain resistance, mutual conductance and amplification factor.

APPARATUS :

Power supply	0-30V	1No.
CRO	20MHz	1No.
Signal generator	1-1MHz	1 No
Resistors	100 Ω	1 No
MOSFET	IRF840	1 No
Bread board		
CRO Probes		

CIRCUIT DIAGRAMS :-



PROCEDURE :

Follow the below mentioned steps to obtain the **Drain Characteristics**

1. Set up the connections as indicated in the figure.
2. Keep both VGG and VDD at zero position.
3. By varying VGG set VGS to some value (slightly greater than the Threshold voltage determined from the transfer characteristics) Say 3.0V
4. Increase VDS by varying VDD gradually and note down the corresponding meter readings as shown in the table.
5. Repeat the steps 3 and 4 for VGS=3.2V and VGS = 3.4V
6. Plot the graph of ID Vs VDS

Follow the below mentioned steps to obtain the **Transfer Characteristics**

1. Set up the connections as indicated in the figure.
2. Keep both VGG and VDD at zero position.
3. Vary the VDD and set $V_{DS} = 5V$.
4. Increase V_{GS} by varying VGG gradually and note down the corresponding meter readings as shown in the table.
5. Note down the minimum value of V_{GS} for which drain current starts flowing and record $V_{TH} =$
6. Repeat for $V_{DS} = 10V$ and $15V$.
7. Plot the graph of I_D Vs V_{GS}

TABULAR FORM:

Drain Characteristics

$V_{GS} = V_2 = 3.0 \text{ (3.2V, 3.4V)}$

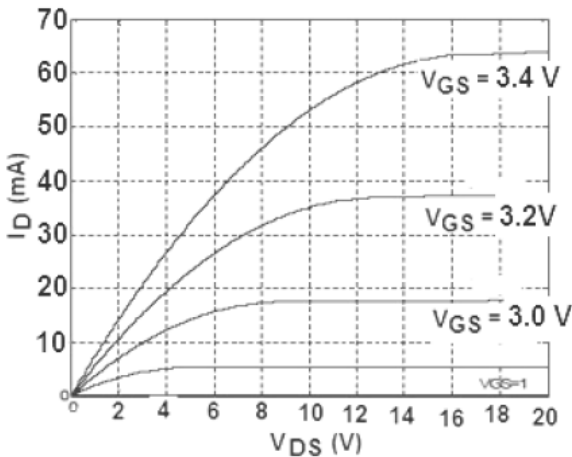
$V_{DS}=V_1, V$	0.2	0.4	0.6	0.8	1.0	1.5	2.0	3.0	5.0	10.0	12	15	18	20
I_D, mA														

Transfer Characteristics :

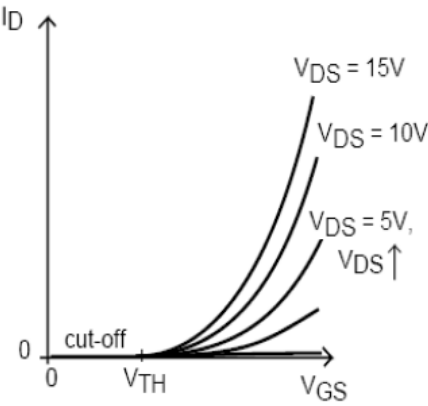
$V_{DS} = V_1 = 5V \text{ (10V, 15V)}$

$V_{GS}=V_2, V$	1.0	2.0	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.8	4.0	4.2	4.5
I_D, mA														

MODEL GRAPH :



Drain Characteristics



Transfer Characteristics

From the graphs determine

$$g_m = \left(\frac{\Delta I_D}{\Delta V_{GS}} \right) \text{ at } V_{DS} \text{ constant}$$

$$r_d = \left(\frac{\Delta I_D}{\Delta V_{DS}} \right) \text{ at } V_{GS} \text{ constant}$$

PRECAUTIONS:

1. Connections must be made with proper polarity.
2. Avoid loose and wrong connections.

QUESTIONS:

1. What is the difference between MOSFET and BJT
2. What are the types of MOSFET?
3. What is the difference between depletion mode and enhancement mode MOSFET's?
4. How MOSFET's are suitable for low power high frequency applications?
5. What is pinch off voltage?
6. In which region the MOSFET is used as a switch?
7. Which parameter defines the transfer characteristics?
8. Why MOSFET's are mainly used for low power applications?
9. How MOSFET is turned off? What are the merits of MOSFET?
10. What are demerits of MOSFET? What are the applications of MOSFET

RESULT: Plotted the transfer and drain characteristics of n-channel MOSFET and calculated its parameters drain resistance, mutual conductance and amplification factor

16. APPLICATIONS OF OPERATIONAL AMPLIFIER

AIM : To realize Summing Amplifier, Subtracting Amplifier, Integrator and Differentiator by using 741 Op-Amp.

APPARATUS:

1. Op-Amp LM 741
2. Resistors – $1K\Omega$ (4), $100K\Omega$ (1), $10K\Omega$ (1) and $15K\Omega$ (1)
3. Capacitors – $0.001\ \mu f$, $0.01\ \mu f$, $0.022\ \mu f$
4. Function Generator
5. TRPS
6. CRO & CRO Probes
7. Bread Board
8. Connecting Wires.

THE IDEAL OP AMP:

An ideal op amp would exhibit the following electrical characteristics.

1. Infinite voltage gain A .
2. Infinite input resistance R_i so that almost any signal source can drive it and there is no loading of the preceding stage.
3. Zero output resistance R_o so that output can drive an infinite number of other devices.
4. Zero output voltage when input voltage is zero.
5. Infinite bandwidth so that any frequency signal from 0 to ∞ Hz can be amplified without attenuation.
6. Infinite common mode rejection ratio so that output common – mode noise voltage is zero.
7. Infinite slew rate so that output voltage changes occur simultaneously with input voltage changes.

APPLICATIONS OF OP AMP:

1. Summing Amplifier:

Op amp may be used to design a circuit whose output is the sum of several input signals. Such a circuit is called a summing amplifier or a summer. If V_1 , V_2 are two input signals given to the inverting terminal, then

$$V_o = - \frac{R_F}{R} (V_1 + V_2)$$

2. Subtracting Amplifier:

The function of a subtractor is to provide an output, which is equal to the difference of two input signals (or) proportional to the difference of two input signals. If V_1 and V_2 are the input voltages at inverting and non – inverting terminals, then

$$V_o = \frac{-R_F}{R} (V_1 - V_2)$$

3. 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 with the feedback resistor R_F replaced by a capacitor C_F . The output voltage is

given by

$$V_o = - \frac{1}{RC} \int V_1 dt$$

Integrator is used in signal wave shaping circuits and in analog computers. If the input is a sine wave, the output is a cosine wave. If the input is a square wave, the output will be a triangular wave. In the practical integrator, R_F is connected across feedback capacitors C_F . This R_F limits the low frequency gain and minimizes the variation in the output voltage. The input signal will be integrated properly if the time constant

$T = R_1 C_F$ is larger than the time period T of the input signal

4. Differentiator:

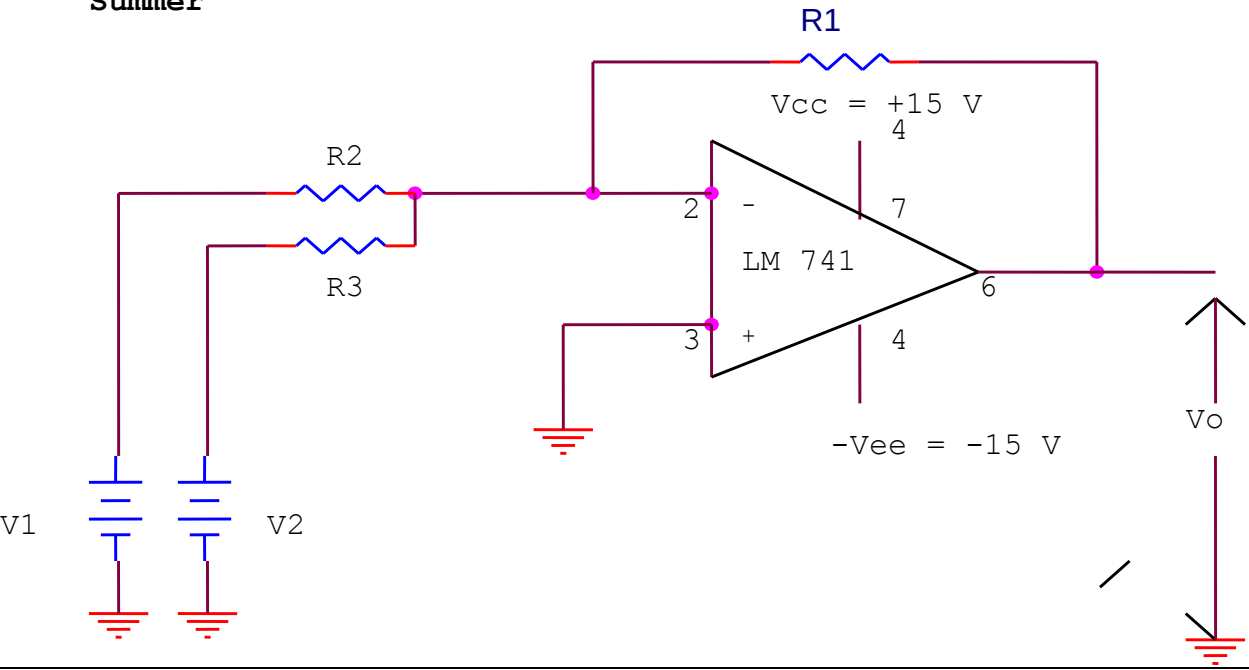
The function of a differentiator is to give an output voltage, which is proportional to the rate of change of input voltage. The differentiator may be constructed from a basic inverting amplifier if an input resistor is replaced by capacitor C_1 . The output voltage is given by

$$V_o = - RC \frac{dV_i}{dt}$$

The condition for differentiator is $\omega \ll T$ where $\omega = \frac{1}{RC}$ for sine wave and square wave inputs, the resulting differentiated outputs are cosine wave and spike outputs respectively. Differentiator is used to detect high frequency components in an input signal.

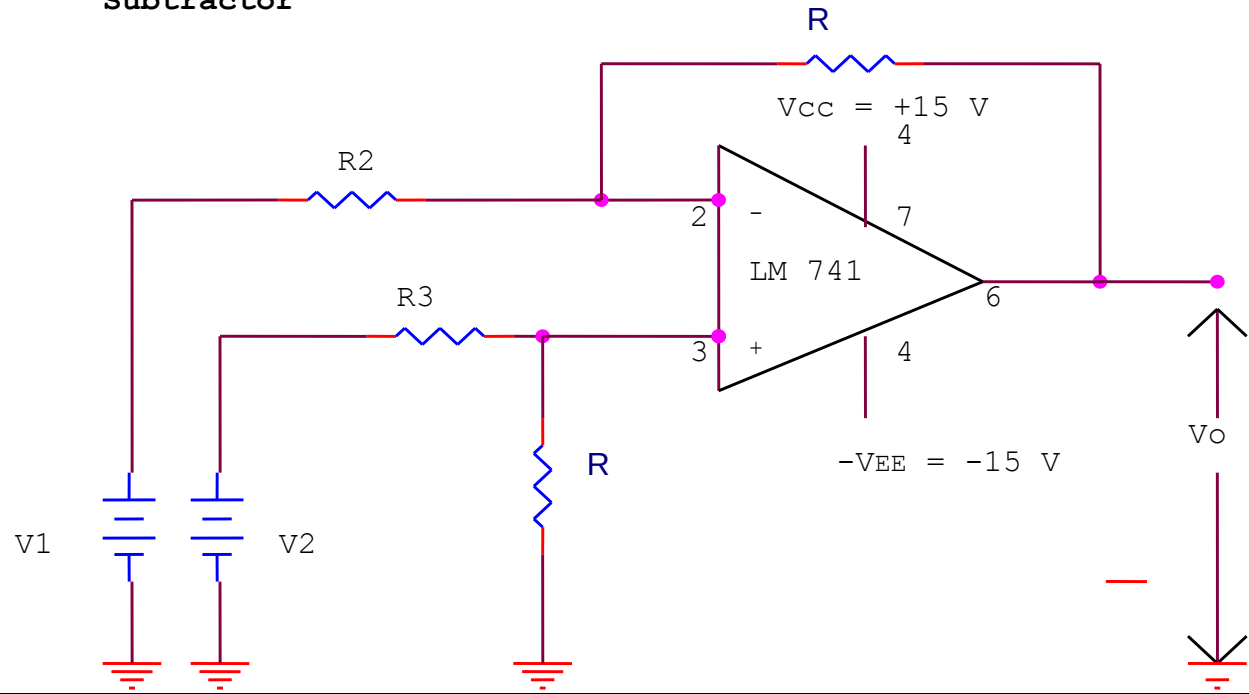
CIRCUIT DIAGRAM

Summer



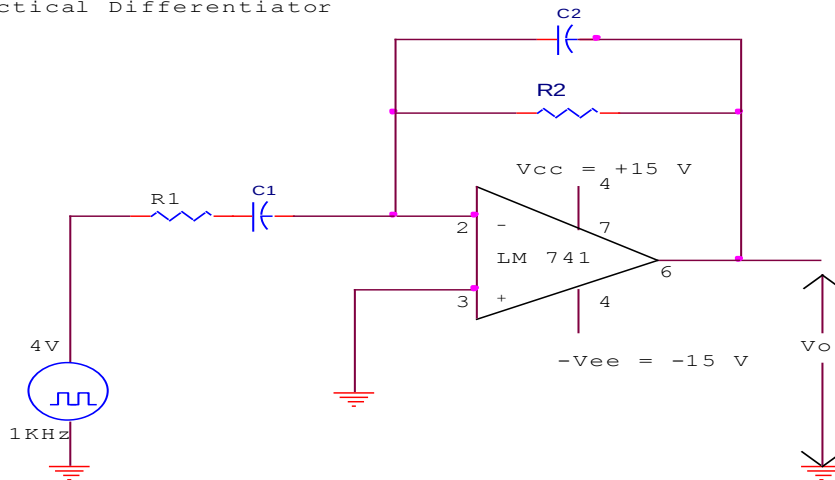
$R1=R2=R3=1K\Omega$

Subtractor



$R1=R2=R3=R4=1K\Omega$

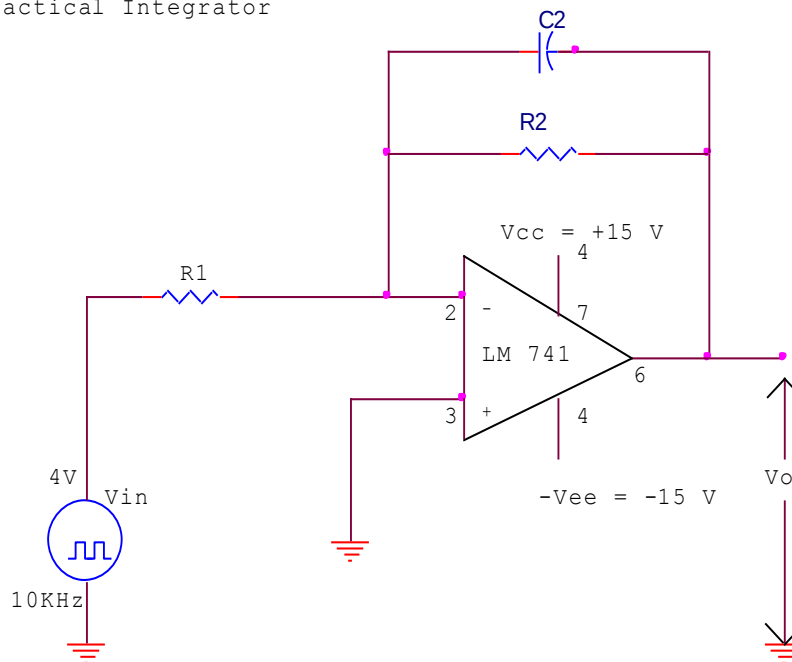
Practical Differentiator



$R1=10K\Omega$, $R2=15K\Omega$

$C1=330pf$, $C2=0.001\mu f$

Practical Integrator



$R1=10K\Omega$, $R2=100K\Omega$, $C2=0.01\mu f$

PROCEDURE:

I. Summing Amplifier:

1. Connections are made as per the circuit diagram.
2. Input voltages V_1 and V_2 are given and the corresponding output voltage V_o is measured from CRO.
3. Output varies as $V_o = -(V_1 + V_2)$, since $R_F = R$.

II. Subtracting Amplifier:

1. Connections are made as per the circuit diagram.
2. Input voltage V_1 and V_2 are given to the inverting and non – inverting terminals respectively and corresponding output voltage is measured from CRO.
3. Output varies as $V_o = V_2 - V_1$.

III Differentiator:

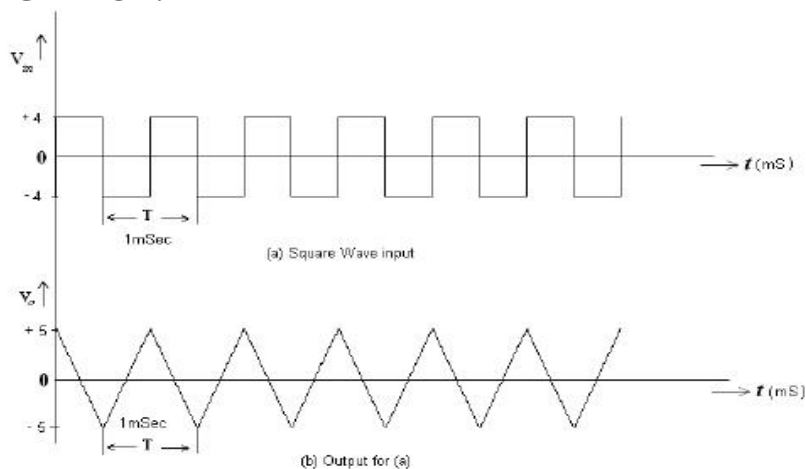
1. Connections are made as per the circuit diagram.
2. A square wave input of 4V (p-p) and frequency of 1KHZ is applied from function generator.
3. Output waveform is observed. Corresponding amplitude and time period is observed and frequency is calculated.
4. With the above data plot the output graphs with time on X-axis and voltage on Y-axis.

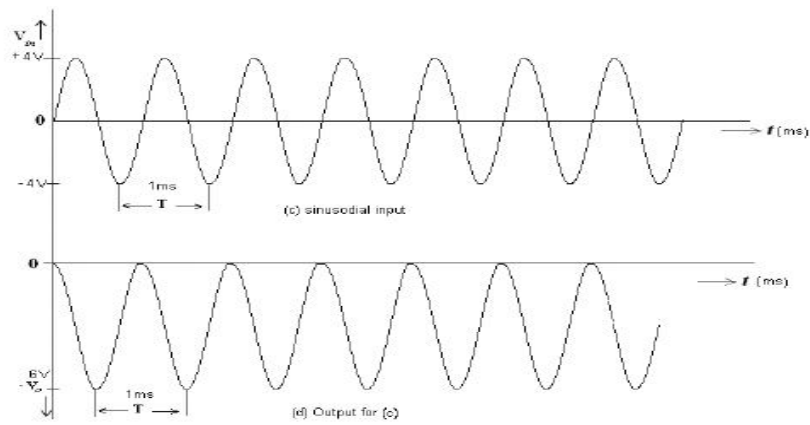
IV. Integrator:

1. Connections are made as per the circuit diagram.
2. By using a function generator, a square wave input 4Vp-p is given.
3. The frequency applied is 10 KHz.
4. A perfect triangular wave is obtained. The peak-to-peak voltage and the time period of input and output waves are measured from CRO.
5. The waveforms are plotted.

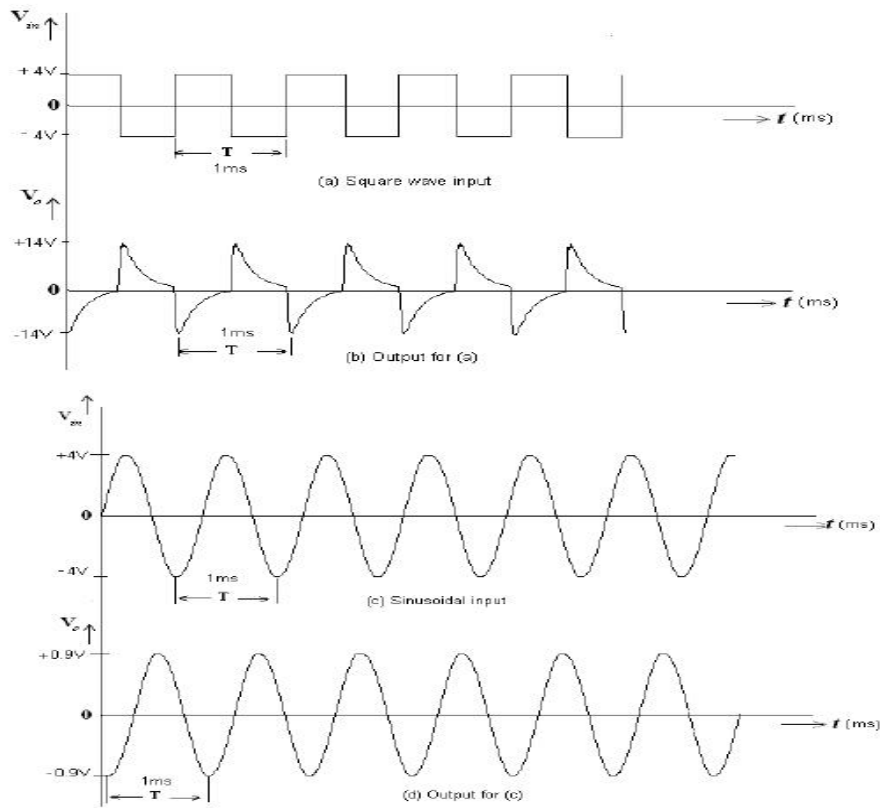
MODEL GRAPHS:

INTEGRATOR:





DIFFERENTIATOR:



PRECAUTIONS:

1. Loose and wrong connections are to be avoided.
2. Waveforms should be obtained without any distortion.

Viva questions

1. What are the ideal characteristics of an OP-AMP?
2. Define OP-AMP.
3. What do you mean by CMRR?
4. Define slew rate.
5. What are the applications of differentiator?
6. What are the applications of integrator?
7. What is a difference between inverting and non-inverting amplifier?

RESULT: Observed the output values for summer and subtractor amplifier and output waveforms of integrator and differentiator.