JEPPIAAR INSTITUTE OF TECHNOLOGY

"Self-Belief | Self Discipline | Self Respect"

DEPARTMENT

OF

ELECTRONICS & COMMUNICATION ENGINEERING

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UNIT I

FEEDBACK AMPLIFIERS AND STABILITY

Feedback Concepts – gain with feedback – effect of feedback on gain stability, distortion, bandwidth, input and output impedances; topologies of feedback amplifiers – analysis of series-series, shunt-shunt and shunt-series feedback amplifiers-stability problem-Gain and Phase-margins-Frequency compensation.

FEED BACK AMPLIFIERS

INTRODUCTION

A practical amplifier has a gain of nearly one million i.e. its output is one million times the input. Consequently, even a casual disturbance at the input will appear in the amplified form in the output. There is a strong tendency in amplifiers to introduce hum due to sudden temperature changes or stray electric and magnetic fields. Therefore, every high gain amplifier tends to give noise along with signal in its output. The noise in the output of an amplifier is undesirable and must be kept to a small a level as possible. The noise level in amplifiers can be reduced considerably by the use of negative feedback i.e. by injecting a fraction of output in phase opposition to the input signal. The object of this chapter is to consider the effects and methods of providing negative feedback in transistor amplifiers.

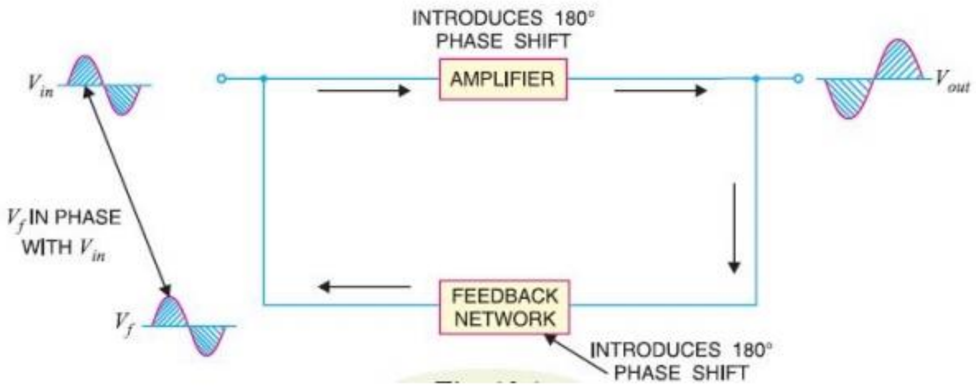

Figure 1.1

Feedback

The process of injecting a fraction of output energy of some device back to the input is known as **feedback**. The principle of feedback is probably as old as the invention of first machine but it is only some 50 years ago that feedback has come into use in connection with electronic circuits. It has been found very useful in reducing noise in amplifiers and making amplifier operation stable. Depending upon whether the feedback energy aids or opposes the input signal, there are two basic types of feedback in amplifiers viz positive feedback and negative feedback.

(i) **Positive feedback.** When the feedback energy (voltage or current) is in phase with the input signal andthus aids it, it is called positive feedback. This is illustrated in Fig. 1.1. Both amplifier and feedback network introduce a phase shift of 180°. The result is a 360° phase shift around the loop, causing the feedback voltage Vf to be in phase with the input signal Vin.

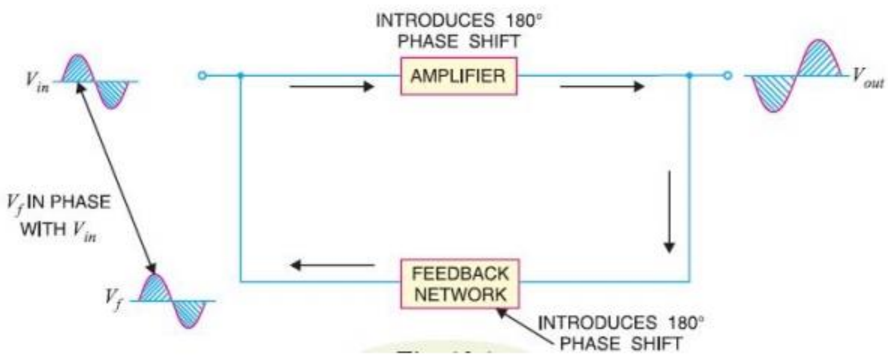

Figure 1.1

The positive feedback increases the gain of the amplifier. However, it has the disadvantages of increased distortion and instability. Therefore, positive feedback is seldom employed in amplifiers. One important use of positive feedback is in oscillators. As we shall see in the next chapter, if positive feedback is sufficiently large, it leads to oscillations. As a matter of fact, an oscillator is a device that converts d.c. power into a.c. power of any desired frequency.

(ii) Negative feedback. When the feedback energy (voltage or current) is out of phase with the input signal and thus opposes it, it is called negative feedback. This is illustrated in Fig. 1.2. As you can see, the amplifier introduces a phase shift of 180° into the circuit while the feedback network is so designed that it introduces no phase shift (i.e., 0° phase shift). The result is that the feedback voltage Vf is 180° out of phase with the input signal Vin.

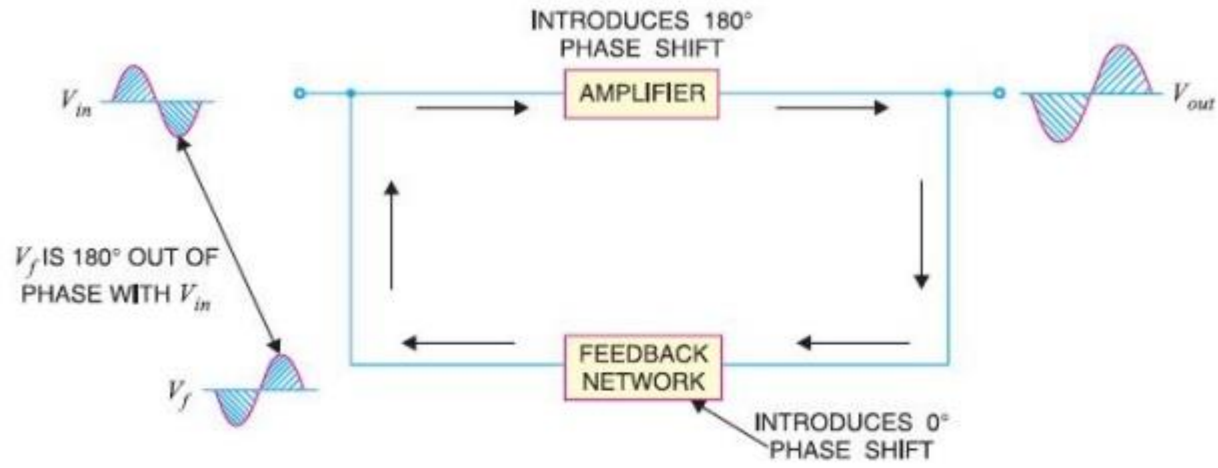

Figure 1.2

Negative feedback reduces the gain of the amplifier. However, the advantages of negative feedback are: reduction in distortion, stability in gain, increased bandwidth and improved input and output impedances. It is due to these advantages that negative feedback is frequently employed in amplifiers.

Principles of Negative Voltage Feedback In Amplifiers

A feedback amplifier has two parts viz an amplifier and a feedback circuit. The feedback circuit usually consists of resistors and returns a fraction of output energy back to the input. Fig. 1.3 *shows the principles of negative voltage feedback in an amplifier. Typical values have been assumed to make the treatment more illustrative. The output of the amplifier is 10 V. The fraction mv of this output i.e. 100 mV is fedback to the input where it is applied in series with the input signal of 101 mV. As the feedback is negative, therefore, only 1 mV appears at the input terminals of the amplifier. Referring to Fig. 1.3, we have, Gain of amplifier without feedback,

$$A_v = \frac{10\text{ V}}{1\text{ mV}} = 10,000$$

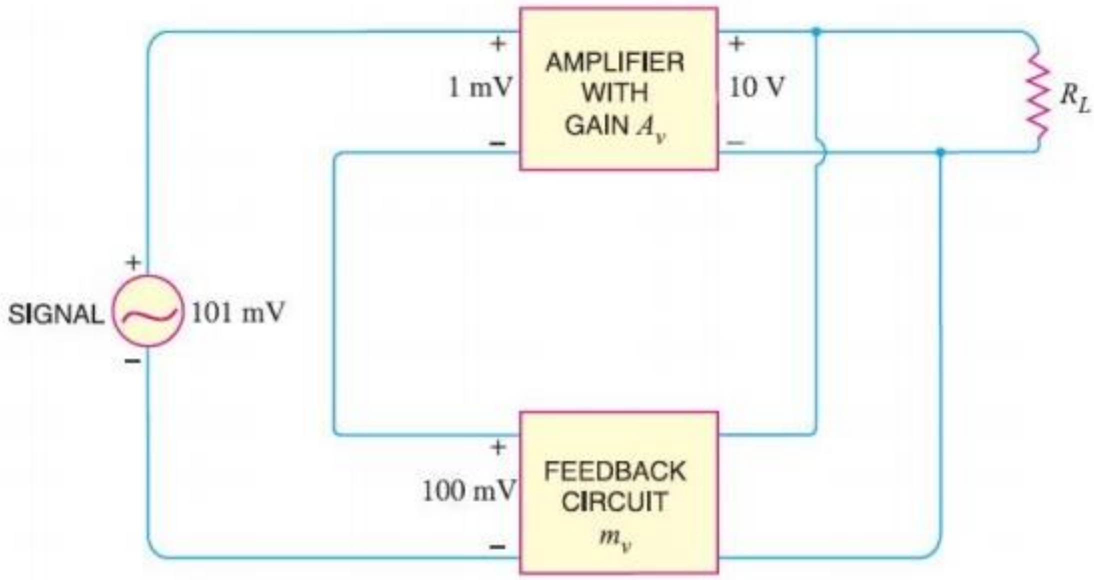

Figure 1.3

$$\text{Fraction of output voltage fedback, } m_v = \frac{100\text{ mV}}{10\text{ V}} = 0.01$$

$$\text{Gain of amplifier with negative feedback, } A_{vf} = \frac{10\text{ V}}{101\text{ mV}} = 100$$

The following points are worth noting :

ü When negative voltage feedback is applied, the gain of the amplifier is reduced. Thus, the gain of above amplifier without feedback is 10,000 whereas with negative feedback, it is only 100.

ü When negative voltage feedback is employed, the voltage actually applied to the amplifier is extremely small. In this case, the signal voltage is 101 mV and the negative feedback is 100 mV so that voltage applied at the input of the amplifier is only 1 mV.

ü In a negative voltage feedback circuit, the feedback fraction mv is always between 0 and 1. The gain with feedback is sometimes called closed-loop gain while the gain without feedback is called open-loop gain. These terms come from the fact that amplifier and feedback circuits form a "loop". When the loop is "opened" by disconnecting the feedback circuit from the input, the amplifier's gain is Av, the "open-loop" gain. When the loop is "closed" by connecting the feedback circuit, the gain decreases to Avf , the "closed-loop" gain.

Gain of Negative Voltage Feedback Amplifier

Consider the negative voltage feedback amplifier shown in Fig. 1.4. The gain of the amplifier without feedback is Av. Negative feedback is then applied by feeding a fraction mv of the output voltage e0 back to amplifier input. Therefore, the actual input to the amplifier is the signal voltage eg minus feedback voltage mv e0 i.e.,

Actual input to amplifier = eg − mv e0

The output e0 must be equal to the input voltage eg − mv e0 multiplied by gain Av of the amplifier i.e.,

$$(e_g - m_v e_0) A_v = e_0$$

or $$A_v e_g - A_v m_v e_0 = e_0$$

or $$e_0 (1 + A_v m_v) = A_v e_g$$

or $$\frac{e_0}{e_g} = \frac{A_v}{1 + A_v m_v}$$

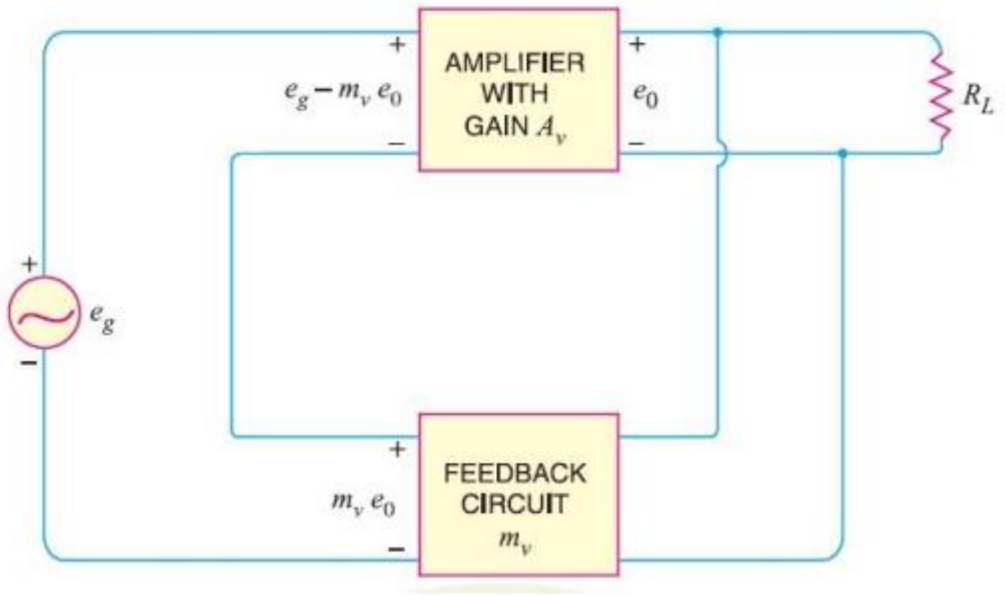

Figure 1.4

But eg is the voltage gain of the amplifier with feedback.

Voltage gain with negative feedback is

$$A_{vf} = \frac{A_v}{1 + A_v m_v}$$

It may be seen that the gain of the amplifier without feedback is Av. However, when negative voltage feedback is applied, the gain is reduced by a factor 1 + Av mv. It may be noted that negative voltage feedback does not affect the current gain of the circuit.

Advantages of Negative Voltage Feedback

The following are the advantages of negative voltage feedback in amplifiers :

(i) Gain stability. An important advantage of negative voltage feedback is that the resultant gain of theamplifier can be made independent of transistor parameters or the supply voltage variations.

$$A_{vf} = \frac{A_v}{1 + A_v\, m_v}$$

For negative voltage feedback in an amplifier to be effective, the designer deliberately makes the product Av mv much greater than unity. Therefore, in the above relation, 1 can be neglected as compared to Av mv and the expression becomes:

$$A_{vf} = \frac{A_v}{A_v\, m_v} = \frac{1}{m_v}$$

It may be seen that the gain now depends only upon feedback fraction mv i.e., on the characteristics of feedback circuit. As feedback circuit is usually a voltage divider (a resistive network), therefore, it is unaffected by changes in temperature, variations in transistor parameters and frequency. Hence, the gain of the amplifier is extremely stable.

(ii) Reduces non-linear distortion. A large signal stage has non-linear distortion because its voltage gainchanges at various points in the cycle. The negative voltage feedback reduces the nonlinear distortion in large signal amplifiers. It can be proved mathematically that :

$$D_{vf} = \frac{D}{1 + A_v\, m_v}$$

where D = distortion in amplifier without feedback

D_{vf} = distortion in amplifier with negative feedback

It is clear that by applying negative voltage feedback to an amplifier, distortion is reduced by a factor 1 + Aν mν .

(iii) Improves frequency response. As feedback is usually obtained through a resistive network, therefore, voltage gain of the amplifier is *independent of signal frequency. The result is that voltage gain of the amplifier will be substantially constant over a wide range of signal frequency. The negative voltage feedback, therefore, improves the frequency response of the amplifier.

(iv) Increases circuit stability. The output of an ordinary amplifier is easily changed due to variations in ambient temperature, frequency and signal amplitude. This changes the gain of the amplifier, resulting in distortion. However, by applying negative voltage feedback, voltage gain of the amplifier is stabilised or accurately fixed in value.

This can be easily explained. Suppose the output of a negative voltage feedback amplifier has increased because of temperature change or due to some other reason. This means more negative feedback since feedback is being given from the output. This tends to oppose the increase in amplification and maintains it stable. The same is true should the output voltage decrease. Consequently, the circuit stability is considerably increased.

(v) Increases input impedance and decreases output impedance. The negative voltage feedback increases the input impedance and decreases the output impedance of amplifier. Such a change is profitable in practice as the amplifier can then serve the purpose of impedance matching.

(a) Input impedance. The increase in input impedance with negative voltage feedback can be explained by referring to Fig. 13.5. Suppose the input impedance of the amplifier is Z_{in} without feedback and Z'_{in} with negative feedback. Let us further assume that input current is i_1. Referring to Fig. 13.5, we have,

$$e_g - m_v e_0 = i_1 Z_{in}$$

Now

$$\begin{aligned} e_g &= (e_g - m_v e_0) + m_v e_0 \\ &= (e_g - m_v e_0) + A_v m_v (e_g - m_v e_0) && [\because e_0 = A_v (e_g - m_v e_0)] \\ &= (e_g - m_v e_0)(1 + A_v m_v) \\ &= i_1 Z_{in} (1 + A_v m_v) && [\because e_g - m_v e_0 = i_1 Z_{in}] \end{aligned}$$

or

$$\frac{e_g}{i_1} = Z_{in}(1 + A_v m_v)$$

But $e_g/i_1 = Z'_{in}$, the input impedance of the amplifier with negative voltage feedback.

$$Z'_{in} = Z_{in}(1 + A_v m_v)$$

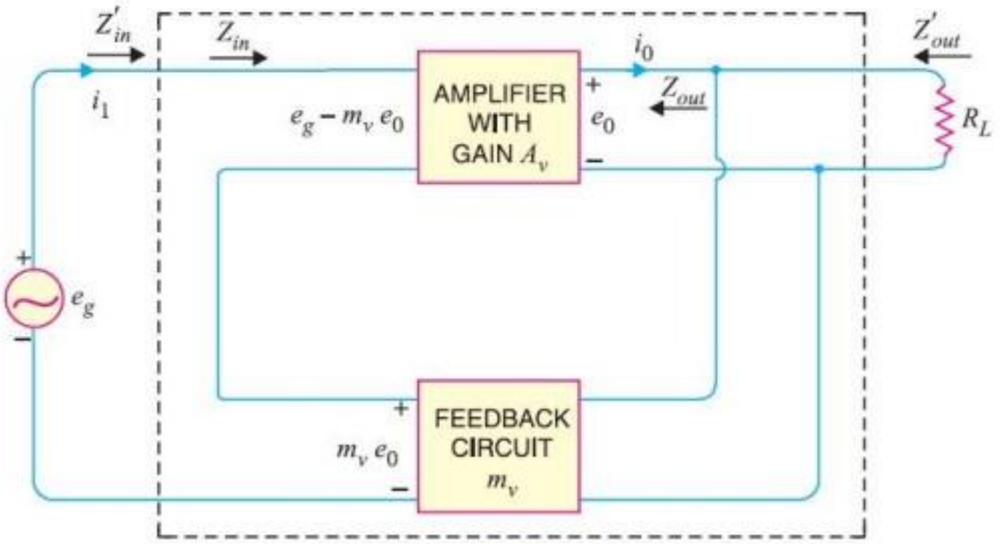

Figure 1.5

It is clear that by applying negative voltage feedback, the input impedance of the amplifier is increased by a factor $1 + A_v m_v$. As $A_v m_v$ is much greater than unity, therefore, input impedance is increased considerably. This is an advantage, since the amplifier will now present less of a load to its source circuit.

(b) Output impedance. Following similar line, we can show that output impedance with negative voltage feedback is given by :

$$Z'_{out} = \frac{Z_{out}}{1 + A_v\, m_v}$$

where Z'_{out} = output impedance with negative voltage feedback

Z_{out} = output impedance without feedback

It is clear that by applying negative feedback, the output impedance of the amplifier is decreased by a factor $1 + A_v\, m_v$. This is an added benefit of using negative voltage feedback. With lower value of output impedance, the amplifier is much better suited to drive low impedance loads.

Feedback Circuit

The function of the feedback circuit is to return a fraction of the output voltage to the input of the amplifier. Fig. 13.6 shows the feedback circuit of negative voltage feedback amplifier. It is essentially a potential divider consisting of resistances R_1 and R_2. The output voltage of the amplifier is fed to this potential divider which gives the feedback voltage to the input. Referring to Fig. 13.6, it is clear that:

$$\text{Voltage across } R_1 = \left(\frac{R_1}{R_1 + R_2}\right) e_0$$

$$\text{Feedback fraction, } m_v = \frac{\text{Voltage across } R_1}{e_0} = \frac{R_1}{R_1 + R_2}$$

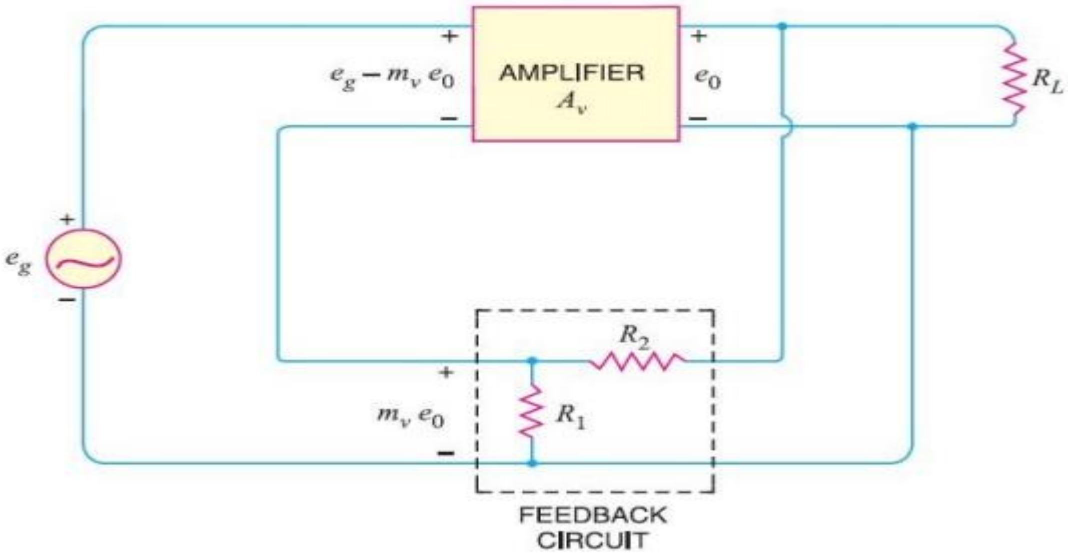

Figure 1.6

Principles of Negative Current Feedback

In this method, a fraction of output current is feedback to the input of the amplifier. In other words, the feedback current (If) is proportional to the output current (I_{out}) of the amplifier. Fig. 1.7 shows the principles of negative current feedback. This circuit is called current-shunt feedback circuit. A feedback resistor Rf is connected between input and output of the amplifier. This amplifier has a current gain of A_i without feedback. It means that a current I_1 at the input terminals of the amplifier will appear as $A_i I_1$ in the output circuit i.e., $I_{out} = A_i I_1$.

Now a fraction m_i of this output current is fedback to the input through Rf. The fact that arrowhead shows the feed current being fed forward is because it is negative feedback.

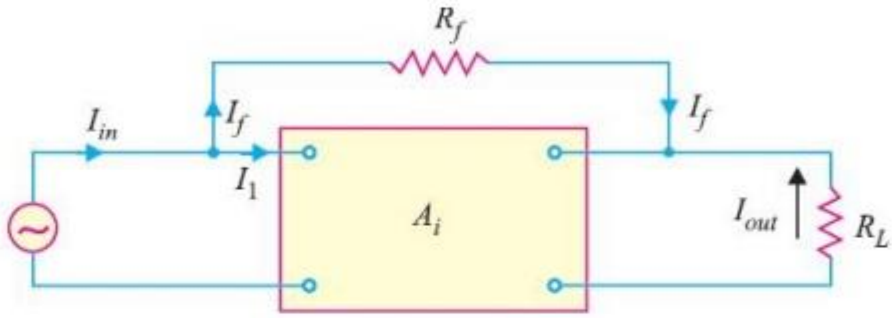

Figure 1.7

Feedback current, If = mi Iout

Note that negative current feedback reduces the input current to the amplifier and hence its current gain.

Current Gain with Negative Current Feedback

Referring, we have,

$I_{in} = I_1 + I_f = I_1 + m_i I_{out}$

But $I_{out} = A_i I_1$, where A_i is the current gain of the amplifier without feedback.

$I_{in} = I_1 + m_i A_i I_1$ (ä $I_{out} = A_i I_1$)

Current gain with negative current feedback is

$$A_{if} = \frac{I_{out}}{I_{in}} = \frac{A_i I_1}{I_1 + m_i A_i I_1}$$

$$\text{or } A_{if} = \frac{A_i}{1 + m_i A_i}$$

This equation looks very much like that for the voltage gain of negative voltage feedback amplifier. The only difference is that we are dealing with current gain rather than the voltage gain.

The following points may be noted carefully :

(i) The current gain of the amplifier without feedback is A_i. However, when negative current feedback is applied, the current gain is reduced by a factor $(1 + m_i A_i)$.

(ii) The feedback fraction (or current attenuation) m_i has a value between 0 and 1.

(iii) The negative current feedback does not affect the voltage gain of the amplifier.

Effects of Negative Current Feedback

The negative current feedback has the following effects on the performance of amplifiers :

(i) Decreases the input impedance. The negative current feedback decreases the input impedance of most amplifiers.

Let

Z_{in} = Input impedance of the amplifier without feedback

Z'_{in} = Input impedance of the amplifier with negative current feedback

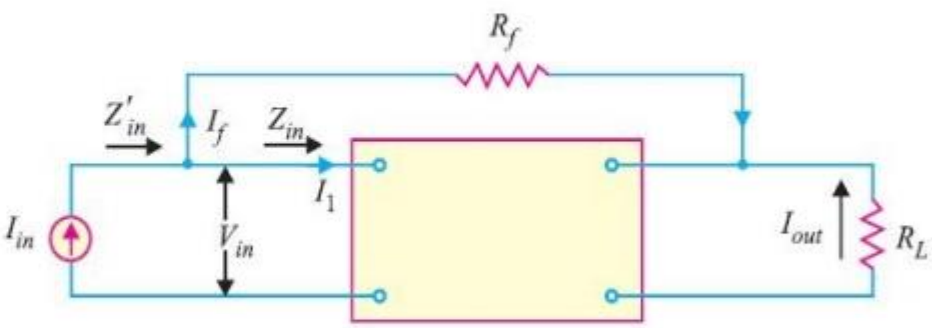

Figure 1.8

Referring to Fig. 1.8, we have,

$$Z_{in} = \frac{V_{in}}{I_1}$$

and

$$Z'_{in} = \frac{V_{in}}{I_{in}}$$

But $V_{in} = I_1 Z_{in}$ and $I_{in} = I_1 + I_f = I_1 + m_i I_{out} = I_1 + m_i A_i I_1$

$$\therefore \quad Z'_{in} = \frac{I_1 Z_{in}}{I_1 + m_i A_i I_1} = \frac{Z_{in}}{1 + m_i A_i}$$

or

$$Z'_{in} = \frac{Z_{in}}{1 + m_i A_i}$$

Thus the input impedance of the amplifier is decreased by the factor $(1 + m_i A_i)$. Note the primary difference between negative current feedback and negative voltage feedback. Negative current feedback decreases the input impedance of the amplifier while negative voltage feedback increases the input impedance of the amplifier.

Increases the output impedance. It can be proved that with negative current feedback, the outputimpedance of the amplifier is increased by a factor $(1 + m_i A_i)$.

$Z'_{out} = Z_{out} (1 + m_i A_i)$

where

Z_{out} = output impedance of the amplifier without feedback

Z'_{out} = output impedance of the amplifier with negative current feedback

The reader may recall that with negative voltage feedback, the output impedance of the amplifier is decreased.

Increases bandwidth. It can be shown that with negative current feedback, the bandwidth of the amplifier is increased by the factor $(1 + m_i A_i)$.

$BW' = BW (1 + m_i A_i)$

where

BW = Bandwidth of the amplifier without feedback

BW′ = Bandwidth of the amplifier with negative current feedback

Emitter Follower

It is a negative current feedback circuit. The emitter follower is a current amplifier that has no voltage gain. Its most important characteristic is that it has high input impedance and low output impedance. This makes it an ideal circuit for impedance matching.

Circuit details. Fig. 1.9 shows the circuit of an emitter follower. As you can see, it differs from the circuitry of a conventional CE amplifier by the absence of collector load and emitter bypass capacitor. The emitter resistance RE itself acts as the load and a.c. output voltage (Vout) is taken across RE. The biasing is generally provided by voltage-divider method or by base resistor method. The following points are worth noting about the emitter follower :

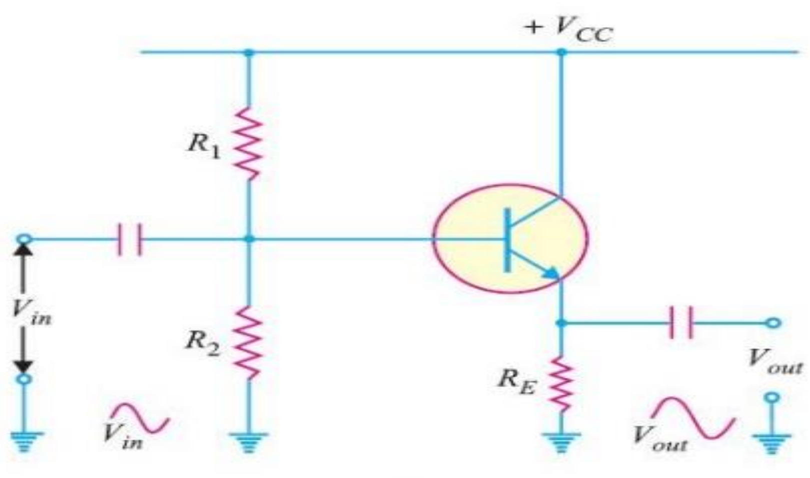

Figure 1.9

(i) There is neither collector resistor in the circuit nor there is emitter bypass capacitor. These are the two circuit recognition features of the emitter follower.

(ii) Since the collector is at ac ground, this circuit is also known as common collector (CC) amplifier.

Operation. The input voltage is applied between base and emitter and the resulting a.c. emitter currentproduces an output voltage ieRE across the emitter resistance. This voltage opposes the input voltage, thus providing negative feedback. Clearly, it is a negative current feedback circuit since the voltage fedback is proportional to the emitter current i.e., output current. It is called emitter follower because the output voltage follows the input voltage

Characteristics.

The major characteristics of the emitter follower are :

(i) No voltage gain. In fact, the voltage gain of an emitter follower is close to 1.

(ii) Relatively high current gain and power gain.

(iii) High input impedance and low output impedance.

(iv) Input and output ac voltages are in phase.

D.C. Analysis of Emitter Follower

The d.c. analysis of an emitter follower is made in the same way as the voltage divider bias circuit of a CE amplifier. Thus referring to Fig. 1.9 above, we have,

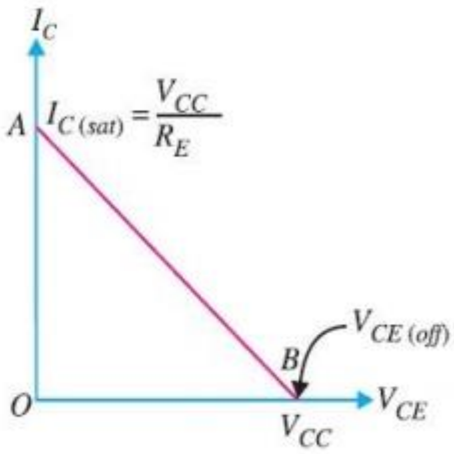

Figure 1.10

$$\text{Voltage across } R_2,\ V_2 = \frac{V_{CC}}{R_1 + R_2} \times R_2$$

$$\text{Emitter current, } I_E = \frac{V_E}{R_E} = \frac{V_2 - V_{BE}}{R_E}$$

Collector-emitter voltage, VCE = VCC − VE

D.C. Load Line. The d.c. load line of emitter follower can be constructed by locating the two end pointsviz., IC(sat) and VCE(off).

(i)When the transistor is saturated, VCE = 0.

$$I_{C(sat)} = \frac{V_{CC}}{R_E}$$

This locates the point A (OA = $V_{CC} \div R_E$) of the d.c. load line as shown in Fig. 1.10.

(ii) When the transistor is cut off, $I_C = 0$. Therefore, V_{CE}(off) = V_{CC}. This locates the point B (OB = V_{CC}) of the d.c. load line.

By joining points A and B, d.c. load line AB is constructed.

Voltage Gain of Emitter Follower

Fig. 1.11 shows the emitter follower circuit. Since the emitter resistor is not bypassed by a capacitor, the a.c. equivalent circuit of emitter follower will be as shown in Fig. 1.12. The ac resistance rE of the emitter circuit is given by

$$r_E = r'_e + R_E \qquad \text{where } r'_e = \frac{25\text{ mV}}{I_E}$$

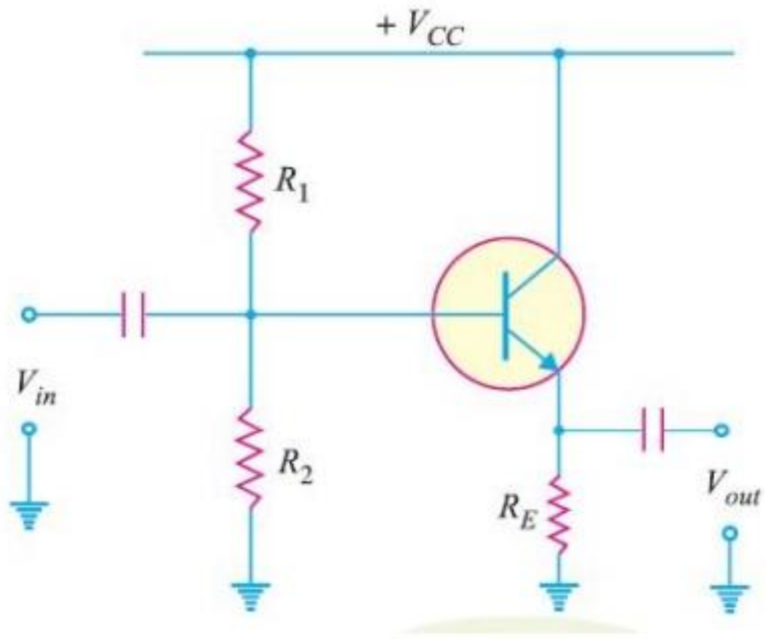

Figure 1.11

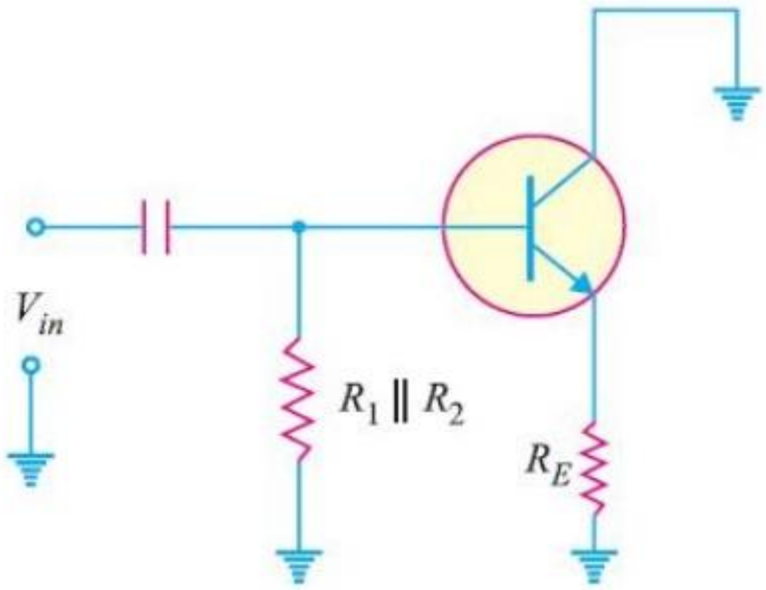

Figure 1.12

In order to find the voltage gain of the emitter follower, let us replace the transistor in Fig. 1.12 by its equivalent circuit. The circuit then becomes as shown in Fig. 1.13. Note that input voltage is applied across the ac resistance of the emitter circuit i.e., (r'e + R_E). Assuming the emitter diode to be ideal,

Output voltage, V_{out} = ie R_E

Input voltage, Vin = ie (r'e + RE)

Voltage gain of emitter follower is

$$A_v = \frac{V_{out}}{V_{in}} = \frac{i_e\ R_E}{i_e\ (r'_e + R_E)} = \frac{R_E}{r'_e + R_E}$$

or $$A_v = \frac{R_E}{r'_e + R_E}$$

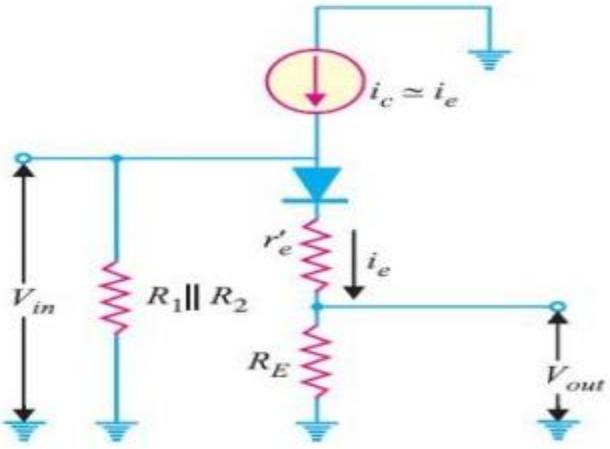

Figure 1.13

In most practical applications, R_E >> r'e so that Aν =1.

In practice, the voltage gain of an emitter follower is between 0.8 and 0.999.

Input Impedance of Emitter Follower

Fig. 1.14 (i) shows the circuit of a loaded emitter follower. The a.c. equivalent circuit with T model is shown in Fig. 1.14 (ii).

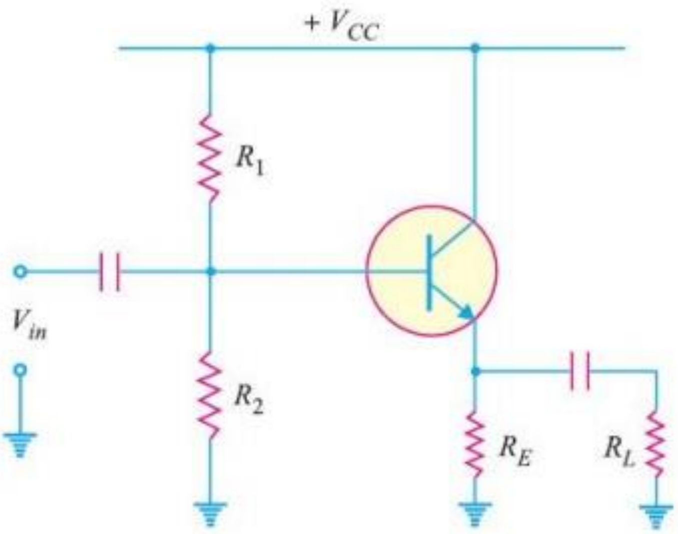

Figure 1.14 (i)

As for CE amplifier, the input impedance of emitter follower is the combined effect of biasing resistors (R1 and R2) and the input impedance of transistor base [Z_{in} (base)]. Since these resistances are in parallel to the ac signal, the input impedance Z_{in} of the emitter follower is given by :

$$Z_{in} = R_1 \,||\, R_2 \,||\, Z_{in(\text{base})}$$

where $$Z_{in\,(base)} = \beta\,(r'_e + R'_E)$$

Now $$r'_e = \frac{25\text{ mV}}{I_E} \quad \text{and} \quad R'_E = R_E \,||\, R_L$$

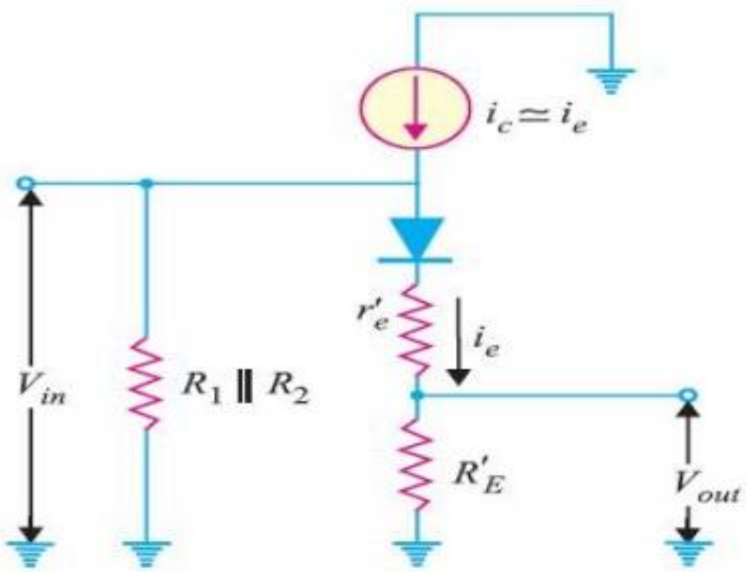

Figure 1.14 (ii)

Output Impedance of Emitter Follower

The output impedance of a circuit is the impedance that the circuit offers to the load. When load is connected to the circuit, the output impedance acts as the source impedance for the load. Fig.1.15 shows the circuit of emitter follower. Here Rs is the output resistance of amplifier voltage source. It can be proved that the output impedance

Z_{out} of the emitter follower is given by :

$$Z_{out} = R_E \parallel \left(r'_e + \frac{R'_{in}}{\beta} \right)$$

In practical circuits, the value of RE is large enough to be ignored. For this reason, the output impedance of emitter follower is approximately given by :

$$Z_{out} = r'_e + \frac{R'_{in}}{\beta}$$

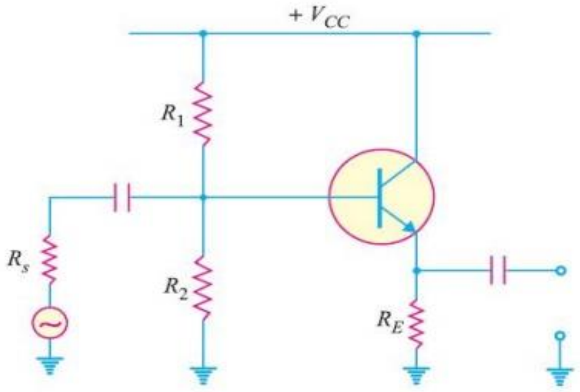

Figure 1.15

Applications of Emitter Follower

The emitter follower has the following principal applications:

(i) To provide current amplification with no voltage gain

(ii) Impedance matching.

(i) Current amplification without voltage gain. We know that an emitter follower is a current amplifier that has no voltage gain ($A_v = 1$). There are many instances (especially in digital electronics) where an increase in current is required but no increase in voltage is needed. In such a situation, an emitter follower can be used. For example, consider the two stage amplifier circuit as shown in Fig. 1.16. Suppose this 2 stage amplifier has the desired voltage gain but current gain of this multistage amplifier is insufficient. In that case, we can use an emitter follower to increase the current gain without increasing the voltage gain.

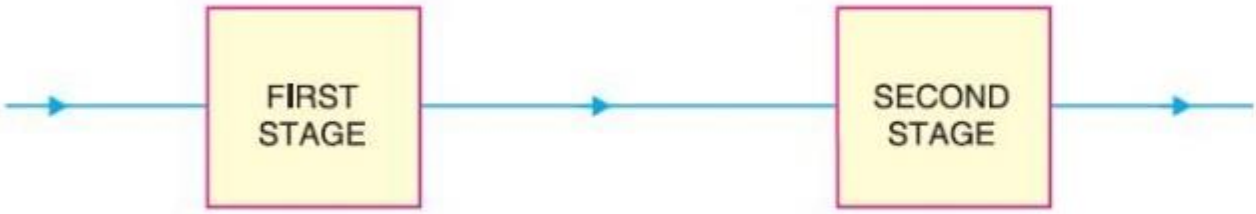

Figure 1.16

(ii) Impedance matching. We know that an emitter follower has high input impedance and low output impedance. This makes the emitter follower an ideal circuit for impedance matching. Fig. 1.17 shows the impedance matching by an emitter follower. Here the output impedance of the source is 120 kΩ while that of load is 20 Ω. The emitter follower has an input impedance of 120 kΩ and output impedance of 22Ω. It is connected between high-impedance source and low impedance load. The net result of this arrangement is that maximum power is transferred from the original source to the original load. When an emitter follower is used for this purpose, it is called a buffer amplifier.

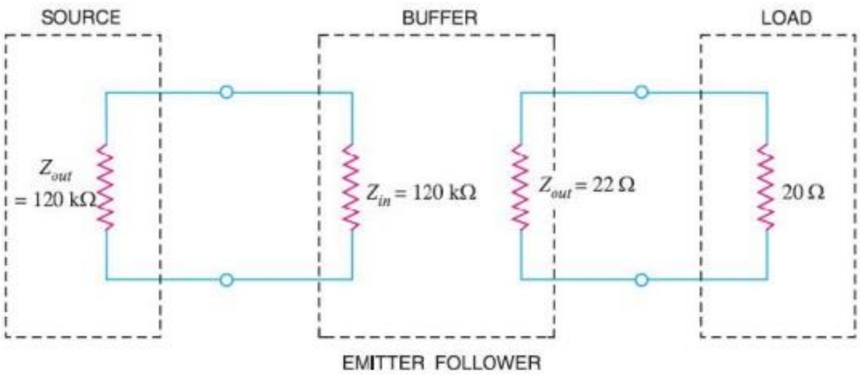

Figure 1.17

It may be noted that the job of impedance matching can also be accomplished by a transformer. However, emitter follower is preferred for this purpose. It is because emitter follower is not only more convenient than a transformer but it also has much better frequency response i.e., it works well over a large frequency range.

Nyquist Criterion

Criterion Of Nyquist:

⎫ The Aβ is a function of frequency. Points in the complex plane are obtained for the values of Aβ corresponding to all values of 'f' from - a to a . The locus of all these points forms a closed curve.

The criterion of nyquist is that amplifier is unstable if this curve encloses the point (-1+j0), and the amplifier is stable if the curve does not enclose this point.

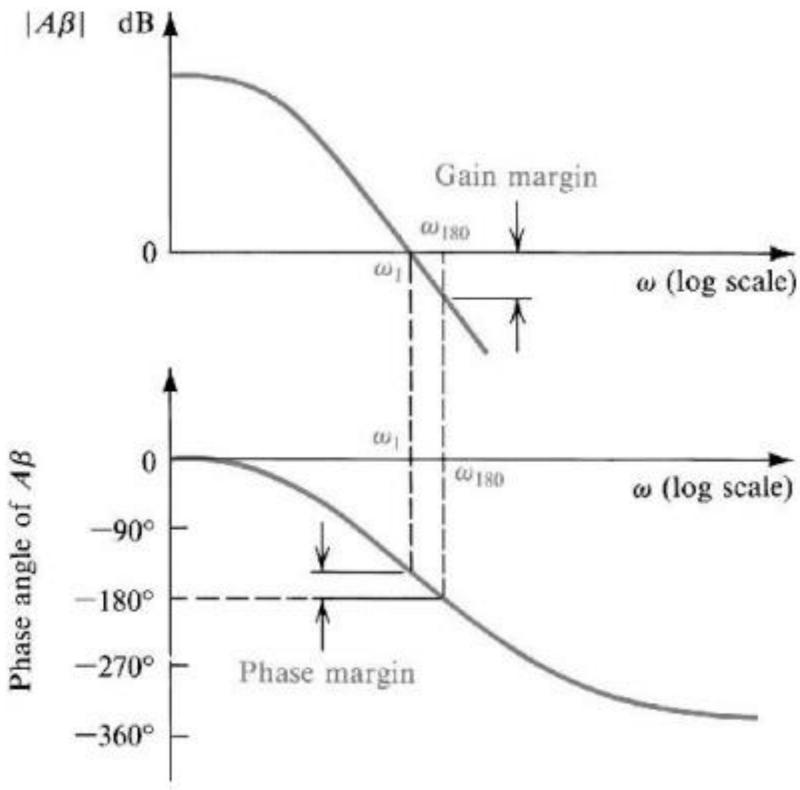

Figure 1.18 Nyquist Plot

The amplifier is unstable if this curve encloses the point –1+j0 and the amplifier is stable if the curve does not enclose this point

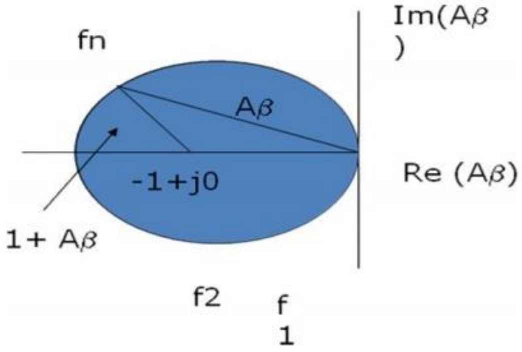

Figure 1.19 Locus of 1+Aβ is a circle of radius unity and centre (–1+j0)

The amplifier is unstable if this curve encloses the point –1+j0 and the amplifier is stable if the curve does not enclose this point

<u>FEEDBACK AMPLIFIERS</u>

1. State the nyquist criterion to maintain the stability of negative feedback amplifier

The nyquist criterion forms the basis of a steady state method of determining whether an amplifier is stable or not.

<u>Nyquist Criterion</u>

The Aβ is a function of frequency. Points in the complex plane are obtained for the values of Aβ corresponding to all values of 'f' from - to . The locus of all these points forms a closed curve.

The criterion of nyquist is that amplifier is unstable if this curve encloses the point (-1+j0), and the amplifier is stable if the curve does not enclose this point.

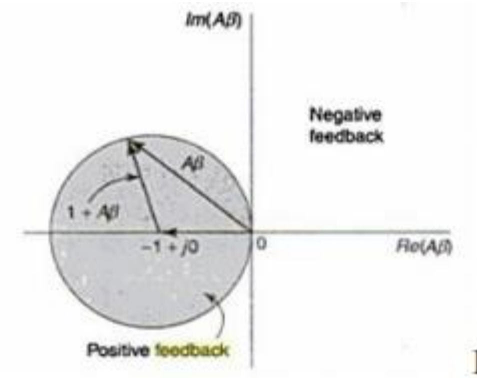

FIG. locus of |1+Aβ|=1

2. Define sensitivity and desensitivity of gain in feedback amplifiers.

Sensitivity : The fractional change im amplification with feedback divided by the fractional change im amplification with out feedback is called the sensitivity of the transfer gain.

$$sensitivity = \frac{\left|\frac{dA_f}{A_f}\right|}{\left|\frac{dA}{A}\right|} = \frac{1}{1 + A\beta}$$

Desensitivity: Desensitivity is defined as the reciprocal of sensitivity. It indicates the factor by which the voltage gain has been reduced due to feedback network.

Desensitivity factor (D) = 1+A β.

Where A = Amplifier gain.

. β = Feedback factor.

3. What is the effect on input and output impendence of an amplifier if it employs voltage series negative feedback?

When voltage series feedback is employed in an amplifier, its input resistance increases and output resistance decreases.

4. Define 'feedback factor' of a feedback amplifier.

It is the ratio between the feedback voltages to the output voltage of the amplifier.

$\beta = V_f / V_o$

Where β is a feedback factor (or) feedback ratio. V_f is the feedback voltage. V_o is the output voltage.

5. What is the impact of negativefeedback on noise in circuits?

When negative feedback is employed in an amlifier ,the noise is reduced.

Let N= noise without feedback

N_f = noise with feedback

The noise with feedback is given by the following relation

$$N_f = \frac{N}{1+A\beta}$$

From above equation it is clear that when the feedback is applied the noise is reduced by a factor (1+Aβ)

6. What is the effect on input and output impendence of an amplifier if it employs current shunt negative feedback?

When **current shunt** feedback is employed in an amplifier, its input resistance decreases and output resistance increases.

7. What is return ratio of feedback amplifier?

A path of a signal from input terminals through basic amplifier, through the feedback network and back to the input terminals forms a loop. The gain of this loop is the product of –Aβ. This gain is known as loop gain or return ratio. Here the minus sign indicates the negative feedback.

8. Justify that negative feedback amplifier increases bandwidth.

When negative feedback is employed in an amplifier, the bandwidth is increased. Let BW= bandwidth without feedback

BW_f = bandwidth with feedback

The bandwidth with feedback is given by the following relation,

$BW_f = BW(1+A\beta)$

From above equation it is clear that when the feedback is applied the bandwidth is increased is by a factor $(1+A\beta)$

9. Distinguish between series and shunt feedback amplifiers Series feedback:

(i). In series feedback amplifier the feedback signal is connected in series with the input signal.

(ii). It increases the input resistance.

Shunt feedback:

(i). In shunt feedback amplifier the feedback signal is connected in shunt with the input signal.

(ii). It decreases the input resistance.

10. What is current-series feedback amplifier. (or) What is transconductance amplifier?

In a current series feedback amplifier the sampled signal is a current and the feedback signal (Which is fed in series)is a voltage.

$Gm = I_o / V_i$

Where G_m = Amplifier gain.

I_o = Output current.

V_i = Input voltage.

11. List the four basic feedback topologies.

ü Current series feedback.

ü Current shunt feedback.

ü Voltage series feedback

ü Voltage shunt feedback

12. List the characteristics of an amplifier which are modified by negative feedback.

· It reduces the gain of an amplifier

· It increases the stability of an amplifier.

· It increases the bandwidth

· It decreases noise and distortion

13. What is Feedback Amplifier? & draw the diagram.

An amplifier with feedback network is known as feedback amplifier. With the help of feedback network, 'a portion of the output signal is feedback to the input & combined with the input signal to produce the desired outputs'

14. Mention the three networks that are connected around the basic amplifier to implement the feedback concept.

The three networks that are connected around the basic amplifier to implement the feedback concept are

ü Mixing Network

ü Sampling Network

ü Feedback Network

15. What happens to the input resistance based on the type of feedback in an amplifier?

· If the feedback signal is added to the input in **series** with the applied voltage, it **increases** the input resistance.

· If the feedback signal is added to the input in shunt with the applied voltage, it **decreases** the input resistance.

16. What are the steps to be carried out for complete analysis of a feedback amplifier?

Step 1 : Identify the topology

Step 2,3: Find input and output circuit

Step 4 : Replace transistor by its h-parameter equivalent circuit

Step 5 : Find open loop voltage gain

Step 6 : Indicate V_0 and V_f and calculate β

Step 7 : Calculate D, A_{vf}, R_{if}, R_{of} and $R_{of.}$