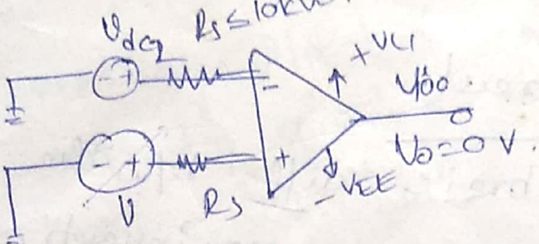
UNIT-II

Specifications of IC741

1. Input offset Voltage:
The input offset voltage V_{io} is the voltage that must be applied between the I/p terminal to get the zero output voltage

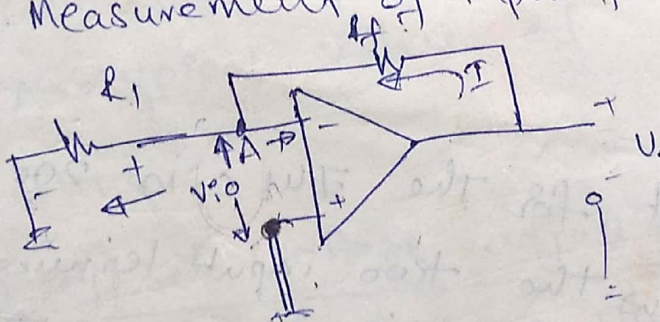


We denote I/p Offset Voltage of V_{io} it may be +ve or -ve

$V_{io} = V_{dc1} - V_{dc2}$

For 741C the max value of of V_{io} is 6mV. This value will be less if the input terminals are matched. For 714C precision op-amp $V_{io} = 150\mu V$.

2. Measurement of input off voltage.



$$I = \frac{V_o - V_A}{R_f} = \frac{V_o - V_{io}}{R_f}$$

$$V_A = IR_1 = V_{io}$$

$$I = \frac{V_{io}}{R_1}$$

$$\frac{V_{io}}{R_1} = \frac{V_o - V_{io}}{R_f}$$

$$V_o = V_{io}\left(1 + \frac{R_f}{R_1}\right)$$

V_{io} +ve

$V_{id} = 0$

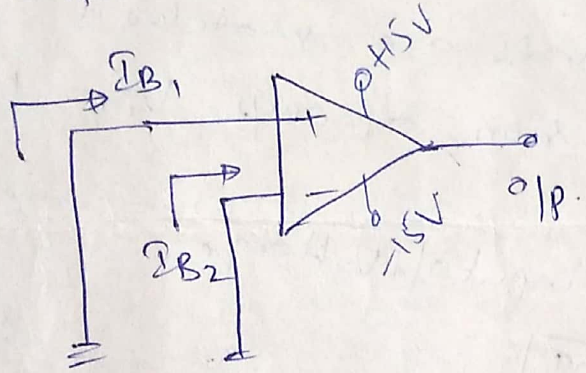
$\left(-\frac{R_f}{R_1}\right)$

Non

output resistance : output resistance R_o is the equivalent resistance that can be measured b/w the o/p terminal of the op-amp and the ground (or common point) It is 75Ω for 741 C op-amp.

② **I/p off set current**

The algebraic diff b/w the currents into the inverting and noninverting terminal is referred to as I/p offset current I_{io}.



$I_{io} = (I_{B_1} - I_{B_2})$

I/p off set current for the 741 C is 200 nA max.

As matching b/w the two input terminal is improved, the differen b/w I_{B_1} and I_{B_2} becomes smaller i.e I_{io} Value decreases.

- 714C precission op-amp max I_{io} - 6nA

③ **Input bias current :** Input bias current I_B is the average of the two current that flow into the inverting and noninverting I/p terminal of the op-amp.

$I_B = I_{B_1} + I_{B_2} / 2$

$I_B = 500\,nA$ for 741C.

$I_B = \pm 7\,nA$ for 714C.

④ Differential I/p resistance: R_i is the equivalent resistant can be measured at the either of the inverting or noninverting I/p terminal with other terminal connected to ground.

for 741C — 2MΩ

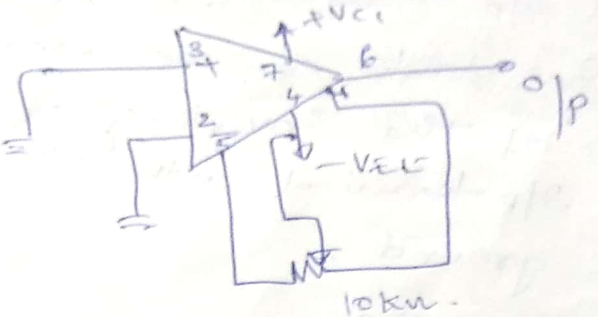
for μAF771 FET I/p op-amp — 1000 GΩ

⑤ Input capacitance:

C_i is measured at either of the input terminal of the op-amp. A typical value of C_i is 1.4 PF for 741C.

⑥ offset voltage adjustment range: One of the features of the 741 op-amp is an offset voltage null capability. The 741 op-amps have pins 1 and 5 marked as offset null for this purpose.

A 10kΩ potentiometer can be connected b/w offset pins 1 and 5 and the wiper of the potentiometer can be connected to the $-V_{EE}$. By Varing the potentiometer, the o/p offset Voltage can be reduced to zero voltage



The offset Voltage adjustment range is the range through which the i/p offset voltage can be adjusted by varing the 10kΩ potentiometer.

For 741C offset adjustment range is $\pm 15mV$.

(7) CMMR. The ratio of differential voltage gain to the common-mode voltage gain

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

$A_d \rightarrow$ same as large signal Voltage gain

$$A_{cm} = \frac{V_{ocm}}{V_{cm}}.$$

for 741C CMRR is 90 dB.

714C CMRR = 120 dB.

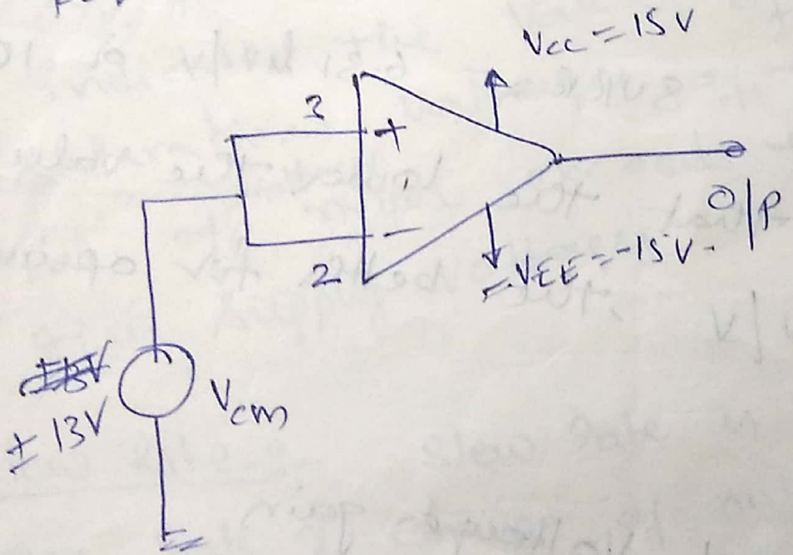
V_{ocm} = output common mode voltage

V_{cm} = i/p Common-mode voltage.

A_{cm} = Common mode voltage gain

Generally A_{cm} is very small and $A_d = A$ is very large. So CMRR is very large. CMRR is Being a large value. most often expressed in decibels (dB) For the 741C, CMRR is 90dB typically. The higher the value of CMRR, the better is the matching between two i/p terminals. and smaller is the output common-mode voltage.

For 714C precision op-amp CMRR = 120 dB.



⑧ SVRR (PSRR):

The change in an op-amps I/p offset Voltage V_{io} caused by variations in supply voltages is called the supply voltage rejection ratio or power supply sensitivity (PSS). These terms are expressed either in µV per V or in dB.

If we denote the change in supply voltages by ΔV and corresponding change in input offset voltage by ΔV_{io}, SVRR can be defined as

$$SVRR = \frac{\Delta V_{io}}{\Delta V}.$$

for 741C SVRR = 150 µV/V.

for 714C SVRR = 6.31 µV/V or 104dB

This means that the lower the value of SVRR in µV/V, the better for op-amp performance.

⑨ Large - Signal Voltage gain

The op-amp amplifies the differen voltage b/w two I/p terminals the voltage gain of the amplifier is defined as

$$\text{Voltage gain} = \frac{\text{output voltage}}{\text{differential I/p voltage}}$$

Because output signal amp is much larger than the i/p signal the voltage gain is commonly called large-signal voltage gain. under test conditions $R_L \geq 2k\Omega$ and $V_o = \pm 10V$ (or $20V$ (p-p) the large signal voltage gain of 741C is 200000 $\underline{\underline{2\times10^5}}$.

(10) The output voltage swing :

The output voltage swing V_{omax} of the 741C is guaranteed to be between -13 and $+13V$ for $R_L \geq 2k\Omega$ that is giving a $26V$ (p-p) undistorted sine wave for ac i/p signals.

for the o/p voltage swing In fact the o/p voltage swing indicates the values of positive and $-ve$ saturations voltages of the op-amp. The o/p voltage never exceeds these limits for given supply voltages.

(11) Slew Rate :- Slew rate is defined as the max rate of change of output voltage per unit of time and is expressed in volts per μsec. In equation form

$$SR = \frac{dV_o}{dt}\Big|_{max} \quad V/\mu sec$$

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Slew rate indicates how rapidly the output of an op-amp can change in response to changes in the i/p frequency. The slew rate changes change in voltage gain and is normally specified at unity (+1) gain.

The slew rate of an op-amp is fixed if the slope requirements of the output signal are greater than the slew rate, then distortion occurs.

* Thus slew rate is one of the important factors in selecting the op-amp for ac applications, particularly at relatively high freq.

* One of the drawbacks of the 741 C is its low slew rate (0.5 V/μsec), which limits its use in high freq application, especially in oscillators, comparators, and filters.

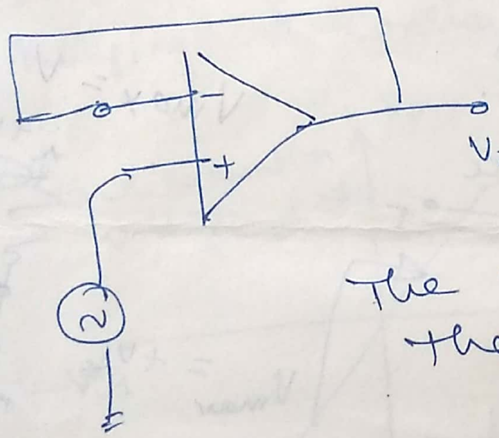
The newer op-amp - LF 351, LF 771 and MC 34001 which are the direct replacements for 741 have a slew rate of 13 V/μsec. In high speed op amp especially, the slew rate is significantly improved. The LM318 has slew rate of 70V/μs

Slew Rate equation: Generally the slew rate is specified for unity gain and hence let us consider the ~~fo~~ voltage follower ~~fo~~ ckt. Let us assume that the i/p is a large amp and high frq sine wave.

The equation for i/p signal is the

$$V_s = V_m \sin\omega t.$$

With no slew rate limitation $V_o = V_m \sin\omega t$



$$\frac{dV_o}{dt} = \omega V_m \cos\omega t.$$

The maximum rate of change of the o/p occurs

$\cos\omega t = 1$ i.e.

$$\left.\frac{dV_o}{dt}\right|_{max} = \omega V_m.$$

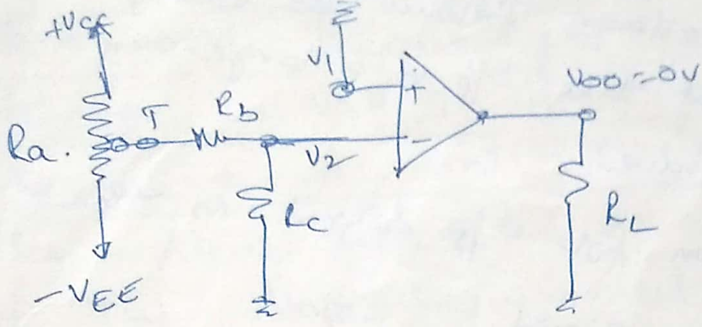
$$= 2\pi f V_m \ V/sec.$$

$$S = \frac{2\pi f V_m}{10^6} \ V/\mu sec.$$

O/p Voltage voltage swing: The op-amp voltage swing is limite it get decided by the supply voltages. It never excee the limits +Vcc and −VEE. Above these values op-am o/p gets saturated.

op-amp o/p gets saturated at +Vcc and −VEE and cannot produce o/p more than +Vcc and −VEE. practically satura ... and −Vsat are slightly less than +Vcc and

offset - voltage compensating network:



if V_{oo} is +ve

$V_1 > V_2$

towards +ve

V_{oo} is -ve

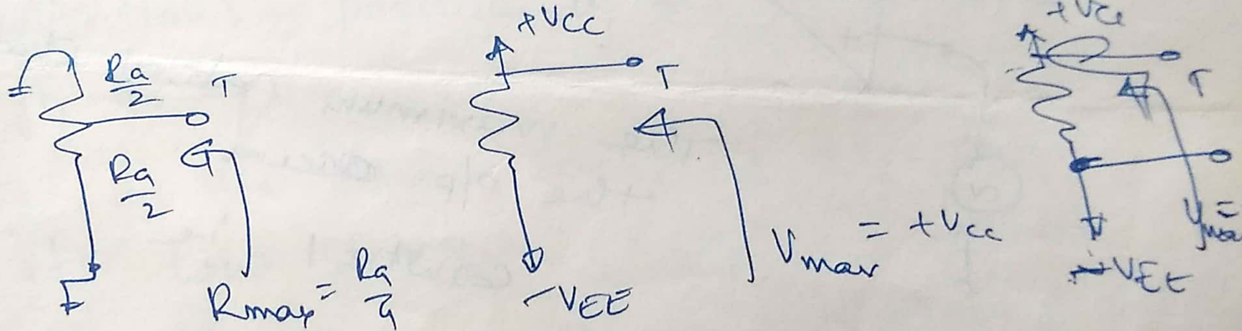
$V_1 < V_2$

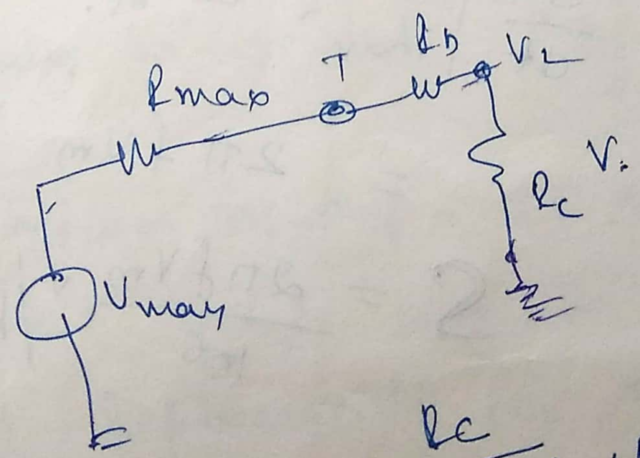
towards -ve

Max thevinin's voltage

$$R_{max} = \frac{R_a}{2} \parallel \frac{R_a}{2} = \frac{R_a}{4}$$

$V_{max} = V.$





$$V_2 = \frac{R_c}{R_{max} + R_b + R_c} V_{max}$$

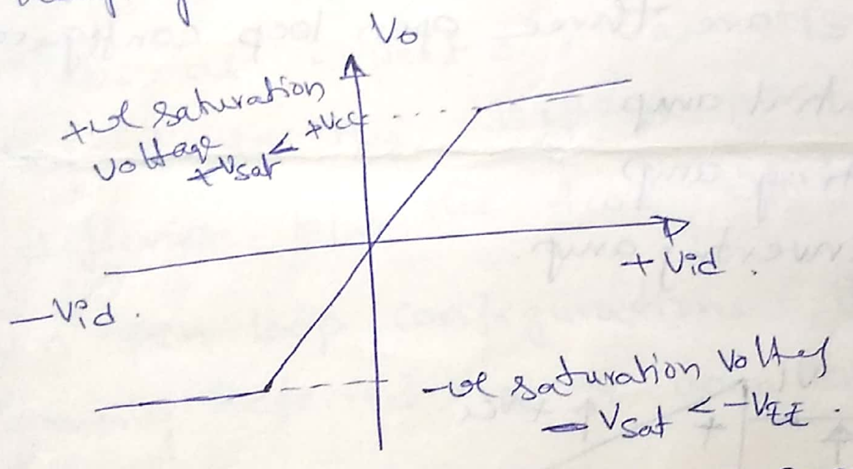
$$V_{io} = \frac{R_c}{R_{max} + R_b + R_c} V_{max}$$

$R_b > R_{max} > R_c$

R_a

Ideal voltage Transfer curve

$V_o = A(V_{id}) = A(V_1 - V_2)$ is the basic op-amp equation, in which the output offset voltage is assumed to be zero. This equation is useful in studing the op-amp's charecteristics and in analyzing different ckt configurations that employ feedback. The graphic representation of this equation is shown in fig. where the output voltage V_o is plotted against i/p difference voltage V_{id} keeping A constant.



The output voltage cannot exceed the positive and -ve saturation voltages. These saturation voltages are specified by an output voltage swing ranting of the op-amp for given values of supply voltages.

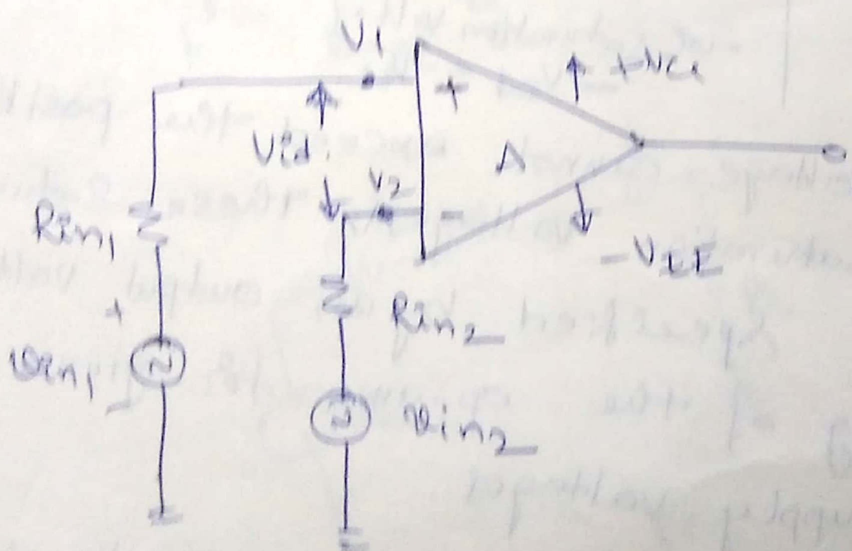
The output voltage is directly proportional to the input difference voltage only until it reaches the saturation voltages and that thereafter output voltage remain constant.

Open loop op-amp configurations

In the case of amps the term open loop indicates that no connection, either direct or via another network, exists between the output and input terminals i.e. the output signal not fed back in any form as part of the input signal and the loop that would have been formed with feed back is open.

When connected in open-loop configuration, the op-amp simply functions as a high-gain amp. There are three open loop configurations

1. Differential amp.
2. Inverting amp
3. Non inverting amp.



$V_o = A(V_{in_1} - V_{in_2})$

Fig shows the open-loop differential amp in which input signals V_{in_1} and V_{in_2} are applied to the +ve and −ve I/P terminals.

Since the op-amp amplifies the difference between the two input signals, this configuration is called the differential amp.

The op-amp can amplifies both ac and dc Voltages. Source resistances R_{in_1} and R_{in_2} are normally negligible compared to the input resistance R_i. Therefore the voltage drop across these resistors can be assumed to be zero, which then implies that

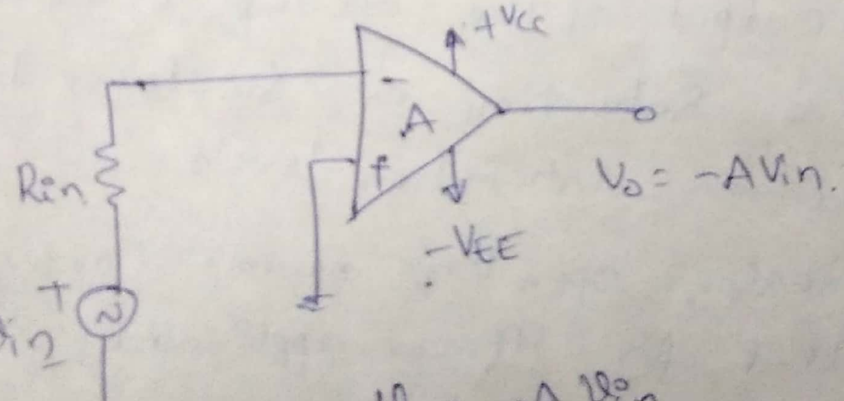
$v_1 = v_{in_1}$ and $v_2 = v_{in_2}$.

So $v_o = A(v_{in_1} - v_{in_2})$

Thus as expected, the output voltage is equal to the voltage gain A times the difference b/w the two i/p voltages.

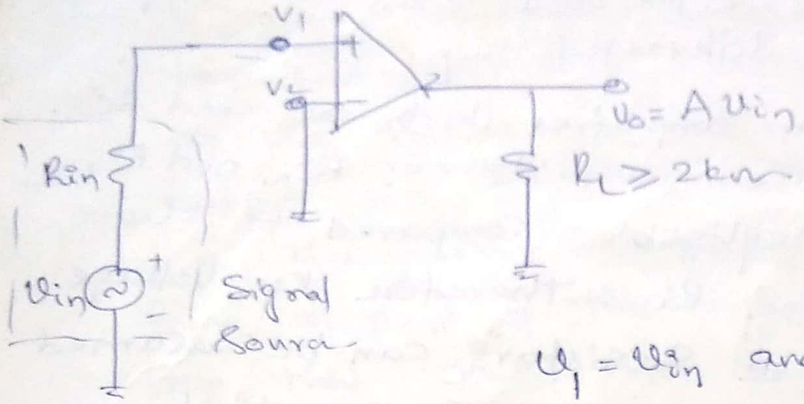
In open loop configurations, gain A is commonly referred to as open-loop gain.

<u>Inverting amp.</u>



$v_o = -A v_{in}$.

The non inverting amp.



$$v_1 = v_{in} \text{ and } v_2 = 0.$$

$$v_o = A v_{in}.$$

This means that the output voltage is larger than the i/p voltage by gain A and is in phase with the i/p signal.

* In all three open-loop configurations any i/p signal (differential or single) i.e is only slightly greater than zero, drives the output to saturation level.

This results from the very high gain (A) of the op-amp. Thus when operated open loop, the output of the op-amp is either -ve or positive saturation or switches between positive and -ve saturation levels.

For this reason, open loop op-amp configurations are not used for linear applications.

Op-Amp with -ve FeedBack

* clipping occurs in open-loop configurations when the output attempts to exceed the saturation levels of the op-amp. Because the open-loop gain of the op-amp is very high, only the smaller signals (of the order of liv or less) having very low freq may be amplified accurately without distortion. However, signals this small are very susceptible to noise and almost impossible to obtain in the laboratory.

* Besides being large, the open-loop voltage gain of the op-amp is not constant. the voltage gain varies with changes in temp and power supply as well as mass production techniques.

* The variations in voltage gain are relatively large in open-loop op-amps in particular, which makes the open-loop op-amp unsuitable for any linear applications. In most linear applications the o/p is proportional to the I/p and is of the same type.

* The B.W (band of freqs for which the gain remains constant) of most open-loop op-amp is impractical in a.c applications.

open-loop bandwidth of the 741C is approximately 5Hz.

* In certain applications the open-loop op-amp is purposely used as a nonlinear device.

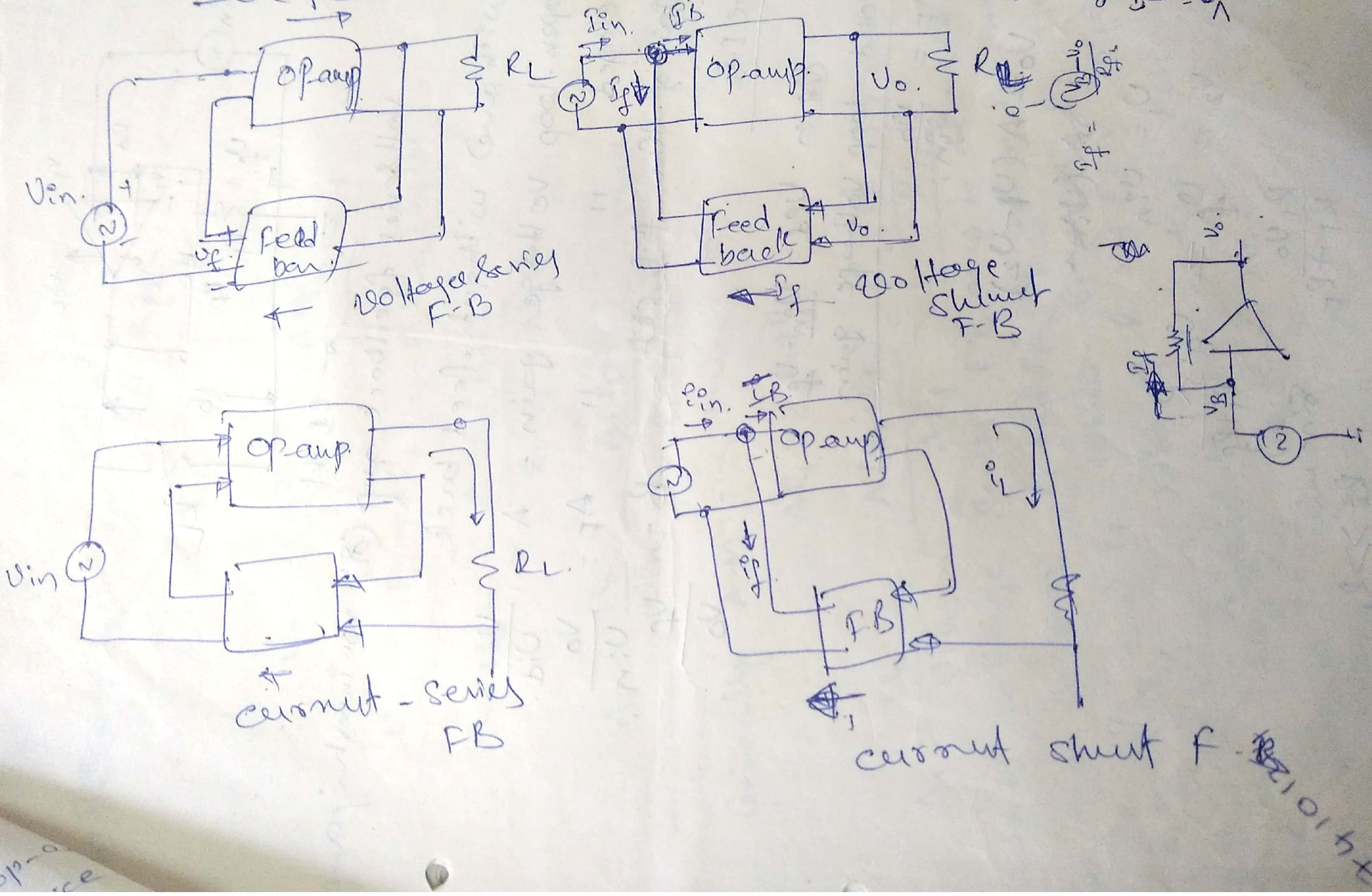
An op-Amp with -ve feedback

we can select as well as control the gain of open-loop op-amp if we introduce a modification in the basic ckt. This modification involves the use of feed back i.e o/p signal is fed back to the I/p either directly or via another n/w.

If the signal fed back is of opposite polarity or out of phase by 180° (or odd multiples of 180°) with respect to I/p signal This feed back is called -ve feed back.

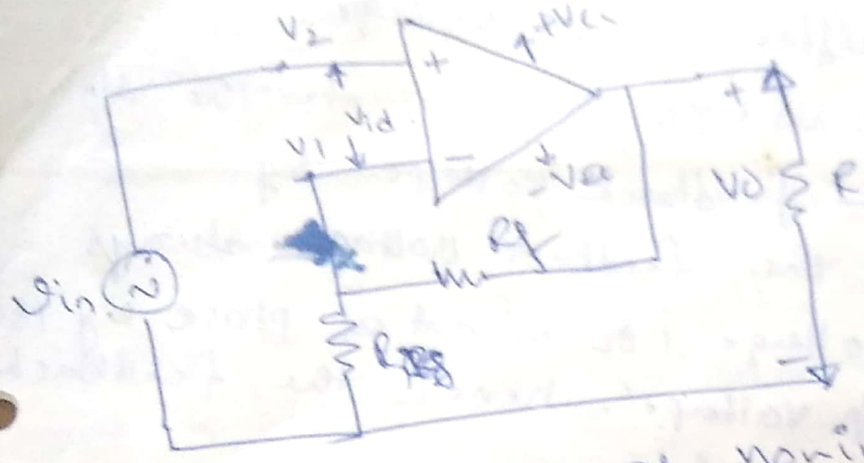
An amp with -ve feed back has a self correcting ability against any change in o/p voltage caused by changes in environmental conditions. -ve feed back is also known as degenerative feed back because when used it reduces the o/p voltage amp and in turn reduces the voltage gain. when used in amplifiers, -ve feed back stabilizes the gain, increases the B.W and changes the I/p and o/p resistances.

Block diagrams for diffrent op-amp configur... of feed m



Voltage Series feedback amp

The schematic diagram of the Voltage Series feedback amp. is shown in fig.



The ckt is known as noninverting amp with feedback. (& closed loop noninverting amplifier) because it uses feedback, and the input signal is applied to the noninverting terminal of the op-amp.

open-loop Voltage gain (or gain without feedback)

$$A = \frac{V_o}{V_{id}}$$

closed loop voltage gain (or gain with feedback)

$$A_F = \frac{V_o}{V_{in}}$$

gain of the feedback ckt = $B = \dfrac{V_f}{V_o}$

A

-ve feedback

$$V_{id} = V_{in} - V_f$$

V_{in} = i/p voltage V_f = feedback voltage.

V_{id} = difference i/p voltage.

This difference voltage is equal to the i/p voltage V_{in} − feedback voltage V_f.

* In otherwords the feedback voltage always opposes the i/p voltage. (& is out of phase by 180° w.r.to the i/p voltage. hence the feedback is said to be -ve.

closed loop Voltage gain.

The closed loop voltage gain $A_F = \frac{V_o}{V_{in}}$

$$V_o = A(V_{in} - V_f).$$

$$V_1 = V_{in}.$$

$$V_2 = V_f = \left(\frac{R_1}{R_1+R_f}\right) V_o.$$

$$V_o = A\left(V_{in} - \frac{R_1}{R_1+R_f} V_o\right)$$

$$V_o\left[1 + \frac{R_1 A}{R_1+R_f}\right] = A V_{in}.$$

$$V_o = \frac{A.V_{in}(R_1+R_F)}{R_1+R_f+AR_1}$$

$$A_F = \frac{V_o}{V_{in}} = \frac{A(R_1+R_F)}{R_1+R_f+AR_1}$$ exact.

$$A\beta \quad AR_1 >> R_1+R_f$$

$$A_f = \frac{\cancel{A}(R_1+R_f)}{\cancel{A}R_1} = 1+\frac{R_f}{R_1} \text{ (Ideal)}$$

$$\boxed{A_f = 1+\frac{R_f}{R_1}} \qquad \text{——— (1)}$$

Gain of the voltage series feedback amp is determined by the ratio of two resistors, R_1 and R_f. If the desired gain is 11, we can choose $R_1 = 1k\Omega$ and $R_f = 10\,k\Omega$ or $R_1 = 100\Omega$ and $R_f = 1k\Omega$. In setting the gain the ratio of R_1 and R_f is important not the absolute values of these resistors.

$$B = \frac{v_f}{v_o} = \frac{R_1}{R_1+R_f}$$

$$\boxed{A_F = \frac{1}{B}}$$

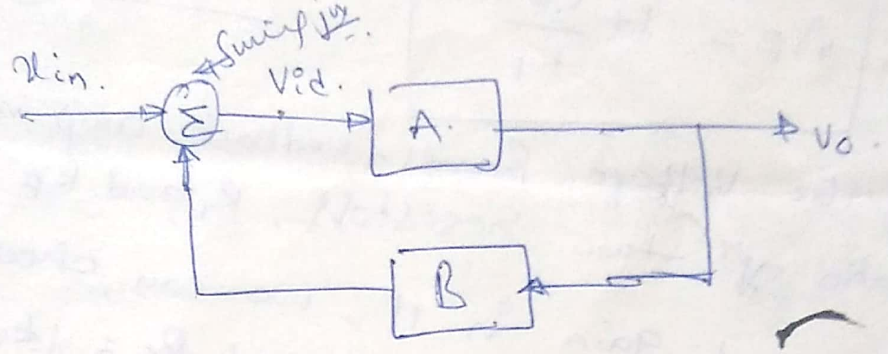
This means that the gain of the feedback ckt is the reciprocal of the closed loop voltage gain. The values of A_F for given values of R_1 and R_f the values of A_F and B are fixed.

The closed loop voltage gain A_F in terms of open loop gain A and feedback ckt gain B. ~~fixed~~

$$A_F = \frac{A(R_1+R_F)}{R_1+R_F+AR_1}$$

$$A_F = \frac{A(R_1+R_F)/R_1+R_F}{1+AR_1/R_1+R_f} = \frac{A}{1+AB}$$

when A_F = closed loop gain.
A = Open loop gain.
B = gain of the feedback ckt.
AB = loop gain.



Difference i/p voltage ideally zero.

$$V_{id} = \frac{V_o}{A}$$

$$V_{id} \simeq 0$$

$$V_1 - V_2 \simeq 0.$$

$$V_1 \simeq V_2$$

Say that the voltage at the noninverting terminal of an op-amp is approximately equal to that at the inverting i/p terminal provided that A is very large.

* This concept is useful in analysis of closed-loop opamp ckts.

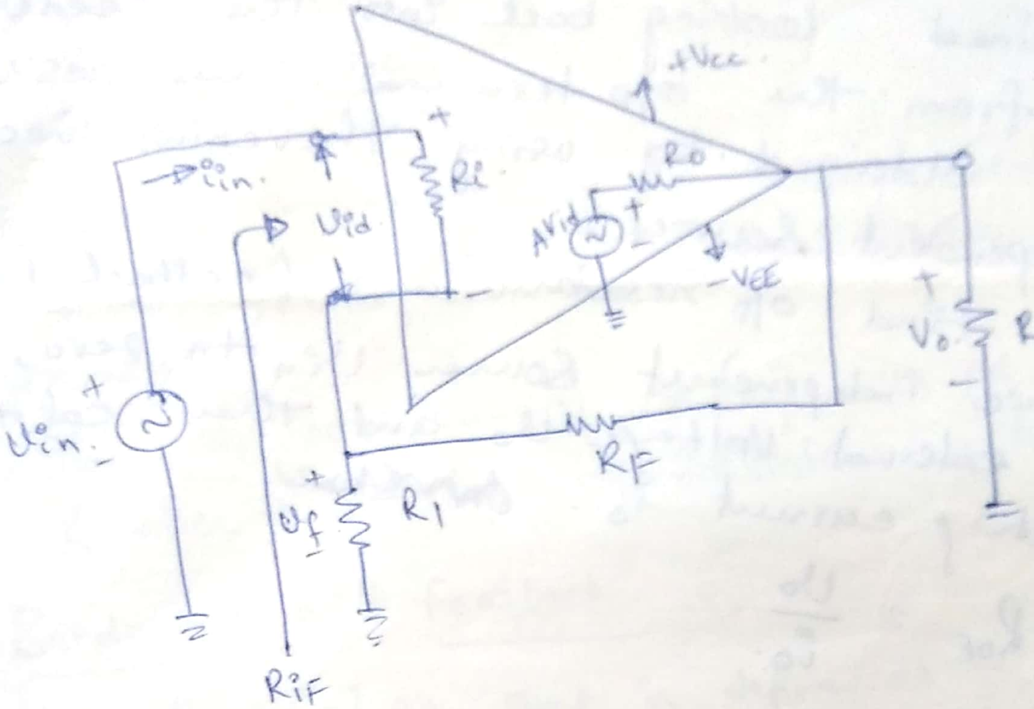
$$V_1 = V_{in}.$$

$$V_2 = V_f = \frac{R_1 V_o}{R_1 + R_F}.$$

$$V_{in} = \frac{R_1 V_o}{R_1 + R_F}$$

$$\boxed{A_F = \frac{V_o}{V_{in}} = 1 + \frac{R_F}{R_1}}$$

I/P resistance with feed back



R_i is the I/p resistance (open loop) of the op-amp, and R_{iF} is the I/p resistem of the amp with feedback. The I/p resistance with feed back is defined as

$$R_{iF} = \frac{V_{in}}{i_{in}} = \frac{V_{in}}{V_{id}/R_i}$$

$$V_{id} = \frac{V_o}{A} \quad \text{and} \quad V_o = \frac{A}{1+AB} V_{in}.$$

$$R_{iF} = \frac{V_{in} R_i \cdot A}{V_o} = \frac{\cancel{V_{in}} R_i \cdot \cancel{A}}{\frac{\cancel{A\,V_{in}}}{1+AB}}$$

$$\boxed{R_{iF} = R_i(1+AB)}$$

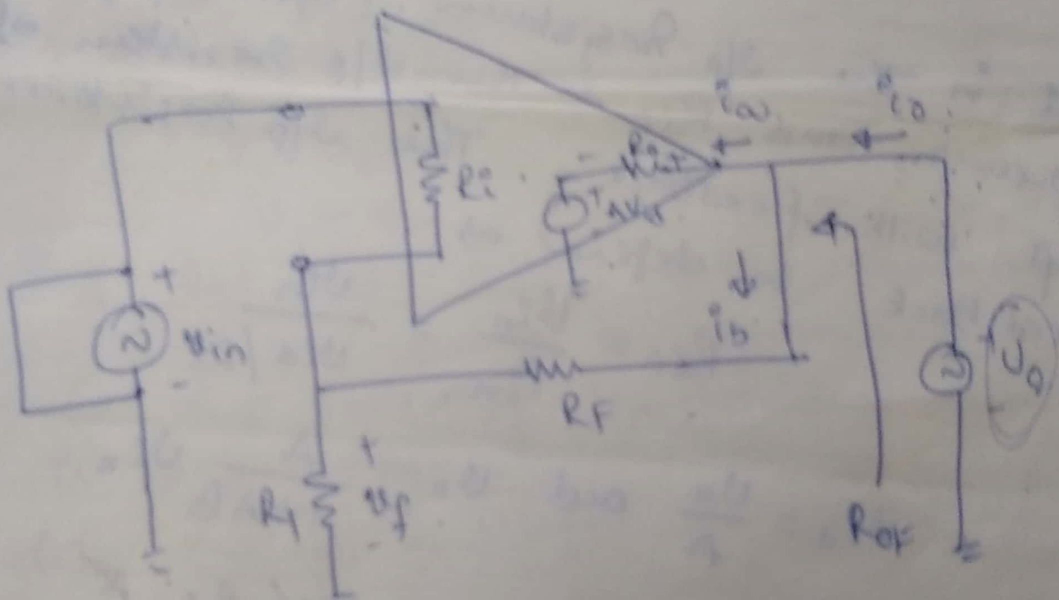
This means that the I/p resistance of the op-amp with feedback is $(1+AB)$ times that without feedback.

O/p Resistance with feedback

O/p Resistance is the Resistance determined looking back into the feedback amp from the o/p terminal. This Resistance can be obtained by using Thevenin's theorem for dependent sources.

* To find o/p Resistance with feedback R_{oF}, reduce independent source V_{in} to zero, apply an external voltage V_o and then cal the resulting current i_o.

$$R_{oF} = \frac{V_o}{i_o}$$



$(R_i \| R_1) + R_F \gg R_o$

$i_o = i_a + i_b$

$\cancel{(R_1 \| R_i) + R_F} \gg R_o$ and $i_a \gg i_b$

$((R_F + R_1) \| R_i)$

$i_o = i_a$

$-V_o + R_o i_o + AV_{id} = 0$

$i_o = \frac{V_o - AV_{id}}{R_o}$

$V_{id} = -V_f$

$= -\frac{R_1 V_o}{R_1 + R_F}$

$= -BV_o$

$V_{id} = -BV_o$

$$i_o = \frac{V_o + AB V_o}{R_o} = \frac{V_o(1+AB)}{R_o}$$

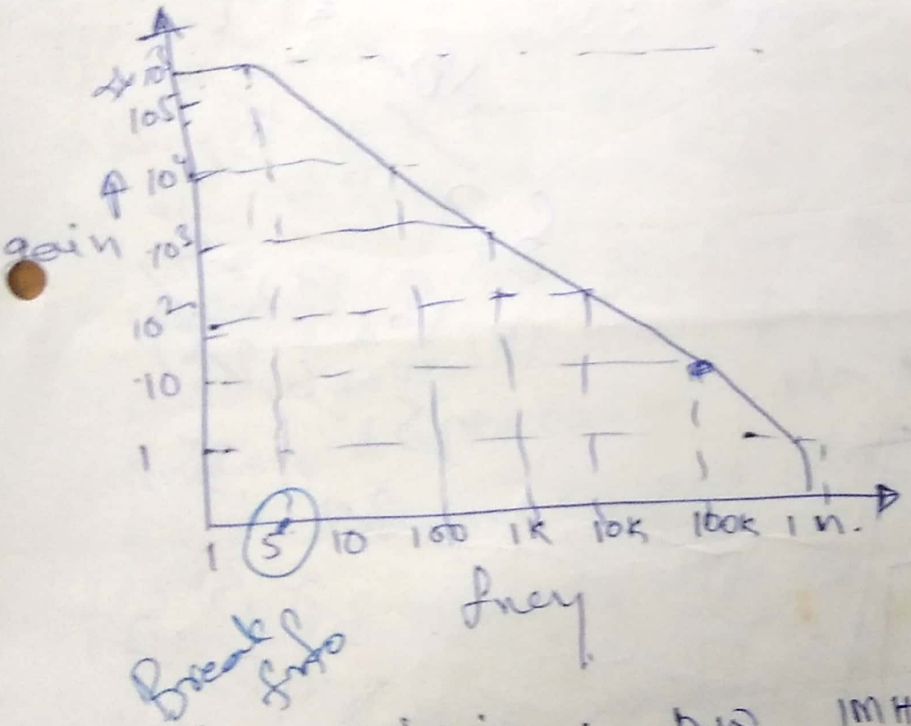
$$\frac{V_o}{i_o} = \frac{R_o}{1+AB}.$$

The o/p resistance of the voltage-series feedback amp is $1/1+AB$ times the o/p resistance R_o of the op-amp.

* the o/p resistance of op-amp with FB is much smaller than the o/p resistance without feedback

Bandwidth with feedback.

The B.W of an amp is defined as the band of freqs for which the gain remains constant.



open loop gain Vs freq curve of the 741C

OGB fn

when gain is 1, B.W 1MHZ.

gain band width product is constant.

741, 5Hz is the break freq.

$UGB = A f_o$

A = opun
f_o = break freq.
. Single brueq.

$UGB = (A_F) f_F$

$A f_o = A_F f_F$

$$f_F = \frac{A(f_o)}{A_F}$$

$$f_F = f_o(1+AB).$$

Total ... with fe... ... Shawa...

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Total o/p offset voltage with feedback.

With feed back the gain of the noninverting amp changes from A to A/1+AB the total o/p offset voltage with feedback must also be 1/1+AB times the voltage without feedback.

$$\text{Total output offset voltage with feedback} = \frac{\text{total o/p offset voltage without feedback}}{1+AB}$$

$$V_{OOT} = \frac{\pm V_{sat}}{1+AB}$$

Voltage Follower.

The lowest gain that can be obtained from a noninverting amp is one. when noninverting amp is configured for unity gain, it is called a voltage follower. because the o/p voltage equal to and in phase with the i/p. In the voltage follower the o/p follows the i/p.

* Although it is similar to the discrete emitter follower, the voltage follower is preferred because it has much high input resistance, and the o/p amp is exactly equal to the i/p.

* To obtain the voltage follower from the noninverting amp simply open R_1 and short R_F.

In this fig all the o/p voltage is fed back into the inverting terminal of the op-amp

Consequently the gain of the feedback ckt is

1. $(B = A_F = 1)$

$A_F = 1$

$1 + AB < A$

$R_{iF} = (1 + A) R_i$

$R_{iF} = A R_i$

$R_{oF} = \frac{R_o}{A}$

$f_F = A f_o$

$V_{OOT} = \frac{\pm V_{sat}}{A}$

* The voltage follower is also called noninverting buffer because, when placed b/w two n/w, it removes the loading on the first n/w.

Prob

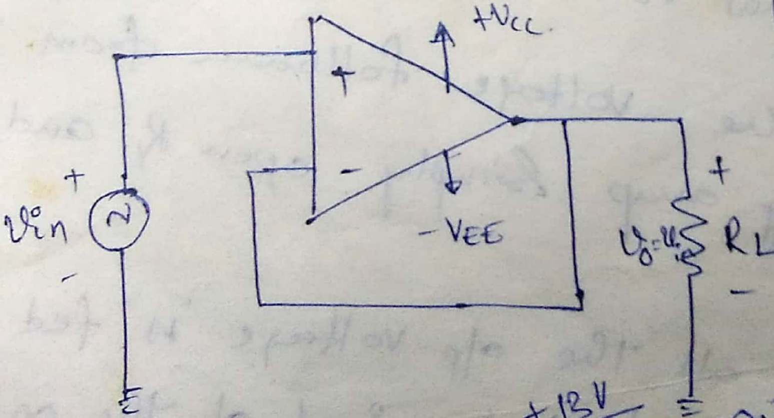
The 741C op-amp having the following parameters is connected as a noninverting amp with $R_1 = 1k\Omega$, $R_F = 10k\Omega$.

$A = 200{,}000$, $R_i = 2M\Omega$ $R_o = 75\Omega$

$f_o = 5Hz$ supply voltages $\pm 15V$.

o/p voltage swing $= \pm 13V$.

Compute the values of A_F, R_{iF}, R_{oF}, f_F and V_{OOT}.



$B = \frac{R_1}{R_1 + R_F} = \frac{1}{11}$

$1 + AB = 1 + \frac{200000}{11} = 18182.8$

$A_F = \frac{200000}{18182.8} = 10.99$

$R_{iF} = 36.4 G\Omega$

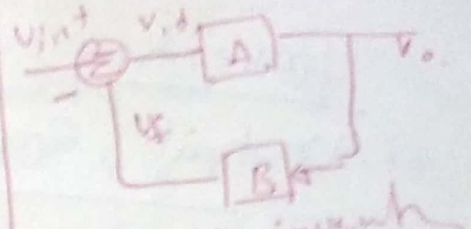
$R_{oF} = \frac{75\Omega}{18182.8} = 4.12m\Omega$

$f_F = (5Hz)(18{,}182)$

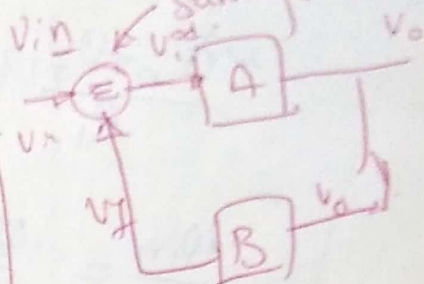
$= 90.9KHz$

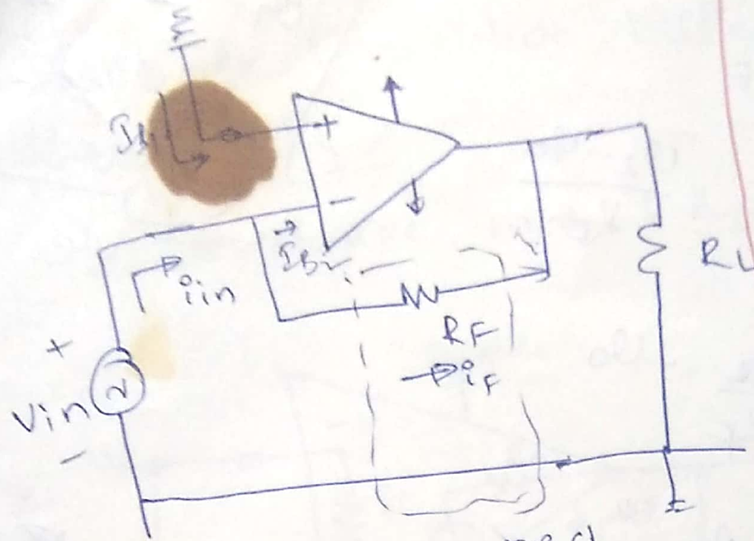
$V_{OOT} = \frac{\pm 13V}{18{,}182.8} = 0.715 mV$

Voltage shunt FB amp.



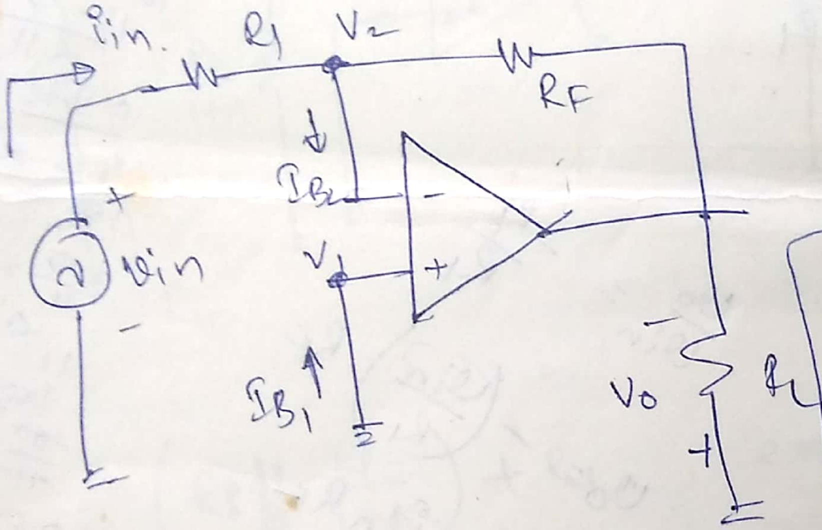
Non inverting





FB CK

$$A_F = \frac{\frac{A R_F}{R_1+R_F}}{1+\frac{A R_1}{R_1+R_F}}$$



$$A_F = \frac{A \cdot K}{1+AB}.$$

$K = \frac{R_F}{R_1+R_F}$ = voltage attenuation

$$B = \frac{R_1}{R_1+R_F}$$

$$i_{in} = i_F + I_B$$

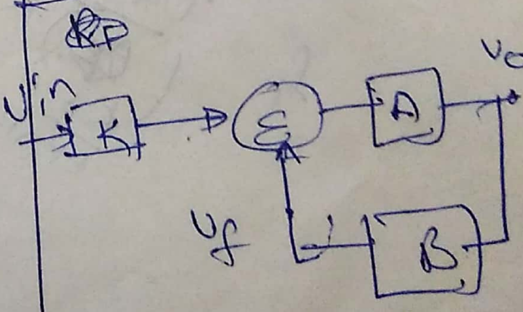
$$i_{in} \simeq i_F$$

$$\frac{v_{in} - v_2}{R_1} = \frac{v_2 - v_o}{R_F}$$

$$v_1 - v_2 = \frac{v_o}{A.}$$

$$v_1 = 0;\ v_2 = -\frac{v_o}{A.}$$

$$\frac{v_{in} + \frac{v_o}{A}}{R_1} = \frac{-\frac{v_o}{A} - v_o}{R_F}$$



Block dia of Inverting amp with FB

Inverting I/p Terminal at Virtual Ground.

$$i_{in} \simeq i_F$$

$$\frac{v_{in} - v_2}{R_1} = \frac{v_2 - v_0}{R_F}$$

$$\frac{v_{in}}{R_1} = \frac{\cancel{v_2} - v_0}{R_F}$$

$$\frac{v_0}{v_{in}} = -\frac{R_F}{R_1}.$$

$$v_1 - v_2 = \frac{v_0}{A}$$

$$v_1 - v_2 = 0$$

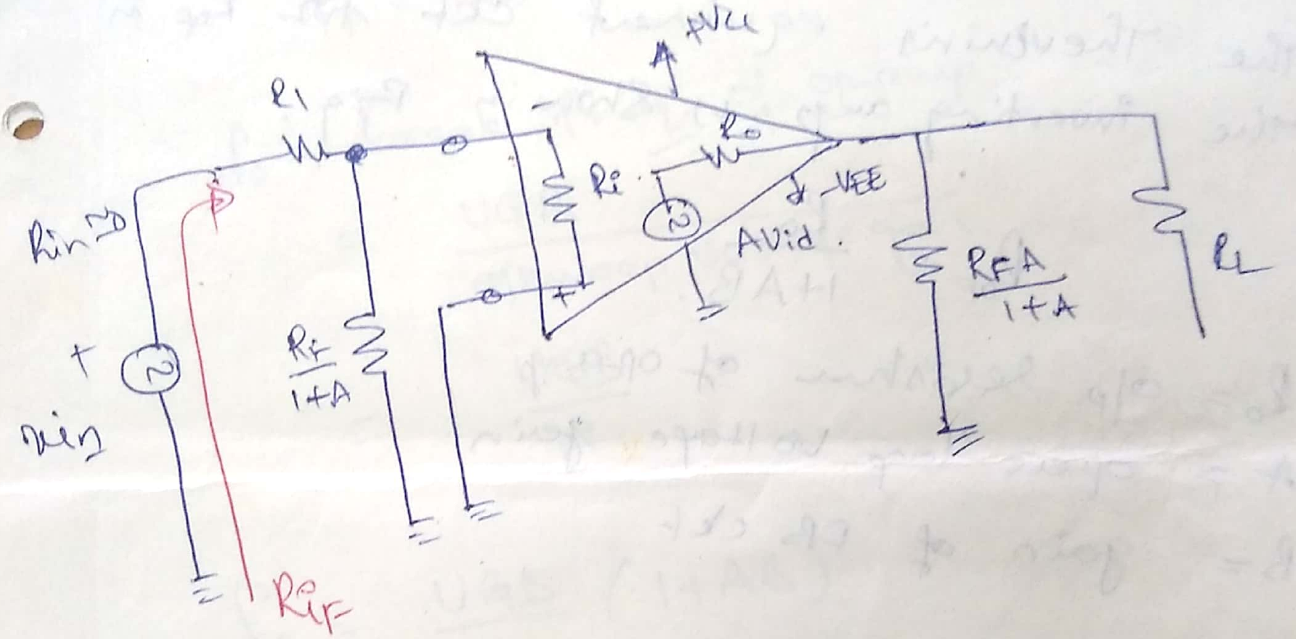
$$v_1 = v_2$$

exact

Input resistance with F.B.

The easiest method of finding the i/p resistance is to Millerize the FB resistor R_F i.e split R_F into two Miller components as shown in fig

The i/p resistance with F.B R_{iF} is the



exact

$$R_{iF} = \left(R_i \parallel \frac{R_F}{1+A} \right) + R_1$$

$$\frac{R_F}{1+A} \parallel R_i \simeq 0$$

$$R_{iF} = R_1$$

Output resistance with FB

R_{OF} is the Resistance measured at the o/p terminal of the FB amp. The o/p resistance of the noninverting amp was obtained by using Thevinin's theorem and we can do the same for the inverting amp.

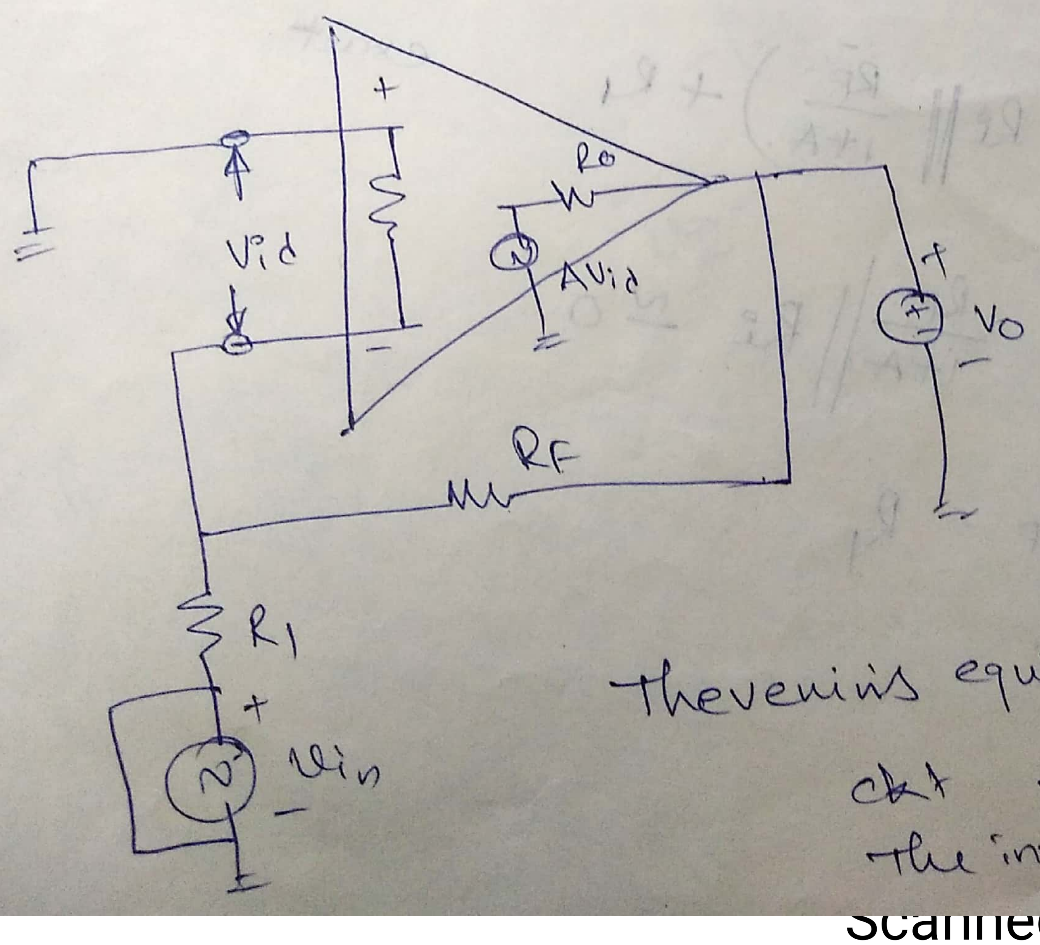
The Thevenin's equivalent ckt for R_{OF} in the inverting amp is shown in Fig.

$$R_{OF} = \frac{R_o}{1+AB}.$$

R_o = o/p resistance of opamp

A = open-loop voltage gain

B = gain of FB ckt



Thevenin's equivalent ckt for R_{OF} of the inverting amp.

Band width with FB

The gain Bandwidth product of a single break freq opamp is always constant. we also saw that the gain of the amp with feed back is always less than the gain with out feed back.

$$f_F = f_0(1+AB)$$

f_0 = break freq of op-amp.

$$= \frac{UGB}{\text{openloop voltage gain}}$$

$$= \frac{UGB}{A}$$

$$f_F = \frac{UGB}{A}(1+AB)$$

$$= \frac{UGB(K)}{A_F}$$

$$K = \frac{R_F}{R_1+R_F}$$

$$A_F = \frac{A\,K}{1+AB}$$

$$A_F = \frac{AK}{1+AB}$$

$$f_F = \frac{UGB(1+AB)}{A}$$

$$= \frac{UGB \cdot K}{AF}$$

$$\frac{UGB \cdot K}{\frac{A \cdot K}{1+AB}}$$

$$= 1MHz\left(1+2\times10^5\times\frac{1}{3.4}\right)$$

$$A_F = KA_F$$

Total output off set voltage with FB.

$$V_{OOT} = \frac{\text{total output off set voltage without FB.}}{1+AB}$$

$$V_{OOT} = \frac{\pm V_{sat}}{1+AB}.$$

$\pm V_{sat} \rightarrow$

$A \rightarrow$ openloop gen.

$B \rightarrow$

$B = \frac{R_F}{R_1+R_F}$

Current -to -Voltage converter.

Let us consider ideal -voltage gain of inverting amp.

$$\frac{v_o}{v_{in}} = -\frac{R_F}{R_1}$$

$$v_o = -\left(\frac{v_{in}}{R_1}\right) R_F.$$

However sim $v_1 = 0$ and $v_1 = v_2$

$$\frac{v_{in}}{R_1} = i_{in}.$$

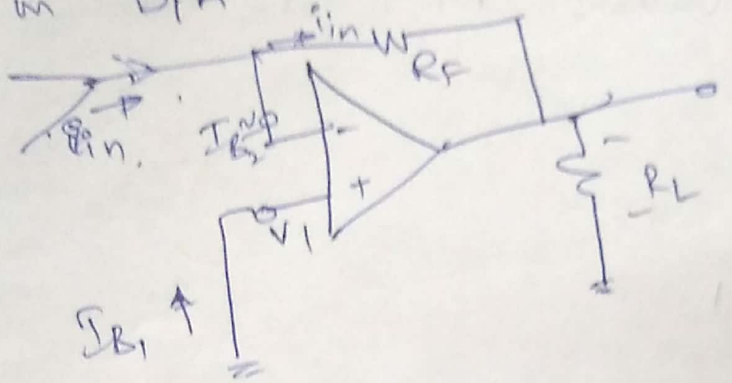
$$v_o = -(i_{in}) R_F.$$

This means that if we replace the v_{in} and R_1 combination by a current source i_{in} as shown in fig the o/p voltage v_o

becomes proportional to the input current i_{in}. In other words, the ckt converts the input current into proportional output voltage.

Apps

Sensing current from photodetectors and in D/A converter applications.



Inverter.

If we need an output voltage signal equal in amplitude but opposite in phase to that of the i/p signal. we can use the inverting amplifier works as inverter. the inverting an inverter if $R_1 = R_F$. Since the inverter is a special case of inverting amp all the equations developed for the inverting amp are also applicable here.

$B = \frac{R_1}{R_1 + R_F}$

$B = \frac{1}{2}$

the eqs can be apply by substituting $A/2$ for $(1+AB)$

$1 + AB$

$1 + \frac{A}{2} \simeq A/$

Since $B = 1/2$

Prob.

For the inverting amp At fig $R_1 = 470\Omega$ and $R_F = 4.7\,k\Omega$. Assume that the op-amp is the 741 having same specification as those given in Ex– cal the values A_F, R_{iF}, R_{oF}, f_F and V_{OOT}

$$K = \frac{R_F}{R_1 + R_F} = \frac{1}{1.1}$$

$$B = \frac{1}{11}.$$

$$1 + AB = 18{,}182.8.$$

$$A_F = -10.$$

$$R_{iF} = 470 + \left[\frac{470}{2{,}00000} \,\Big\|\, 2\times10^{6}\right) = 470\,\Omega$$

$$R_{oF} = \frac{75}{18{,}182.8} = 4.12\,m\Omega$$

$$f_F = 100\,KHZ. = \frac{5HZ\,(18{,}182.8}{1/1.1}$$

$$V_{OOT} = \frac{\pm 13V}{18{,}182.8} = \pm 0.715\,mV.$$