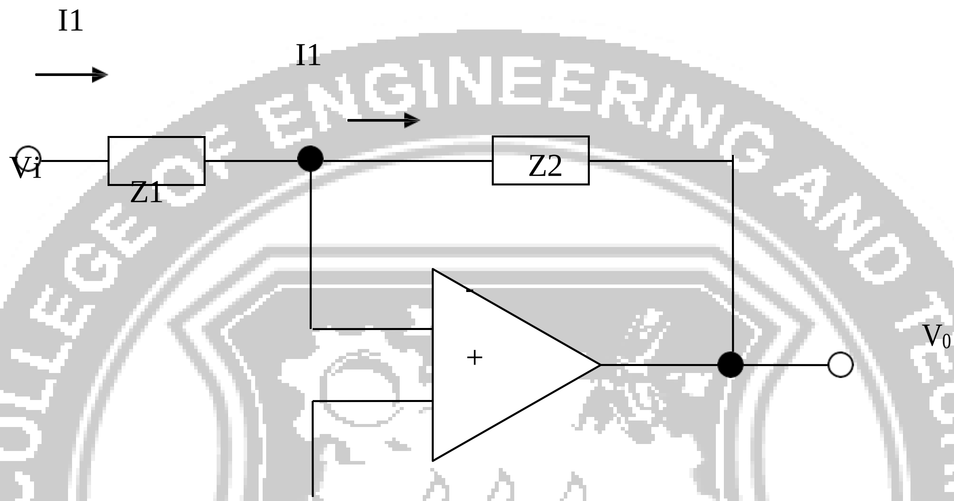
UNIT – III

APPLICATIONS OF OPERATIONAL AMPLIFIER

SIGN CHANGER (PHASE INVERTER)



The basic inverting amplifier configuration using an op-amp with input impedance Z_1 and feedback impedance Z_f.

If the impedance Z_1 and Z_f are equal in magnitude and phase, then the closed loop voltage gain is -1,and the input signal will undergo a 180^0 phase shift at the output. Hence, such circuit is also called phase inverter. If two such amplifiers are connected in cascade, then the output from the second stage is the same as the input signal without any change of sign.

Hence, the outputs from the two stages are equal in magnitude but opposite in phase and such a system is an excellent paraphase amplifier.

Scale Changer:

Referring the above diagram, if the ratio Z_f / Z_1 = k, a real constant, then the closed loop gain is –k, and the input voltage is multiplied by a factor –k and the scaled output is available at the output. Usually, in such applications, Z_f and Z_1 are selected as precision resistors for obtaining precise and scaled value of input voltage.

PHASE SHIFT CIRCUITS

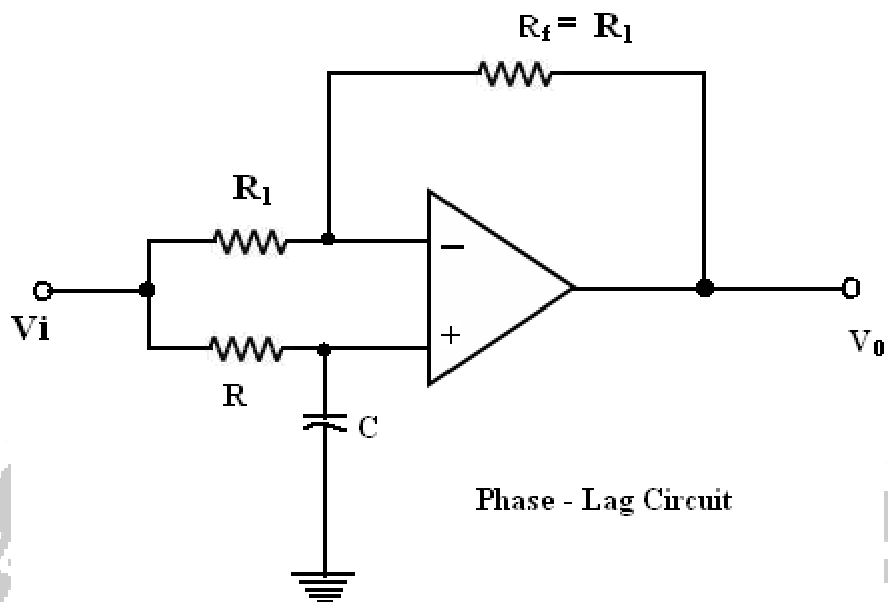
The phase shift circuits produce phase shifts that depend on the frequency and maintain a constant gain. These circuits are also called constant-delay filters or all-pass filters. That constant delay refers to the fact the time difference between input and output remains constant when frequency is changed over a range of operating frequencies.

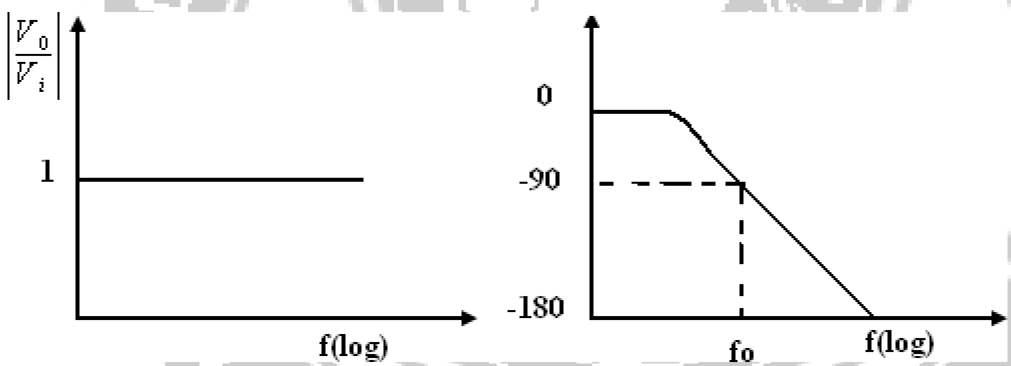
This is called all-pass because normally a constant gain is maintained for all the frequencies within the operating range. The two types of circuits, for lagging phase angles and leading phase angles.

Phase-lag circuit:

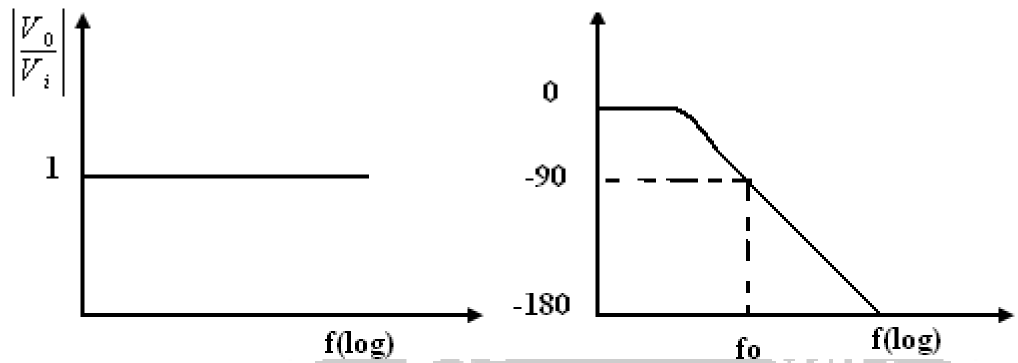
Phase log circuit is constructed using an op-amp, connected in both inverting and non inverting modes. To analyze the circuit operation, it is assumed that the input voltage v1 drives a simple inverting amplifier with inverting input applied at(-)terminal of op-amp and a non inverting amplifier with a low-pass filter.

It is also assumed that inverting gain is -1 and non-inverting gain after the low-pass circuit is $1 + \frac{R_f}{R_1}$ =1+1=2, Since $R_f = R_1$





The relationship is complex as defined above equation and it shows that it has both magnitude and phase. Since the numerator and denominator are complex conjugates, their



Voltage follower:

If $R_1=\infty$ and Rf=0 in the non inverting amplifier configuration .

The amplifier act as a unity-gain amplifier or voltage follower.

That is

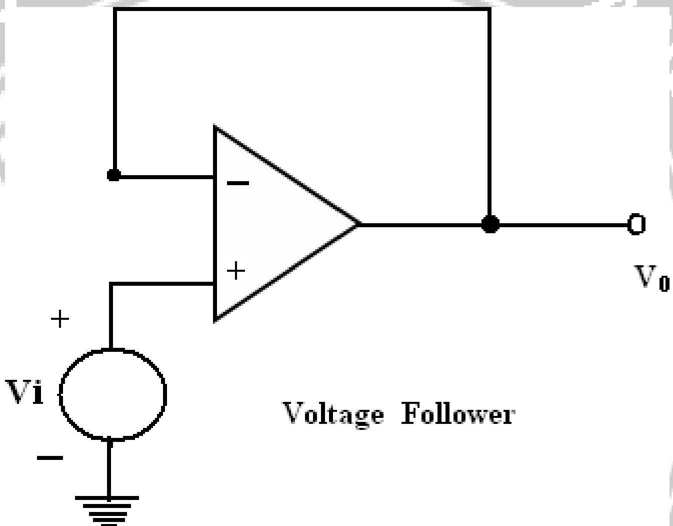
$$A_v = 1 + \frac{R_f}{R_1}$$

Since $\frac{R_f}{R_1} = 0$, $A_v = 1$

The circuit consist of an op-amp and a wire connecting the output voltage to the input ,i.e the output voltage is equal to the input voltage, both in magnitude and phase.$V_0=V_i$

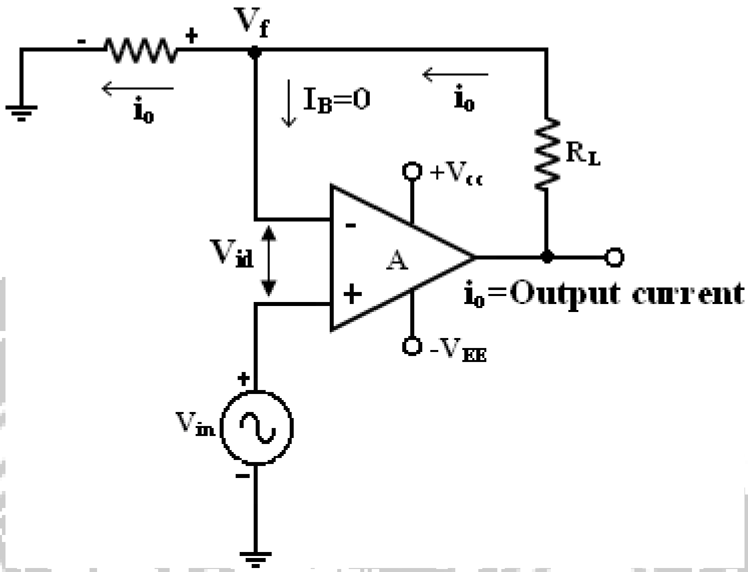
Since the output voltage of the circuit follows the input voltage, the circuit is called voltage follower. It offers very high input impedance of the order of MΩ and very low output impedance.

Therefore, this circuit draws negligible current from the source. Thus, the voltage follower can be used as a buffer between a high impedance source and a low impedance load for impedance matching applications.



Voltage to Current Converter with floating loads (V/I):

1. Voltage to current converter in which load resistor R_L is floating (not connected to ground).
2. Vin is applied to the non inverting input terminal, and the feedback voltage across R_1 devices the inverting input terminal.
3. This circuit is also called as a current – series negative feedback amplifier.
4. Because the feedback voltage across R_1 (applied Non- inverting terminal) depends on the output current i_0 and is in series with the input difference voltage V_{id}.



Writing KVL for the input loop,

$$Vin \square V_{id} \square V_f$$

$$V_{id} \text{ t } 0v \text{ , since } A \text{ is very large A}$$

$$Vin \square V_f \quad ` \quad a$$

$$Vin \square R_1 \quad or$$

$$i_0$$

From the fig input voltage Vin is converted into output current of Vin/R_1 [Vin -> i_0] . In other words, input volt appears across R_1. If R_1 is a precision resistor, the output current (i_0 = Vin/R_1) will be precisely fixed.

Applications:

1. Low voltage ac and dc voltmeters
2. Diode match finders
3. LED
4. Zener diode testers.