Bhartiya Vidya Bhavan's Shri Ishvarlal L. P. Arts-Science and J. Shah Commerce College, Dakor
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B.Sc. (semester -3)

Subject : Physics

Course : USO3CPHY22

BASIC SOLID STATE ELECTRONICS

UNIT 3: FEEDBACK IN AMPLIFIERS

Lecture 3

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- Quick Revision of Lecture 2
- Increase in Input Impedance
- Decrease in Output Impedance
- Increase in Bandwidth
- RC Coupled Amplifier without Bypass Capacitor
- Emitter Follower circuit
- ASSIGNMENT

❖ *Quick Revision of Lecture 2*

❖ How negative feedback is advantageous

- (i) It improves the stability of amplifier gain
- (ii) It reduces the distortion and noise
- (iii) It increases the input impedance.
- (iv) It decreases the output impedance
- (v) It increases the bandwidth.

❖ Voltage gain of Series Voltage Negative feedback Amplifier

- for Positive feedback $A_f = \frac{A}{1-A\beta}$ & for Negative feedback $A_f = \frac{A}{1+A\beta}$

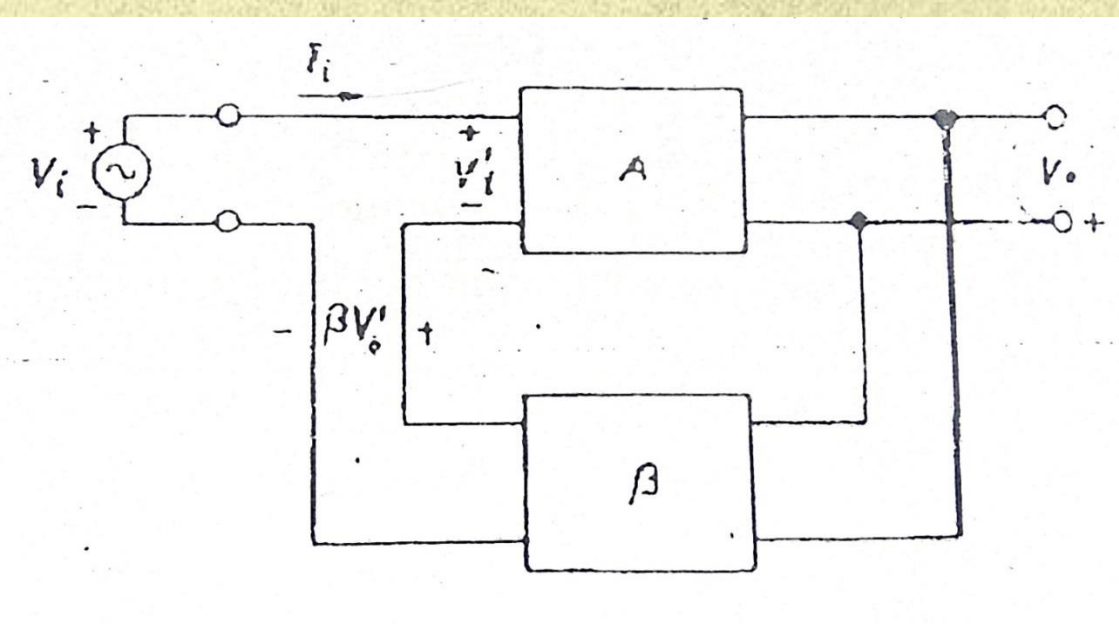
❖ *Stabilization of gain*

- $(1+A\beta)$ >>> 1, the percentage change in A_f is very much less than the percentage change in A…

❖ *Reduction in Distortion and Noise*

❖ V_f is subtracted from V_i and gives the resulting output V_i ' with more higher peak Thus every time input is predistorted to compensate for the flattening caused by the amplifier.

❖ *Increase in Input Impedance*



- As shown in the circuit diagram below V_i is the input voltage and I_i is the input current
- Then the input impedance of the feedback amplifier is.... $Z_{if} = \frac{V_i}{I_i}$ .....(1)
- Here the net input to the basic amplifier is

$$Vi' = V_i - \beta V_o' \quad .....(2)$$

- If the input current to the basic amplifier is I_i' then the input impedance of the amplifier without feedback is $Z_i = \frac{Vi'}{I_i'}$ .....(3)
- Now we know that $V_o' = AV_i'$ Then substituting the value of V_o' in eqn (2) we get

$$Vi' = V_i - \beta AV_i' \quad \text{and} \quad V_i = Vi' + \beta AV_i' \quad .....(4)$$

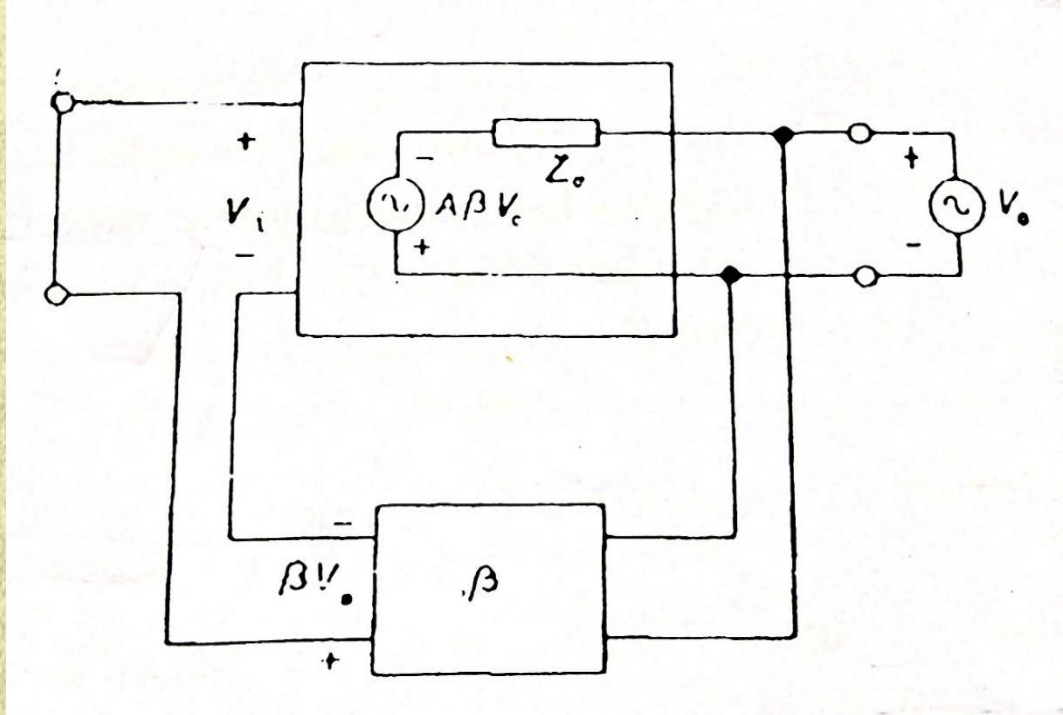
❖ ***Increase in Input Impedance***

- Dividing above equation (4) by I_i , we get
- $\frac{V_i}{I_i} = \frac{V_i'}{I_i'} (1 + A\beta)$ .....(5)
- from equation (1) ,(3) and (5) we get…

- $Z_i = Z_{if} (1 + A\beta)$

- Thus we see that input impedance increases by a factor of $(1 + A\beta)$

❖ *Decrease in Output Impedance*



- The circuit diagram shows a feedback amplifier whose output side has been replaced by an equivalent voltage source $A\beta V$ in series with impedance Z_0.
- If I_o is the current through Z_0, then we can write for the output loop as

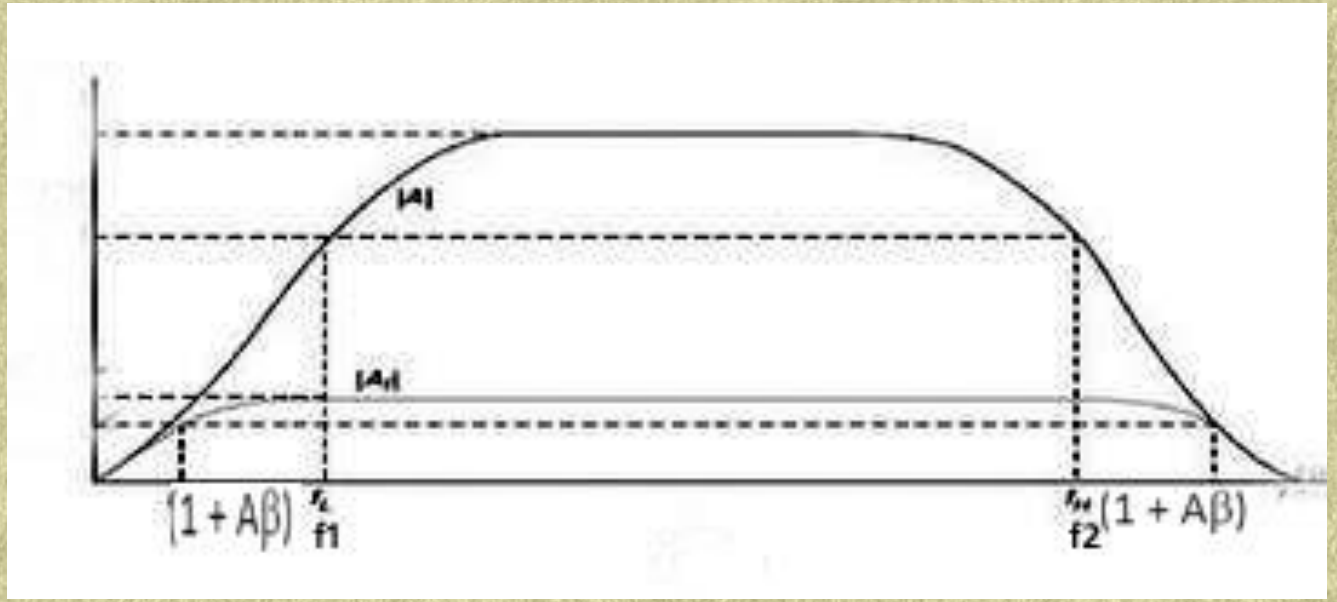
$$V_o + A\beta V_o = I_o Z_o \quad \therefore \quad V_o (1+A\beta) = I_o Z_o$$

$$\therefore \quad \frac{V_o}{I_o} = \frac{Zo}{1 + A\,\beta} \ldots\ldots(1)$$

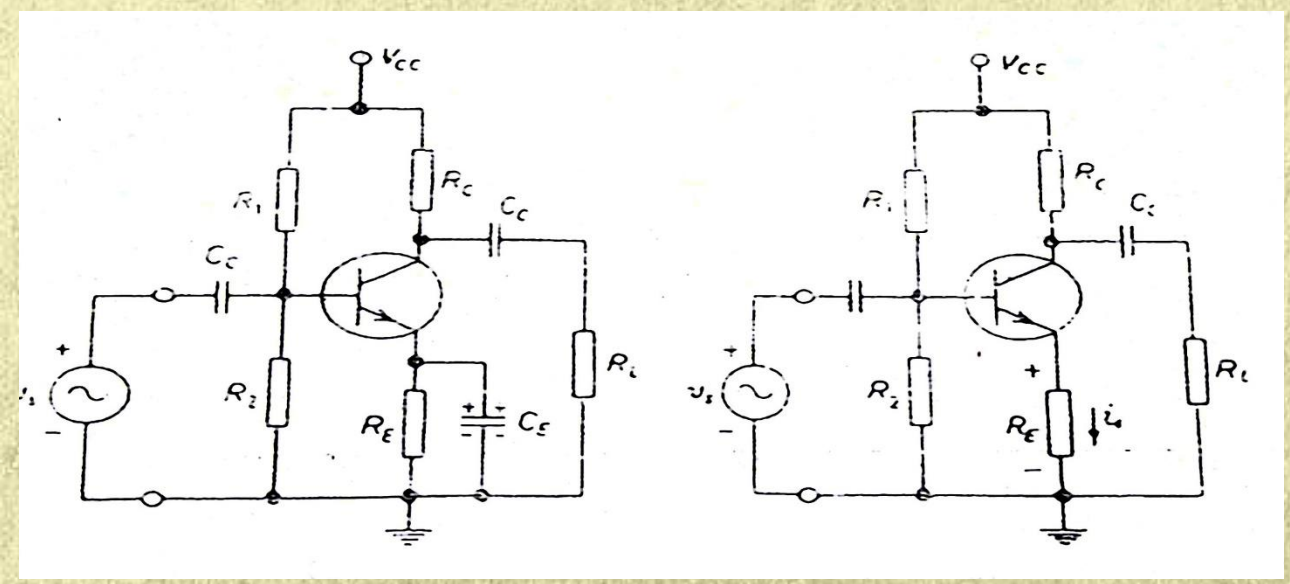
- Then the output impedance with feedback is given as $Z_{of} = V_o / I_o$
- And using equation (1), we get $Z_{of} = \frac{V_o}{I_o} = \frac{Zo}{1 + A\,\beta}$
- This shows that the output impedance is reduced by the factor of (1 + AB)

❖ ***Increase in Bandwidth***

- The negative feedback affects the cut-off frequencies of an amplifier.
- The lower cut-off frequency f_1 is lowered by a factor of $(1+ A\beta)$ and the upper cut-off frequency f_2 is raised by the same factor $(1 + A\beta)$
- Now since $f_1 << f_2$ the bandwidth $(f_2 – f_1)$ also increases by a factor $(1 + A\beta)$



❖ RC Coupled Amplifier without Bypass Capacitor

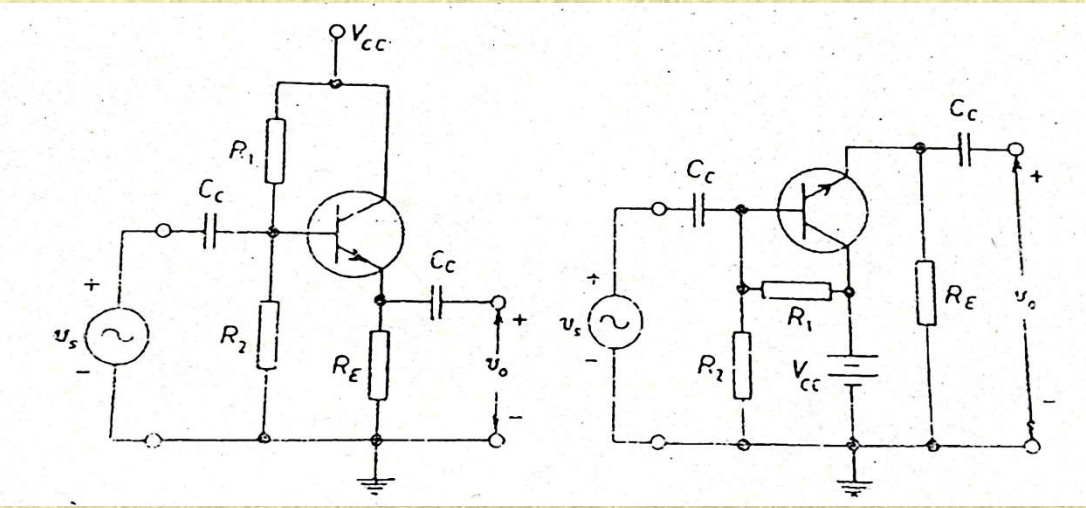


- As figure shows that RC coupled amplifier circuit. Here the transistor is used in the CE mode
- The effective input voltage of such an amplifier is the ac signal between the base and the emitter
- In this circuit, it is the same as the voltage Vs Supplied by the signal source
- If the bypass capacitor C_E is removed The result is the circuit it figures Now the situation becomes entirely different The effective input voltage to the amplifier no more remains the same
- At the instant when the source voltage V_s increases during its positive half-cycle, the emitter base junction becomes more forward biased

❖ ***RC Coupled Amplifier without Bypass Capacitor***

- The collector current increases and so does the ac emitter current i_e in the direction indicated in the figure
- This develops an ac voltage i_eR_E across the resistor R_E with a polarity as shown in figure.
- The effective input voltage is not same as the voltage V_s
- The feedback voltage i_eR_E is proportional to the output current and it appears in series with the source voltage Vs
- This type of negative Feedback is very commonly used in practical amplifier such as in public address systems, tape recorder, record player, stereo amplifier, etc

❖ ***Emitter Follower circuit***



- As emitter follower is a very useful negative feedback circuit and is extensively used in electronic instruments.
- If the resistance Is reduced to zero and output is taken from the emitter terminal instead of the collector terminal in the circuit as shown in figure.

- The effective input voltage in this circuit is $V_s - V_d$. It means that the whole of the output voltage V_o is fed back to the input side The gain of the amplifier is drastically reduced.

- The voltage gain of this amplifier is less than unity . For such amplifier the output will be less than the input. It is found that the input impedance of this circuit is very high, and the output impedance is very low.

❖ ***Emitter Follower circuit***

- The circuit is used for impedance matching. The last stage of a signal generator used in the laboratory is an emitter follower.
- The oscillator is not loaded and its frequency remains constant Because of its high input impedance and low output impedance properties, an emitter follower is capable of giving power to a load connected to its output without requiring much power at the input It thus works as a Buffer amplifier.
- When the input Vs goes through its positive half-cycle, the output V_o is also seen to go through its positive half cycle.
- In the other words the output and the input are in same phase In magnitude, the output is almost the same as the input Thus we see that the emitter closely follows the input. Hence the name **emitter follower**
- The emitter-follower circuit is also called common-collector amplifier circuit.

❖ ***Assignment***

SHORT QUESTION

1.Define voltage gain and current gain of an amplifier.

2. Explain the increase bandwidth of negative feedback amplifier.

3. Draw the block diagram for series current and shunt voltage feedback network.

4. Draw the block diagram for series-voltage and shunt current feedback networks

5. Write the expression for voltage gain of negative feedback and positive feedback amplifier.

6. Write the equation for input and output impedance of negative feedback amplifier

❖ ***Assignment***

LONG QUESTIONS

1. With the help of necessary diagram explain the concept of feedback in amplifiers.
2. Discuss the different types of feedback networks along with their block diagram.
3. Derive the expression for the voltage gain of a negative feedback amplifier.
4. Explain how negative feedback is use to stabilize the gain of amplifier
5. Define the input impedance of a feedback amplifier and show that the negative feedback increases the input impedance.
6. Write a note on R-C coupled amplifier without bypass capacitor.

- IN NEXT LECTURE WE WILL START OSCILLATORS
- PLEASE TRY TO LEARN NEGETIVE FEEDBACK AMPLIFIERS FROM LECTURES
- PLEASE WRITE ASSIGNMENT QUESTIONS …
- MAKE NOTES

THANK YOU.....