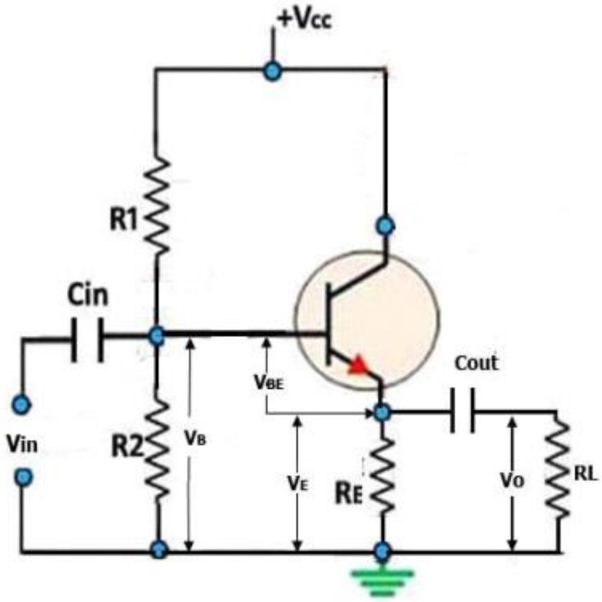
MODULE-1

EMITTER FOLLOWER



- Emitter follower is an amplifier circuit in common collector configuration.
- It is a current amplifier that has no voltage gain.
- The circuit arrangement of an emitter follower is shown in fig above. The main difference between an emitter follower and conventional amplifier is the absence of the collector load and emitter bypass capacitor.
- The emitter resistor R_E itself acts as the load and the a.c output voltage V_o is taken across it.
- The input to this circuit is applied to the base of the transistor, while the output is taken from the emitter.
- During the positive half cycle of the input signal, the forward bias on the base **(V_B)** is increased causing increase in emitter voltage **(ie $V_E = V_B - V_{BE}$).**
- Since emitter is the output terminal, it is seen that the output voltage from an emitter follower is almost the same as its input voltage in its magnitude and phase.
- Thus, the output voltage at emitter follows the input signal applied to the base terminal and hence this circuit is called as ***emitter follower***

Applications of Emitter Follower

1. The main application of emitter follower circuit is for impedance matching.
2. It is used to transfer energy from a high output impedance circuit to that of a low impedance circuit.
3. It can also be used as a two-way amplifier, because it can pass a signal in either direction.

MULTISTAGE AMPLIFIERS

In practical applications, the output of a single state amplifier is usually insufficient, though it is a voltage or power amplifier. Hence they are replaced by **Multi-stage transistor amplifiers**.

In Multi-stage amplifiers, the output of first stage is coupled to the input of next stage using a coupling device. These coupling devices can usually be a capacitor or a transformer. This process of joining two amplifier stages using a coupling device can be called as **Cascading**.

The following figure shows a two-stage amplifier connected in cascade.

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$$A_V = A_{V1} \times A_{V2} = \frac{V_2}{V_1} \times \frac{V_0}{V_2} = \frac{V_0}{V_1}$$

Where A_V = Overall gain, A_{V_1} = Voltage gain of 1st stage, and A_{V_2} = Voltage gain of 2nd stage.

If there are **n** number of stages, the product of voltage gains of those **n** stages will be the overall gain of that multistage amplifier circuit.

Purpose of coupling device

The basic purposes of a coupling device are

- To transfer the AC from the output of one stage to the input of next stage.
- To block the DC to pass from the output of one stage to the input of next stage, which means to isolate the DC conditions.

Following are the commonly used coupling schemes in multi stage amplifiers

1. Resistance capacitance (RC) coupling
2. Transformer coupling
3. Direct coupling

1. Resistance capacitance (RC) coupling

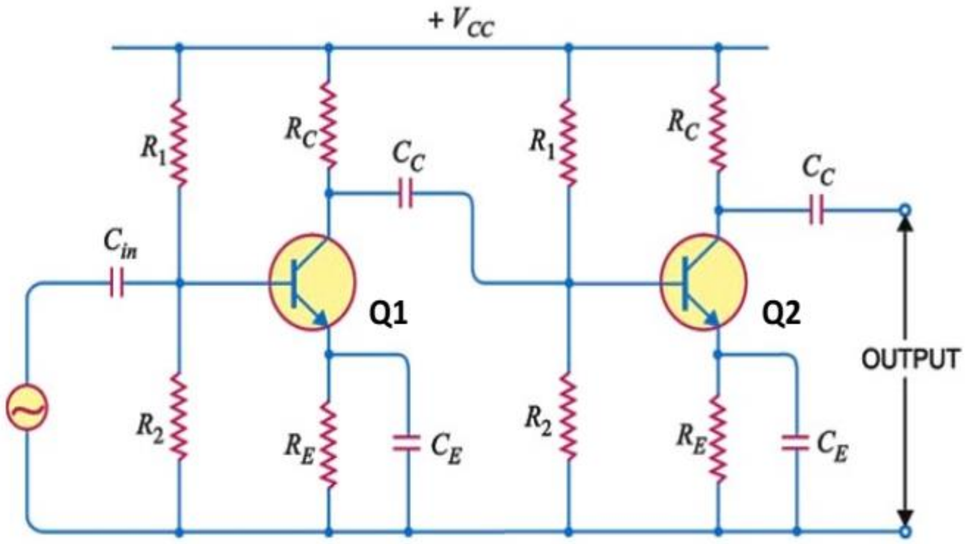


Fig above shows the circuit diagram of a RC couple amplifier .In this circuit the signal developed across the collector resistor (Rc) of each stage is coupled through a capacitor (Cc) in to the base of the next stage . This capacitor blocks d.c voltage of the first stage from reaching the base of the second stage and isolates the d.c. conditions of one stage from the following stage.The other components in the circuit has their own functions. Where R_1 R_2 and R_E form the biasing and stabilizing network, the emitter bypass capacitor C_E offers low reactance to the signal to avoid negative feed back.

Operation:

When an ac signal is applied to the input of the first stage it is amplified by the first transistor and the output appears across its collector resistor Rc. This signal is then coupled to the input of the second stage through the coupling capacitor Cc. The second stage does further amplification of the signal and delivers the output through output coupling capacitor Cc to the load resistor R_L. The voltage developed across R_L will be the output voltage.

The output signal in a two stage Rc coupled amplifier will be in phase with the input signal. Because the signal phase had been reversed twice (once from each stage) by the amplifier.

Advantages of RC coupled amplifier

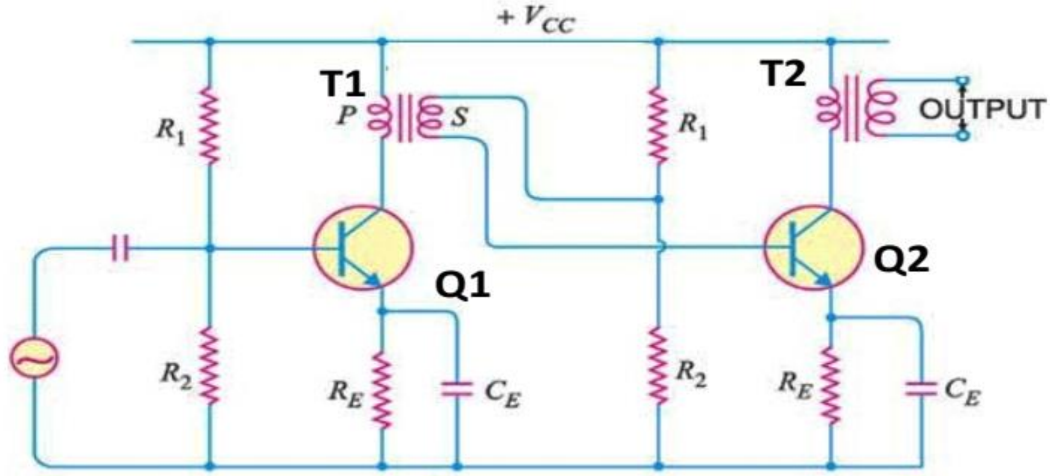
- Excellent frequency response over AF range
- Requires no expensive or bulky components
- More compact and cheap
- Overall amplification is higher than that of the other couplings
- Minimum possible non-linear distortion.

Disadvantages

- Low voltage and power gain
- Becomes noisy with age, particularly in moist climates
- Poor impedance matching
- Requires high supply voltage to overcome the large drop across collector load resistor
- Not suit for high frequency application

2. Transformer Coupling

Ans:



In the transformer coupledd amplifier a transformer is used to transfer a.c signal from the output of first stage to the input of the second stage

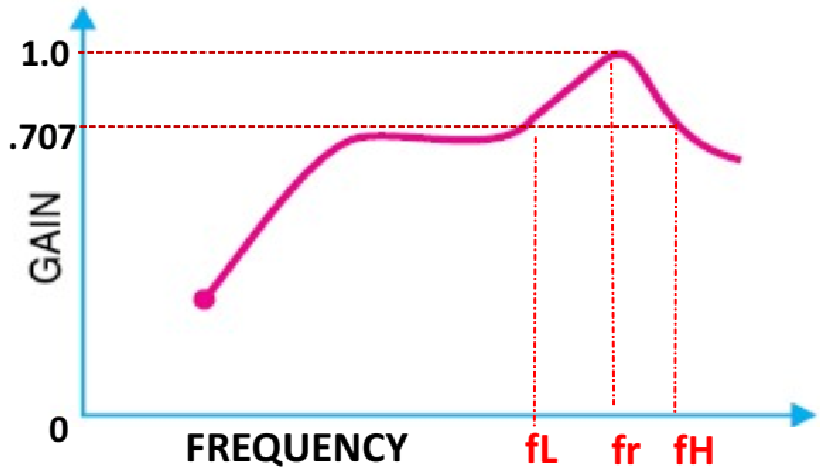
In this circuit d.c isolation between the two stages is provided by the transformer it self and no coupling capacitor is used for this purpose. At the same time the a.c signal voltage developed across the primary winding is transferred to the secondary by magnetic induction with in the transformer.

When an ac input signal is applied to the base of transistor **Q_1** it gets amplified and appears across the primary of the transformer **T_1**. The voltage induced a cross secondary of **T_1** is transferred to the base of second stage transistor**Q_2**. The second stage does amplification in the exactly similar way and delivers output across the secondary of **T_2**

Application

Transformer coupling is mostly used in circuits where, impedance matching is necessary such as output stage of a multistage amplifier, where the output impedance of the power amplifier is to be matched with the impedance of the loads such as loudspeaker voice coil, for maximum power transfer.

Frequency Response



The frequency response curve of a typical transformer coupled amplifier is shown in fig. Here the gain is constant only over a narrow range of frequency, and it is maximum at the resonant frequency(fr) of the tuned circuit formed by the inductance and winding capacitance of the transformer.

Lower cut of frequency (F_L): It is the lowest freqency geting a gain of 70.7%(3db)

Higher cut of frequency (F_H): It is the highestt freqency geting a gain of 70.7%(3db)

Band width: In the frequency response curve of RC coupled amplifier shown in fig above the lower cut-off frequency and upper cut-off frequency are marked as **f_L** and **f_H**respectively. The difference between these frequencies is the bandwidth (BW)

ie **$BW = f_H - f_L$**

3. **Direct Coupling**

Ans:

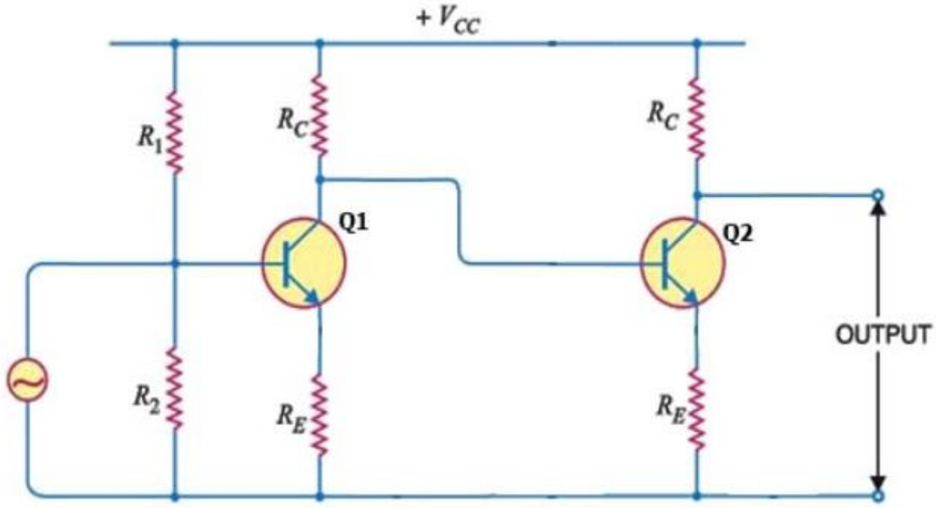


Fig above shows a two stage direct coupled amplifier circuit.In this method of coupling, the collector of one stage is connected to the base of next stage and the collector of the last stage is connected to the load .The resisters R_1 and R_2 provide voltage divider bias for the first transistor. . Here no coupling and bypass capacitors used. There fore both dc as well as ac are coupled to the next stage .In the circuit the d.c voltage at the collector of the first transistor also reaches the base of the second stage.

The signal to be amplified is applied to the base of the first transistor. The amplified output developed across Rc of the first stage drives the base of second transistor and the output is obtained across the collector load resister of the second stage

Advantages

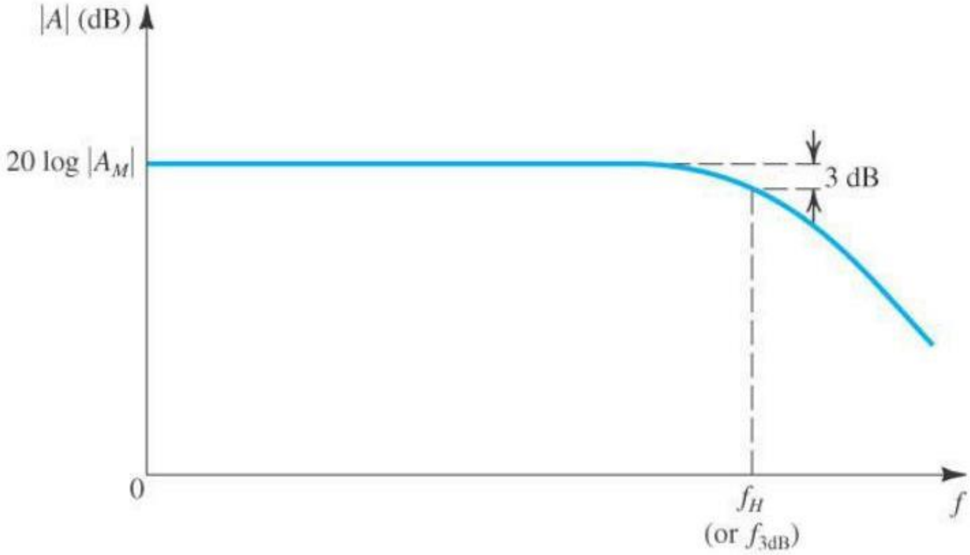
- The circuit is simple and less expensive since it makes use of minimum number of components.
- It can amplify very low frequency signals even d.c signals.
- The frequency response curve is flat up to uppercut off frequency.
- Phase shift and frequency distortion will not occur.

Applications

Direct coupled amplifiers finds application in the low frequency circuits .Following are few of the application fields of direct coupled amplifiers

- Regulator circuits of electronic power supplies
- Differential amplifiers
- Computers
- Pulse amplifiers
- Electronic measuring instruments etc.

Frequency Response



Comparison

	Rc coupling	Transformer coupling	Direct coupling
▪ Frequency response	Good (Flat response over AF range)	Poor(Gain is constant only over a narrow range)	Best(Flat response up to upper cut off frequency)
▪ Size	Small	Most	Least
▪ Cost	Low	High	Least
▪ Impedance matching	Poor	Very good	Good
▪ Application	Voltage amplifiers	Power amplifiers	DC and low frequency amplifiers