The Transistor as an Amplifier

The process of linearly increasing the amplitude of an electrical signal is called as Amplification. The signal , aβcan be defined as anything which carries some relevant information. By using the gain transistor can act as an amplifier. Amplifier is any device which strengthens the amplitude of a signal. The important applications of amplifier are in loud speakers, Bio medical applications etc. When atransistor gets biased in the active (linear) region, the Base-Emitter (BE) junction has a small (Low) resistance due to the forward biasing condition and due to reverse biasing condition; the Base-Collector (BC) junction has a high (Large) resistance.

The Speculations used for the design of transistor as an amplifier are:

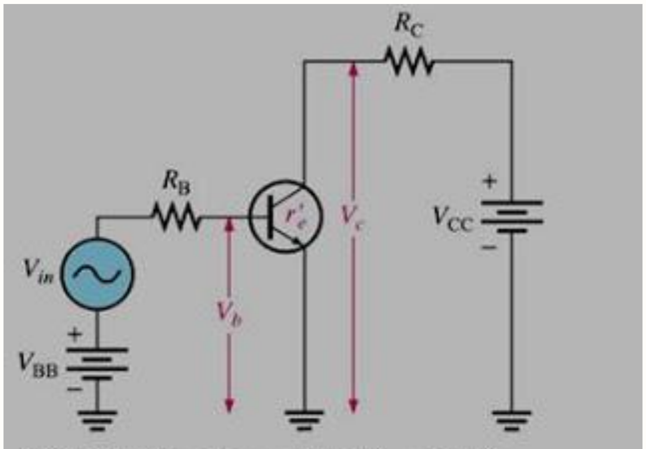
i) Consider the DC and AC quantities:

1. Both ac and dc quantities are used in amplifier circuits.
2. For both ac and dc currents capital letters are used.
3. For dc quantities subscript will be capital letter (Uppercase).
4. For ac quantities Subscript will be lowercase (Small letters) .

ii) Transistor Amplification :

, atransistor)β– Since the collector current is equal to the base current multiplied by the current gain (can amplify the current.
The Base current (IB) is very small (comparatively very low) compared to IC and IE.
– So it is clear that, IC is almost equal to IE.

Now we can consider the following circuit for the transistor application



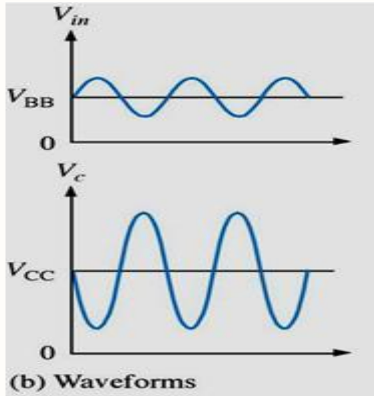
(a) Circuit with ac input voltage V_{in} and dc bias voltage superimposed

– From the circuit, it is clear that at the input side, an ac voltage Vin¬, is superimposed on the applied dc bias voltage VBB.

– Through the collector resistance, RC, the Dc bias voltage VCC is connected to the collector.

– The ac input voltage can produces an ac base current (at the Base), which will results in a much higher ac collector current than the base current.

– The ac collector current yields to an ac voltage across RC (The collector resistance), will produces an amplified, inverted, reproduction of the ac input voltage in the active region of the transistor.



(b) Waveforms

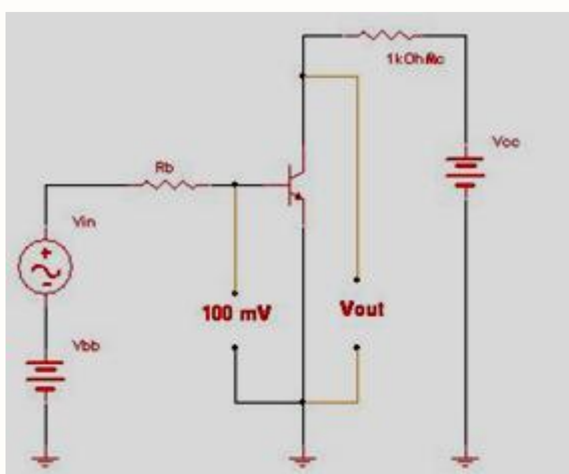
To the ac wave, the forward biased base-emitter junction present at low resistance.
This internal ac emitter resistance can be denoted (represented) by r'e.
Ie (or) Ic = Vb/ r'e
Vc = Ic*RC , which is the ac collector voltage,
Since Ie ? Ic, the ac collector voltage can be Vc ? IeRC.
Vb = Vin – IbRB, where Vb can be considered as the ac input voltage of the transistor
The transistor ac output voltage can be considered as Vc

– The ratio of Vc to V¬b (Vc /V¬b) can be defined as the ac voltage gain Av, of the above transistor circuit.
ie, Av = Vc/Vb (1)
Now we can Substitute IeRC for Vc and Ie r'e for Vb which will make (1) as
Av = Vc/Vb ? (IeRC)/(Ie r'e) = RC/ r'e (2)

– Thus from (2) it is clear that the amplification depends on the ratio of RC and r'e.

– RC will be always much larger in value than r'e, In other words, the output voltage is larger than the input voltage.

Now we can consider one example for the transistor circuit:
Determine the voltage gain and the ac output voltage .Ωfor the following circuit if r'e = 120



Solution:
We know that the voltage gain is

= 8.333Ω /120 Ω Av ? RC/r'e = 1 k
Hence the output voltage is
Vout = AvVb = (8.333)*(100 mV) = 0.8333 Vrms

Source:

http://www.electronicsandcommunications.com/2013/04/the-transistor-as-amplifier.html