Vivekanand College, Kolhapur (Autonomous)

Notice

Date: 29.03.2023

B.Sc. II Electronics

Paper-: Operational Amplifier

Assignment No.-I

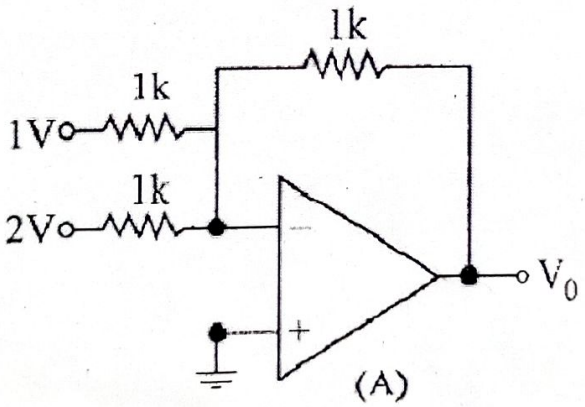
All the students of B.Sc. II Electronics are hereby informed that they should write a Home assignment of total 20 marks on a full scape paper and submit to the department on or before **06/4/2023.**

Q.1 Long answer questions: [8 marks]

1. Draw circuit diagram of op-amp in inverting amplifier. Find the expression for its output voltage & gain.

Q.2 Short answer questions: [4 marks]

1. Explain the common mode rejection ratio (CMRR) and slew rate of op-amp.
2. Explain the open loop and close loop configuration of operational amplifier
3. Identify the configuration of Op-amp and then find output voltage.



Subject Teacher
P. R. Bagade

Head of Department
HEAD
DEPARTMENT OF ELECTRONICS
VIVEKANAND COLLEGE, KOLHAPUR
(AUTONOMOUS)

VIVEKANAND COLLEGE ★ KOLHAPUR ★ ESTD. JUNE 1964

Shri Swami Vivekanand Shikshan Sanstha's

VIVEKANAND COLLEGE, KOLHAPUR(AUTONOMOUS)

B.Sc. II (Electronics) Assingment 2022-2023

Sr. No	Roll No.	Name of student	Assingment 1	Assingment 2
1	7722	ANCHI SIDDHARTH VIKAS		
2	7723	ATIGRE SARTHAK SUJIT	S. S. A.	
3	7724	BUCHADE VIVEK VASANT	Buchade	
4	7725	CHAVAN SNEHAL BHIKAJI	Schavan	
5	7726	CHOUGULE ROHIT ANAND	Rchougule	
6	7727	DANGAR NOOR SANAULLA	Not Submitted	
7	7728	DESAI SEJAL ANIL	Sdesai	
8	7729	GADKARI SOURAV SHARAD	Sgadkari	
9	7730	JADHAV ANANYA NETAJI	Aajadhav	
10	7731	KUMBHAR TRUPTI ARVIND		
11	7732	PATIL DIPTI DILIP	Dpatil	
12	7733	Patil Sudarshan Rajaram	Spatil	
13	7734	PAWAR SHUBHAM SUDHIR	Spawar.	
14	7735	PENDHARI SAMIR BAKASH		
15	7736	PIRJADE SAHAD MAKSUD	Not Submitted	
16	7737	SHINDE AJIT BABAN	Not Submitted	
17	7738	SHINDE SHIVAM FIROJ	Not Submitted	
18	7739	SWAMI YASH ANIL		
19	7740	TERANI AKSHATA SANJAY	A. S. Terani	
20	7777	SHAIKH ADNAN MOHAMMADYASIN	ShaikhAd	
21	7778	BERAD ROHIT BHALCHANDRA	Rberad	
22	7779	BHAPKAR SAI SANTOSH	Sbhapkar	
23	7780	BHOSAKE ADITYA AJIT		
24	7781	Bhosale Asleshiya Dhanawant	Abhosale	
25	7782	CHOUGULE SIDDHESH SURESH	Schougule	
26	7783	Jadhav Rajdeep Uday	Rujadhav	
27	7784	Jadhav Rutuja Sunil	Rjadhav	
28	7785	KADAM PREM BABASAHEB		
29	7786	Kagude Darshan Sanjay	D. Skagude	
30	7787	MANER MOHAMMED TAQUEE MOHAMMED SHAFI	Not Submitted	
31	7788	Modak Mussaddique Firoz	MModak	
32	7789	Patil Akshata Ashok	Apatil	
33	7790	PATIL ATHARV SHAHAJI	Apatil	
34	7791	PATIL OMKAR SANJAY	Spatil	
35	7792	PATIL PARTH PRAVIN	PRPatil	
36	7793	PATIL PRATIK SURESH		
37	7794	PATIL SAKSHI RANGRAO		

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38	7795	PATIL SANIKA ANANDA		
39	7796	Patil Sayali Sampat		
40	7797	PATIL SHAKTI PRAKASH		
41	7798	PATIL SHUBHAM JANARDAN		
42	7799	PATIL VAISHNAVI KRISHNAT		
43	7800	PATIL VIPUL Ashok	Not Submitted	
44	7801	Pawar Vaishnavi Subhash		
45	7802	Rathod Snehal Ramesh		
46	7803	SAVARATKAR ONKAR HARIBHAU		
47	7804	SHINDE AARY ANIL		
48	7805	SUTAR SHRADDHA NAGESH		
49	7806	Upadhye Suyash Bahubali	Not Submitted	
50	7807	WAWARE SHIVANJALI SANJAY		
51	7989	Sanket D. Panhalkar		
52	8984	Pratik M. Desai		
53				

P.R. Bagade

Subject Teacher

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Shri Swami vivekanand Shikshan Santha's

VIVEKANAND COLLEGE, KOLHAPUR (AUTONOMOUS)

B.Sc . - II (Sem-IV)-2022-23

Electronics Department

Home Assignment : Operational Amplifier

Marks Entry

Sr. No.	Roll No.	Student Name	Marks
1	7722	ANCHI SIDDHARTH VIKAS	18
2	7723	ATIGRE SARTHAK SUJIT	16
3	7724	BUCHADE VIVEK VASANT	17
4	7725	CHAVAN SNEHAL BHIKAJI	18
5	7726	CHOUGULE ROHIT ANAND	17
6	7727	DANGAR NOOR SANAULLA	**Not Submitted**
7	7728	Desai Sejal Anil	18
8	7729	GADKARI SOURAV SHARAD	17
9	7730	Jadhav Ananya Netaji	15
10	7731	KUMBHAR TRUPTI ARVIND	17
11	7732	PATIL DIPTI DILIP	17
12	7733	Patil Sudarshan Rajaram	17
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15	7736	PIRJADE SAHAD MAKSUD	**Not Submitted**
16	7737	SHINDE AJIT BABAN	**Not Submitted**
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33	7790	PATIL ATHARV SHAHAJI	16

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34	7791	PATIL OMKAR SANJAY	18
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50	7807	WAWARE SHIVANJALI SANJAY	19
51	7889	Panhalkar Sanket Dattatray	15
52	8984	Desai Pratik M	14

Subject Teacher
Mr.P.R.Bagade

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18/20

Date
Page

• Assignment No : 01 •

• Name : Omkar Sanjay patil Roll No. - 7791

• Std : B.Sc.II • Sub : Electronics

• clg name : "VCK"

Q.1 Long answer questions.

1. Drow circuit diagram of op-amp in inverting amplifier. find the expression for its output voltage & gain.

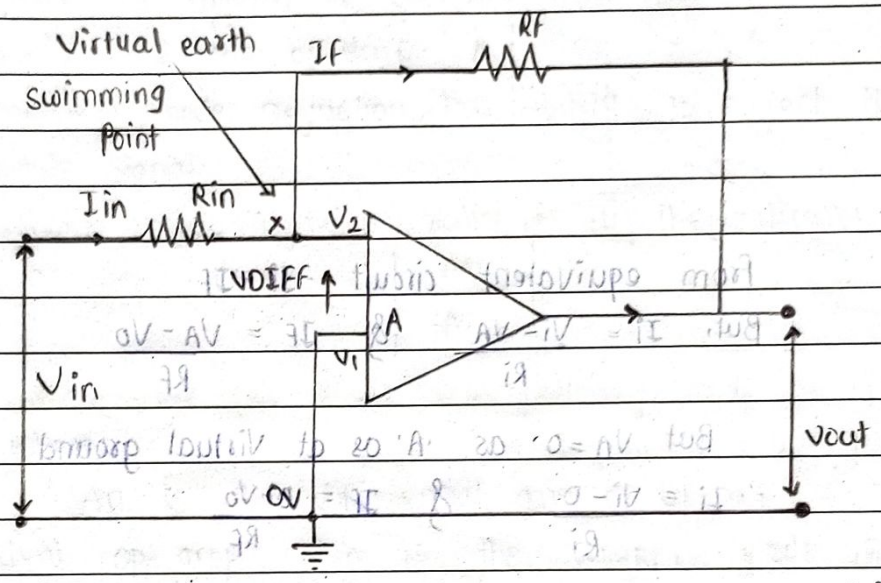

fig. op-amp as inverting amplifier.

In this inverting amplifier circuit the operational amplifier is connected with feed back to produce a closed loop operation. when dealing with operational amplifiers there are two very important rules to remember about inverting amplifiers. there are "No current flows into the input terminal" are that "V_1 always equals V_2".

8 This is beacause the junction of the input and feed back signal (x) is at the same potential as the positive (+) input which is at zero volts or ground - then the junction is a virtual ground beacuse of this virtual ground node the input resistance of the amplifier is equal to the value of the input resistor. Rin and the closed loop gain of the inverting amplifier can be set by the ratio of the two external resistors.

The equation for calculating the closed loop gain of -

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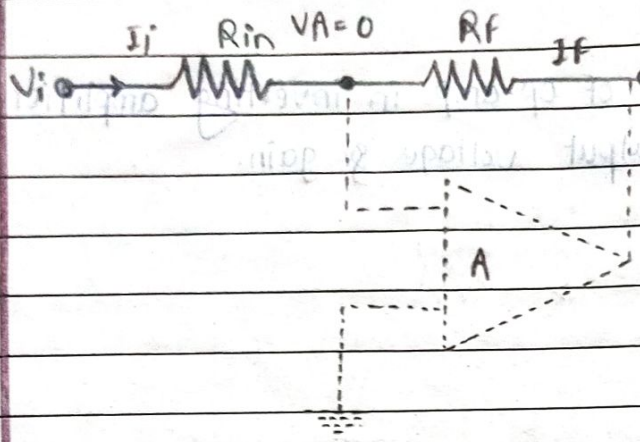
inverting amplifier, current (i) flows through the resistor network as shown.



From equivalent circuit $-Ii - If$

But, $Ii = \frac{Vi - VA}{Ri}$ & $If = \frac{VA - Vo}{RF}$

But $VA = 0$ as 'A' as at Virtual ground

$\therefore Ii = \frac{Vi - 0}{Ri}$ & $If = \frac{0 - Vo}{RF}$

$\therefore Vi = -\frac{Vo}{RF}$

$$\boxed{AVF = -\frac{RF}{Ri}} \quad \text{①}$$

$\therefore \frac{Vo}{Vi} = -\frac{RF}{Ri}$

$$\boxed{Vo = -\frac{RF}{Ri} \times Vi} \quad \text{②}$$

Eqn ① represents expression for closed-loop gain eqn ② the expression for output signal.

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Short answer questions.

1. Explain the common mode rejection ratio (CMRR) and slew-rate of op-amp.

CMRR:

Common mode refer to the situation when the same-voltage is applied to both the inverting and non-inverting-terminal of the op-amp.

Common mode rejuction has ability to reject the common-mode signal.

Common mode rejection ratio is mathematically defined-as $CMRR = \left| \frac{A_D}{A_{cm}} \right|$

where,

A_D is the differential gain of op-amp, ∞ For an-ideal op-amp A_{cm} is the common mode gain of the-op-amp.

The CMRR of an ideal op-amp is ∞. That means it is able-to reject all common mode signals.

- Slew rate:

Slew rate is the maximum rate of change of output-voltage with respect to time.

$$SR = \frac{dV_o}{dt}$$

Slew rate is usually specified in V/μs. It indicates-how rapidly the output of an op-amp changes in-response to changes in input. For ex. a 1V/μs slew-rate means that output rises or falls by 1V.

SR is a key factor for selecting op-amp for AC-applications.

The input and slew limited output voltage wave form are shown in the figure below.

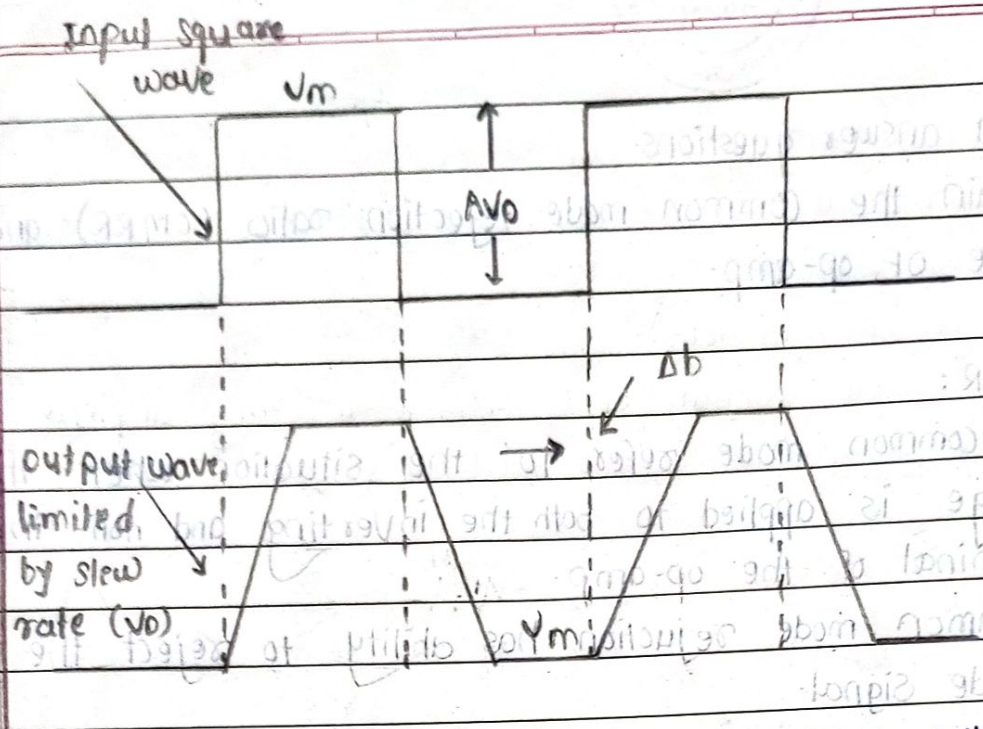

Fig. Input and slew limited output voltage waveform.

2. Explain the open loop and close loop configuration of operational amplifier.

• open loop configuration:

In open loop configuration of op-amp there is no connection between input and output terminals, That is, output signals is not feed back in any from as part of the input signal.

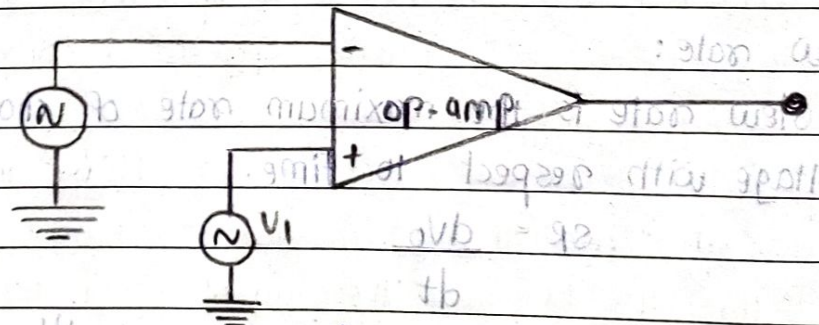

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fig. open loop configuration of op-amp

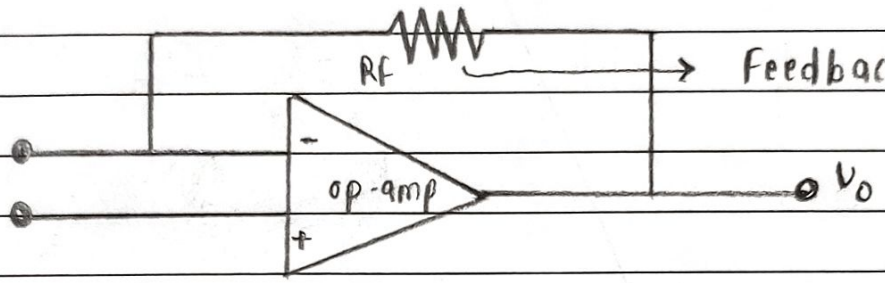
Open loop gain (Aol) is the gain of an op-amp who no feed back is given Aol is very high op-amp ICs it is higher than 100000. so even a very small difference in up and un will drive the output to supply voltage. than is termed as subratio of the amplifier beacause of magnitude of open loop gain it is user as a standard

differential amplifier.

- close loop configuration:

In close loop configuration of op-amp output signal is feed back to the input either directly or via another network - The feedback helps to control gain. If the signal feedback - is of opposite or out of phase by 180° with respect to - the input signal, the feedback is called negative feedback

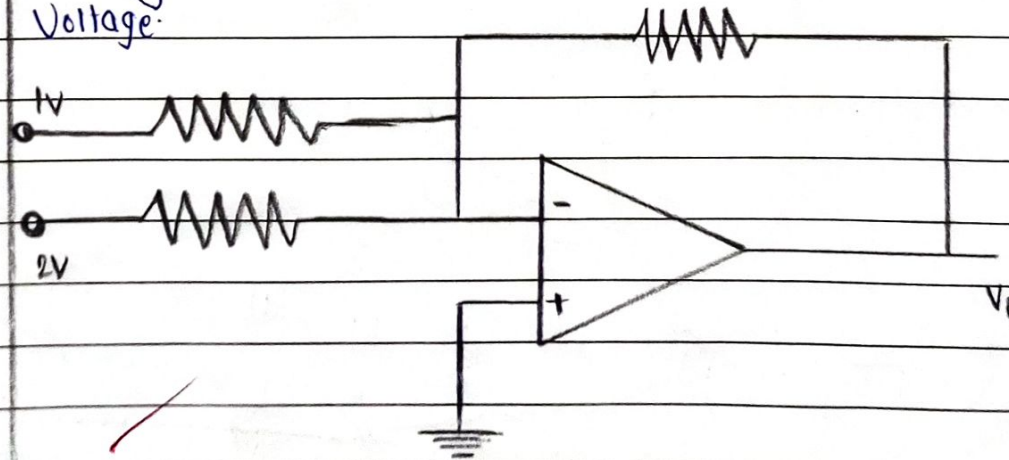
4



In above figure, Rf is added as a negative feedback - called feedback register. The feed back is said to be negative - as the feedback register connects the output to the inverting - input terminal.

The gain resulting with feedback is called closed loop - gain of the op-amp.

3. Identify the configuration of op-amp and then find output - voltage.



2

This is close loop configuration of op-amp.

$V_o = -(1V + 2V)$

$\therefore \boxed{V_o = -3V}$

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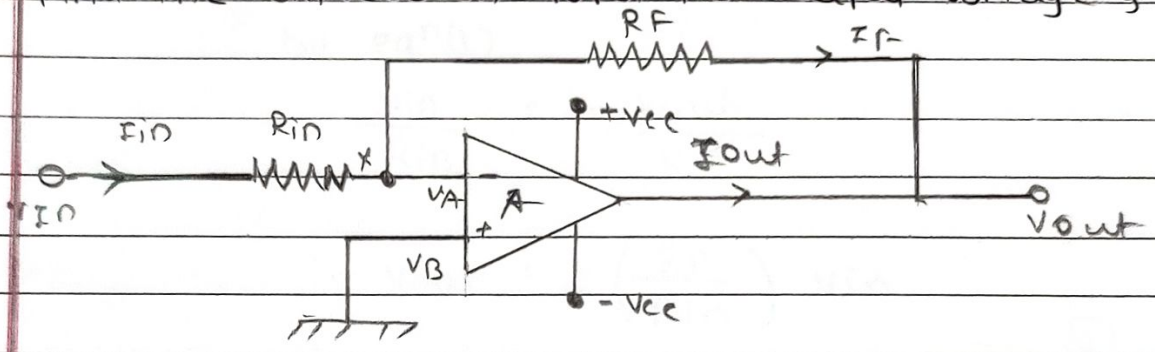
8+8 = 16/20

Assignment No - 1

Name - DARSHAN SANJAY KAGUDE
Roll No - 7786 Std - BSC-II
Subject - Electronics Date - 5/4/2023

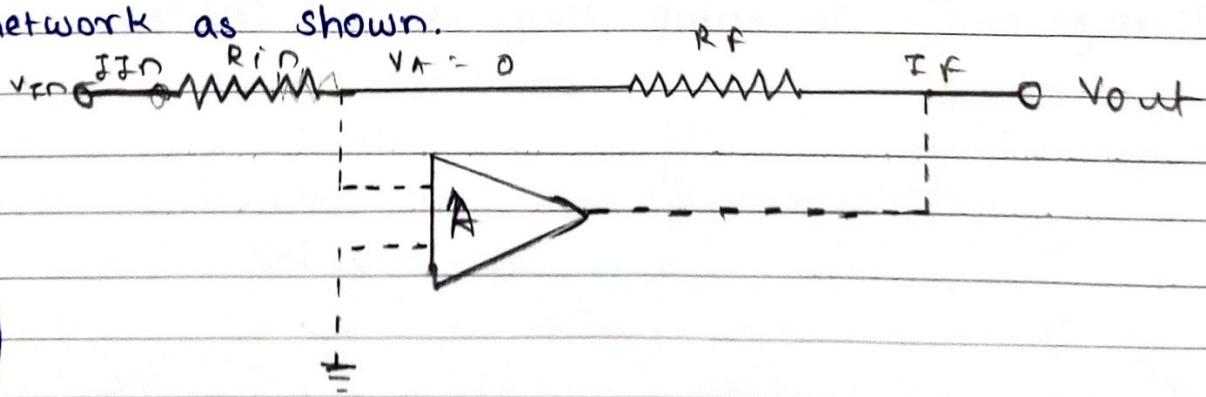
Q.1 long answer question.

1) Draw circuit diagram of op-amp in inverting amplifier. find the expression for its output voltage & gain



1) op-amp as inverting amplifier

In above figure operational amplifier is connected with feedback to produce a closed loop operation by the concept of virtual ground there is no current flows into the input terminal and V_A is always equal to V_B because VB is grounded in inverting amplifier is equal to the value of the input resistor Rin and the closed loop gain of the inverting amplifier can be set by the ratio of the two external resistor the current flows through the resistor network as shown.



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From equivalent circuit

$$I_{in} = I_f \quad \text{— (1)}$$

$$I_{in} = \frac{v_{in} - V_A}{R_{in}} \quad \& \quad I_f = \frac{V_A - V_{out}}{R_f}$$

By virtual GND concept $V_A = 0$

$$\therefore \frac{v_{in} - 0}{R_{in}} \quad \& \quad \frac{0 - v_{out}}{R_f}$$

∴ by eqⁿ(1)

$$\frac{v_{in}}{R_{in}} = \frac{-v_{out}}{R_f}$$

$$\therefore v_{out} = -\left(\frac{R_f}{R_{in}}\right) v_{in} \quad \text{— (2)}$$

$$\therefore \frac{v_{out}}{v_{in}} = \frac{-R_f}{R_{in}}$$

$$\therefore G = \frac{v_{out}}{v_{in}} = \frac{-R_f}{R_{in}} \quad \text{— (3)}$$

∴ eqⁿ (2) gives output voltage of inverting amplifier the negative sign indicates the phase-inversion between input and output signals

eqⁿ (3) becomes gives gains of inverting amplifier.

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Q.2 Short answer questions.

1) Explain the comman mode rejection ration (cmRR) and slew rate of op-amp.

→ commanmode Rejection Ratio (cmRR)

comman mode refers to the situation when the same voltage is applied to both the inverting and non-inverting terminal of the op-amp

comman mode Rejection ~~Ratio~~ has ability to reject the coman mode signal

Comman mode rejection ratio is mathamatically defined as

$$cmRR = \left| \frac{AD}{Acm} \right|$$

4 where

AD is the differential gain of op-amp, ∞ for an ideal op-amp

Acm is the comman mode gain of op-amp

the cmRR of an ideal op-amp is ∞ that means it is able to reject all commen mode signals.

- Slew Rate:

slew rate is the maximum rate of change of output voltage with respect to time.

$$SR = \frac{dVo}{dt}$$

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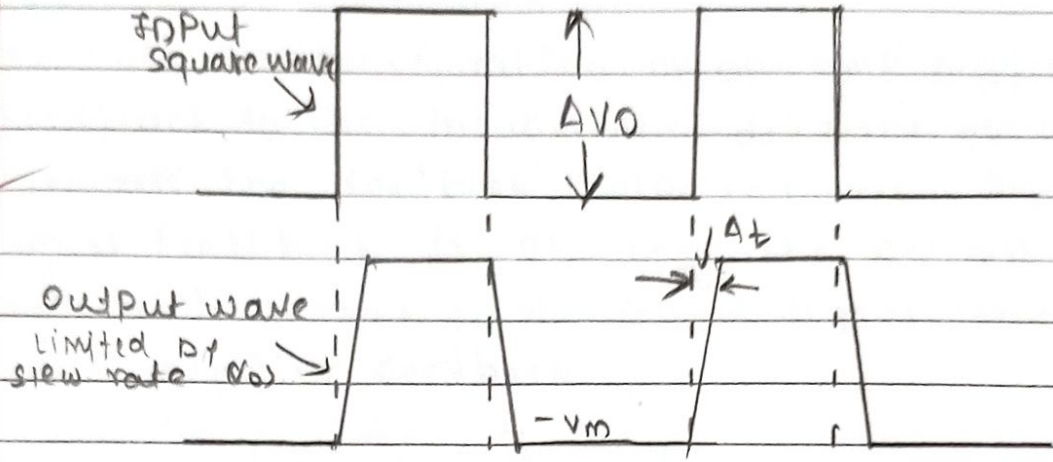
Slew Rate is usually specified in V/μs it indicates how rapidly the output of an op-amp changes in response to change in input. For example, a 1V/μs slew rate means that the output rises or falls by 1V in

SR is a key factor selected op-amp for AC applications.

The input and slew limited output voltage waveform are shown in the figure

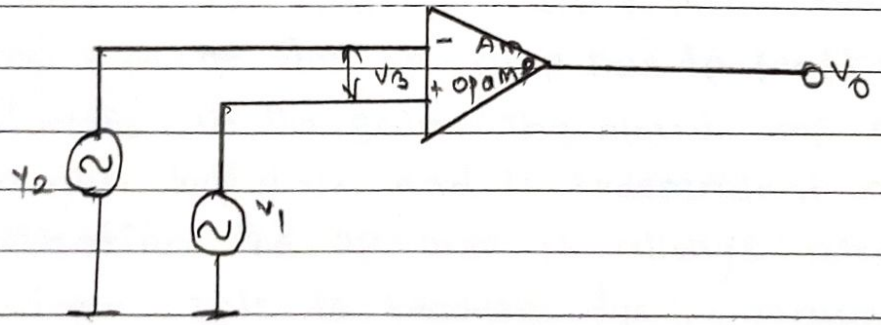


input and slew limited output voltage waveform

2) Explain the open loop and close loop configuration of operational amplifier

→ open loop configuration

In open loop configuration of op-amp there is no connection between input and output terminals that is, output signals is not feedback in any form as part of the input signal



open loop configuration of op-amp

Open loop gain (A_{OL}) is the gain of an op-amp whe no feedback is given A_{OL} is very high. For op-amp ICs it is higher than 1000,000 so even a very small difference in vp an vn will drive the output to supply voltage when the out put voltage

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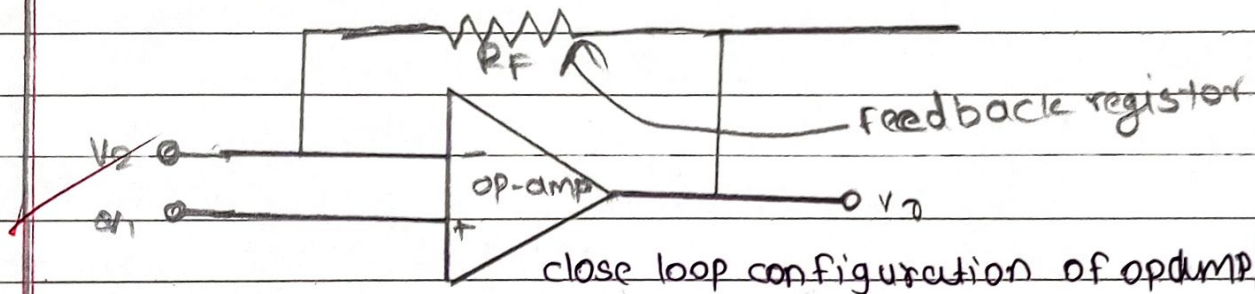
becomes greather that saturation of the amplifier because of magnitude of open loop gain it is use as a standard differential amplifier so, open loop amplifier is use a compartor application

- close loop configuration:

In close loop configuration of op-amp output signal is feedback to the input either directly or via another networks the feedback helps to control ~~signals~~ gains. if the signal feedback is of opposite or out of phase by 180° with respect to the ~~signal~~ input signal. the feedback is called negative feedback



close loop configuration of opamp

In above figure Rf is added as a negative feedback called feedback register. The feedback is said to be negative as the feed back register connects the output to the inverting input terminal. The gain resulting with feedback is called closed loop gain of the op-amp. Due to feedback register. There is reduction in the gain. The closed loop gain is much less that the open loop gain and is independent of it. in linear application the op-amp is always used with negative feedback. This is because. due to reduced gain. The output is not driven into the saturation and the circuit behaves in a linear manner.

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18/20 7

Rajdhani

DATE / /

Assignment - 1

Name: Vaishnavi Krishnat Patil

Roll No: 7799

Subject: Electronics

Q.1 Long answer questions:

1) Draw circuit diagram of op-amp in inverting amplifier. Find the expression for its output voltage & gain.

→

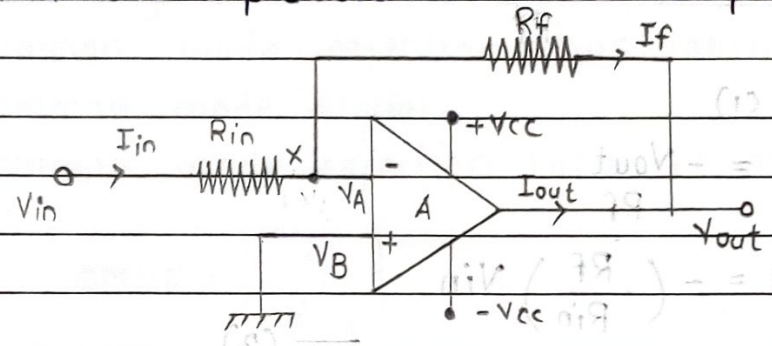
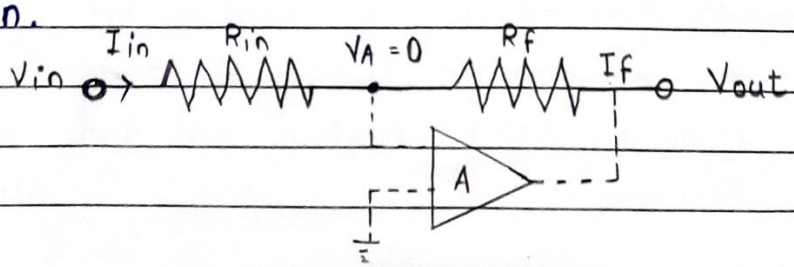


fig: Op-amp as inverting amplifier

In above figure operational amplifier is connected with feedback to produce a closed loop operation. By the concept of virtual ground there is no current flows into the input terminal and V_A is always equals to V_B because V_B is grounded in inverting amplifier. The input resistance of the amplifier is equal to the value of the input resistor, Rin and the closed loop gain of the inverting amplifier can be set by the ratio of the two external resistors.

The current flows through the resistor network as shown.



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From equivalent circuit

$$I_{in} = I_f \quad \text{— (1)}$$

$$I_{in} = \frac{V_{in} - V_A}{R_{in}} \quad \& \quad I_f = \frac{V_A - V_{out}}{R_f}$$

By virtual GND concept $V_A = 0$

$$\therefore \frac{V_{in} - 0}{R_{in}} \quad \& \quad \frac{0 - V_{out}}{R_f}$$

∴ by eqⁿ (1)

$$\frac{V_{in}}{R_{in}} = -\frac{V_{out}}{R_f}$$

$$\therefore V_{out} = -\left(\frac{R_f}{R_{in}}\right) V_{in} \quad \text{— (2)}$$

8

$$\therefore \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}}$$

$$\therefore G = \frac{V_{out}}{V_{in}} = -\frac{R_f}{R_{in}} \quad \text{— (3)}$$

∴ eqⁿ (2) gives output voltage of inverting amplifier the negative sign indicates the phase-inversion between input and output signals.

eqⁿ (3) gives gain of inverting amplifier.

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Q.2 Short answer questions

1. Explain the common mode rejection ratio (CMRR) and slew rate of op-amp.

- **Common Mode Rejection Ratio (CMRR):**

Common mode refers to the situation when the same voltage is applied to both the inverting and non-inverting terminal of the op amp.

Common mode rejection has ability to reject the common mode signal.

Common mode rejection ratio is mathematically defined as.

$$CMRR = \left| \frac{A_D}{A_{CM}} \right|$$

Where,

A_D is the differential gain of op-amp, ∞ for an ideal op-amp.

A_{CM} is the common mode gain of an op-amp.

The CMRR of an ideal op-amp is ∞. That means it is able to reject all common mode signals.

- **Slew Rate:**

Slew Rate is the maximum rate of change of output voltage with respect to time.

$$SR = \frac{dV_o}{dt}$$

Slew Rate is usually specified in V/μs. It indicates how rapidly the output of an op-amp changes in response to changes in input. For example, a 1V/μs slew rate means that the output rises or falls by 1V in one 1μs.

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DATE / /

SR is a key factor for selecting op-amp for AC applications.
The input and slew limited output voltage waveform are show in the figure below.

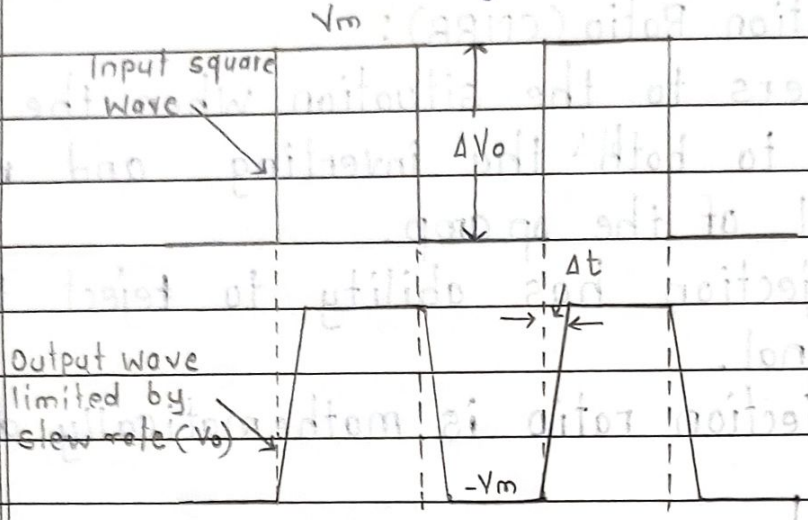

fig: Input and slew limited output voltage waveform

2. Explain the open loop and close loop configuration of operational amplifier.

- Open loop configuration:
In open loop configuration of op-amp there is no connection between input and output terminals. That is, output signal is not feedback in any form as part of the input signal.

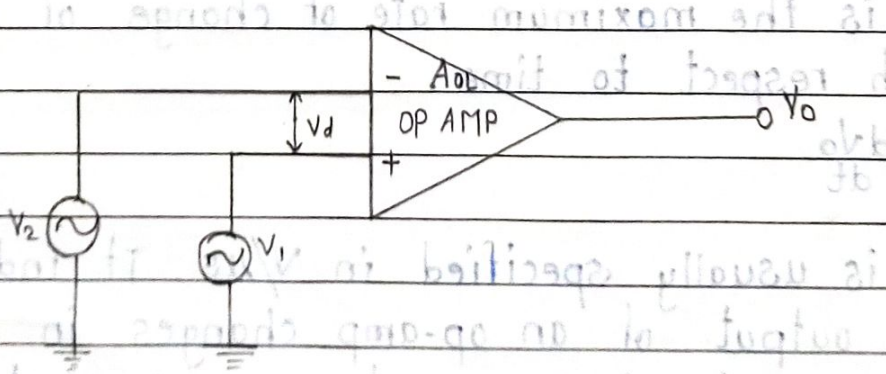

fig: Open loop configuration of op-amp

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Open loop gain (A_{OL}) is the gain of an op-amp when no feedback is given. A_{OL} is very high, for op-amp ICs it is higher than 1,00,000. So even a very small difference in V_p and V_o will drive the output to supply voltage. When the ouput voltage becomes greater than or equal to supply voltage, than is termed as saturation of the amplifier. Because of magnitude of open loop gain it is use as a standard differential amplifier. So, open loop amplifier is use a comparator application.

- Close loop configuration:

In close loop configuration of op-amp output signal is feedback to the input either directly or via another network. The feedback helps to control gain. If the signal feedback is of opposite or out of phase by 180° with respect to the input signal, the feedback is called negative feedback.

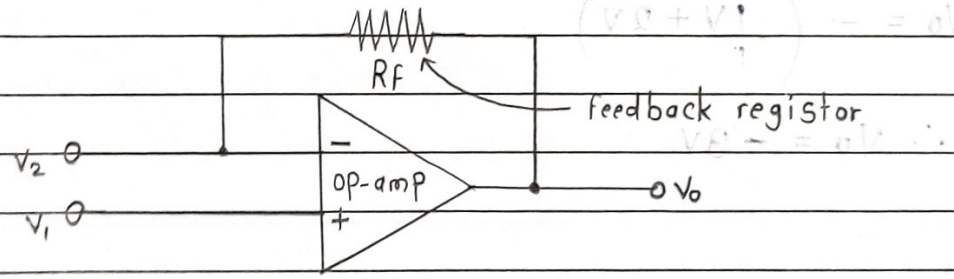

fig: Close loop configuration of op-amp / feedback configuration

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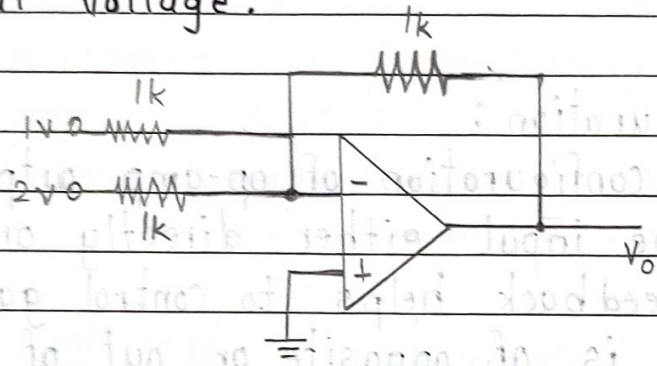
In above figure Rf is added as a negative feedback called feedback registor. The feedback is said to be negative as the feedback registor connects the output to the inverting input terminal.
The gain resulting with feedback is called closed loop gain of the op-amp.

Due to feedback resistance, there is reduction in the gain. The closed loop gain is much less than the open loop gain and is independent of it. In linear application the op-amp is always used with negative feedback. This is because, due to reduced gain, the output is not driven into the saturation and the circuit behaves in a linear manner.

3. Identify the configuration of op-amp and the find output voltage.



This is close loop configuration of op-amp

$$V_o = -(1V + 2V)$$

$$\therefore V_o = -3V$$

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