Faculty of Engineering

Electronics and Communication Department

Electronics Circuits

Fall 2023

Academic year : First

2023-2024

Faculty of Engineering

Electronics and Communication Department

Electronics Circuits

Fall 2023

Name:

Section:

Grade:

Date:

TA:

Table of Content

INSTRUCTIONS

- **Attend on-time.**
- **Read the experiment before you come.**
- **Don’t eat or drink in the laboratory.**
- **Keep the laboratory clean.**
- **Be quiet and polite.**

INRODUCTION

This course covers the following:

- **Current Source**
- **OP-Amp Apps part 1**
- **OP-Amp Apps part 2**
- **Power Amplifier – Class B**
- **Feedback in Amplifiers**
- **Differential Amplifier**

Current source

Objective

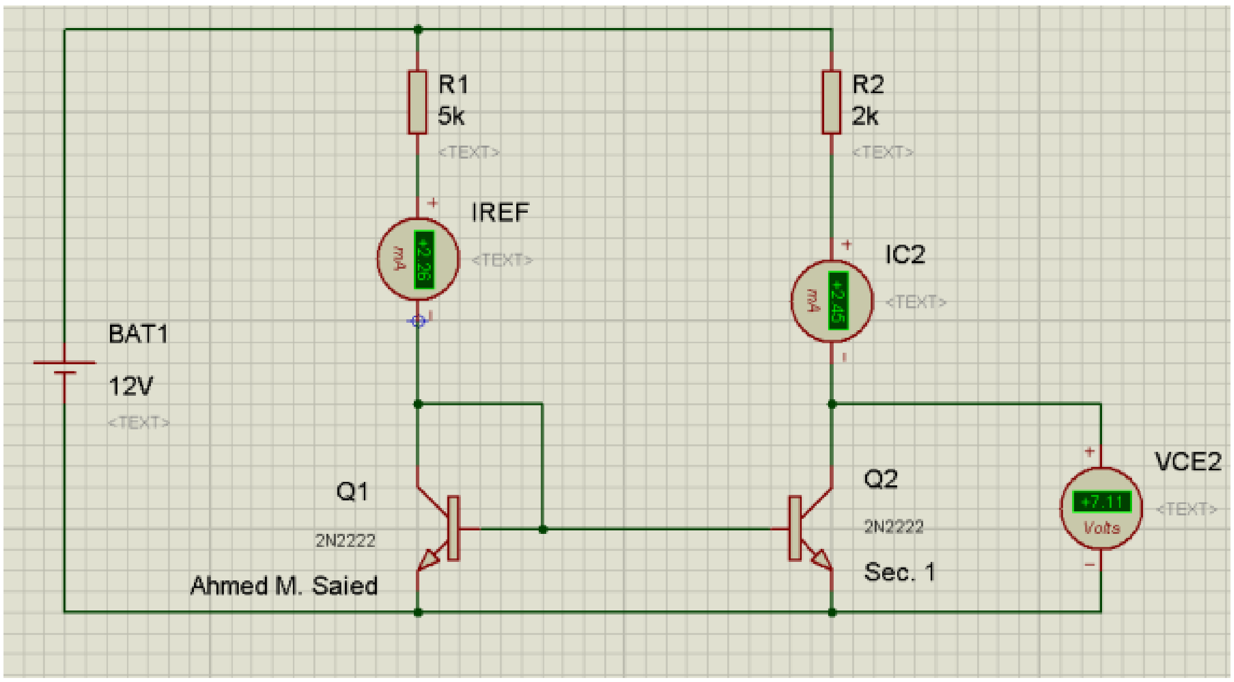
To demonstrate the concept of current source and get mirror output current equal to the reference current.

Tools and equipments

- DC power supply
- Function generator
- DMM(Digital multi meter)
- Oscilloscope
- 5k x1
- 2k x1
- 2N2222 transistor x2

Procedures

1- Implement the circuit as the figure



2- Change DC Ammeter (Display range) to Milliamps

3- Put R2 at : 1KΩ, 2KΩ, 3KΩ, 4KΩ, 5KΩ, 7KΩ, and 10KΩ

4- Fill the Tables (by hand), and draw IC2, VCE2 Relation (simulation in solid-line and experimental in dash-line)

Results

Simulation Results (I_{ref}=)

R2							
V_{CE2}							
I_{C2}							

Experimental Results(I_{ref}=   )

R2							
V_{CE2}							
I_{C2}							

Comment:

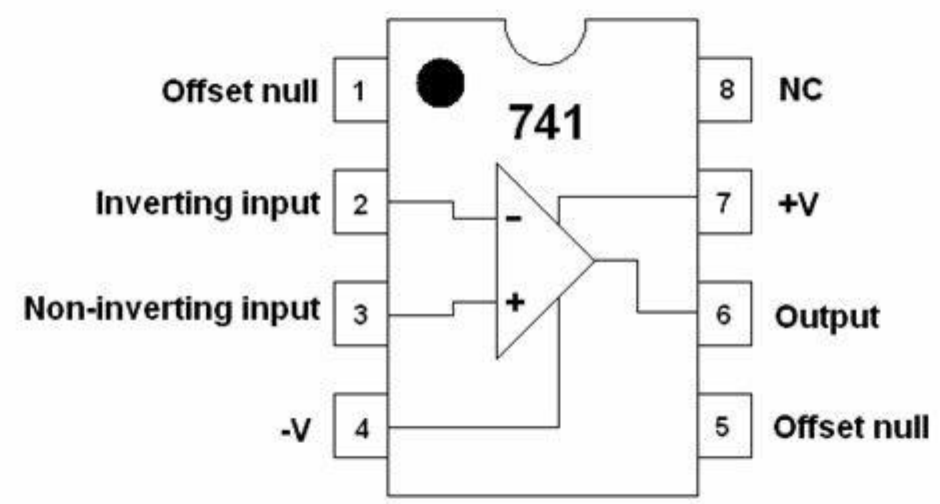
Opamp applications part 1

Objective

Implement an Op-Amp. Amplifiers, and control the gain of each circuit.

Tools and equipments

- IC 741 x1
- 1 $K\Omega$ x1
- 10 $K\Omega$ x1
- 100 Ω x1
- 5 $K\Omega$ x1
- 100 uf x1



Procedures

1- Construct the circuits as shown in figure below.

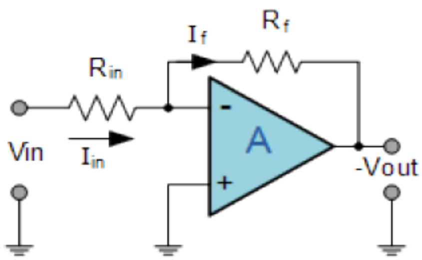
2- Adjust the AC voltage source to the values you need.

3- Use the oscilloscope to measure the output voltage.

4- Compare it with the output voltage obtained from the gain equation.

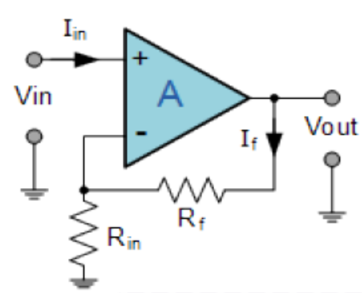
5- Record your notes.

Inverting Op-amp



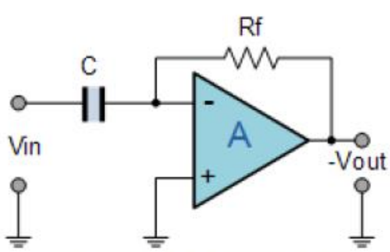
$$A = \frac{Vout}{Vin} = -\frac{Rf}{Rin}$$

Non-inverting Op-amp



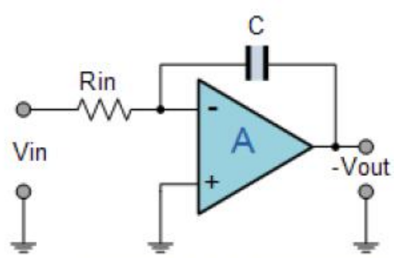
$$A = \frac{Vout}{Vin} = 1 + \frac{Rf}{Rin}$$

Differentiator Op-amp



$$Vout = -Rf\,C\,\frac{dVin}{dt}$$

Integrator Op-amp



$$Vout = -\frac{1}{j\omega RinC}Vin$$

Comment:

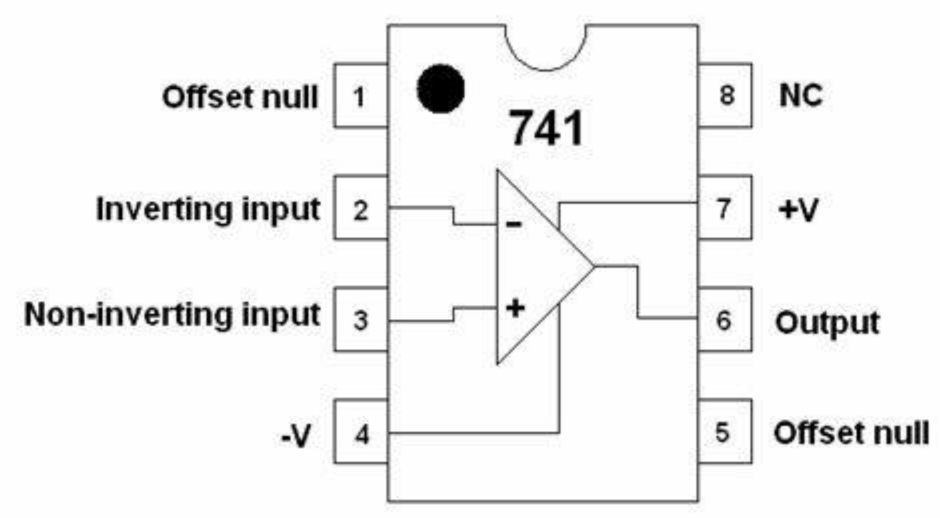
Opamp applications part 2

Objective

Implement an Op-Amp. Amplifiers, and control the gain of each circuit.

Tools and equipments

- IC 741 x1
- 1 $K\Omega$ x1
- 10 $K\Omega$ x1
- 100 Ω x1
- 5 $K\Omega$ x1
- LED x2



Procedures

1- Construct the circuits as shown in figure below.

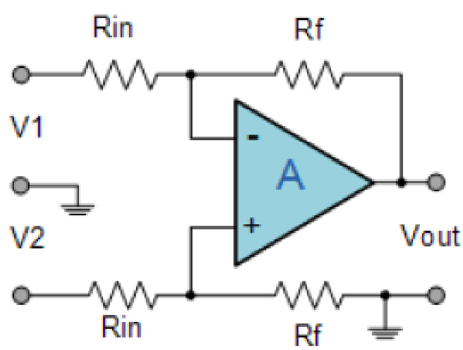
2- Adjust the AC voltage source to the values you need.

3- Use the oscilloscope to measure the output voltage.

4- Compare it with the output voltage obtained from the gain equation.

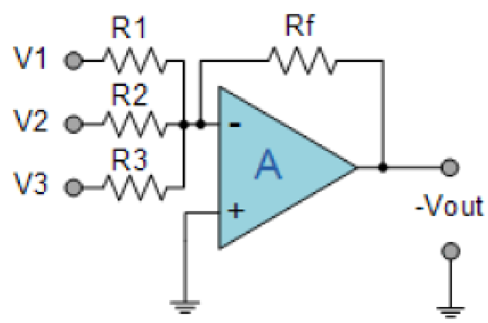
5- Record your notes.

Differential Op-amp

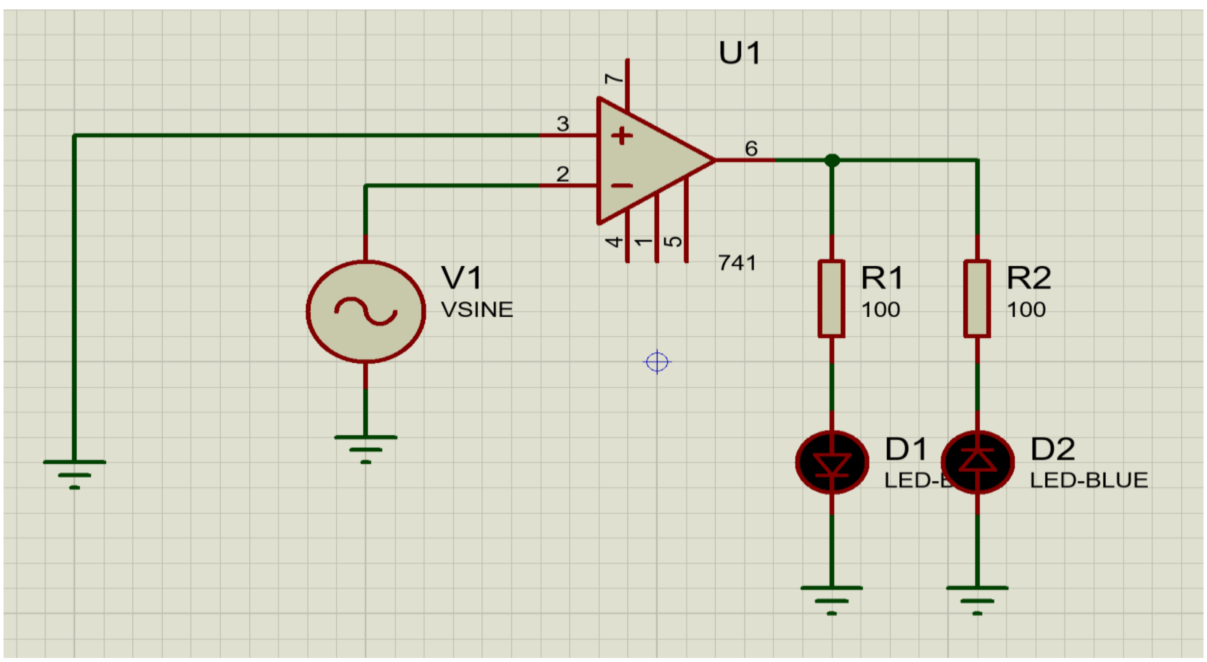


$$Vout = \frac{Rf}{Rin}(V2 - V1)$$

Summing Op-amp



$$Vout = -\left(\frac{Rf}{R1}V1 + \frac{Rf}{R2}V2 + \frac{Rf}{R3}V3\right)$$



<u>Comment:</u>

Power Amplifier- class B

Objective

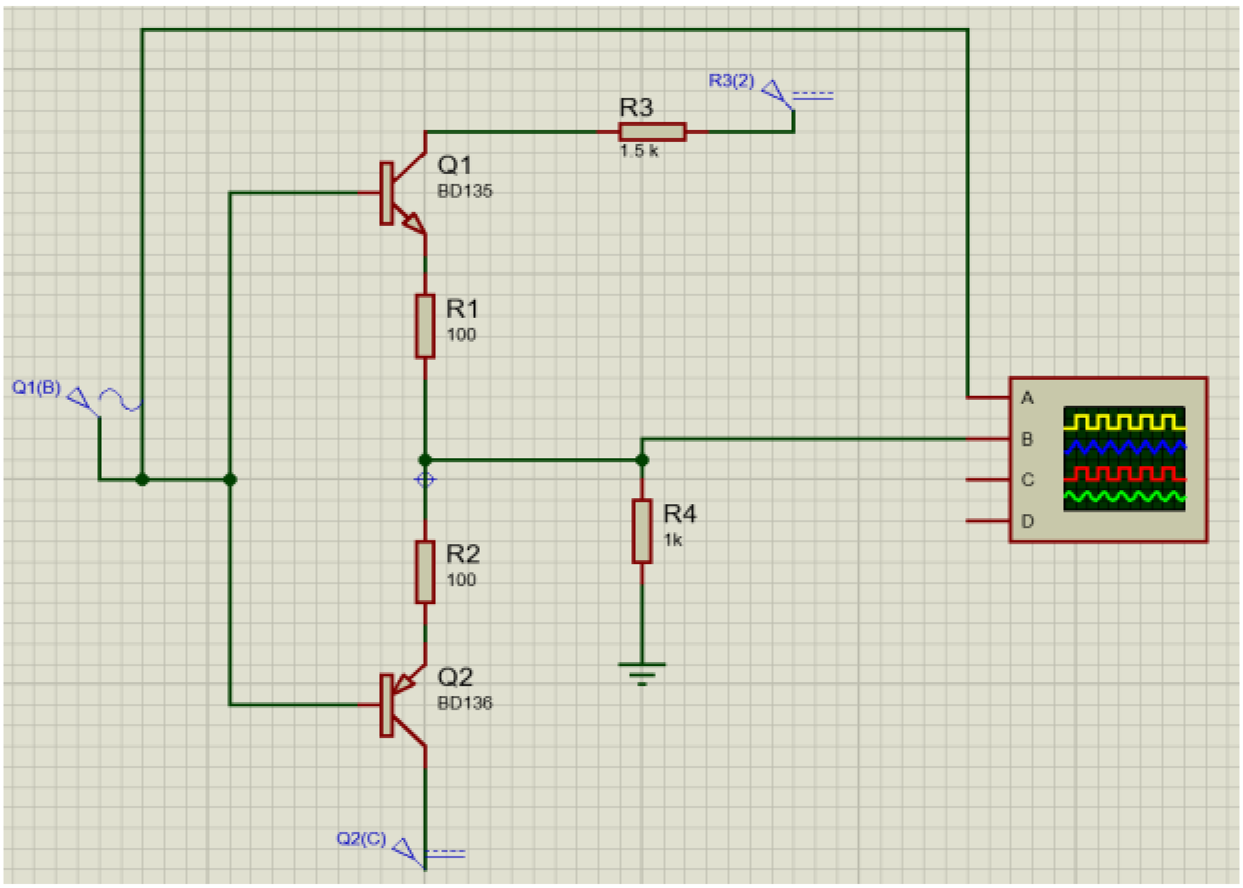
- To draw the output signal of the class B power amplifier and calculate its efficiency.

Tools and equipments

- DC power supply
- Function generator
- Oscilloscope
- 1k x1
- 1.5k x1
- 100 Ω x2
- BD135 transistor x1
- BD136 transistor x1

Procedures

1- Connect the circuit as the following figure



2- Adjust two power supply to 12 and -12 volt

3- Adjust the DC input to the amplitude 5 volt peak value and 1khz frequency

4- Display the output on the oscilloscope and draw it in your paper.

Results

1- Comment on the output of oscilloscope.

……..

2- Measure input and output voltage peak values and then compute the source and output power and efficiency.

$PS = (2\ VCC.VOP)/\pi.RL =$ …………….

$PL = VOP^2 / 2.RL =$ ………………

Efficiency= PL/PS = ………………..

What is your suggestion to disappear the cross over distortion happened?
……..

Comment:

Feedback in Amplifiers

Objective

To study the effects of feedback on the amplifier characteristics (gain, bandwidth, input and output impedance).

Tools and equipments

- DC power supply
- Function generator
- Oscilloscope
- 1k x4
- 0.1 uF x5
- 100 uF x3
- 6.8K x1
- 10k x2
- 320k x4
- 470 Ω x2
- 56K x2

- 100 Ω x2
- 220 Ω x2
- 220 K x2
- 2n2222 transistor x6

Introduction

Feedback is a method in which a portion of the output returned to the input in order to modify the characteristics of the device. Feedback can apply to transistor amplifier circuits to modify their performance characteristics such as gain, bandwidth, input and output impedance etc.

An amplifier in which feedback is incorporated known as feedback amplifier. Block diagram of typical feedback amplifier shown in Fig. (1). Feedback can divide in two categories depending upon the phase of the returned (feedback) signal with respect to the input signal. If the returned signal is in phase with input signal, feedback is known as positive feedback. It increases the gain of the amplifier but reduces the bandwidth and stability of the circuit. It used to produce oscillation. If the feedback signal is out of phase with respect to the input signal, it is know as a negative feedback. Negative feedback improves the performance of an amplifier but reduces the Overall gain. It helps to stabilize the gain, increases bandwidth: reduces distortions and assures the repeatability of the circuit performance.

There are number of ways by which a signal can be derived from output and can be returned to input. Therefore, feedback amplifiers can be classified in the following four groups depending upon the interconnections of the basic amplifier and the input and output terminals of feedback network as shown in Fig. (2).

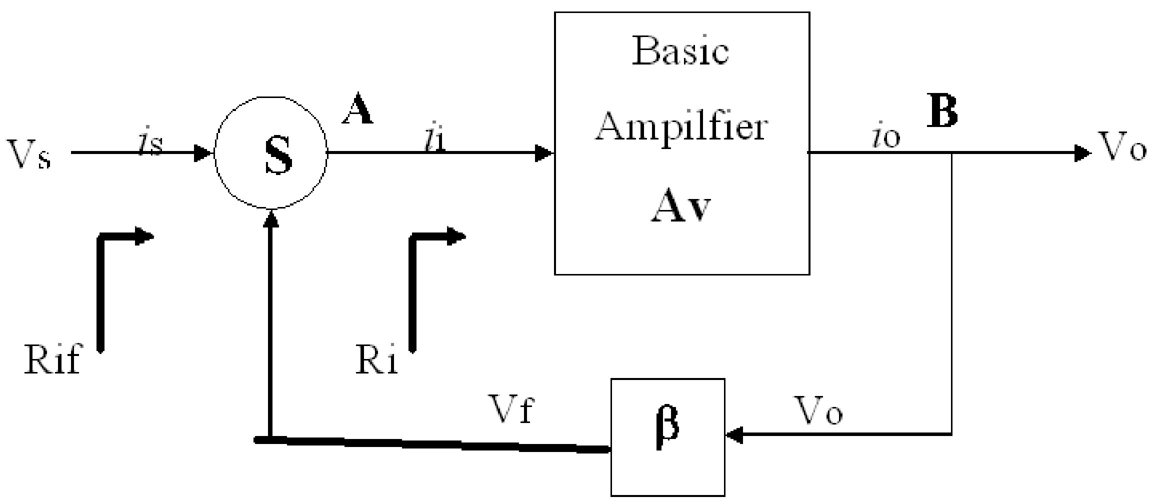


Fig.(1) Block diagram of basic feedback amplifier

(A) voltage shunt feedback

Voltage-Shunt configuration of feedback amplifier is shown in Fig.(2-a). The feedback network consists of a single resistance Rf. Voltage developed across RL is sampled and feedback to input through Rf. The shunt connections at input and output terminals reduce input and Output impedance. The amplifier works as trans-resistance type voltage amplifier. Fig.(3-a) is a Voltage-Shunt feedback amplifier with:

$$\beta = \frac{I_f}{V_o}$$

(B) voltage series feedback

Voltage-Series topology of the feedback amplifier is shown in Fig.(2-b). Voltage developed across load resistance is sampled and feedback to input through resistance Rf and RE (potential divider) as shown in Fig.(3-b). Sampled voltage is proportional to the output voltage and feedback in series with the input voltage.

Series connection at input increases input resistance and shunt connection at output reduces output resistance. The resulting amplifier is a true voltage amplifier.

$$Vf = Vo\,\frac{R2}{R1+R2}$$

$$\beta = \frac{Vf}{Vo}$$

$$\text{So;} \quad \beta = \frac{R2}{R1+R2}$$

(c) current shunt feedback

Current-Shunt topology of the feedback amplifier is shown in Fig.(2- c). Feedback signal is proportional to the output current and feedback to input in shunt. The series connection at the output increases output resistance and shunt connection at input decreases input resistance. The amplifier works as a true current amplifier.

$$\beta = \frac{I_f}{I_o}$$

(D)current series feedback

In Current-Series configuration feedback signal is proportional to the load current and fed to input through a resistance RE in series with the input signal as shown in Fig.(2-d). The series connection at the input and the output increases the input and output impedance. Amplifier-circuit works as trans-conductance type current amplifier.

$$I = I_c$$

$$V_f = I_c \cdot R$$

$$\beta = \frac{V_f}{I_o} = \frac{I_c \cdot R}{I_c}$$

$$\beta = R$$

Tables (i) and (ii) show the different topologies of the feedback with their analysis and the effect of negative feedback on amplifier characteristics respectively.

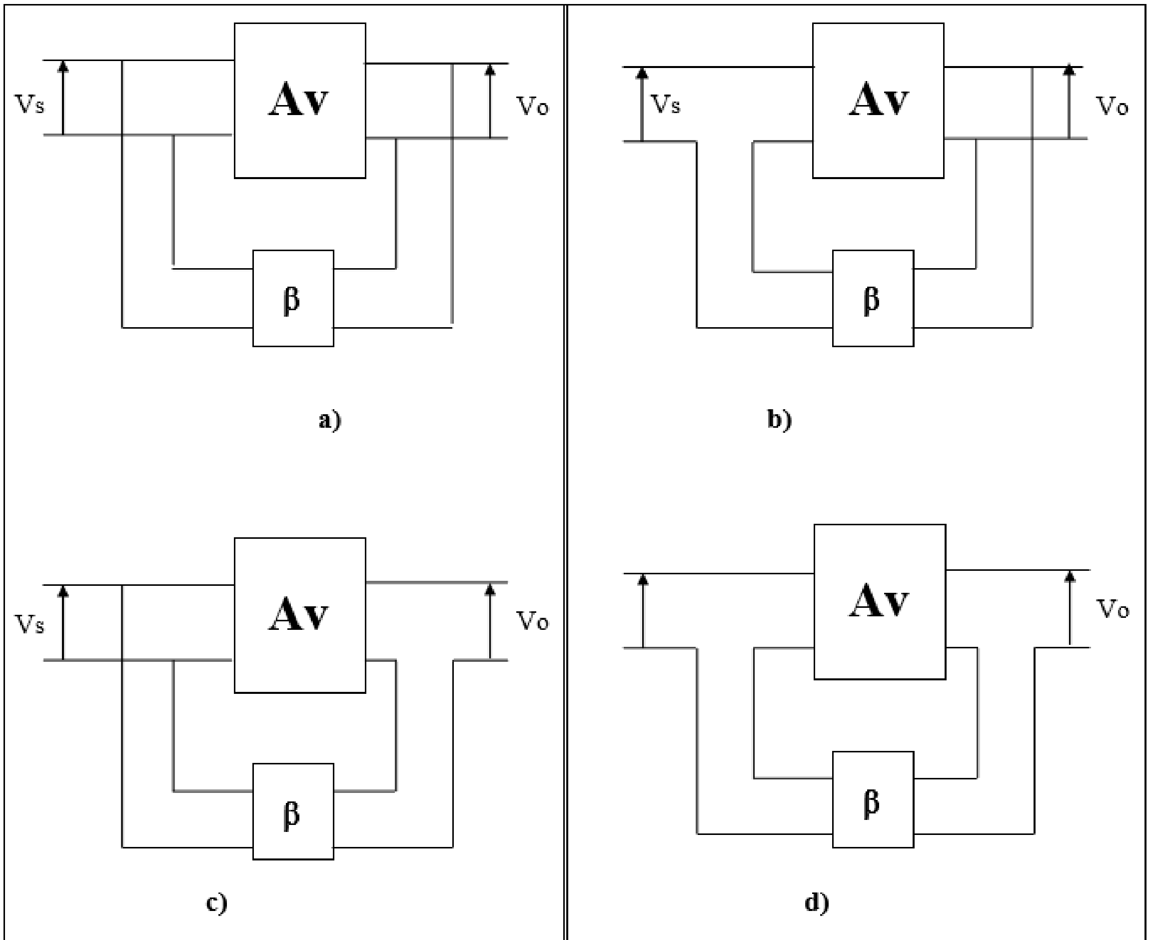


Fig.(2) Feedback amplifier

Procedures

1. Connect the circuit as shown in Fig.(4-a).

2. Measure dc collector current I_{c1} without input signal (if the value of Ic1 is not between 4 and 4.5mA, change the value of RB.

3. With disconnect 22kΩ, Set the input voltage at 5 kHz, and then change the input voltage until the output becomes 4 V_{p-p}. Then calculate the voltage gain.

4. Measure the output resistances.

5. Find frequency response by measuring voltage gain to different frequencies (30, 100, 200, 500, lkΩ , 10kΩ, 30kΩ etc). Determine upper and lower half power frequencies and bandwidth.

6. Connect a resistance R_f (feedback network) = 470Kohm between points A and B, and repeat steps 3 and 4. Determine bandwidth by measuring frequencies at which gain =0.707 times the gain at 5 kHz.

7. Replace resistance R_f=470Kohm by 1M and repeat steps 4 and 5. Determine bandwidth as in step 6.

8. Connect circuit as shown in Fig. (4-b), and repeat steps 2, 3, 4 and 5 .

9. Connect a resistance R_f of 22Kohm between points A and B as shown in Fig.(4-a) and repeat steps 3, 4 and 6.

10. Replace R_f =22Kohm by 47kohm and repeat step 6.

11. Remove R_f and C_E [as shown in Fig.(4-d) and repeat steps 3,4, and 5.

12. Connect the circuit as shown in the Fig.(4e), and repeat steps 2, 3, 4 and 6.

13. Remove R_f and repeat step.3, 4 and 6.

14. Connect the circuit as shown in Fig. (4c) and repeat steps 2, 3, 4 and 6

15. Remove R_f and C_f and repeat steps 3, 4 and 6.

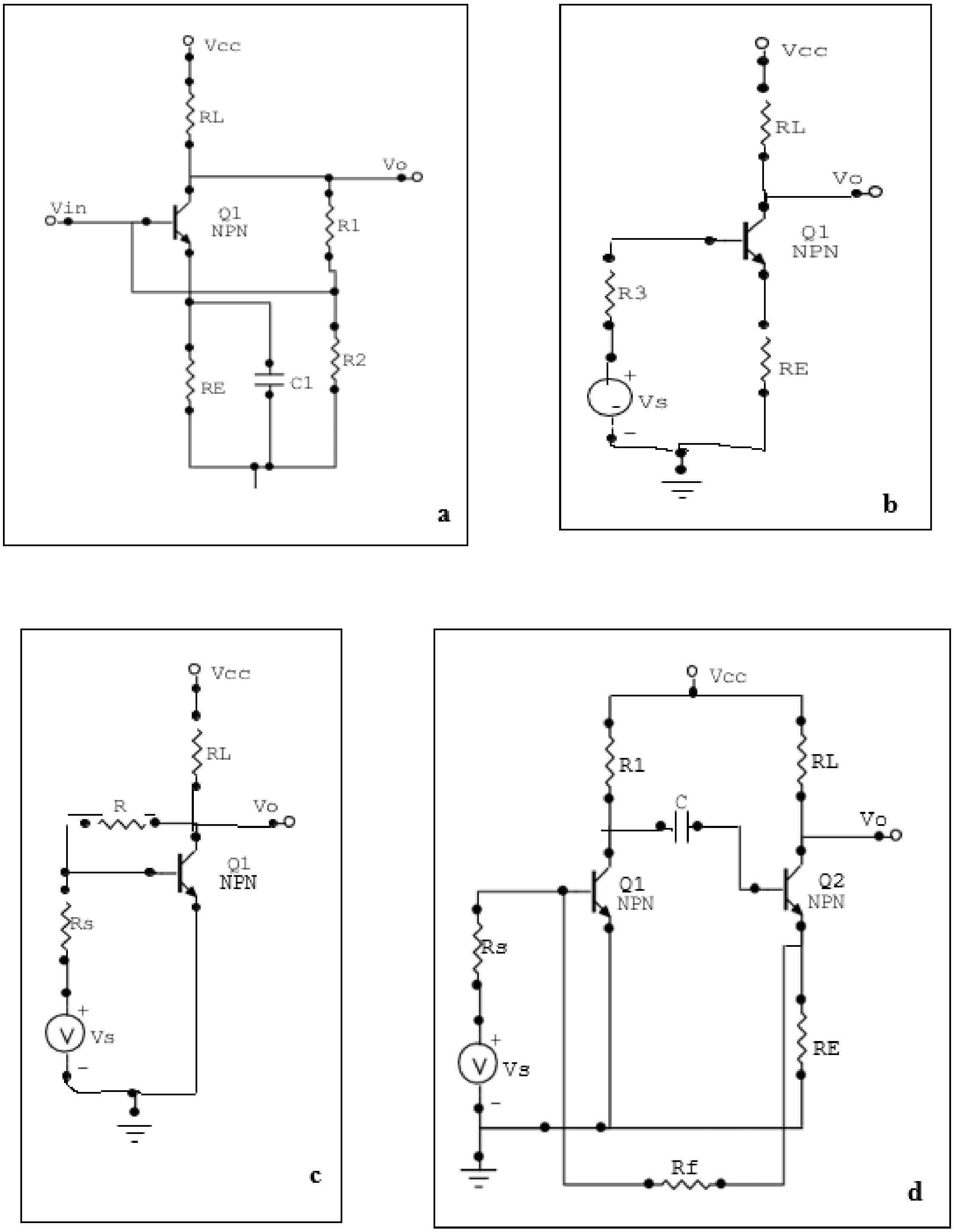
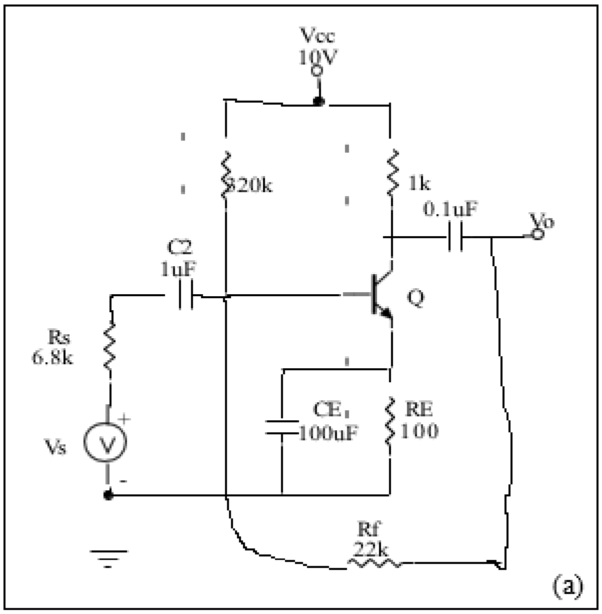
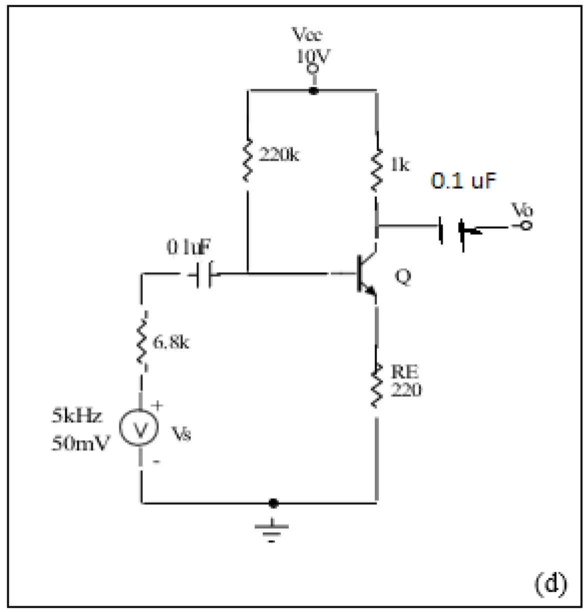
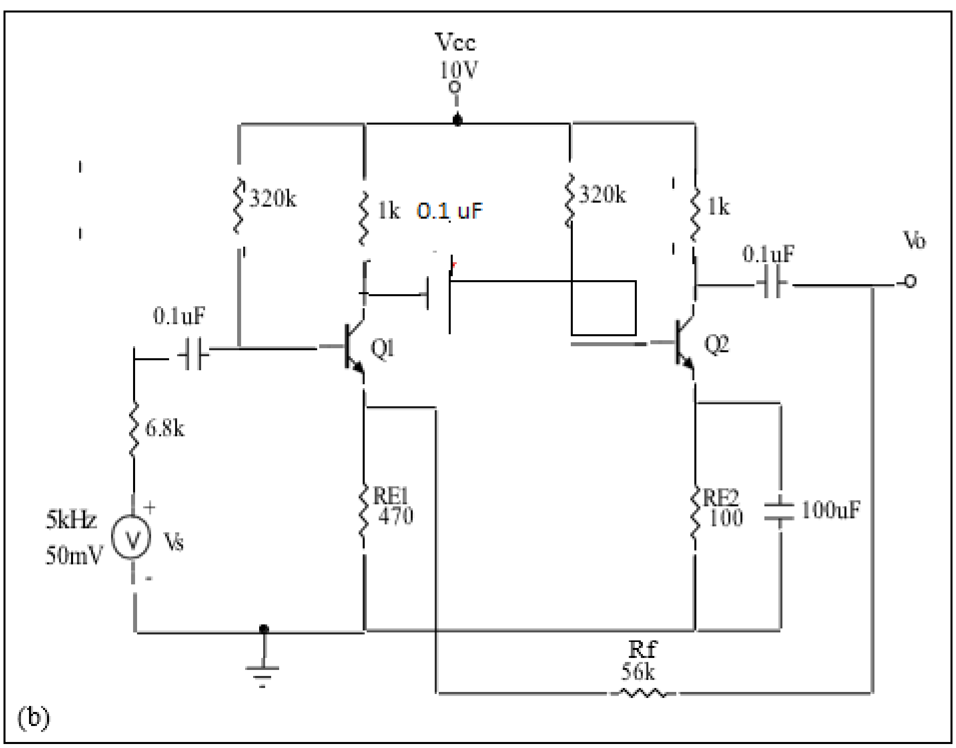

Vcc
RL
Vo
Vin
Q1
NPN
R1
R2
RE
C1
a
Vcc
RL
Vo
Q1
NPN
R3
Vs
RE
b
Vcc
RL
R
Vo
Q1
NPN
Rs
Vs
c
Vcc
R1
RL
C
Vo
Q1
NPN
Q2
NPN
Rs
Vs
RE
Rf
d

Fig. (3)


Vcc
10V
320k
1k
0.1uF
Vo
C2
1uF
Q
Rs
6.8k
CE
100uF
RE
100
Vs
Rf
22k
(a)


Vcc
10V
220k
1k
0.1 uF
Vo
0.1uF
Q
6.8k
RE
220
5kHz
50mV
Vs
(d)


Vcc
10V
320k
1k
0.1 uF
320k
1k
0.1uF
Vo
0.1uF
Q1
Q2
6.8k
RE1
470
RE2
100
100uF
5kHz
50mV
Vs
Rf
56k
(b)

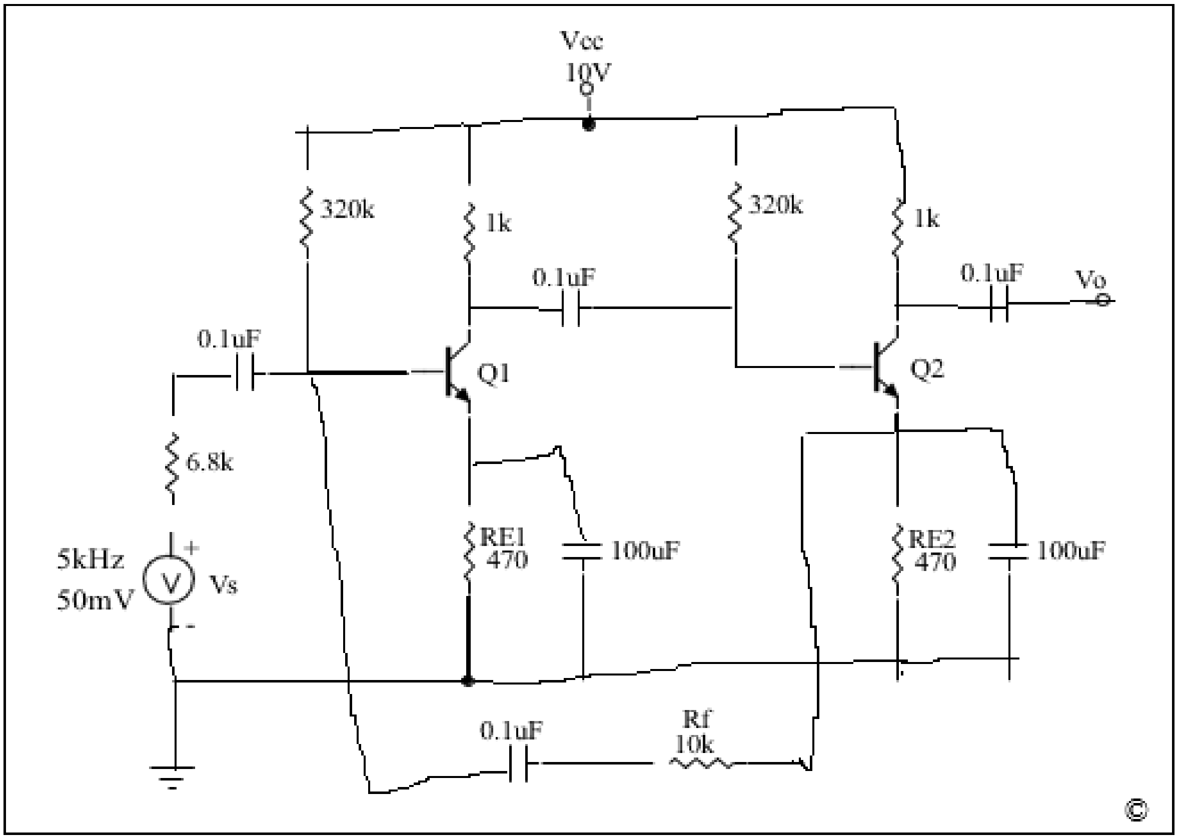


Fig (4) Feedback amplifier circuit configuration

Comment:

Differential amplifier

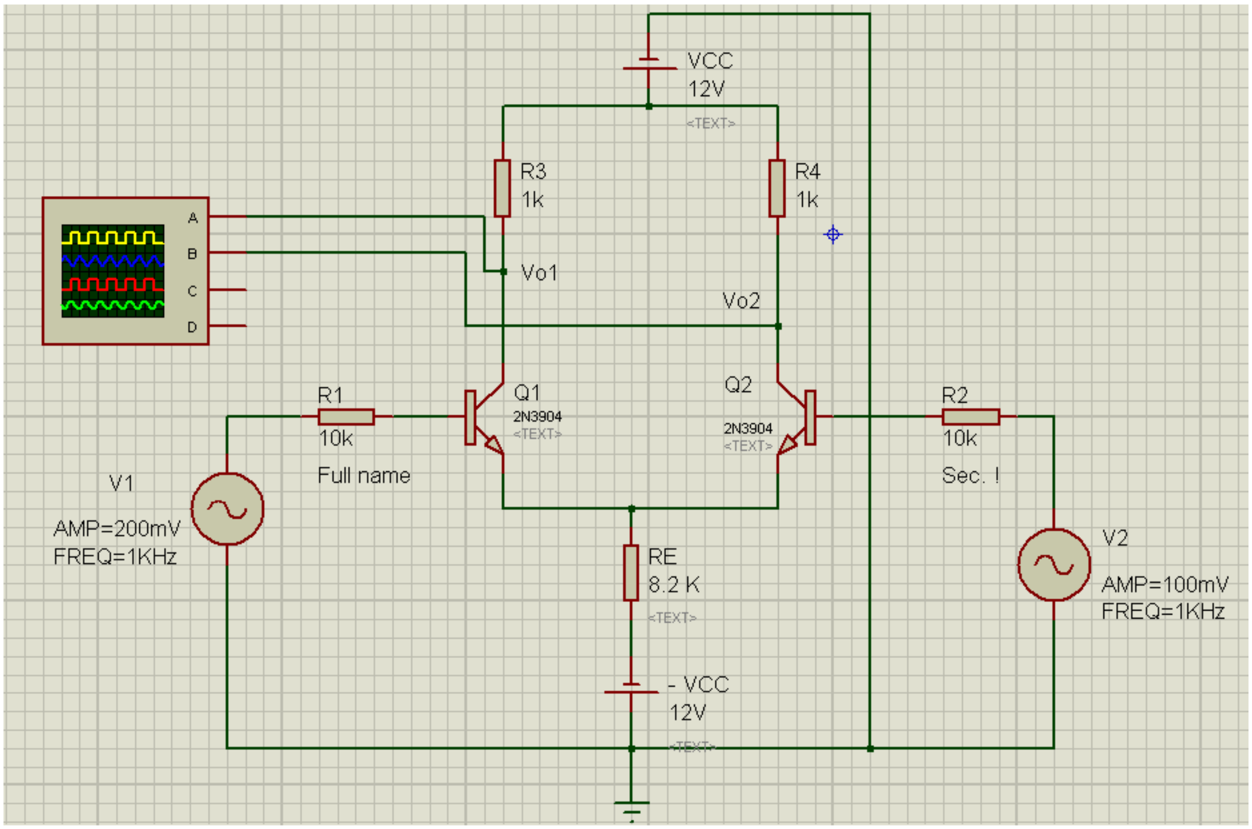
Objective

To understand the advantages of differential amplifier and how to connections of it.

Tools and equipments

- DC power supply
- Function generator
- Oscilloscope
- 1k x2
- 10k x2
- 8.2K x1
- 2n2222 transistor x3

Procedures



1- Implement the circuit as the figure.

2- Add your full name to R1 text, and Sec. to R2 text (without delete the description), and change the style to COMPONENT ID.

3- Get I_{c1}, I_{E1} , I_{B1} with Ammeter. Then calculate β, re , gm and fill Table 1.

4- Fix V1 at 200mV and fill Table 2 (Vo1 and Vo2) at the three modes of the Differential Amplifier:

a- Double input mode by putting V2 at 100mV (lick the figure).

b- Single input mode by deleting V2 source and connect R2 to the ground.

c- Common input mode by connecting R2 to V1 (the same source for 2 input).

5- Right click oscilloscope figure and chose Digital oscilloscope. Put all

oscilloscope's channels Off except Ch. B to calculate Vo2. Then change Ch. A to

be AC and calculate Vo1 (Important order).

6- Take 3 screen for the Oscilloscope results at the three modes. Then print them

in 1 page, and don't present results without your name (it's really dangerous).

7- Calculate Avdm , Avcm , and CMRR and compare it with simulation

Results

DC Analysis	I_{C1}	I_{E1}	I_{B1}	β	$r_e = \frac{V_T}{I_E}$	$g_m = \frac{I_C}{V_T}$
Simulation						
Measurements						

Table 1

V1	V2	Vo1	Vo2	$Av = \frac{Vo1}{V1-V2}$
200mV	100mV			$Av_{dm} =$…………..
200mV	0			$Av_{dm} =$…………..
The same source (200mV)				$Av_{cm} =$ …………..

$r_\pi = \frac{V_T}{I_B} =$……………………..., $rie = \frac{R_B + r_\pi}{1+\beta} + r_e =$……………

$Av_{dm} = \frac{-Rc}{rie} =$ ...., $Av_{cm} = \frac{-Rc}{2RE} =$ ....

$CMRR = \frac{Av_{dm}}{Av_{cm}} =$ ...., ...

Comment:

