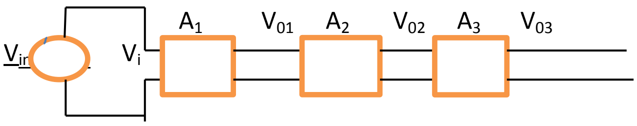
1. Multistage Amplifier

Many times the gains from a single stage amplifier in terms of voltage, Current, Power and frequency response are not sufficient hance multistage amplifiers are employed. In this case the output of one stage acts as input for the next stage



V_{out} upto say ‘n’ terms

The multistage amplifiers are divided into TWO categories
1). CASCADE Amplifiers: In these type of amplifiers each stage of amplifier and the inter-stage coupling are identical.
2).COMPOUND Amplifiers: In this type different types of amplifier stages can be employed say if first is CE then second one can be CB Or one of the inter-coupling stage may be different.

OVERALL GAIN

In cascade type of amplifiers,the output a.c. voltage of first stage becomes input voltage of the second and so on
$V_{01}=A_1V_{in}$(1^{st} stage) ; $V_{02}=A_2V_{01}$(2^{nd} stage)………… $V_{0n}=A_nV_{0(n-1)}$(n^{nd} stage)
Thus this multistage amplifier can be seen as equivalent to a single amplifier having input as V_{in} and overall output as V_0
As $A_v = V_0/ V_{in} =$ (V_{01}/ V_{in})X (V_{02}/ V_{01}) X (V_{03}/ V_{02}) X ………..($V_{0n}/ V_{(n-1)}$)
= A_1 X A_2 X A_3 X…………. A_{n-1} X A_n = Product of gain of all individual stages.
In Units of Decibel(dB) it is given as
$G = G_1 + G_2 + G_3 +$…………….. G_n
Also overall current gain is given as $A_i = A_{i1} + A_{i2} + A_{i3} +\ldots A_{in}$
And overall Power gain is given as $A_p = A_v$ X A_i and $G_p = (10 \log_{10} A_p)$dB

2. A **Resistance Capacitance (RC) Coupled Amplifier** is basically a multi-stage amplifier circuit extensively used in electronic circuits. Here the individual stages of the amplifier are connected together using a resistor–capacitor combination due to which it bears its name as RC Coupled.
Figure 1 shows such a two-stage amplifier whose individual stages are nothing but the common emitter amplifiers. Hence the design of individual stages of the **RC coupled amplifiers** is similar to that in the case of common emitter amplifiers in which
(1).The resistors R_1 and R_2 form the biasing network while the emitter resistor RE form the stabilization network.

(2). The C_E is also called bypass capacitor which passes only AC while restricting DC, which causes only DC voltage to drop across R_E while the entire AC voltage will be coupled to the next stage.

(3). The coupling capacitor C_C also increases the stability of the network as it blocks the DC while offers a low resistance path to the AC signals, thereby preventing the DC bias conditions of one stage affecting the other.

(4). In addition, in this circuit, the voltage drop across the collector-emitter terminal is chosen to be 50% of the supply voltage V_{CC} in order to ensure appropriate biasing point.

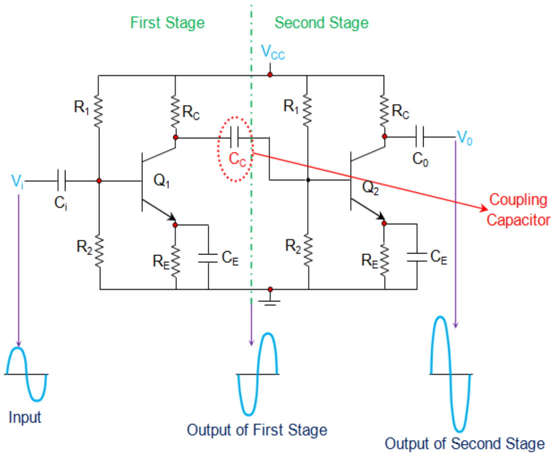


Figure 1 Two-Stage RC Coupled Amplifier

Working :- (1).In this kind of amplifier, the input signal applied at the base of the transistor in stage 1 (Q_1) is amplified and appears at its collector terminal with a phase-shift of 180°.

(2).The AC component of this signal is coupled to the second stage of the **RC coupled amplifier** through the coupling capacitor C_C and thus appears as an input at the base of the second transistor Q_2.

(3).This is further amplified and is passed-on as an output of the second stage and is available at the collector terminal of Q_2 after being shift by 180° in its phase. This means that the output of the second stage will be 360° out-of-phase with respect to the input, which in turn indicates that the phase of the input signal and the phase of the output signal obtained at stage II will be in SAME PHASE.

(4).Also the cascading of individual amplifier stages increases the gain of the overall circuit as the net gain will be the product of the gain offered by the individual stages.

(5).In reality the net gain will be slightly less than this, due to the loading effect.

(6).Multistage RC coupled amplifier can be fabricated by joining(cascading) any number of common emitter amplifiers but by keeping in mind that when the number of stages are even, the output will be in-phase with the input while if the number of stages are odd, then the output and the input will be out-of-phase.

Frequency Response

The frequency response of a **RC coupled amplifier** (a curve of amplifier's gain v/s frequency), shown by Figure 2, indicates it can be divided into three stages a). Low frequency <50 Hz c).b). High frequency range > 20kHz. And c). Mid frequency 50< but < 20Khz

EXPLANATION

a). at low frequencies, the reactance of coupling capacitor C_C is high which causes a small part of the signal to couple from one stage to the other. Moreover for the same case, even the reactance of the emitter capacitor C_E will be high due to which it fails to shunt the emitter resistor R_E effectively which in turn reduces the voltage gain.
b). At high frequencies, the reactance of C_C will be low which causes it to behave like a short circuit. This results in an increase in the loading effect of the next stage and thus reduces the voltage gain. In addition to this, for this case, the capacitive reactance of the base-emitter junction will be low. This results in a reduced voltage gain as it causes the base current to increase which in turn decreases the current amplification factor β.
c).Now the gain of the amplifier is constant over a wide range of mid-frequencies because in mid-frequency range, as the frequency increases, the reactance of C_C goes on decreasing which would lead to the increase in gain if not compensated by the fact that the reduction in reactance leads to an increase in the loading effect.Both these almost balance out and due to this reason, the gain of the amplifier remains uniform/constant throughout the mid-frequency band.

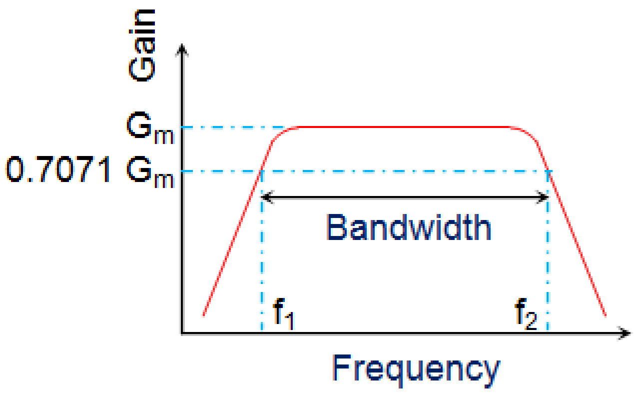


Figure 2 Frequency Response Curve of a RC Coupled Amplifier

Advantages of RC Coupled Amplifier

1. Cheap, economical and compact as it uses only resistors and capacitors(passive components).
2. Offers a constant gain over a wide frequency band(audible range).Hence used in audio amplifiers

Disadvantages of RC Coupled Amplifier

Unsuitable for low-frequency amplification.

1. Low voltage and power gain as the effective load resistance (and hence the gain) is reduced due to the fact that the input of each stage presents a low resistance to its next stage.
2. Moisture-sensitive, making them noisy as time elapses.
3. Poor impedance matching as it has the output impedance several times larger than the device at its end-terminal (for example, a speaker in the case of a public address system).
4. Narrow bandwidth when compared to JFET amplifier.

Applications of RC Coupled Amplifier

1. RF Communications.

2. Optical Fiber Communications.
3. Public address systems as pre-amplifiers.
4. Controllers.
5. Radio or TV Receivers as small signal amplifiers.

<u>Do from book the analysis of RC coupled by h-parameters(equivalent circuit analysis)</u>